The Evolution of Jah Hut Agricultural Practices in Peninsular Malaysia: History, Sustainability, and Livelihoods

Vishalini Arumugam

School of Environment and Geographical Sciences
Faculty of Science and Engineering
University of Nottingham Malaysia

Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

15 March 2025

Abstract

This thesis examines the historical evolution, sustainability, and socio-economic significance of Jah Hut Indigenous agriculture, with a focus on shifting cultivation and its transformations in response to modernization, land tenure policies, and environmental changes. The study addresses the limited documentation of Orang Asli agricultural practices, particularly how traditional land-use systems have adapted or been displaced over time. By integrating historical, ecological, and socio-economic analyses, this research provides a comprehensive understanding of the resilience and challenges facing Jah Hut farmers today.

A mixed-methods approach was used, incorporating archival research, ethnographic fieldwork, household surveys, participatory discussions, and sustainability assessments. Rooted in decolonizing methodologies and Critical Indigenous Theory, this study prioritizes Jah Hut epistemologies, ensuring ethical engagement through Free, Prior, and Informed Consent (FPIC). A research protocol was developed in collaboration with the Jah Hut community, reinforcing knowledge reciprocity and trust-building in data collection and analysis.

Findings reveal that Jah Hut shifting cultivation remains ecologically viable, promoting biodiversity conservation, soil fertility, and climate resilience. The agricultural system embodies a hybrid model, integrating elements of traditional shifting cultivation and Indigenous agroforestry. Intercropping and rotational cropping strategies sustain soil health, but land tenure insecurity, restrictive conservation policies, and market pressures have significantly disrupted traditional practices. The transition toward cash crop cultivation - particularly oil palm and rubber - has reshaped land-use patterns, altered food security dynamics, and contributed to a decline in intergenerational knowledge transmission. Additionally, gendered divisions of labor remain crucial, with women playing a central role in seed preservation, weeding, and post-harvest processing.

The research applies the modified IDEA (*Indicateurs de Durabilité des Exploitations Agricoles*) framework to assess Jah Hut agricultural sustainability. The assessment underscores that Jah Hut agricultural systems demonstrate agroecological resilience but face structural barriers that hinder long-term viability. Economic constraints, limited market access, and state-led agricultural interventions often fail to align with Indigenous governance structures, leading to a gradual erosion of self-sufficiency.

To provide an accurate representation of Jah Hut livelihoods, this study employs an adapted Sustainable Livelihoods Framework (SLF) that expands beyond conventional economic assessments. By incorporating Indigenous governance structures, non-monetary economic exchanges, and ecological stewardship, the modified SLF framework offers a holistic understanding of how Jah Hut households navigate subsistence farming, wage labor, and external development pressures. The findings challenge mainstream livelihood models that overlook Indigenous agency and highlight the need for policies that prioritize land tenure security, cultural sustainability, and food sovereignty.

This research contributes to ongoing policy discussions on Indigenous land rights, sustainable agriculture, and cultural preservation. It advocates for participatory governance models, tenure security, and agroecological approaches that support Indigenous autonomy. Recognizing shifting cultivation as a dynamic and knowledge-intensive agricultural system rather than an obstacle to development is essential for ensuring the long-term resilience of Jah Hut agriculture in Peninsular Malaysia.

Acknowledgements

This journey would not have been possible without the guidance, support, and kindness of many individuals and communities, to whom I am deeply grateful.

First and foremost, I dedicate this work to my beloved late mother, Mdm. Vijaila Thiagarajah, whose deepest wish was for me to pursue a PhD. Her love, sacrifices, and unwavering belief in me continue to be my guiding light. This achievement is for her.

I extend my heartfelt gratitude to my PhD supervisor, Prof. Tapan Kumar Nath for his steadfast support, insightful guidance, patience, and constructive feedback throughout this journey. I also acknowledge my co-supervisor, Dr. Wong Ee Phin, for her input during this process.

I am deeply indebted to Prof. Kirk Endicott for his invaluable comments on Chapters 4 and 5. My sincere appreciation also goes to Dr. Izawati Wook and Dr. Yogeswaran Subramaniam for their expertise on Orang Asli land rights; and to Prof. Shanthi Thambiah and Dr. Kamal Solhaimi Fadzil for their mentorship in researching with the Orang Asli. A special thanks to Dr. Alberto Gomes, Dr. Zanisah Man, and Dr. Suria Selasih Angit Asra Ramlan for their invaluable feedback on my questionnaire, helping refine my research design. To the many others whose insights were indispensable – you have my deepest gratitude.

I am profoundly grateful to the communities of Berdut, Sungai Mai, and Pasu for welcoming me, sharing their knowledge, and supporting this research in countless ways. To the Jah Hut elders who generously shared their wisdom - Chan Tok (Moyang), Yusof Awing (Josh), Mohammad Abu, Akau Mintos, Gemok Namak, Yusri Ahon, Yangman, Mazuin Akoi, Batin Rahman Chang, Rizal Latif, and Dei Wok - I am honored to have learned from you. Special thanks to Jef Yangman and Yusof Awing for their guidance and connections that made this work possible. To Issabila Rahman (Pasu), Yuni and Anis (Sg Mai), thank you for being my tireless guides and interpreters. My deepest gratitude and respect to the ancestors of these villages, whose spiritual presence guided and permitted my fieldwork and whose wisdom continues to resonate in this research.

To my husband, Alextair Mascarenhas, words cannot fully express my gratitude for your unwavering support, patience, and belief in me. Your love and encouragement sustained me through this journey, and your help with data analysis was invaluable. I could not have done this without you - thank you for standing by me and bearing with me every step of the way.

To my sister, Janarthani Arumugam, who first planted the seed of this research in my heart, I am eternally grateful. Your guidance, inspiration, and enduring support have been my anchor, and I continue to lean on you for strength and wisdom.

To my daughter, Jhamuna S Kumaresan, you are my greatest joy. This work is, in part, for you - to honor our shared connection to the land, to knowledge, and to the stories of those who came before us.

I extend my gratitude to JPA for granting me the study leave and scholarship to pursue this PhD. I also acknowledge JAKOA and PERHILITAN for their approval of research permits and data for this study.

To the faculty and staff of EGS, FOSE and PGR Operations UNM, thank you for your invaluable insight, support, and encouragement throughout this journey. Your contributions - whether through feedback, logistical assistance, or mentorship - have been instrumental in shaping my academic experience.

Above all, I give my deepest thanks to the Universe for Its guidance, wisdom, and synchronicities that made this journey possible. For the unseen forces that paved my way, for the strength to persevere, and for the moments of clarity that illuminated my path - I am forever grateful.

Table of Contents

List of Figures

List of Tables

Appendices

Declaration/Statement of Originality

I, Vishalini Arumugam, hereby declare that this thesis, titled **“The Evolution of Jah Hut Agricultural Practices in Peninsular Malaysia: History, Sustainability and Livelihoods”**, is the result of my own independent research and has not been submitted previously, in whole or in part, for the award of any degree or qualification at any other university or institution.

I affirm that all sources of information, literature, and data used in this research have been duly acknowledged and cited. Any assistance, contributions, or collaborative work that has informed this study has been appropriately credited in the text.

Furthermore, I confirm that this thesis complies with the ethical guidelines and research integrity standards set by the University of Nottingham Malaysia. Any work involving human participants, especially engagement with the Jah Hut community, has been conducted in accordance with approved research protocols, ensuring informed consent, cultural sensitivity, and ethical research practices.

Signed,

(Vishalini Arumugam)
Student ID: 20288232
University of Nottingham Malaysia
15 March 2025

Presentations, Publications, and Conference Proceedings Related to the Thesis

1. **Living and Working with the Jah Hut of Peninsular Malaysia: Experiences and Lessons in Decolonizing Fieldwork**
   Presented at the Research Methodology Conference 2023: Decolonising Research Methodologies and Method, 16 June 2023, London, United Kingdom. Organised by The London Institute of Social Studies, UK.

2. **Assessing the Sustainability of Indigenous Food Production Systems and Its Impact on Indigenous Food Sovereignty and Food Security: Insights from a Study involving the Orang Asli Jah Hut in the Krau Forest and Wildlife Reserve**
   Presented at the Sustainable Agroecology: Governance, Practices, Potentials, and Tensions in a Comparative Perspective Workshop, 17 and 18 July 2023, University of Kassel, Witzenhausen, Germany.

Chapter 1 : Introduction

1.1. Context of the Study

Present-day food production consists of two major systems: (1) traditional (Indigenous[1] and rural/peasant[2]); and (2) modern agriculture[3] (Gliessman, 2015). Modern (or agro-industrial) agriculture as it is practiced today has its roots in the Green Revolution[4] of the mid-twentieth century (Patel, 2013). While significantly increasing farm productivity and profitability and reducing labor requirements (Pinstrup-Andersen & Hazell, 1985), modern agriculture has been linked to a multitude of damaging outcomes. These include environmental degradation, resource depletion, risks to food safety and human health, loss of biological and genetic diversity, regional disparities, and long-term unsustainability (Boafo & Lyons, 2022 and Zhang et al., 2017). Despite such evidence, several global policy frameworks continue to promote modern agriculture as a 'win-win' solution for productivity, development, and sustainability (OECD, 2021; FAO, 2011; World Bank, 2008). This thesis challenges those assumptions and offers a critical lens on these narratives, further expanded in Chapter 2. For the rural/peasant and Indigenous communities, the impact of modern agriculture has been especially severe, with multifaceted, negative socioeconomic and ecological implications (Eliazer Nelson et al., 2019 and Shiva, 1991).

Unlike modern agriculture, traditional agriculture, largely practiced by Indigenous communities around the world, is a repository of wealth that may be utilized by modern agricultural systems to increase resiliency to climactic extremes (Altieri et al., 2015). Importantly, Indigenous agriculture (IA) embodies sustainable and secure food production strategies that enable food sovereignty[5] for millions of Indigenous and rural communities

[1] Indigenous agriculture refers to the farming practices and systems that have been developed and sustained by Indigenous communities over generations, and deeply rooted in local/Indigenous knowledge, cultural values, and a holistic understanding of the relationship between humans, land, and nature (Sharma et al., 2020).
[2] Rural/peasant agriculture refers to farming in traditional rural communities by people who depend on agriculture for their livelihood and subsistence (Seligmann, 2008).
[3] Modern agriculture (including the more intensified and technologically advanced industrial agriculture) refers to mainstream agricultural practices relying on the use of modern technologies such as genetically modified crops, synthetic inputs (chemical fertilizers and pesticides) and mechanized farming methods that prioritize high yields and efficiency (Sangha, 2014).
[4] The Green Revolution refers to the significant increase in agricultural productivity through the adoption of modern technology and practices, aimed at increasing agricultural production worldwide to address food shortages, particularly in developing countries. It is characterized by the intensive use of high-yield crop varieties and chemical fertilizers, as well as the expansion of irrigation infrastructures (Ameen & Raza, 2017).
[5] Indigenous food sovereignty is the right of Indigenous Peoples to control their own food systems in a manner that is culturally appropriate and sustainable (M. A. Huambachano, 2019).

around the world while conserving important ecosystems[6] (Altieri, 2004a). Indigenous natural resource management systems are sophisticated and complex and are based on several generations of careful observations of the natural and physical environment (Whyte, 2019). A few common farming practices include the cultivation of home gardens (Conversa et al., 2020; Thorn et al., 2020; Williams & Kramer, 2019), Indigenous agroforestry (Abbas et al., 2017) as well as shifting cultivation (Cramb et al., 2009).

There is a growing recognition of IA as a viable alternative for sustainable food production and environmental safety against anthropogenic threats, chiefly climate change and an expanding human population (Watson, 2019). However, IA systems are constantly under threat of extinction due to socio-environmental and political dynamics, thus endangering Indigenous food security, livelihoods, and associated biodiversity (Abas et al., 2022). Currently, there is an increasing awareness of not just the need to protect and preserve but also to recognize and integrate IA into mainstream/modern agricultural research for the development of sustainable agriculture (Makondo & Thomas, 2018). In this regard, research on contemporary Indigenous agriculture is also gaining momentum worldwide (Arcand et al., 2020).

Malaysia has a global standing as one of the 12 mega-biodiverse countries in the world, with its unique tropical rainforests constituting the core of its biodiversity (UN Environment Program). Malaysia has a significant cultural diversity of Indigenous people who live in these biodiversity hotspots, both in East and West Malaysia (Kardooni et al., 2014). Of particular interest to this study are the Orang Asli (or Original People) of Peninsular Malaysia, who live close to, or within forested areas. These communities and the forest ecosystem have successfully co-evolved over thousands of years (Rambo, 1984), and their traditional ecological knowledge[7] (TEK) and conceptions are deeply embedded in their traditional religious systems (Kamal & Lim, 2019). Historically, although the Orang Asli were mostly hunter-gatherers (Dentan et al., 1997), there is evidence that the Orang Asli have a long history of utilizing IA to ensure food security. Subsistence farming such as home gardens (Milow et al., 2010), shifting cultivation/swiddening (Dressler et al., 2017; Gomes, 2012 and Harper, 1997), and various forms of agroforestry (Keat et al., 2018) are still in practice.

[6] Indigenous people occupy and are custodians of approximately 22% of the world's land surface, and contain 80% of the world's biodiversity (Domínguez & Luoma, 2020) .
[7] Traditional ecological knowledge is a reservoir of Indigenous ways of knowing that encompasses cosmology, beliefs, traditions, practices and institutions accumulated and passed on through generations (Gómez-Baggethun et al., 2013)

The Orang Asli are a socioeconomically and culturally marginalized, impoverished minority group (Ismail et al., 2019). These communities are engaged in an ongoing struggle to maintain their identity and control over their lands and resources amidst growing encroachment on their territories (Azima et al., 2015; Nah, 2008). Dispossession and displacement from their native lands, and the degradation of their traditional environments have severely impacted their livelihoods, food security, and sovereignty (Kari et al., 2016; Perrey, 2017). Their traditional knowledge and Indigenous management systems are also under serious threat (Sayok & Teucher, 2018), with communities increasingly focused on cash crop cultivation (Nicholas, 2000).

Contemporary research involving the Orang Asli is largely centered around documenting their TEK of medicinal botany (Kodoh & Mojiol, 2017; Fui et al., 2015; Alias, 2014; Ong et al., 2012). Published literature regarding the historical and contemporary IA practices of the Orang Asli is vastly limited. Likewise, the link between Orang Asli IA and their livelihoods remains under-investigated. This study is an attempt to systematically examine the IA of the Orang Asli Jah Hut living within and around the Krau Wildlife Reserve (now renamed Tengku Hassanal Wildlife Reserve) in the state of Pahang, Peninsular Malaysia, who have been identified as maintaining the age-old traditional practice of shifting hill rice cultivation (or swiddening). The study also investigates the sustainability of these practices, and the contribution of IA towards their livelihoods and food sovereignty. This study is critical in uncovering valuable insights into Jah Hut IA practices and their contribution to the communities' socioecology and livelihood.

1.2. Research Problem

There is a significant lack of published information regarding Orang Asli sub-groups that have continued practicing Indigenous agriculture (IA) from the pre-1950s period to the present. While it is well documented that many Orang Asli communities have transitioned to cash crop cultivation, there remains limited understanding of how this shift has affected their socio-economic status. As of 2015, 50.92% of Orang Asli households were below the poverty line, with 34.34% categorized as hard-core poor (Saifullah et al., 2021). This indicates a downward transition from self-sufficiency to economic dependence on external markets. However, the specific ways in which this economic shift has impacted traditional livelihoods, agricultural knowledge, and long-term sustainability remain understudied.

For the Jah Hut specifically, there has been no in-depth examination of their perspectives, cosmology, and cultural relationship with traditional agriculture. The extent to which their Indigenous knowledge systems are being preserved or are at risk of disappearing remains unclear. Understanding how Jah Hut agricultural traditions continue to evolve, and whether they are actively maintained, modified, or abandoned, is critical in assessing the resilience of their food systems and cultural identity.

Additionally, there is limited clarity on the interactions between social, economic, ecological, and institutional factors that shape the sustainability of Jah Hut traditional agricultural practices systems. The impact of modernization on Jah Hut Indigenous agriculture is another critical gap, particularly as land-use policies, economic shifts, and external interventions continue to redefine how they engage with agriculture. A particularly pressing issue is the preservation of Indigenous crop varieties, which face increasing threats from modern agricultural practices, globalization, and climate change. Given the Jah Hut's long history of agricultural adaptation, their strategies for climate-resilient farming warrant further investigation, as they offer potential insights for sustainable land management.

A universal challenge for Indigenous agricultural communities worldwide - one that is equally pressing for the Jah Hut - is land tenure security and its impact on agricultural sustainability. Given the historical marginalization of Indigenous land rights, the Jah Hut's experience provides an important case study for understanding how land policies influence the long-term viability of Jah Hut agricultural practices. Similarly, Indigenous food security is a key concern, particularly in relation to how traditional Jah Hut farming contributes to local food systems and the challenges they face in ensuring a stable food supply.

By addressing these gaps, this study aims to provide a localized understanding of the socio-economic, ecological, and governance dimensions shaping Jah Hut agriculture today.

1.3. Research Questions

This study is guided by three key research questions, each addressing a crucial aspect of Jah Hut agriculture, its historical transformations, sustainability, and socio-economic significance.

First, this study asks: How has agriculture evolved in Southeast Asia and among the Orang Asli in Peninsular Malaysia, and what are the historical trajectories of Jah Hut traditional agriculture, particularly shifting cultivation? This question investigates the broader agricultural transformations in Southeast Asia and how these trends have shaped Orang Asli farming practices over time (Chapter 4). It further explores the historical continuity and adaptations of Jah Hut shifting cultivation, analyzing external influences such as land tenure policies, modernization, and socio-economic changes that have impacted their traditional agricultural systems (Chapter 5).

Second, the study examines: How sustainable are current Jah Hut agricultural practices in relation to ecological, social, and economic dimensions? This question assesses the viability of contemporary Jah Hut farming methods, including shifting cultivation, by considering land-use patterns, agroecological practices, and environmental resilience (Chapter 5). It also investigates the adaptive strategies used by Jah Hut farmers to sustain agricultural productivity while navigating land tenure uncertainties, conservation policies, and climate-related challenges (Chapter 6).

Finally, this research questions: How do Jah Hut agricultural practices contribute to livelihoods and food security, and what challenges do they face in sustaining these roles? This question examines the role of Jah Hut agricultural systems (traditional and modern) in supporting food security, household economies, and cultural identity, assessing the ways in which Jah Hut agricultural practices ensure dietary diversity and local food resilience (Chapter 7). It also considers the pressures introduced by modernization and market integration, evaluating how external economic forces have influenced agricultural livelihoods of the community.

By addressing these research questions, this study will provide a comprehensive understanding of the historical, ecological, and socio-economic dynamics of Jah Hut agriculture, offering valuable insights into both its resilience and vulnerabilities in the face of ongoing transformations.

1.4. Research Objectives

The Jah Hut are one of the 18 recognized Orang Asli sub-groups in Peninsular Malaysia, belonging to the Senoi[8] group. Their livelihood strategies combine subsistence agriculture, hunting, gathering, and forest-related activities. In addition to cultivating food crops for household consumption, they engage in the collection and trade of forest products and cultivate cash crops such as oil palm and rubber. Despite these economic adaptations, their traditional agricultural practices traditional remain central to their cultural identity and local food security.

As with many other Orang Asli communities, the Jah Hut face mounting pressures from modernization, land tenure insecurity, and integration into Malaysia's dominant socio-economic framework. While maintaining distinct cultural traditions, they also navigate external constraints that affect their agricultural choices. The study of Jah Hut agriculture provides important insights into land-use sustainability, knowledge transmission, and resilience in Indigenous farming systems, offering a localized perspective on broader discussions of Indigenous land rights, agricultural transitions, and environmental governance.

Taking these considerations into account, this study is structured around the following objectives:

i. To determine the historical evolution of traditional agricultural practices of the Orang Asli Jah Hut in Peninsular Malaysia, particularly in periods where formal records have been limited;
ii. To assess the sustainability of current Jah Hut agricultural practices, considering ecological, social, and economic dimensions; and
iii. To assess the impact of Jah Hut agriculture on livelihoods and food security.

This research contributes to a deeper understanding of Jah Hut agricultural resilience, examining how their traditional knowledge and farming systems interact with contemporary socio-economic and environmental challenges. The findings will provide a foundation for policy discussions on Indigenous land rights, agricultural sustainability, livelihoods and cultural preservation.

[8] The Senoi have a strong tradition as swidden horticulturists, distinguishing them from other Orang Asli groups in Malaysia (Endicott, 2016).

1.5. The Orang Asli of Peninsular Malaysia

The Orang Asli (a Malay term for 'original people') are a group of heterogeneous Indigenous minorities of Peninsular Malaysia[9] constituting various sub-ethnic groups with distinct languages, customs, and lifestyles (Dentan et al., 1997). The Orang Asli were among the first people living in the Malay Peninsular, predating the arrival of other ethnic groups. They are the descendants of the Hoabinhians (stone tools using hunter-gatherers), the earliest human inhabitants of the Malay Peninsular from 11,000 B.C. (Bellwood, 2007). The Orang Asli's ancestry is deeply rooted in the ancient landscapes of the region, where they have developed unique social structures and traditional knowledge systems over generations (Bulbeck, 1998). The Orang Asli's oral traditions and folklore are important reservoirs of valuable information about their past (Zuhairi et al., 2021; Bidin et al., 2013). These narratives often contain myths, legends, and stories passed down through the generations, shedding light on their beliefs, cosmologies, and relationship with the natural environment.

A majority of Orang Asli groups speak languages in the Mon-Khmer sub-group of the Austroasiatic language family (also known as 'Aslian'), although in recent decades, Aslian speakers also use colloquial or standard Malay (Dunn et al., 2013). The Department of Orang Asli Development (JAKOA), Ministry of Rural Development Malaysia - for ease of official administration - has classified the Orang Asli into three main groups: Semang (Negrito), Senoi, and Proto Malay (Aboriginal Malay). This broad classification was devised based on genetically distinct ancestry (Fix, 2008), along with differences in morphology, culture, language, and geographical locations. The three major groups are further divided into 18 sub-ethnic groups[10], with two distinct linguistic categories, as shown in Table 1.1.

[9] The Indigenous people of East Malaysia (Sabah & Sarawak) are known as Orang Asal, with at least 95 distinct sub-groups, distinguishable by their own language and culture (Source: Sabah & Sarawak Government data).
[10] Until 2018, the Temoq sub-group (originally classified under the Proto-Malay group) existed separately. However, they are now regarded as part of the Semelai by JAKOA (K. M. Endicott, 2016)

Major Group[a]	Sub-group[a]	Traditional Distribution[a]	Language Group[b]
Semang (Negrito)	Batek	Kelantan & Pahang	Austro-Asiatic
	Jahai	Perak & Kelantan	Austro-Asiatic
	Kensiu	Kedah	Austro-Asiatic
	Kintak	Kedah	Austro-Asiatic
	Lanoh	Perak & Kelantan	Austro-Asiatic
	Mendriq	Perak, Kelantan & Pahang	Austro-Asiatic
Senoi	Che Wong	Pahang	Austro-Asiatic
	Jah Hut	Pahang	Austro-Asiatic
	Mah Meri	Selangor	Austro-Asiatic
	Semai	Perak, Pahang & Selangor	Austro-Asiatic
	Semaq Beri	Pahang & Terengganu	Austro-Asiatic
	Temiar	Perak & Kelantan	Austro-Asiatic
Proto-Malay (Aboriginal Malay or 'Melayu Asli')	Jakun	Pahang & Johor	Austronesia
	Orang Kanak	Johor	Austronesia
	Orang Kuala	Johor	Austronesia
	Orang Seletar	Johor	Austronesia
	Semelai	Pahang, Negeri Sembilan	Austro-Asiatic
	Temuan	Selangor, Negeri Sembilan, Melaka, Johor & Pahang	Austronesia

TABLE 1.1: DIVISION AND DISTRIBUTION OF ORANG ASLI COMMUNITIES IN PENINSULAR MALAYSIA

[a] *JAKOA (http://www.jakoa.gov.my, accessed 16 January 2024)*
[b] *Ethnologue languages of the World (http://ethnologue.com, accessed 16 January 2024)*

According to JAKOA's published data, the population size of Orang Asli was 209,575, in 2022, accounting for approximately 0.64% of Malaysia's total population of 32.7 million for the same period[11]. The Senoi are the largest in number (55.21%), followed by the Proto-Malay (41.77%) and Negrito (3.02%). Several studies have shown evidence that the phenotypically dark-skinned and curly-haired Semang were the first settlers of Peninsular Malaysia, having arrived between 74,000 to 40,000 years ago (Baer, 2014 and Bellwood, 2007). Meanwhile, the physically taller and lighter-skinned Senoi may have entered Peninsular Malaysia from the north (Southeast Asia mainland) between 4,000 to 10,000 years ago (Blust, 2013; Jinam et al., 2012). The Austronesian-speaking, light-skinned, and sea-faring Proto-Malays were the last to arrive in Peninsular Malaysia (in 2,000 B.C.) from middle Asia (Yunnan), and the current-

[11] Malays make up the majority of the Malaysian population at 51.3%, along with large minorities of Chinese (26.4%), other Bumiputera (native) (11.3%) and Indians (8.3%) (Department of Statistics Malaysia, https://www.dosm.gov.my, accessed 16 January 2024)

day Malay (also termed as Deutero-Malays) race is believed to have emerged from this group (Fix, 1995).

Orang Asli communities are located throughout Peninsular Malaysia, except Perlis and Penang states. The distribution of the 18 sub-groups is shown in Figure 1.1. The Semang group is generally found in the northern region of Peninsular Malaysia, while the Senois have traditionally inhabited the central Main Range (except the Mah Meri, who are located on the west coast in Selangor), followed by the Proto-Malays who are largely found in the southern region. Figure 1.2 illustrates the forest cover of Peninsular Malaysia in 2017, and when compared with the map of the Orang Asli distribution (Figure 1.1), it is evident that a significant proportion of the Orang Asli population lives close to, or within forested areas. While many Orang Asli communities have been forced to transition from their traditional hunter-gatherer lifestyles as a result of encroaching modernity, a few still reside in remote areas while others have been relocated to new resettlement/regroupment areas on the outskirts of existing rural villages or near townships (Abdullah, 2018; Aiken & Leigh, 2015; Karim & Hashim, 2012). The general locations of these groups, however, have remained fairly constant over the years.

FIGURE 1.1: DISTRIBUTION OF ORANG ASLI SUB-GROUPS IN PENINSULAR MALAYSIA (ENDICOTT, 2016)

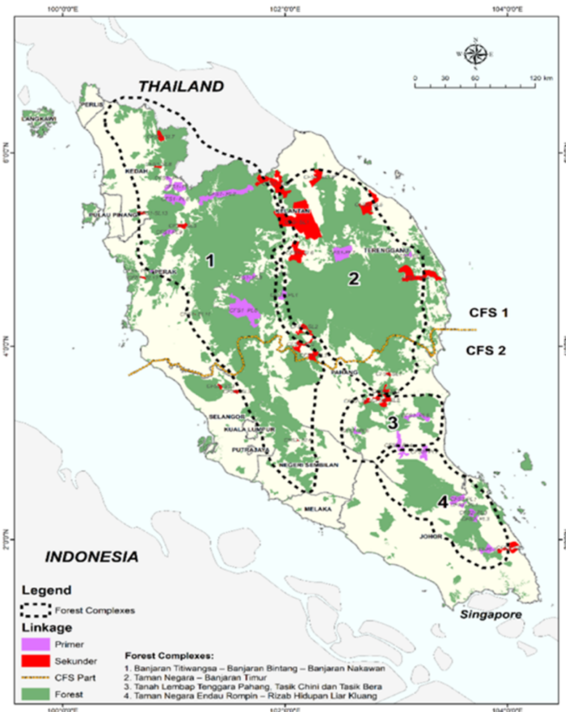

FIGURE 1.2: PENINSULA MALAYSIA FOREST COVER IN 2017 (YAYASAN HASANAH ISSUE BRIEF)

The pre-1950s economy of most Orang Asli groups was largely subsistence-based (hunting, fishing, wild food foraging, horticulture, and shifting cultivation/swiddening), along with trade or sale of forest products (Dentan et al., 1997). Among the 18 sub-groups, at least 13 were involved in traditional agriculture (such as swiddening and horticulture), as shown in Table 1.2.

Sub-Group[a]	Official Category/Group[a]	Pre-1950 economy[a]	Location[b]
Mendriq	Semang	Swiddening & foraging	Kelantan
Lanoh	Semang	Swiddening, foraging & trading	Perak
Chewong	Senoi	Swiddening & foraging	Pahang
Temiar	Senoi	Swiddening & trading	Kelantan Perak
Semai	Senoi	Swiddening & trading	Pahang Perak Selangor
Jah Hut	Senoi	Swiddening & trading	Pahang
Semaq Beri	Senoi	Swiddening & foraging	Pahang Terengganu
Mah Meri	Senoi	Swiddening, fishing & foraging	Selangor
Temoq	Proto-Malay	Swiddening, foraging & trading	Pahang
Semelai	Proto-Malay	Swiddening & trading	Pahang Negeri Sembilan
Jakun	Proto-Malay	Horticulture & trading	Pahang Johor
Temuan	Proto-Malay	Horticulture & trading	Selangor Negeri Sembilan Pahang Melaka
Orang Kanak	Proto-Malay	Horticulture & trading	Johor

TABLE 1.2: ORANG ASLI GROUPS INVOLVED IN AGRICULTURE IN THE PRE-1950S

[a] *Endicott, 2016*
[b] *JAKOA (http://www.jakoa.gov.my, accessed 17 January 2024)*

Swiddening[12] was practiced by at least 60% of the Orang Asli (mainly Senoi) population in the pre-1950s for subsistence and accounted for the "bulk of their caloric intake"(UNESCO, 1983). Despite earlier criticism, multiple studies have demonstrated that traditional shifting cultivation practices are environmentally sustainable (Bruun et al., 2018; van Vliet et al., 2012; Rerkasem et al., 2009). In the case of Peninsular Malaysia, several studies have elucidated swidden hill rice cultivation among the Temiar, Semelai, and Semai groups (Benjamin, 2012; Gomes, 2012; Gianno & Bayr, 2009). These studies have shown that traditional swiddening practiced by the said groups has metaphysical dimensions that are linked to ecological conservancy. This concept is a stark difference from the approaches of modern agriculture which is profit and output based. Currently, there appears to be a scarcity of sufficiently insightful information regarding the Orang Asli communities that are actively involved in swidden farming, particularly hill paddy cultivation, which is an important economic and dietary resource for the Orang Asli. The major economic activities of the Orang Asli involve small-scale cash crop cultivation (such as oil palm and rubber) and engagement in the wage labor market. Despite this transition, the Orang Asli to this day, are reliant on the forest for sustenance and their livelihoods (Mat et al., 2022).

In terms of the socio-political scenario before the 1950s period, the Orangs Asli oversaw their interactions with the outside world, were politically independent, and could fully support themselves economically. However, their marginalization emerged through a combination of colonial and post-independence land policies that failed to recognize customary land tenure systems, treating Orang Asli territories as state land (Endicott, 2016; Nicholas, 2000). These legal frameworks, including the 1954 Aboriginal People's Act, placed Indigenous land and mobility under state control, establishing legal and structural exclusion (Subramaniam, 2013; Nicholas, 2005).

Subsequent modernization agendas, government regroupment schemes, and state-led development projects led to the degradation of traditional environments, disrupting long-standing livelihood systems and spiritual relationships to land (Nicholas, 2010 & 2004). Land rights challenges, inherited from colonial policy legacies, continue to negatively impact the economic activities and livelihood strategies of the Orang Asli (Endicott, 2016). In addition,

[12] Swiddening is a traditional agricultural practice that refers to the intermittent clearing and burning of a small patch of forest to grow food crops. The land is left to fallow upon harvest, thereby allowing the restoration of nutrients and plant diversity in the plot (Cramb et al., 2009)

current policies on modern resource management have largely failed, due to the exclusion of Indigenous and local communities from decision-making processes (Nicholas, 2003). Protected areas have been imposed without pre-engagement, consultation, or consent, leading to conflict, social disadvantage, displacement, and the loss of traditional knowledge and resource management systems (Kamal & Lim, 2019). For instance, the Jakun Orang Asli in the South-East Pahang Peat Swamp Forest (SEPPSF), which includes the Pekan, Nenasi, Kedondong, and Resak Forest Reserves, have been excluded from conservation decisions despite their reliance on the forest for livelihood, and has contributed to logging, land conversion, and water pollution to the detriment of the community (Kamal & Lim, 2019).

1.6. The Jah Hut and Their Economy

The Jah Hut belong to the Senoi[13] group of Orang Asli, and speak the Jah Hut language, which is a central Aslian (Austroasiatic) language (Diffloth, 1976). They are distributed across 14 villages in central Pahang, Peninsular Malaysia, approximately 180 kilometers northeast of Kuala Lumpur. The villages are located in a hill tract area about 15 to 30 kilometers deep along the right bank of the Pahang River between Jerantut and Temerloh. The district of Temerloh is also home to Temuan, Semelai, Semaq Beri, and Che Wong settlements. The Jah Hut are unique in that their settlements are found exclusively in Pahang, in Aboriginal Areas or Aboriginal Reserves either within or on the fringes of the Krau Wildlife Reserve (renamed Tengku Hassanal Wildlife Reserve in 2023) and within the Krau River basin. As of 2022, the total population of the Jah Hut was about 7,477 (JAKOA officer, personal communication, 2/9/2022). The demography of the Jah Hut is shown in Table 1.3, while Figure 1.3 illustrates the location of all 14 Jah Hut villages. The three villages (Sg Mai, Pasu, and Berdut) involved in this study are highlighted in yellow.

[13] The Senois (particularly Semai and Temiar) are well-known swidden agriculturists, distinguished from other Orang Asli groups

No.	Name of Village	District	Sub-district (Mukim)	Total inhabitants
1	Kampung Seboi	Temerloh	Jenderak	323
2	Kampung Paya Mendoi	Temerloh	Jenderak	446
3	Kampung Penderas	Temerloh	Jenderak	1,062
4	Kampung Paya Pelong	Temerloh	Jenderak	704
5	Kampung Paya Mengkuang	Temerloh	Songsang	714
6	Kampung Lubok Wong	Temerloh	Jenderak	338
7	Kampung Pasu	Temerloh	Jenderak	808
8	Kampung Kuala Terbol	Temerloh	Jenderak	296
9	Kampung Pian	Temerloh	Jenderak	730
10	Kampung Paya Rekoh	Temerloh	Jenderak	327
11	Kampung Berdut	Temerloh	Jenderak	331
12	Kampung Sungai Mai	Jerantut	Burau	447
13	Kampung Sungai Kiol	Jerantut	Tebing Tinggi	778
14	Kampung Sungai Kol	Jerantut	Hulu Cheka	173
			Total	7,477

TABLE 1.3: JAH HUT DEMOGRAPHY IN CENTRAL PAHANG

(Source: JAKOA officer, personal communication, 2/9/2022*)*

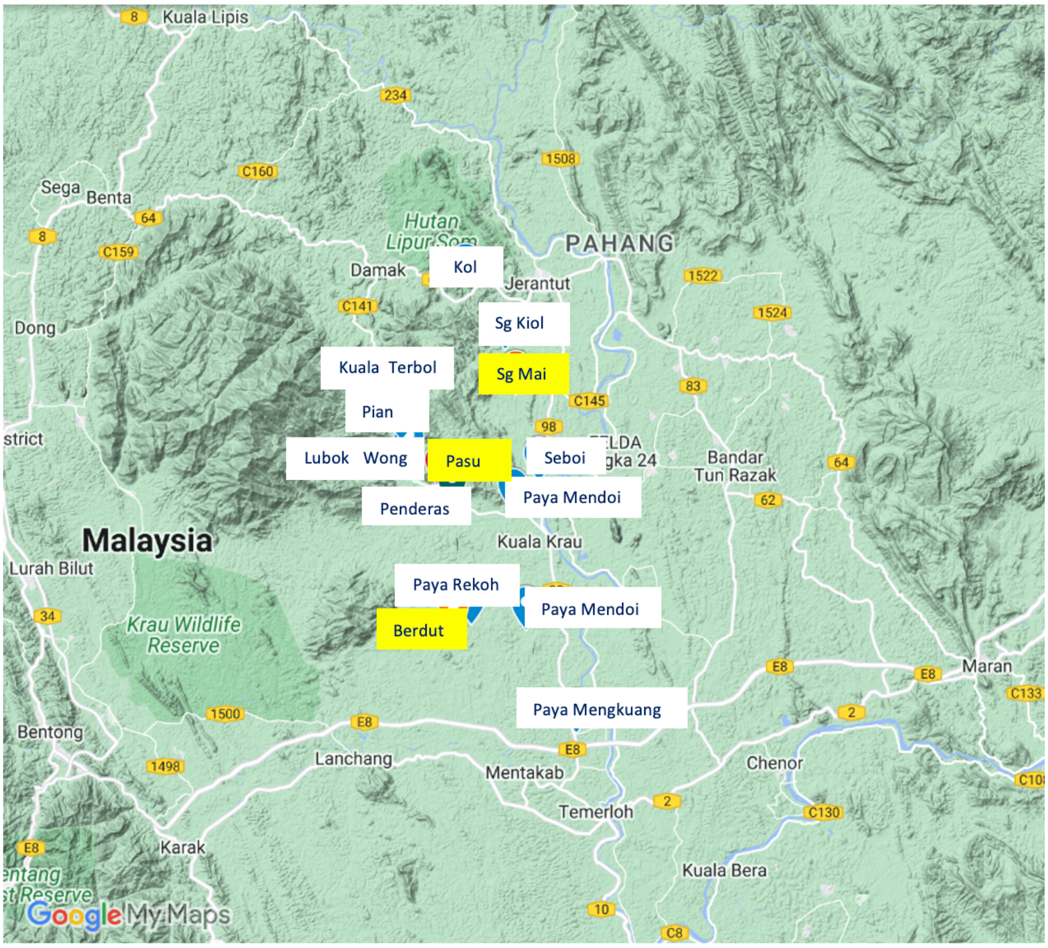

FIGURE 1.3: LOCATION OF JAH HUT VILLAGES IN PAHANG

(*Source: Map data © 2023 Google*)

Historically, the Jah Hut were swidden agriculturists and engaged in the trade of forest products (Balee, 2012; Couillard, 1979). Nowadays, a majority of the population has settled into sedentary farming (rice, maize, and cassava, among others), while cash crop cultivation (rubber and oil palm) forms a major part of their economy (JAKOA, http://www.jakoa.gov.my, accessed 16 January 2024). The communities have also continued to engage in non-timber forest product collection for their livelihoods (Howell et al., 2010). While it is evident that members of this group are still practicing traditional agriculture, particularly hill rice cultivation, the details of these practices or the contribution towards their livelihoods are not known.

1.7. Krau Forest and Wildlife Reserve

The Krau Wildlife Reserve (originally named Krau Game Forest) and Krau Forest Reserve (KWFR) is a protected area (PA) established in 1923. It is the largest wildlife reserve in

Peninsular Malaysia, currently occupying 62,395 hectares, and located near Mt. Benom in Temerloh within the Krau, Lompat, and Teris River basins. The altitude of the reserve is between 43 meters at Kuala Lompat to 2,107 meters at the peak of Mt. Benom (Department of Wildlife and National Parks; http://wildlife.gov.my, accessed 18 January 2024). The reserve is made up of tropical rainforests with pronounced dry seasons, and abundant rainfall during rainy seasons. The average annual temperature is between 23 to 33 degrees Celsius. The surrounding land of KWFR was cleared to plant rubber, but it has since been replaced with oil palm.

The Jah Hut, along with the neighboring Che Wong sub-group have traditionally lived within and around the KWFR for many centuries, pre-dating the establishment of KWFR (Balee, 2012). Naturally, these communities have always had access to KWFR and its resources for their subsistence and livelihood activities. The areas inhabited by the Jah Hut consist of lowland dipterocarp forests (occurring below 300 meters) of the Krau River Basin, and a significant part of this tract has been commercially logged during the 1970s and 1980s. Following two degazettements in the 1960s, the Jah Hut settlements on the Sungai Krau were removed from the reserve, but the communities were never able to move to their intended reserve, instead, the area was logged (Yusof & Sorenson, 2000). Hence, the Jah Hut have not only been displaced from their traditional land but continue to face mounting encroachment in their current settlements over the last few decades.

1.8. Rationale for Selecting Research Sites

Multiple scoping visits were made to different sub-groups of Orang Asli (Jah Hut, Temuan, Semai, and Batek) in various locations in Peninsular Malaysia, including Perak, Selangor, Kuala Lumpur, and Pahang to ascertain the suitability of the communities in terms of meeting the research objectives, demography and geographical locations of the communities. However, not all met the full criteria for research feasibility. In some cases, community interest, timing, or access limitations prevented further engagement. Ethical research with Indigenous communities necessitates voluntary, trust-based collaboration, and the Jah Hut were the most aligned with the study's objectives, accessibility needs, and willingness to participate - as further detailed in Chapter 4.

The Jah Hut communities in the three villages (Berdut, Sungai Mai and Pasu) were found to be the most suitable for the study for the following reasons: (1) Relevance to the research objectives; (2) Access to the communities: Acceptance by the communities and willingness to engage with the research. This was made possible with the availability of key informants who facilitated the process. Engaging well with the community and gaining their trust is a crucial point for research involving the Orang Asli; (3) Physical accessibility and feasibility are practical aspects that require due consideration since logistical and practical challenges may negatively impact the study; (4) Choice of multiple sites enables comparative analysis, even though it involves the same sub-group. The local context and experiences of the communities differ with each location; (5) Contribution to knowledge: the Jah Hut are an under-researched sub-group in the area of traditional agriculture. This provides a unique perspective on transitions and the prevalence of a particular practice since the communities are involved in both traditional and cash crop cultivation; and (6) Sufficiency of resources in terms of available time and funding.

1.9. Significance of the Study

This study is significant as it documents Jah Hut Indigenous agricultural practices, highlighting their role in sustainable land use, biodiversity conservation, and food security. It examines how historical transitions, land tenure policies, and modernization pressures have shaped their farming systems, offering insights into the sustainability of Indigenous agriculture. By addressing policy implications related to land rights and agricultural resilience, this research contributes to discussions on culturally responsive sustainability frameworks. Ultimately, it supports efforts to recognize and protect Indigenous knowledge, ensuring that Jah Hut agricultural traditions remain valued in broader environmental and development policies.

1.10. Structure of the Thesis

Chapter 2: Literature Review

This chapter reviews the historical evolution of Indigenous agriculture and situates Jah Hut farming practices within broader agroecological and sustainability frameworks. It examines key concepts such as land tenure, shifting cultivation, food security, and environmental adaptation, drawing from regional and global Indigenous agricultural studies.

Chapter 3: Methodological Framework

This chapter outlines the theoretical and methodological framework employed in this study, integrating Decolonizing Methodologies and Critical Indigenous Theory. A mixed-methods approach was used, combining archival research, household surveys, key informant interviews, and sustainability assessments to analyze Jah Hut agricultural practices. Additionally, this chapter details the research protocol developed to work ethically and respectfully with the Jah Hut community.

Chapter 4: The Evolution of Agriculture in Southeast Asia and Orang Asli Agriculture in Peninsular Malaysia

This chapter explores the historical development of agriculture in Southeast Asia, particularly in the context of Orang Asli farming systems. It provides a foundational understanding of the long-standing adaptation strategies of Indigenous groups, including how land policies, economic changes, and modernization have influenced traditional agricultural practices.

Chapter 5: Jah Hut Traditional Agriculture

This chapter focuses on current Jah Hut agricultural practices, particularly shifting cultivation, agroforestry, and mixed cropping systems. It discusses the role of spiritual beliefs, rituals, and traditional ecological knowledge in guiding farming decisions while addressing the challenges of land tenure insecurity and policy constraints.

Chapter 6: The Sustainability of Jah Hut Agricultural Practices

This chapter evaluates the sustainability of Jah Hut agricultural practices using a modified IDEA sustainability framework. It examines ecological, economic, and social sustainability dimensions, highlighting how shifting cultivation continues to be a viable but increasingly constrained farming system due to external pressures.

Chapter 7: Assessing the Livelihoods of Jah Hut Communities

This chapter contextualizes Jah Hut agriculture within their broader livelihood strategies, integrating the Sustainable Livelihoods Framework (SLF). It assesses how shifting cultivation interacts with wage labor, government policies, and market access, highlighting both opportunities and constraints for economic resilience.

Chapter 8: Integrated Findings, General Discussion, and Policy Recommendations

The final chapter synthesizes key findings from the research, demonstrating how Jah Hut agriculture is both sustainable and under threat from external policies. It presents policy recommendations focused on land tenure security, participatory governance, and culturally appropriate agricultural support, ensuring that Jah Hut farming systems remain resilient and recognized.

References

Abas, A., Aziz, A., & Awang, A. (2022). A Systematic Review on the Local Wisdom of Indigenous People in Nature Conservation. *Sustainability (Switzerland)*, *14*(6). https://doi.org/10.3390/su14063415

Abbas, F., Hammad, H. M., Fahad, S., Cerdà, A., Rizwan, M., Farhad, W., Ehsan, S., & Bakhat, H. F. (2017). Agroforestry: a sustainable environmental practice for carbon sequestration under the climate change scenarios—a review. *Environmental Science and Pollution Research*, *24*(12), 11177–11191. https://doi.org/10.1007/s11356-017-8687-0

Abdullah, J. (2018). Resettlement of Orang Asli (Aborigines) in Malaysia—Marginalization or Demarginalization of an Ethnic Group. In *Perspectives on Geographical Marginality 3* (Springer, pp. 145–155). https://doi.org/10.1007/978-3-319-59002-8_10

Aiken, S. R., & Leigh, C. H. (2015). Dams and Indigenous Peoples in Malaysia: Development, displacement and resettlement. *Geografiska Annaler, Series B: Human Geography*, *97*(1), 69–93. https://doi.org/10.1111/geob.12066

Alias, A. (2014). The Challenges of Managing Traditional Knowledge Related to Medicinal Plants among the Batek Community in Kuala Koh, Gua Musang, Kelantan, Malaysia. *Journal of Social and Development Sciences*, *5*(4), 275–283. https://doi.org/10.22610/jsds.v5i4.827

Altieri, M. A. (2004). Linking ecologists and traditional farmers in the search for sustainable agriculture. *Frontiers in Ecology and the Environment*, *2*(1), 35–42. https://doi.org/10.1890/1540-9295(2004)002[0035:leatfi]2.0.co;2

Altieri, M. A., Nicholls, C. I., Henao, A., & Lana, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development*, *35*(3), 869–890. https://doi.org/10.1007/s13593-015-0285-2

Ameen, A., & Raza, S. (2017). Green Revolution: A Review. *International Journal of Advances in Scientific Research*, *3*(12), 129–137. https://doi.org/10.7439/ijasr

Arcand, M. M., Bradford, L., Worme, D. F., Strickert, G. E. H., Bear, K., Dreaver Johnston, A. B., Wuttunee, S. M., Gamble, A., & Shewfelt, D. (2020). Sowing a Way Towards Revitalizing Indigenous Agriculture: Creating Meaning from a Forum Discussion in Saskatchewan, Canada. *Facets*, *5*(1), 619–641. https://doi.org/10.1139/FACETS-2020-0004

Azima, A. M., Lyndon, N., Sharifah Mastura, S. A., Saad, S., & Awang, A. H. (2015). Orang asli semelai: Conflict of defending land ownership rights. *Mediterranean Journal of Social Sciences*, *6*(4S3), 63–69. https://doi.org/10.5901/mjss.2015.v6n4s3p63

Baer, A. S. (2014). Human History and the Orang Asli in Southeast Asia. *Faculty Research Publications (Integrative Biology)*. ir.library.oregonstate.edu

Balee, W. (2012). Indigenous Forests of Malaysia and Amazonia: Towards Comparison of Jah Het and Ka'apor Arboriculture. *Bangi Public Lectures*, 1–44.

Bellwood, P. (2007). *Prehistory of the Indo-Malaysian Archipelago* (3rd ed.). ANU E Press. https://library.oapen.org/bitstream/handle/20.500.12657/33649/1/459472.pdf

Benjamin, G. (2012). *Temiar Religion*. NUS Press SIngapore.

Bidin, S., Saad, S., Aziz, N. A., & Rahman, A. A. (2013). Oral Tradition as the Principal Mean for the Cross-generational Transferor of Knowledge to Illuminate Semai People's Beliefs. *Procedia - Social and Behavioral Sciences*, *90*, 730–736. https://doi.org/10.1016/j.sbspro.2013.07.146

Blust, R. (2013). Terror from the sky: Unconventional linguistic clues to the negrito past. *Human Biology*, *85*(1–3), 401–415. https://doi.org/10.3378/027.085.0319

Boafo, J., & Lyons, K. (2022). The Rhetoric and Farmers' Lived Realities of the Green Revolution in Africa: Case Study of the Brong Ahafo Region in Ghana. *Journal of Asian and African Studies*, *57*(3), 406–423. https://doi.org/10.1177/00219096211019063

Bruun, T. B., Berry, N., de Neergaard, A., Xaphokahme, P., McNicol, I., & Ryan, C. M. (2018). Long rotation swidden systems maintain higher carbon stocks than rubber plantations. *Agriculture, Ecosystems and Environment*, *256*, 239–249. https://doi.org/10.1016/j.agee.2017.09.010

Bulbeck, D. (1998). Origins of Civilization in West Malaysia and the Orang Asli. *Malaysian Archeology Journal*, *11*, 95–99. https://arkeologimalaysia.org.my/jurnalarkeologi/index.php/jurnalarkeologi/article/viewFile/55/28

Conversa, G., Lazzizera, C., Bonasia, A., Cifarelli, S., Losavio, F., Sonnante, G., & Elia, A. (2020). Exploring on-farm agro-biodiversity: a study case of vegetable landraces from Puglia region (Italy). *Biodiversity and Conservation*, *29*(3), 747–770. https://doi.org/10.1007/s10531-019-01908-3

Couillard, M.-A. (1979). A Jah Hut Community and its Wood Carvings. In *wedwe*.

Cramb, R. A., Pierce Colfer, C. J., Dressler, W., Laungaramsri, P., Le, Q. T., Mulyoutami, E., Peluso, N. L., & Wadley, R. L. (2009). Swidden transformations and rural livelihoods in southeast asia. *Human Ecology*, *37*(3), 323–346. https://doi.org/10.1007/s10745-009-9241-6

Dentan, R. K., Endicott, K., Gomes, A. G., & Hooker, M. B. (1997). *Malaysia and the Original People* (First Edition). Allyn and Bacon.

Department of Statistics Malaysia. (2023). *Demographic Statistics Malaysia Third Quarter 2023*. https://www.dosm.gov.my/uploads/release-content/file_20231107101245.pdf

Diffloth, G. (1976). Jah-Hut, An Austroasiatic Language of Malaysia. In *Southeast Asian linguistic studies* (Vol. 2, pp. 73–118). https://doi.org/10.15144/PL-C42.73

Domínguez, L., & Luoma, C. (2020). Decolonising conservation policy: How colonial land and conservation ideologies persist and perpetuate Indigenous injustices at the expense of the environment. *Land*, *9*(3). https://doi.org/10.3390/land9030065

Dressler, W. H., Wilson, D., Clendenning, J., Cramb, R., Keenan, R., Mahanty, S., Bruun, T. B., Mertz, O., & Lasco, R. D. (2017). The Impact of Swidden Decline on Livelihoods and Ecosystem Services in Southeast Asia: A Review of the Evidence from 1990 to 2015. *Ambio*, *46*(3), 291–310. https://doi.org/10.1007/s13280-016-0836-z

Dunn, M., Kruspe, N., & Burenhult, N. (2013). Time and place in the prehistory of the Aslian languages. *Human Biology*, *85*(1–3), 383–400. https://doi.org/10.3378/027.085.0318

Eliazer Nelson, A. R. L., Ravichandran, K., & Antony, U. (2019). The impact of the Green Revolution on Indigenous crops of India. In *Journal of Ethnic Foods* (Vol. 6, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s42779-019-0011-9

Endicott, K. M. (2016). *Malaysia's original people: past, present and future of the Orang Asli* (K. Endicott, Ed.; First Edition). NUS Press.

Fix, A. G. (1995). Malayan Paleosociology: Implications for Patterns of Genetic Variation among the Orang Asli. *American Anthropologist*, *97*(June), 313–323. https://www.jstor.org/stable/681964

Fix, A. G. (2008). Genes, Language, and Ethnic Groups: Reconstructing Orang Asli Prehistory. *Bulletin of the Indo-Pacific Prehistory Association*, *19*, 11–16. https://journals.lib.washington.edu/index.php/BIPPA/article/view/11716/10345

Food and Agriculture Organization of the United Nations (FAO). (2011). *Save and grow: A policymaker's guide to the sustainable intensification of smallholder crop production.*Rome. FAO. https://www.fao.org/publications/save-and-grow/en/

Fui, L. H., Haron, N., Yusof, N., Baharuddin, I. N., Mustapha, N. M., Lee, T. A., Zaidi, N. H., Jamaludin, F., & Mohtar, M. (2015). Documenting Traditional Forest-Related Knowledge of Medicinal Plants in Malaysia: A Comprehensive Approach. *Journal of Tropical Resources and Sustainable Science (JTRSS)*, *3*(1), 77–85. https://doi.org/10.47253/jtrss.v3i1.693

Gianno, R., & Bayr, K. J. (2009). Semelai agricultural patterns: Toward an understanding of variation among Indigenous cultures in southern peninsular Malaysia. *Journal of Southeast Asian Studies*, *40*(1), 153–185. https://doi.org/10.1017/S0022463409000071

Gliessman, S. R. (2015). *The Ecology of Sustainable Food Systems* (E. W. Engles, Ed.). CRC Press, Taylor & Francis Group.

Gomes, A. (2012). Alter-native 'development': Indigenous forms of social ecology. *Third World Quarterly*, *33*(6), 1059–1073. https://doi.org/10.1080/01436597.2012.681491

Gómez-Baggethun, E., Corbera, E., & Reyes-García, V. (2013). Traditional ecological knowledge and global environmental change: Research findings and policy implications. *Ecology and Society*, *18*(4). https://doi.org/10.5751/ES-06288-180472

Harper, T. N. (1997). The politics of the forest in colonial Malaya. *Modern Asian Studies*, *31*(1), 1–29. https://doi.org/10.1017/s0026749x00016917

Howell, C. J., Schwabe, K. A., & Samah, A. H. A. (2010). Non-timber forest product dependence among the Jah Hut subgroup of Peninsular Malaysia's Orang Asli. *Environment, Development and Sustainability*, *12*(1), 1–18. https://doi.org/10.1007/s10668-008-9176-x

Huambachano, M. A. (2019). Indigenous Food Sovereignty. *New Zealand Journal of Ecology*, *43*(3), 1–6. https://doi.org/10.2307/26841826

Ismail, R., Gopalasamy, R. C., Saputra, J., & Puteh, N. (2019). Impacts of a Colonial Policy Legacy on Indigenous Livelihoods in Peninsular Malaysia. *Journal of Southwest Jiaotong University*, *54*(5). https://doi.org/10.35741/issn.0258-2724.54.5.18

Jinam, T. A., Hong, L. C., Phipps, M. E., Stoneking, M., Ameen, M., Edo, J., & Saitou, N. (2012). Evolutionary history of continental southeast asians: Early train hypothesis based on genetic analysis of mitochondrial and autosomal DNA data. *Molecular Biology and Evolution*, *29*(11), 3513–3527. https://doi.org/10.1093/molbev/mss169

Kamal, S.F., & Lim, V. C. (2019). Forest reserve as an inclusive or exclusive space? Engaging orang ASLI as stakeholder in protected area management. *Journal of Tropical Forest Science*, *31*(3), 278–285. https://doi.org/10.26525/jtfs2019.31.3.278

Kardooni, R., Kari, F. B., Yahaya, S. R. B., & Yusup, S. H. (2014). Traditional knowledge of Orang Asli on forests in peninsular Malaysia. *Indian Journal of Traditional Knowledge*, *13*(2), 283–291.

Kari, F. B., Masud, M. M., Yahaya, S. R. B., & Saifullah, M. K. (2016). Poverty within watershed and environmentally protected areas: the case of the Indigenous community in Peninsular Malaysia. *Environmental Monitoring and Assessment*, *188*(3), 1–14. https://doi.org/10.1007/s10661-016-5162-1

Karim, H. A., & Hashim, A. H. (2012). The Effect of a Resettlement Scheme on the Social-Cultural Changes of the Temuan Community. *Procedia - Social and Behavioral Sciences*, *42*(July 2010), 362–373. https://doi.org/10.1016/j.sbspro.2012.04.200

Keat, N. J., Nath, T. K., & Jose, S. (2018). Indigenous Agroforestry Practices by Orang Asli in Peninsular Malaysia: Management, Sustainability and Contribution to Household Economy. *Indian Journal of Traditional Knowledge*, *17*(3), 542–549.

Kodoh, J., & Mojiol, A. R. (2017). Traditional Knowledge on the Uses of Medicinal Plants Among the Ethnic Communities in Kudat, Sabah, Malaysia. *International Journal of Agriculture, Forestry and Plantation, 5*, 79–85. http://ijafp.com/wp-content/uploads/2017/10/FR-15.pdf

Makondo, C. C., & Thomas, D. S. G. (2018). Climate Change Adaptation: Linking Indigenous Knowledge with Western Science For Effective Adaptation. *Environmental Science and Policy*, *88*, 83–91. https://doi.org/10.1016/j.envsci.2018.06.014

Mat, M., Peter Midmore, D. |, & Plotnikova, M. (2022). *Understanding the experiences of Indigenous minorities through the lens of spatial justice: The Case of Orang Asli in Peninsular Malaysia*. https://doi.org/10.1111/rsp3.12512

Milow, P., Ramli, M. R., & Chooi, O. H. (2010). Preliminary Survey on Plants in Home Gardens in Pahang, Malaysia. *Journal of Biodiversity*, *1*(1), 19–25. https://doi.org/10.1080/09766901.2010.11884715

Nah, A. M. (2008). Recognizing Indigenous identity in postcolonial malaysian law. *Bijdragen Tot de Taal-, Land- En Volkenkunde / Journal of the Humanities and Social Sciences of Southeast Asia*, *164*, 212–237. papers2://publication/uuid/A1BDA0EF-9710-44EA-B87C-82D6D4A11245

Nicholas, C. (2000). *The Orang Asli and the contest for resources: Indigenous politics, development and identity in Peninsular Malaysia*. International Work Group for Indigenous Affairs (IWGIA) and Center for Orang Asli Concerns (COAC).

Nicholas, C. (2003). Orang asli Resource Politics. *RSCD Conference on Politics of the Commons: Articulating Development and Strengthening Local Practices*, *July*. http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/1252/Colin_Nichols.pdf?sequence=1&isAllowed=y

Nicholas, C. (2004). *The Orang Asli and the Contest for Resources: Indigenous Politics, Development and Identity in Peninsular Malaysia* (Second). International Work Group for Indigenous Affairs and Centre for Orang Asli Concerns. https://www.iwgia.org/images/publications/0133_95_The_Orang_Asli_and_the_contest_for_resources.pdf

Nicholas, C. (2005). *The Orang Asli and the legal framework for forest management in Peninsular Malaysia*. In Colchester, M., & Chao, S. (Eds.), *Protecting and promoting the rights of Indigenous Peoples in conservation* (pp. 103–122). Forest Peoples Programme.

Nicholas, C. (2010). *Orang Asli: Rights, Problems, Solutions* (Second, Vol. 5600). SUHAKAM.

Nicholas, C. G. (2000). The Orang Asli and the Contest for Resources: Indigenous Politics, Development and Identity in Peninsular Malaysia. In *IWGIA Document No.95*. International Work Group on Indigenous Affairs; Center for Orang Asli Concerns. http://nanyang.academia.edu/GeoffreyBenjamin/Papers/1196302/Orang_Asli

Ong, H. C., Norliah, A., & Sorayya, M. (2012). Traditional knowledge and usage of edible plants among the Temuan villagers in Kampung Tering, Kuala Pilah, Negeri Sembilan, Malaysia. *Indian Journal of Traditional Knowledge*, *11*(1), 161–165.

Organisation for Economic Co-operation and Development (OECD). (2021). *Making better policies for food systems*. Paris. OECD. https://doi.org/10.1787/ddfba4de-en

Patel, R. (2013). The Long Green Revolution. *Journal of Peasant Studies*, *40*(1), 1–63. https://doi.org/10.1080/03066150.2012.719224

Perrey, S. D. (2017). Food Sovereignty, Gender and Transitions in Traditional Culinary Knowledge in the Chinantla, Oaxaca, Mexico. *Master's Thesis*, *25*(1), 9–14. https://doi.org/10.1016/j.jpainsymman.2017.04.009

Pinstrup-Andersen, P., & Hazell, P. B. R. (1985). The Impact of the Green Revolution and Prospects for the Future. *Food Reviews International*, *1*(1). https://pdf.usaid.gov/pdf_docs/pnaaz044.pdf

Rambo, A. T. (1984). Part III Integrative Case Studies. In *An Introduction to human ecology research on agricultural systems in Southeast Asia* (pp. 237–253). East-West Center. https://scholarspace.manoa.hawaii.edu/bitstream/10125/30618/3/IntroductionToHumanEcologyResearchOnAgriculturalSystemsInSoutheastAsiaPartIII1984%5Bpdfa%5D.PDF

Rerkasem, K., Lawrence, D., Padoch, C., Schmidt-Vogt, D., Ziegler, A. D., & Bruun, T. B. (2009). Consequences of swidden transitions for crop and fallow biodiversity in southeast asia. *Human Ecology*, *37*(3), 347–360. https://doi.org/10.1007/s10745-009-9250-5

Saifullah, M. K., Masud, M. M., & Kari, F. B. (2021). Vulnerability context and well-being factors of Indigenous community development: a study of Peninsular Malaysia. *AlterNative*, *17*(1), 94–105. https://doi.org/10.1177/1177180121995166

Sangha, K. K. (2014). Modern agricultural practices and analysis of socioeconomic and ecological impacts of development in agriculture sector, Punjab, India - A review. *Indian Journal of Agricultural Research*, *48*(5), 331–341. https://doi.org/10.5958/0976-058X.2014.01312.2

Sayok, A. K., & Teucher, U. (2018). Loss of food plants knowledge and identity among Indigenous Peoples in Malaysia. *Journal of Advanced Research in Social and Behavioural Sciences*, *11*(1), 174–188.

Seligmann, L. J. (2008). Agrarian Reform and Peasant Studies: The Peruvian Case. In *A Companion to Latin American Anthropology* (pp. 337–351). Blackwell Pub.

Sharma, I. P., Kanta, C., Dwivedi, T., & Rani, R. (2020). *Indigenous Agricultural Practices: A Supreme Key to Maintaining Biodiversity* (pp. 91–112). https://doi.org/10.1007/978-981-15-1902-4_6

Shiva, V. (1991). The Violence of the Green Revolution. In *The Journal of Value Inquiry* (2nd ed., Vol. 27). Zed Books Ltd. https://www.academia.edu/31972793/The_Violence_of_the_Green_revolution_Vandana_Shiva

Subramaniam, Y. (2013). *Legal pluralism and the Indigenous Peoples of Malaysia: Problems and prospects*. *Australian Journal of Asian Law*, 14(2), 1–17. https://doi.org/10.3316/informit.270803958983472

Thorn, J. P. R., Thornton, T. F., Helfgott, A., & Willis, K. J. (2020). Indigenous uses of wild and tended plant biodiversity maintain ecosystem services in agricultural landscapes of the Terai Plains of Nepal. *Journal of Ethnobiology and Ethnomedicine*, *16*(1), 33. https://doi.org/10.1186/s13002-020-00382-4

UN Environment Program. (n.d.). *Malaysia Biodiversity Facts*. Convention on Biological Diversity. https://www.cbd.int/countries/profile/?country=my

UNESCO. (1983). Swidden Cultivation in Asia - Content Analysis of the Existing Literature: A Stocktaking Exercise. In *Swidden Cultivation in Asia: Vol. 1,2,3*. UNESCO Regional Office for Education in Asia and the Pacific.

van Vliet, N., Mertz, O., Heinimann, A., Langanke, T., Pascual, U., Schmook, B., Adams, C., Schmidt-Vogt, D., Messerli, P., Leisz, S., Castella, J. C., Jørgensen, L., Birch-Thomsen, T., Hett, C., Bruun, T. B., Ickowitz, A., Vu, K. C., Yasuyuki, K., Fox, J., … Ziegler, A. D. (2012). Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment. *Global Environmental Change*, *22*(2), 418–429. https://doi.org/10.1016/j.gloenvcha.2011.10.009

Watson, D. (2019). Adaptation to climate change through adaptive crop management. *Sustainable Solutions for Food Security: Combating Climate Change by Adaptation*, 191–210. https://doi.org/10.1007/978-3-319-77878-5_10

Whyte, K. (2019). Traditional ecological knowledge: learning from Indigenous practices for environmental sustainability. *Ethnobiology Letters*, 111–112.

Williams, N. E., & Kramer, D. B. (2019). Agricultural Biodiversity Maintenance in a Coastal Socio-Ecological System: the Pearl Lagoon Basin, Nicaragua. *Human Ecology*, *47*(1), 111–120. https://doi.org/10.1007/s10745-018-0042-7

World Bank. (2008). *World development report 2008: Agriculture for development***.** Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/5990

Yusof, E., & Sorenson, K. W. (2000). Krau Wildlife Reserve - Protected Area Management Experiences. In *Journal of WIldlife and Parks* (Vol. 18, pp. 3–13). https://www.wildlife.gov.my/images/document/penerbitan/jurnal/Jil182000.pdf

Zhang, Y., Min, Q., Li, H., He, L., & Zhang, C. (2017). A Conservation Approach of Globally Important Agricultural Heritage Systems (GIAHS): Improving Traditional Agricultural Patterns and Promoting Scale-Production. *Sustainability*, *9*(295), 1–12. https://doi.org/10.3390/su9020295

Zuhairi, M. H., Rosnon, M. R., & Abu Samah, A. (2021). The Tenets of The Mah Meri Oral Tradition, Life Issues and Challenges in Pulau Carey, Selangor. *International Journal of Academic Research in Business and Social Sciences*, *11*(12), 429–439. https://doi.org/10.6007/ijarbss/v11-i12/11789

Chapter 2 : Literature Review

2.1. The Historical Evolution of Indigenous Agriculture

The origin and evolution of Indigenous agriculture are intertwined with the history of human civilization and the development of agricultural practices worldwide. It is a complex and multifaceted process, with various factors influencing its development across vastly different regions. Through a comprehensive review of scholarly research, the following sections examine the historical evolution, multifaceted dimensions, contemporary challenges, and transformative potential of Indigenous agricultural practices within the broader discourse of agroecological transitions[14].

2.1.1. The Origin of Agriculture: From Hunting and Gathering to Plant Domestication

Before the emergence of the first agriculturists, nomadic hunter-gatherers[15] had existed for approximately four million years, surviving on hunting, fishing, and foraging for wild plants[16] and resources (Locay, 1989). The emergence of *Homo sapiens* (modern humans) around 200,000 to 300,000 thousand years ago in Africa, and their subsequent migrations across continents about 60,000 to 70,000 years ago (Mirazón Lahr & Foley, 1998) set the stage for a diversity of human adaptations to changing environments. Archaeobotanical evidence suggests that initial crop domestication[17] only began around 13,000 to 12,000 BCE, during the Pre-Pottery Neolithic Period (Zeder, 2011). Leading up to this period, hunter-gatherers engaged in various forms of plant exploitation[18], as illustrated in (Harris, 2015), which depicts the transition from wild plant procurement to organized agriculture[19]. While this account is widely referenced, it is vital to note that archaeological narratives often reflect dominant

[14] Agroecological transitions refer to the process of transforming modern agricultural systems and practices towards more ecologically sustainable and socially equitable framework by adapting traditional and local agricultural methods (Wezel et al., 2020)

[15] Hunter-gatherers are defined as groups primarily engaged in extracting food from wild, non-domesticated sources, not managed by humans. This classification also encompasses their distinctive social structures and ideologies, which emphasize extensive sharing among kin and a perception of the environment as a generous provider (Jordon, 2018; Winterhalder, 1981)

[16] Wild plants are species that grow and thrive naturally in self-sustaining populations within natural or semi-natural ecosystems without human intervention (Malmstrom & Alexander, 2016)

[17] Domestication is a biological phenomenon characterized by traits in crops that emerge from adaptation to cultivation, distinguishing them from their close wild relatives (Harris & Fuller, 2014)

[18] Plant exploitation refers to any activity where humans utilize plants to meet their needs (Harris, 2015)

[19] Although the term 'agriculture' is broadly used to indicate the numerous methods of utilizing crops and domestic animals for landscape-scale food production (Harris & Fuller, 2014), for this study the term will exclusively refer to the cultivation of crops, excluding animal husbandry.

perspectives that may overlook diverse regional trajectories and Indigenous knowledge systems – a theme explored in greater depth in Chapter 4.

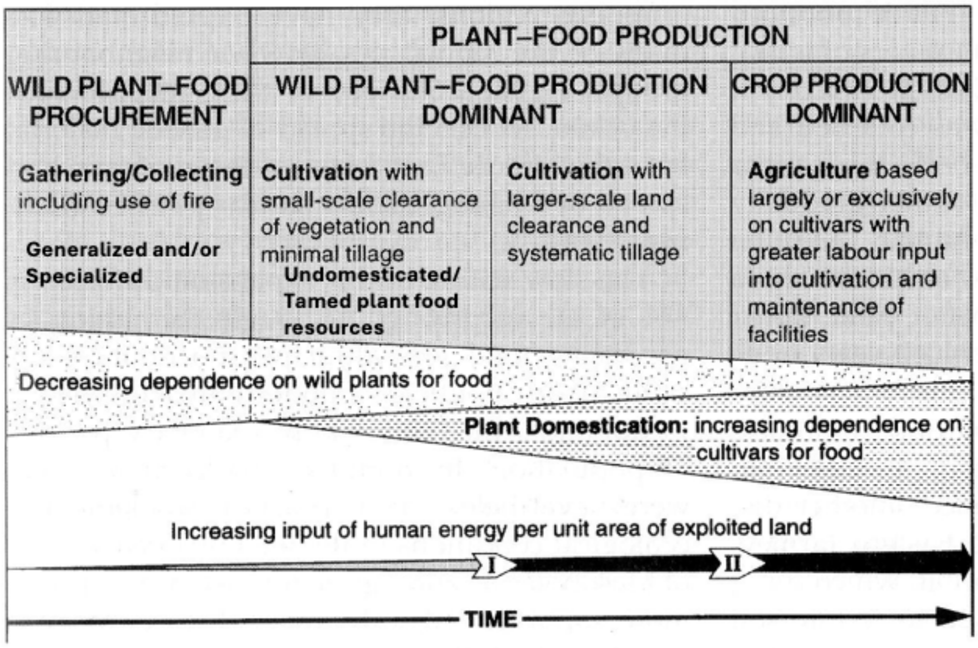

FIGURE 2.1: A CLASSIFICATION AND EVOLUTIONARY MODEL OF PLANT EXPLOITATION SYSTEMS

(Source: Atkins et al., 1998)

This model presents a non-linear continuum, tracing the progression from simple gathering to increasingly sophisticated crop production methods. It illustrates the growing influence of human intervention in shaping plant environments and species, marking a shift from passive interaction to the deliberate cultivation and management of plants through primitive agriculture[20]. Harris' framework underscores the complexity of agricultural evolution, demonstrating the dynamic relationship between biological and cultural advancements in plant resource manipulation.

The first threshold is that of hunter-gatherers who were engaged in generalized and/or specialized wild plant gathering (Zvelebil & Pluciennik, 2011). According to another researcher, Winterhalder (1981), generalized methods involve opportunistic and seasonal use, either through group movements between resource patches (residential mobility) or by deploying task groups to collect resources and return them to a central location (logistic

[20] The term 'primitive agriculture' emerged from academic discussions and research in the fields of anthropology, archaeology, and history (Kagawa, 1973; Buckland, 1878), and refers to early forms of farming practices (rudimentary cultivation techniques and limited domestication of plants and animals) that were prevalent before the more advanced agricultural systems found in the Neolithic Revolution

procurement). In contrast, specialized gathering focuses on the regular targeting of specific resources, leading to more sedentary, territorial, and technologically advanced communities. These communities often employ logistic strategies and may engage in environmental management techniques such as clearing and soil disturbance[21] to enhance resource productivity and reliability, sometimes resulting in biological responses such as increased reproduction among the targeted species. Together, these practices reflect the adaptive strategies of hunter-gatherer societies to their environments, incorporating both mobility and resource management.

The following phase is taming (behavioral domestication of wild plant resources) and common techniques include protective tending of selected plants, selective burning of woodland, weeding, and soil modification (Zvelebil, 1994). This stage may even involve sowing or planting. In some instances, this may lead to the third stage, which is domestication. While Harris' model attempts to explain how the transition may have occurred, it fails to explain why. Buckland (1878) was among the first to suggest that primitive agriculture likely emerged from necessity during times of scarcity, with women playing a crucial role in its early stages. This trend is observed in many Indigenous societies at present (Dagar, 2022; Nongrum & Syiem, 2022; Sithole, 2019).

Recent scholarship has further challenged such linear or Eurocentric interpretations of plant domestication, offering a more nuanced and globally inclusive view. For instance, Bogaard et al. (2021) and Purugganan (2019) presented plant domestication as a continuous evolutionary process shaped by people and nature working together. Bogaard et al. (2021) emphasize the complexity of the domestication process, viewing it through the lens of process philosophy and archaeology, which reveals a adaptive exchange of domestic and wild traits within hybrid plant communities. They argue that plant domestication encompasses mutualistic relationships that span time and space, shaped by interactions between human and plant species. Similarly, Purugganan (2019) uses genetics, genomics, and archaeobotany to argue that domestication is a gradual, adaptive process influenced by unconscious selection and interspecific hybridization rather than a rapid, intentional act. Both studies highlight the role of natural selection under cultivation and the genetic contributions from wild relatives, which enhance diversity and

[21] Soil disturbance is any activity that disrupts the soil structure, including tilling, digging holes, foot traffic or livestock movement (Curran at al., 2007)

adaptation through hybridization, emphasizing the complex ecological interactions and gene flow that characterize the domestication process of wild plants to become crops. Together, challenge the idea of human control over nature to recognizing it as an interconnected, evolutionary continuum.

2.1.2. The Neolithic Revolution and its Impact on Civilization

The domestication of plants set the stage for what is widely called the Neolithic Revolution (or Agricultural Revolution or First Cultural Revolution), marking a major turning point from nomadic hunter-gatherer societies to settled agricultural communities around 10,000 BCE (Mazoyer & Roudart, 2006). Although this period is often described as a universal "revolution," archaeological evidence reveals that the pace, form, and significance of this transition varied considerably across regions and cultures. The first agricultural societies did not emerge simultaneously worldwide, but instead developed independently, as shown in Table 2.1.

Period	Region	Domesticated Plants	Agricultural Techniques & Practices
10,000 BCE	Amazonia	Maize (*Zea mays*), manioc/cassava (*Manihot esculanta*), sweet potato (*Ipomoea batatas*), squash (*Cucurbita sp*), arrowroot (*Maranta arundinacea*), and leren (*Goeppertia allouia*) (Iriarte et al., 2020)	Polyculture agroforestry systems (Maezumi et al., 2018a); home gardens; long-term cultivation of plots in and around larger and more permanent settlements; (Nascimento et al., 2022; Erickson, 2010 & 2008); Amazonian Dark Earths (ADEs) (Iriarte et al., 2020)
10,000 BCE	Southern Levant (also known as Near East, Middle East, Southwestern Asia and the Fertile Crescent)	Wild einkorn wheat (*Triticum boeoticum*), wild barley (*Hordeum spontaneum*), two species of "goat-face grass" (*Aegilops speltoides* and *Aegilops squarrosa*) and wild emmer wheat (*Triticum dicoccoides*) (Flannery, 1973), lentils (*Lens culinaris*), wild black lentils (*Lens nigricans*), peas (*Pisum sativum*), grass peas (*Lathyrus sativus*), chickpeas (*Cicer sp*), broad beans (*Vicia faba*), bitter vetch (*Vicia ervilia*), rambling vetch (*Vicia peregrina*), wild oats (*Avena sterilis*), flax (*Linum usitatissimum*) and the common fig (*Ficus carica*) (Abbo et al., 2013)	Transplantation (Flannery, 1973), early adoption of irrigation, (Angelakis et al., 2020), water management systems (Avni, 2022)
9,000 BCE	Mesoamerica	Earliest maize cultivation, beans (eg. *Phaseolus vulgaris, Phaseolus lunatus*), manioc, squash (*Cucurbita pepo, Cucurbita maxima, Cucurbita moschata and Cucurbita argyrosperma*), sunflower seeds (*Helianthus annuus*) and Mexican cotton (*Gossypium hirsutum*) (Zizumbo-Villarreal & Colunga-GarcíaMarín, 2010; Pope et al., 2001; Pohl et al., 1996)	Three Sisters' intercropping complex (squash, beans and maize) practiced by Indigenous tribes to maintain soil fertility (Ngapo et al., 2021)

Period	Region	Domesticated Plants	Agricultural Techniques & Practices
8,000 BCE	China*	Rice (*Japonica* rice variety gene pool) (Zhao, 2010), broomcorn millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) (X. Yang et al., 2012)	Floodplain farming (Rosen, 2008), irrigation and water management (Fuller & Qin, 2009), paddy field cultivation (Zong et al., 2007), shifting cultivation (Songqiao, 1993)
8,000 BCE	Africa (Nile Valley, Ethiopian Highlands, West Africa and the Sahel Region)	Teff (*Eragrostis tef*), coffee (*Coffea arabica* & *Coffea canephora*), enset banana (*Ensete ventricosum*), African rice (*Oryza glaberrima*), sorghum (*Sorghum bicolor*), finger millet (Eleusine coracana), pearl millet (*Pennisetum glaucum*), yams (Dioscorea spp.) and oil palm (*Elaeis guineensis*)	Shifting agriculture, irrigation and water management, mixed cropping, terracing and water harvesting
7,000 BCE	India* (Indus and Ganges Valley)	Rice (*indica* and *aus* rice variety gene pool), wheat, barley, millets, lentils, peas and Indigenous pulses (*Vigna radiata* and *Macrotyloma uniflorum*) and millet grasses (*Brachiaria ramosa* and *Setaria verticillate*) (Civán et al., 2015; Pokharia et al., 2018)	Shifting cultivation, irrigation, mixed cropping, floodplain farming
4,000 BCE	Mainland Southeast Asia	Rice (*japonica*) originated from China (Gao et al., 2020a), broomcorn and foxtail millets (Guo et al., 2022; Wang et al., 2022), taro (*Colocasia esculenta*), bananas (Musa spp.), yam (Dioscorea spp.), sweet potato (*Ipomoea batatas*), manioc/cassava (*Manihot esculenta*) (Li, 1970)	Arboriculture, shifting cultivation, wet rice cultivation, intercropping and polyculture

TABLE 2.1: THE EMERGENCE OF AGRICULTURE IN MAJOR REGIONS OF THE WORLD (NEOLITHIC REVOLUTION)

**China and India are considered major players in the early and independent domestication of rice*

During this period, communities devised a diverse range of agricultural techniques and systems – such as polyculture agroforestry, home gardens, early irrigation, intercropping (e.g. the "Three Sisters"), and terracing – that reflected deep ecological knowledge and cultural adaptation. Rather than representing a straightforward leap toward progress, these practices were highly sophisticated and locally acclimated, with implications for sustainable agriculture and resource management that persist today.

The shift from foraging to agriculture is still regarded as one of the most debated junctures in human history. Archaeologists, anthropologists, ecologists, and economists continue to discuss the innumerable factors involved, from population density and climate shifts to social organization and technological innovation (Shavit & Sharon, 2023; Svizzero, 2017; Ashraf & Michalopoulos, 2010; Köhler-Rollefson & Köhler-Rollefson, 1988; Hole, 1984). Jones et al. (2021) and Locay (1989) point to rising human population density, declining foraging yields, human migration, climatic shifts, and rising social pressures. Advancements in technology, including the creation of tools for digging and harvesting, and innovations in food processing and storage likely facilitated plant cultivation by making it more practical, contributing to establishing and maintaining settled human communities (Zeder, 2015). Zeder's position was echoed by Hodder (2018) who challenged the previous simpler explanations and emphasized the role of human-object interactions over long periods, and that this relationship was as critical as ecological or climactic factors (warming) in shaping early agricultural societies.

At the same time, alternative perspectives, such as Bender's (1978), argue that simply intensifying resource use does not automatically result in greater production or a commitment to agriculture, but these are rather the results of changing social demands[22] and relationships within societies. Bender goes on to emphasize the significance of cultural and ritual practices in influencing economic behaviors, indicating that social complexities and structured hierarchies were in place well before the emergence of agriculture.

Emerging research further contests the narrative of a rapid and universally beneficial "revolution." Allaby et al. (2022) propose a much more gradual, landscape-level evolution, marked by incremental changes, and ongoing integration of wild and cultivated resources.

[22] The pressures and expectations arising from a society's evolving relationships, hierarchies, and obligations, which drive increased production and economic intensification beyond mere subsistence needs (Bender,1978).

These studies highlight the importance of acknowledging that early agriculture was neither always more productive nor less risky than foraging (Bowles, 2011), and that the transition often involved new forms of labor, risk, and even hardship.

Another scholar, Zeder (1994), critiques the uniformitarian[23] models of cultural evolution by demonstrating the existence of significant regional variations in food production and the adoption of agriculture, suggesting that both wild and domestic resources were persistently integrated in post-Neolithic economies. This illustrates the adaptability and localized responses of early agricultural societies to their specific environmental and demographic conditions, underscoring the complexity and diversity of subsistence strategies following the Neolithic Revolution.

Although the Neolithic Revolution is frequently celebrated for advancing agriculture-based civilizations and initiating major societal transformations, it also brought numerous challenges - environmental degradation through deforestation, soil erosion, and loss of biodiversity and habitat due to increased land use and intensive monoculture practices (Runnels, 1995). Simultaneously, the move to settled farming worsened social inequalities and stratification, centralizing wealth, and resources, which led to increased social disparities (Morales & Rodriguez-Lara, 2020; Bowles & Choi, 2019; Leppard, 2019) and intensified health issues as sedentary lifestyles and grain-centric diets contributed to nutritional deficiencies and the spread of diseases (Larsen, 2006).

It is evident from the literature that the Neolithic Revolution profoundly impacted Indigenous cultures and traditional knowledge, transforming social organization, cultural practices, and biological makeup. The adoption of agriculture also had a major influence on human-environment interactions, altering subsistence strategies and resource management (Borrell et al., 2015; Fu et al., 2012). This shift affected economic systems and settlement patterns, influencing how Indigenous communities interacted with their environments (Svizzero & Tisdell, 2014). Ultimately, the transition to agriculture had far-reaching effects on the social, economic, and environmental dynamics of human societies, reshaping language, genetics, and cultural practices among Indigenous groups.

[23] In the context of anthropology and archaeology, 'uniformitarianism models' refers to the assumption that the same cultural or social processes observed in the present can be applied to understand past human behaviors and societal developments (Cameron, 1993)

2.1.3. The Importance of Examining Early Foragers and Primitive Agriculturists

Examining the activities of early foragers and primitive agriculturists is vital for understanding the evolution of Indigenous agriculture (Rowley-Conwy & Layton, 2011), as it sheds light on the transition from survival-based foraging to sustainable farming (Greaves & Kramer, 2014). Early foragers laid the groundwork for the development of agricultural systems (Barker & Richards, 2013), and this evolution continued with primitive agriculturists who expanded upon these strategies by domesticating plants and animals, thereby creating new ecological niches and enabling communities to settle (Harris, 2015). These historical practices shed light on the transfer of knowledge, the adaptation to diverse environments, and the preservation of cultural heritage within many modern Indigenous communities that maintain their ancestral agricultural traditions.

Moreover, these early agricultural activities underscore the cultural identities of many Indigenous communities and provide insights into their adaptations to diverse climates and geographies, enhancing agriculture's role in sustaining ecological balance and cultural heritage (Pluciennik & Zvelebil, 2008). By understanding these interactions and the spread of agricultural practices across regions, insights are gained into the resilience of Indigenous agricultural systems against environmental challenges and their evolution in response to societal changes (Johnson & Earle, 1987). This knowledge is crucial not only for cultural preservation but also for informing sustainable modern agricultural practices that address contemporary global challenges such as threats to food security and climate change[24].

2.1.4. The Ethnogenesis[25] of Indigenous Peoples

Several studies postulate the post-Neolithic evolution of Indigenous populations, thought to have occurred separately from mainstream societies, and involving a multifaceted interaction of geography, cultural resilience, selective adaptation, and the impacts of colonization (Weik, 2014). Hu (2013) point to geographic isolation that kept Indigenous groups separate, as natural barriers like mountains slowed the spread of agricultural practices from Neolithic centers. Yet

[24] Werndl (2016) defines climate change as significant changes in the distribution of climate variables over time that are driven by external factors (such as variations in solar radiation or greenhouse gas levels), and internal dynamics within the climate system. By comparing climate distributions across different periods, these alterations can be identified, highlighting shifts caused by natural events or human activities.
[25] Ethnogenesis in this context refers to the ways in which Indigenous groups have formed and maintained their own unique identities in response to various internal and external factors (Weik, 2014)

other scholars cite cultural resilience and deep-rooted spiritual beliefs that clashed with agricultural lifestyles as the basis for many Indigenous communities to continue their hunter-gatherer ways, (Corr & Powers, 2012; Sidbury & Cañizares-Esguerra, 2011). Meanwhile, other communities adopted select Neolithic technologies without fully opting for sedentary agricultural lifestyle, thus preserving their unique cultural identities (Svizzero & Tisdell, 2014).

Fundamentally, colonization radically shaped Indigenous societal evolution by introducing disruptive socio-economic structures that deliberately marginalized Indigenous practices and enforced new norms, further distinguishing these communities from mainstream societies (Sheikh, 2020; Voss, 2015; Nixon Njau, 2014). For example, the historical and ongoing struggles of Indigenous Peoples in Latin America from the impact of colonialism, the imposition of controlled identities, and the political mobilization for rights and autonomy have been well documented (Arceneaux, 2022). Indigenous identity has been constantly shaped and reshaped by external forces ranging from colonial powers to modern nation-states. Despite significant advancements, Indigenous Peoples continue to face poverty, discrimination, and lack of political representation (Stavenhagen, 2006). Globalization has resulted in both the empowerment - by providing avenues for Indigenous political mobilization - and exploitation of Indigenous communities (Arceneaux, 2022).

2.1.5. Indigenous Agriculture: Evolution and Persistence

As human populations spread to various regions, they brought their unique agricultural knowledge with them, leading to the development of diverse farming practices tailored to specific environments and cultural contexts (Pluciennik & Zvelebil, 2008). Over time, these practices evolved in response to changing environmental conditions, societal needs, and technological advancements (Mazoyer & Roudart, 2006). Complex systems that incorporated techniques (such as crop rotation, intercropping, agroforestry, and terracing) were developed (Altieri, 2004). The progression of Indigenous agriculture from the pre-Neolithic period to the present is illustrated in Figure 2.2.

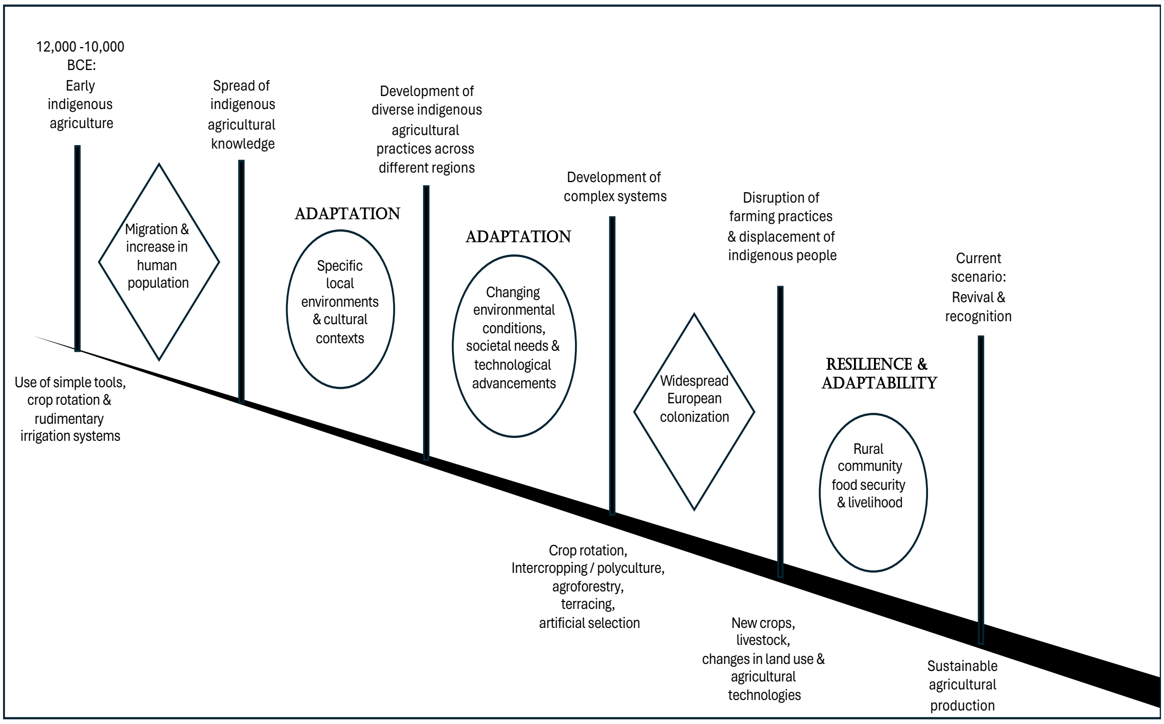

FIGURE 2.2: THE EVOLUTION OF INDIGENOUS AGRICULTURE

(Source: Author's interpretation)

A major disruption in the evolution of Indigenous agriculture occurred with European colonization that brought new crops, livestock, changes in land use, and agricultural technologies that often disrupted Indigenous farming practices (Malli et al., 2023; Moura et al., 2019), caused adverse and persistent population health issues (Skelly et al., 2018) and led to the displacement of Indigenous people (Mazoyer & Roudart, 2006). However, many Indigenous farmers continued to adapt to changes and new techniques while maintaining their traditional knowledge and practices (Altieri, 2004). An example is the Three Sisters companion planting technique (maize, beans, and squash) used by Native American tribes continued to persist and adapt (Ngapo et al., 2021). Currently, there is an increase in research interest in Indigenous agriculture and knowledge systems, reflecting an acknowledgment of the value of traditional knowledge in addressing contemporary global challenges related to agriculture, sustainability, and environmental conservation (Amare & Gacheno, 2021; Chen et al., 2021; Khatri et al., 2021; Arcand et al., 2020).

The Food and Agriculture Organization (FAO) has increasingly emphasized the crucial role of Indigenous agriculture in ensuring food security, income generation, and environmental stewardship, particularly in biodiverse regions across the Global South. According to FAO data (2021), Indigenous Peoples - comprising 476 million people globally - manage 28% of the Earth's surface and 11% of its forests, a significant contribution to biodiversity conservation and sustainable food systems. Indigenous food systems are efficient, generating 50 to 80 percent of food and resources in their territories (FAO, 2019a), and ecologically balanced, conserving soil and sustainability (Altieri & Koohafkan, 2004).

However, FAO's depth of sincerity and support have been challenged by scholars and Indigenous communities as being merely rhetorical. Giraldo and Rosset (2018) caution that the institutionalization of agroecology within FAO frameworks has depoliticized its grassroots origins, diluting its focus on Indigenous resistance and food sovereignty. FAO's promotion of top-down models such as Conservation Agriculture and Climate-Smart Agriculture is seen to align more with agribusiness interests than with Indigenous autonomy (Altieri et al., 2012).

Additionally, FAO's technical classifications of land and forests frequently clash with Indigenous relational understandings of territory, potentially undermining community governance (González & Kröger, 2020). Although FAO promotes the "10 Elements of Agroecology," its frameworks often prioritize scalability and technocratic solutions over participatory, territorialized approaches rooted in Indigenous knowledge and leadership (Wezel et al., 2020; Rivera-Ferre, 2018).

As noted by Lemke and Delormier (2017), FAO-led consultations with Indigenous communities have symbolically acknowledged their contributions but have not resulted in meaningful shifts in global agricultural policy. This gap between recognition and actual empowerment suggests that FAO's engagement with Indigenous agroecology remains more strategic than transformative - raising important questions about who controls the narrative and benefits from the institutionalization of traditional knowledge.

This disconnection between institutional endorsement and systemic inaction is particularly troubling when considering the escalating threats to Indigenous agriculture. Indigenous agricultural systems face multiple and compounding pressures. Key among these threats are climate change (Norton-Smith et al., 2016), land loss resulting from land grabbing and industrial agricultural expansion (B. Yang & He, 2021; Gilbert, 2017; Mollett, 2016), erosion of traditional knowledge (Athayde et al., 2017; Kodirekkala, 2015; Sujarwo et al., 2014; Brodt, 2001), the endangerment of Indigenous crops (Porcuna-Ferrer et al., 2024), biodiversity loss (Sambo, 2014; Thrupp, 2000; Upreti & Upreti, 2002), and resource extraction (Bebbington, 2013; Lertzman & Vredenburg, 2005). Although the historical evolution of Indigenous agriculture demonstrates its resilience and adaptability, there are serious concerns about its continued sustainability and the impact of these pressures on Indigenous livelihoods, cultural identity, and ecological balance (FAO et al., 2021).

2.2. Positioning Indigenous Agriculture within the Frame of Modern Agriculture and Agroecology

2.2.1. Major Milestones in Agriculture

The subsequent evolution of agriculture from the Neolithic Revolution to the modern/industrial era was a gradual and complex process that occurred over the last 12,000 years. Figure 2.3 highlights key milestones in this transition that have shaped the history of human food production and land use. The pathways of three major agricultural systems - modern and Indigenous agriculture, and agroecology[26] - are mapped out.

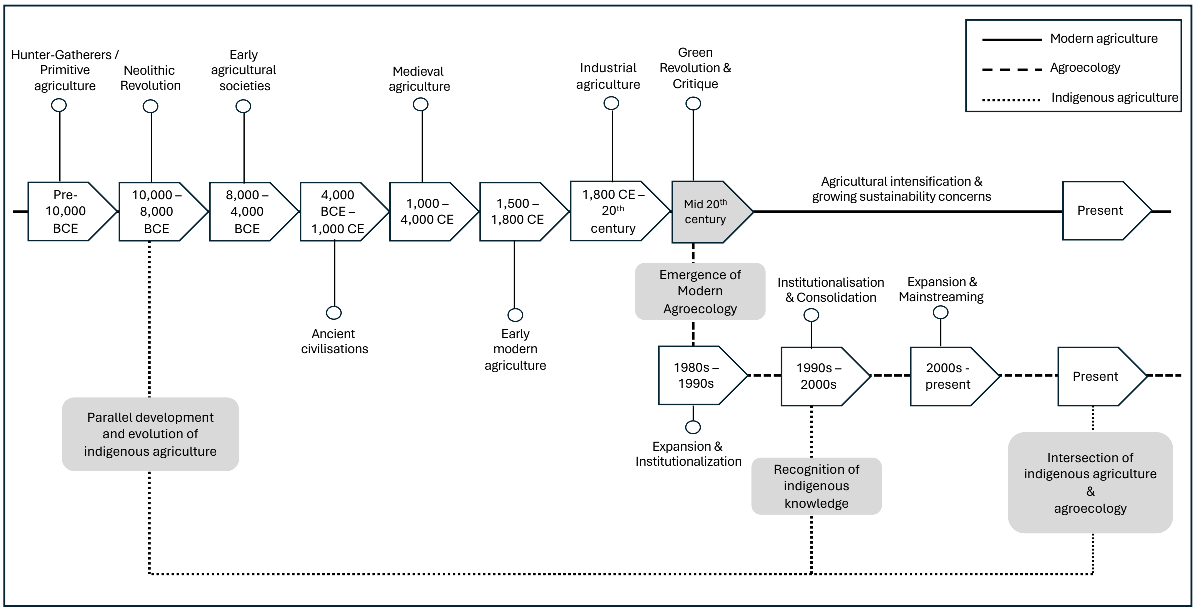

FIGURE 2.3: MAJOR MILESTONES IN THE EVOLUTION OF AGRICULTURE

(Source: Author's interpretation)

[26] Agroecology is a science, practice, and movement that integrates research, education, action, and change to enhance the sustainability of all aspects of the food system. It is based on ecological thinking, emphasizing a holistic, systems-level perspective on the food system. It is transdisciplinary, with a participatory approach involving all stakeholders. It challenges the existing industrial food system's economic and political powers with alternative structures and policy actions (S. Gliessman, 2018)

While agroecology is a relatively recent development, both Indigenous and modern agriculture share roots in ancient practices (Martin & Sauerborn, 2013). The divergence of modern and Indigenous agriculture presumably began with the onset of the Neolithic Revolution, where farming practices evolved towards industrialization and intensive farming methods during the 18th and 19th centuries (Pluciennik & Zvelebil, 2008). This shift marked a significant departure of modern agriculture from the diverse, sustainable practices typical of Indigenous agriculture, towards a more uniform and production-focused approach.

Early modern agriculture has had a far-reaching, and disastrous impact on humans. To illustrate this point, Nunn & Qian (2010) explain the pivotal Columbian Exchange between the 15th and 18th centuries that revolutionized food production worldwide but devastated Indigenous populations with disease in the New World. The subsequent Industrial Revolution (1,800 CE to the 20th century) radicalized the transformation further with the introduction of mechanization, phenomenally increasing efficiency and production capabilities (Tomory, 2016). This era led to the establishment of the Green Revolution (GR), which transformed global agriculture by introducing high-yield crop varieties, synthetic fertilizers, and pesticides, dramatically increasing food production. In the short term, the GR helped avert famine, especially in India, Mexico and China, where wheat and rice yields tripled (Pinstrup-Andersen & Hazel, 1985).

However, the GR produced disastrous long-term impacts. Harwood (2019) argues that experts defending the GR claimed they could not foresee its negative effects, but historical evidence suggests otherwise. Early critics warned about social and environmental risks, which were largely ignored. Many policymakers focused solely on increasing yields without considering long-term ecological and social impacts. (Harwood, 2019). The GR's heavy reliance on chemical fertilizers and pesticides caused soil degradation, biodiversity loss, and declining fertility, while pesticide contamination of water sources has reached hazardous levels in affected regions (John & Babu, 2021; Vos & Bellù, 2018). Excessive pesticide use led to the emergence of resistant pests, creating a chemical dependency and posing serious public health risks due to high residues in food and water (Harwood, 2019).

Beyond its environmental toll, the GR reinforced economic and geopolitical inequalities. Baofo & Lyons (2021) argue that the GR was part of a neocolonial agenda, favoring multinational corporations that sought to control seed markets and agricultural inputs, and forcing farmers into dependency. This corporate-driven model systematically displaced smallholder farmers, reinforced market dependency, and prioritized profits over sustainability. Similarly, Ajl & Sharma (2022) contend that the suppression of alternative agrarian models was a deliberate strategy to entrench Western-led agricultural modernization and maintain geopolitical control over developing nations.

Economically, the GR disproportionately benefited large-scale farmers with access to land, irrigation, and capital, while smallholder farmers struggled with debt from costly seeds and inputs (Ameen & Raza, 2017). Land consolidation policies linked to GR further displaced Indigenous and small-scale farmers, exacerbating poverty and inequality (Boafo & Lyons, 2021). While the GR prevented famine, it failed to eradicate hunger or improve the equitable distribution of food (Patel, 2013). Hunger persisted not due to food scarcity, but because of the GR's emphasis on production over distribution (Ajl & Sharma, 2022). Additionally, the focus on wheat, rice, and maize led to the displacement of traditional, diverse crops, causing nutritional deficiencies in many regions (Nelson, 2019).

2.2.2. The Emergence of Agroecology and the Integration of Indigenous Knowledge Systems

The negative impact of the GR paved the way for the emergence of agroecology in the 1930s as a viable alternative to industrial agriculture, following the recognition the value of traditional and Indigenous agricultural practices (Astier et al., 2017). Agroecology then evolved into a broader social movement advocating for a transformative shift in the global food systems, with interpretations and practices of agroecology as varied as the regions that have adopted this approach (Wezel et al., 2009; Wezel & Soldat, 2009). In the 2000s, agroecology was included in international policy debates and global agendas, thus solidifying the mainstreaming of this movement (Anderson & Maughan, 2021). Concurrently, in the recent decades, recognition grew for traditional knowledge/traditional ecological knowledge[27] (TEK), which forms the basis of Indigenous agriculture. TEK's potential to enhance biodiversity conservation and environmental management when combined with scientific ecological knowledge was

[27]TEK is a comprehensive, local knowledge system based on the cultural practices and environmental interactions of Indigenous and local communities. It integrates empirical observations with cultural values, promoting sustainable resource use (Berkes et al., 2000). The term TEK has been used interchangeably with traditional knowledge, Indigenous technical knowledge, ethnoecology, and rural knowledge.

acknowledged (Swiderska et al., 2011; Berkes et al., 2000). The ongoing study of traditional/Indigenous agroecosystems has accelerated the emergence of agroecological principles in the last four decades (Alzate et al., 2019).

As a result, the recognition of TEK laid the foundation for the convergence of Indigenous agriculture and the broader agroecological movement in recent years, particularly in terms of climate change-resilient farming systems (Altieri & Nicholls, 2017; Altieri et al., 2015). Based on the synthesis of multiple studies, Figure 2.4 is a visualization of the framework that depicts this intersection and the resulting agroecological transitions to modern sustainable agriculture.

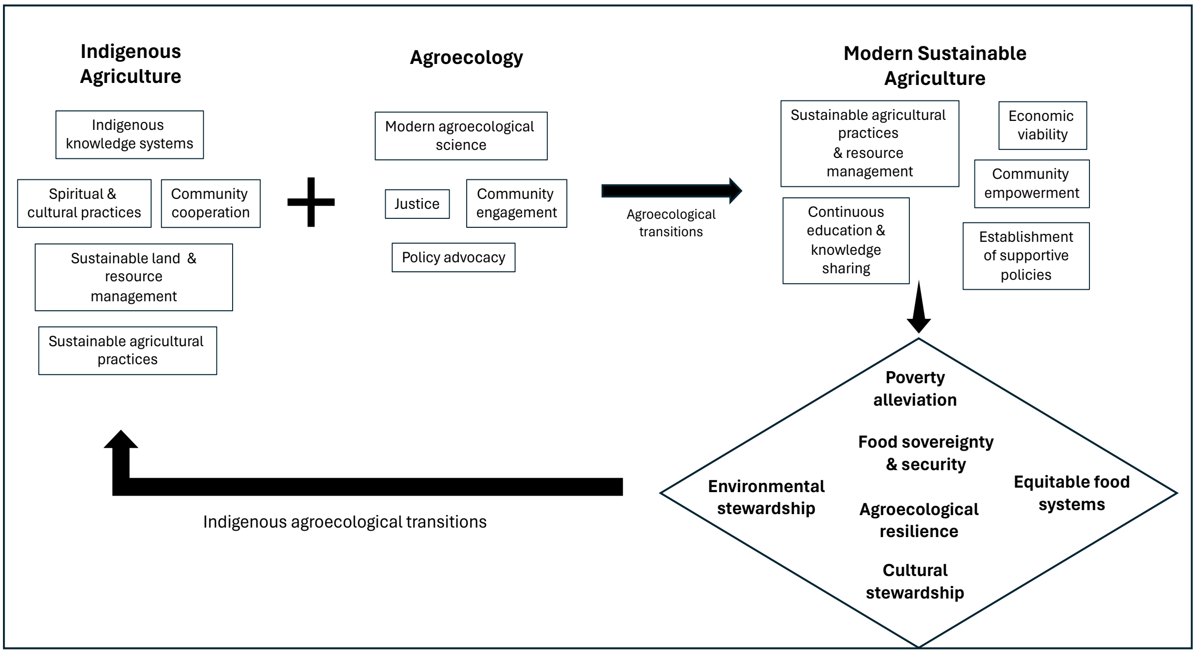

FIGURE 2.4: INTEGRATION OF INDIGENOUS AGRICULTURE WITHIN THE AGROECOLOGICAL FRAMEWORK

(Source: Author's interpretation)

Agroecology is the bridge between traditional/Indigenous practices and modern sustainable agriculture (Wezel et al., 2020), while simultaneously centering social justice through food sovereignty for rural and Indigenous communities (Boillat & Bottazzi, 2020; Hernandez, 2020; Timmermann & Félix, 2015) and preserving their cultural practices, ecological sustainability, and economic stability (Price et al., 2022; Anderson et al., 2019). The convergence of these practices leads to sustainable, resilient, equitable food systems for all. At the same time, due to this interaction and synergy, agroecological transitions are taking place within the Indigenous agriculture system as well, by way of Indigenous agroecological transitions. Key outcomes for Indigenous communities include food sovereignty and security, agroecological resilience, environmental stewardship, equitable food systems, and cultural stewardship. In this way, Indigenous communities are equally benefited by the process.

2.2.3. Characteristics of Agroecology, Modern and Indigenous Agriculture: A Comparison

There are clear differences between the current three main forms of agriculture, namely modern/industrial, Indigenous (or traditional) agriculture, and agroecology as shown in Table 2.2.

Criteria	Modern/ Industrial Agriculture	Indigenous Agriculture	Agroecology
Methods	Heavy reliance on chemical inputs (synthetic fertilizers and pesticides)	Relies on ecological and natural inputs and cycles (polycultures, crop rotations, and agroforestry)	Uses organic fertilizers and natural pest control measures, minimizes reliance on chemical inputs
	Utilizes large-scale, mechanized farming techniques	Practices are typically labor-intensive rather than mechanized	Uses energy efficient, cost-effective, sustainable mechanization (eg.conservation tillage equipment)
	Emphasizes monoculture	Focuses on diversity and the integration of multiple crop and animal species	Focuses on systems thinking and recognizes the interdependence of plants, animals, humans, and the environment
Objectives	Focused primarily on maximizing yield and profits	Aims to achieve food sovereignty and maintain the sustainability of the community's resources	Seeks to create sustainable agricultural systems that are productive, resilient to climate change, and beneficial to ecosystems
	Oriented towards large-scale production for national and global markets	Produces for local consumption and sustains the community's cultural and spiritual needs	Promotes social equity and community development alongside environmental objectives

Criteria	Modern/ Industrial Agriculture	Indigenous Agriculture	Agroecology
Environmental Impact	Often leads to significant environmental degradation (soil depletion, water pollution from runoff, and reduced biodiversity)	Tendency towards environmental sustainability, promoting biodiversity, soil health, and water conservation	Reduced negative impacts on the environment, enhanced biodiversity and soil fertility
	Contributes to greenhouse gas emissions through the use of fossil fuel-based machinery and inputs	Often utilizes practices that are adapted to local environmental conditions, minimizing ecological disruption	Seeks to mitigate climate change through sustainable practices like carbon sequestration and reduced energy use
Socioeconomic Impact	Can lead to the consolidation of land into fewer hands, resulting in fewer, larger farms	Supports community resilience by distributing resources and knowledge within the community	Encourages community involvement and empowerment through participatory approaches
	Often involves capital-intensive operations that can exclude smaller farmers	Preserves traditional knowledge and practices, passing these from generation to generation	Supports local economies and promotes fair trade, aiming to achieve both social justice and environmental sustainability
	Potentially reduces labor requirements per due to mechanization	Often challenged by lack of formal recognition and support, facing threats from land grabbing and commercial pressures	
Technological Integration	High degree of integration with global supply chains	Less reliant on modern technology and more on traditional practices that are passed down through generations	Leverages technologies that enhance the efficiency and sustainability while reducing ecological footprints (eg. renewable energy sources)
	Rapid adoption of new technologies, (eg. genetically modified organisms, GMOs, precision farming, and artificial intelligence)	May incorporate sustainable technologies in a way that aligns with traditional practices	The use of precision agricultural technologies (GPS, drone surveillance)

TABLE 2.2: THE CHARACTERISTICS OF MODERN AGRICULTURE, IA AND AGROECOLOGY

(Integrated sources: Çakmakçı et al., 2023; Wezel et al., 2020; Sangha, 2014; Altieri, 1995; Batie & Taylor, 1991)

Modern agriculture maximizes yields using synthetic chemicals and advanced machinery at a significant environmental and social cost, contrasting with agroecology and traditional or Indigenous farming methods (Batie & Taylor, 1991). Agroecology combines ecological science with practical farming to create sustainable and resilient food systems, benefiting the environment and local communities (Anderson et al., 2019). Meanwhile, traditional agriculture is rich in cultural heritage, utilizing time-honored methods that leverage biodiversity and natural ecosystem processes (Altieri, 1995). While Indigenous agriculture and agroecology both emphasize sustainability, biodiversity, and community resilience they differ in their degree of integration with modern scientific approaches and global markets.

2.3. The Foundations of Indigenous Agriculture

2.3.1. Principles and Processes

Indigenous agriculture or farming is an integral component of Indigenous Peoples' cultural identity and autonomy (Lamino Jaramillo & Boren-Alpízar, 2023; FAO et al., 2021). Beyond food production, Indigenous farming also supports the cultural, spiritual, and ecological health of the community. Indigenous Peoples' relationship with their ancestral lands is considered sacred, as land carries deep cultural and spiritual significance (Swiderska et al., 2022). Indigenous farmers have "developed and/or inherited complex farming systems that have helped them meet their subsistence needs" for thousands of years without mechanization or chemical inputs (Altieri, 1995). They use techniques that are optimized for productivity in the long term, focused on total farming system production. Usually, this involves small-scale mixed-crop subsistence systems. Indigenous management systems are sophisticated, unique, appropriate, and able to overcome various constraints such as slope, flooding, droughts, pests, disease, and low soil fertility (Altieri, 1995). The overarching principles and processes of Indigenous agricultural systems are explained in Table 2.3.

Principles & Processes	Practices	Rationale
Spatial and temporal diversity and continuity	Multiple cropping design	Constant food supply
		Vegetation cover for soil protection
		Diverse & nutritionally adequate diet

Principles & Processes	Practices	Rationale
	Extended crop harvest	Reduced necessity for storage
	Continuous sequence of crops	Maintain biotic relationships
Optimal use of space and resources	Crop mixtures with different growth habits, canopies, and root structures	Optimal use of environmental inputs (nutrients, water & solar radiation)
Recycling of nutrients	Collection of nutrient materials (manure, forest litter)	
	Fallow or rotational systems Intercropping with legumes	Maintenance of soil fertility
Water conservation	Cropping patterns adapted to amount and distribution of rainfall	Resource efficient, cost-effective, lower environmental impact (compared to irrigated systems); sustainable
	Emphasis on soil cover management	Avoid evaporation and runoff
Control of succession and protection of crops	Crop species and variety mixtures	Protection against pests and diseases
	Crop canopies	Suppress weed growth and minimize the need for weed control
Preservation of genetic diversity and adaptability to local conditions	Seed saving and sharing	Sociocultural heritage preservation, economic benefits, community resilience, resilience to climate change

TABLE 2.3: PRINCIPLES AND PROCESSES OF INDIGENOUS AGRICULTURE

(Source: Duthie-Kannikkatt et al., 2019; Altieri, 1995)

2.3.2. TEK in Indigenous Agriculture

TEK forms the basis of Indigenous agriculture, providing a critical foundation for agricultural practices that are closely adapted to local environments and sustainable in nature (Berkes, 2018). TEK in Indigenous agriculture involves the application of detailed knowledge about local ecosystems, soil types, water sources, plant species, and climate patterns, all of which are crucial for cultivating crops and managing livestock in ways that align with the ecological capacities and constraints of the area (Altieri, 1995). The various dimensions of TEK in Indigenous agriculture are detailed in Figure 2.5.

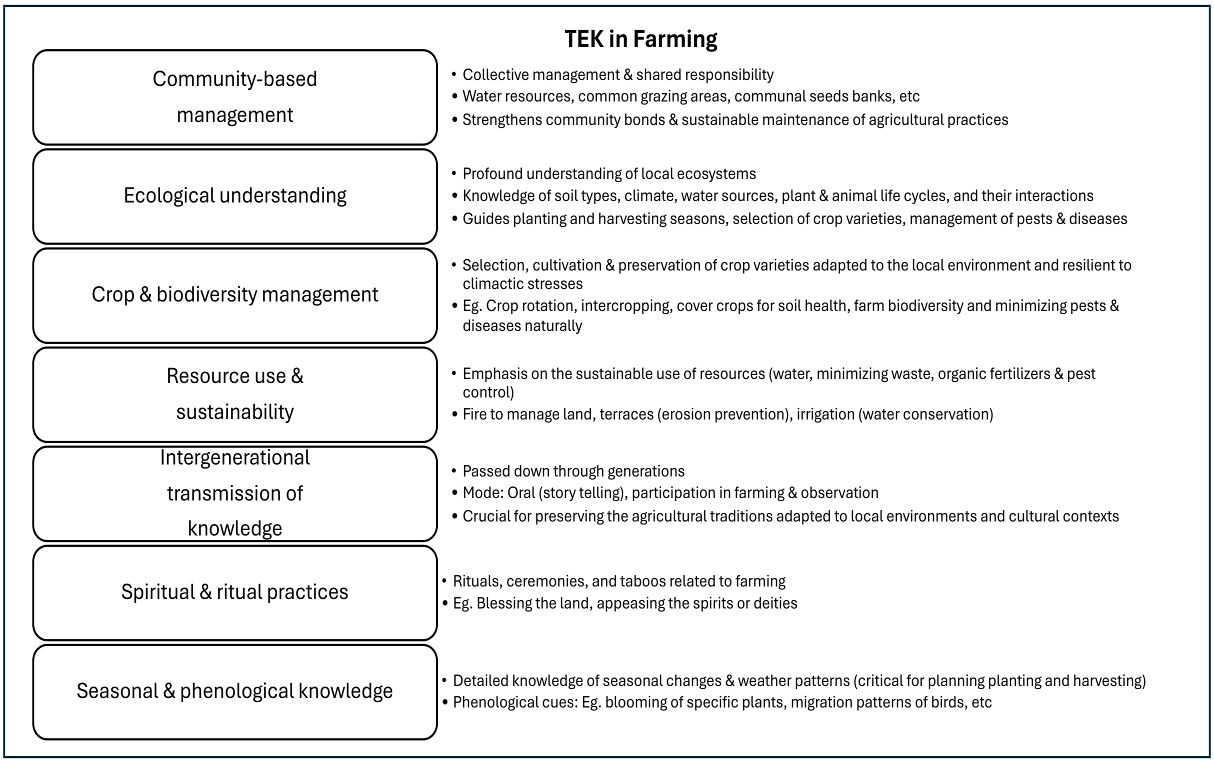

FIGURE 2.5: THE SEVEN DIMENSIONS OF TEK

(Source: Altieri, 1995)

TEK is inherently experimental, relying on keen observation and learning by trial and error (Altieri, 1995). TEK is also adaptive, constantly evolving to meet changing environmental conditions and societal requirements (Berkes, 2018). A few examples that demonstrate the experimental and adaptive nature of TEK include the selection of seed varieties according to the local environment, experimenting with new cultivation techniques in response to biological or socioeconomic constraints, and sustainable land management techniques such as water harvesting, soil conservation, and the sophisticated management of ecosystems (Berkes, 2018; Altieri, 1995).

2.3.3. Indigenous Pest Control Methods

Indigenous farmers utilize a variety of methods to manage agricultural pests, as shown in Table 2.4. These strategies are made up of direct (cultural, mechanical, physical, and biological) and built-in control mechanisms (Altieri, 1995). Indigenous pest control methods represent the natural management of pests, as opposed to the use of chemical-based substances commonly found in modern/industrial agriculture (ibid.).

STRATEGY	PRACTICES
Mechanical & physical control	Scarecrows, sound devices
	Wrapping of fruits, pods
	Painting stems, trunks with lime or other materials
	Destroying ant nests
	Digging out eggs/larvae
	Hand picking
	Removal of infested plants
	Selective pruning
	Application of materials (ash, smoke, salt, etc)
Cultural practices	Intercropping
	Overplanting or varying seeding rates
	Changing planting dates
	Crop rotation
	Timing of harvest
	Mixing crop varieties
	Selective weeding
	Use of resistant varieties
	Fertilizer management
	Water management
	Plowing and cultivation techniques
Biological control	Use of geese and ducks
	Transfer of ant colonies
	Collecting and/or rearing predators and parasites for field release
	Manipulation of crop diversity
Insecticidal control	Use of botanical insecticides
	Use of plants or plant parts as repellents and/or attractants
	Use of chemical pesticides
Religious/spiritual practices	Addressing spirits or gods
	Placement of crosses or other objects in the field
	Prohibition of planting dates and other seasonal restrictions

TABLE 2.4: PEST MANAGEMENT STRATEGIES EMPLOYED BY TRADITIONAL FARMERS (ALTIERI,1995)

2.4. Early Indigenous Cultivation Methods and Agroecosystems[28]

2.4.1. Seed Crop and Vegetative Reproduction

Early wheat farming in the Near East or early maize agriculture in Mesoamerica and Peru are examples of seed crop cultivation (Flannery, 1973). These were basic and simple ecosystems, with a limited number of species, usually a single crop. While highly productive, these systems were unstable because of low species diversity. Seed crops were found mostly in arid regions with good archeological preservation, as such much is known about farming here. Also, morphological changes in the seeds following domestication can usually be detected (ibid.).

On the other hand, vegeculture or vegetative reproduction such as manioc in Amazonia or yams and taro in Southeast Asia involve complex ecosystems, with a large diversity of cultivated species in a single field (Hutterer, 1983). Although less productive than seed crops, this method is substantially more stable ecologically (Flannery, 1973). Most early centers for vegeculture were humid tropical regions with poor archeological preservation. Most plants were cultivated by cutting roots or other vegetative parts which shows little or no morphological change after domestication. As such, less is known about root crops. The earliest methods of cultivation possibly included both shifting cultivation (or swiddening) and fixed-plot horticulture (ibid.).

2.4.2. Home Gardens

Home gardens form one of the earliest, most complex, multi-layered systems permanently found in small plots adjacent to houses, and are markedly different from dry or wet field cultivation (Rajagopal et al., 2021; Hutterer, 1983). Home gardens mimic natural forest ecosystems and contain a diverse mix of species of different heights and niches, that make up food and medicinal sources, timber, and industrial materials such as fibers (Yinebeb et al., 2022; George & Christopher, 2020; Díaz-Reviriego et al., 2016; Thomas & van Damme, 2010). They may have evolved from vegetational complexes found near waste areas surrounding the encampments of foraging populations (Hutterer, 1983). Home gardens may represent extremely early, unique and distinctive forms of cultivation especially in the tropics (ibid.).

[28]Agroecosystems are ecosystems that are managed and used for agriculture, replacing the natural flora and fauna with human selected crops and livestock (Altieri & Koohafkan, 2004). Indigenous agroecosystems are agricultural systems that are developed, managed and preserved by Indigenous communities based on traditional ecological knowledge and cultural practices (Olofson, 1983).

They are considered a major form of sustainable agriculture and subsistence (Huai & Hamilton, 2009).

2.4.3. Shifting Cultivation (Swiddening)

Shifting cultivation is practiced by approximately 200 to 300 million Indigenous Peoples across 64 developing countries, mainly in Southeast Asia and South America, where it has provided livelihoods and subsistence for millennia (Nath et al., 2022). Historically, shifting cultivation involves the rotational clearing of forest patches for crop cultivation, followed by a fallow[29] period longer than the crop phase to restore soil fertility (Kellogg, 1963). Traditional swidden systems are ecologically sophisticated and well-adapted to tropical conditions, allowing farmers to manage weeds, pests, and soil nutrients effectively (Magnuszewski et al., 2015; Warner, 1991).

The cornerstone of swidden/fallow cultivation lies in its reliance on natural processes and the cultivators' deep understanding of microenvironments in forests and fields, as well as the specific microsite requirements of different crops. This knowledge allows swiddens to thrive where other land use systems fail (Warner, 1991). Traditional swidden/fallow systems are highly adaptable, responding dynamically to environmental shifts and population changes, making them resilient land-use strategies (ibid.). Importantly, the practice of shifting cultivation is diverse and complex, with varying forms across different regions, reflecting the unique ecological and cultural contexts in which it is practiced (Nath et al., 2022). It is not merely an agricultural system, but a way of life deeply entrenched in the cultural and spiritual beliefs of Indigenous communities, serving as a cornerstone of food security and social identity (ibid.).

2.4.3.1. Challenges, Myths and Policy Marginalization

Despite its ecological benefits, shifting cultivation is undergoing significant transformations due to restrictive policies, conservation efforts, and economic pressures (Burchfield, 2022; Kilawe et al., 2018). Many policies marginalize shifting cultivation in favor of large-scale, capital-intensive agriculture, often disregarding its historical and ecological significance

[29] There are three types of fallows: (1) forest fallow (20-25 years); (2) bush fallow (6-10 years), and grass fallow (less than 5 years) (Altieri, 1995).

(Falvey, 2017). The persistence of myths surrounding shifting cultivation serves the interests of powerful entities seeking to exploit Indigenous lands for resource extraction and industrial farming (Dove, 1983). These misconceptions enable policies that displace traditional swidden agriculturists, framing them as inefficient or environmentally destructive while facilitating corporate land grabs and large-scale agricultural expansion (ibid.).

A case study by Lawrence et al. (2019) highlights how globalized agriculture[30] is shifting land tenure from community-based systems to individual ownership, pushing traditional farmers into market-oriented activities. This transition from small-scale, diverse farming to large-scale monocropping and livestock farming accelerates deforestation and biodiversity loss (ibid.). Political and economic forces at the global level intensify these changes, reinforcing land concentration in the hands of a few while dispossessing Indigenous cultivators.

In Tanzania, shifting cultivation is declining due to land tenure policies and competition from pastoralists, negatively impacting food security and household incomes (Kilawe et al., 2018). Similarly, in Vietnam, state interventions since the colonial period have sought to replace shifting cultivation with permanent agricultural systems, citing economic inefficiency and environmental concerns (McElwee, 2022). These interventions, including land-use zoning, resettlement, and fixed cultivation programs, have often failed due to strong cultural attachments and economic dependence on swidden practices (Pandey et al., 2020).

Southeast Asia has seen extensive criminalization of shifting cultivation, with restrictive conservation policies undermining smallholder farmers who lack viable alternatives (Mertz & Bech Bruun, 2017). In the Brazilian Amazon, where fire-based shifting cultivation remains crucial, fire management policies fail to align with local practices, limiting compliance (Carmenta et al., 2013). Furthermore, globalized agriculture is shifting land ownership from community-based systems to individual ownership, fostering market-driven land use and landscape transformations that undermine traditional cultivation systems (Lawrence et al., 2019).

[30] Globalized agriculture is the integration and interdependence of agricultural production and distribution systems across the world, and involves the transfer of agricultural practices, technologies, and crops between countries, causing changes to local farming practices, food availability, and economic conditions (Robinson, 2018).

2.4.3.2. Misconceptions and Ecological Sustainability

Swidden agriculture has been criticized, misrepresented, and misunderstood over the decades (Nath et al., 2022; Dove, 1983). The widespread belief that shifting cultivation causes deforestation overlooks the larger role of commercial plantations, logging, and land-use change (Nath et al., 2022). Empirical studies challenge direct links between shifting cultivation and deforestation, advocating for nuanced, evidence-based policies that integrate Indigenous knowledge (ibid.). In reality, swidden agriculture can support higher population densities and be more productive per hectare than commercial logging or monocropping systems (Dove, 1983).

Contrary to popular narratives, shifting cultivation promotes biodiversity and acts as a carbon sink. Regenerating secondary forests from fallow periods provide better ecosystem services than many forms of conventional agriculture (Mertz et al., 2021). Secondary woodland habitats support high biodiversity levels and contribute to carbon sequestration (Mcnicol et al., 2015). Sustainability in shifting cultivation depends on ecological factors such as soil fertility, fallow periods, and forest regeneration, as well as market access and economic incentives that allow cultivators to maintain traditional practices without environmental degradation (Cairns, 2007).

2.4.3.3. The Future of Shifting Cultivation: Sustainability and Indigenous Sovereignty

The decline of shifting cultivation is often framed as inevitable due to pressures from land use changes, logging, and national policies (Warner, 1991). However, its future does not have to be one of disappearance, but rather adaptation. By integrating traditional ecological knowledge (TEK) with agroforestry and sustainable land management, swidden agriculture can continue to serve both economic and ecological functions (Hazarika et al., 2024).

Despite these challenges, shifting cultivation remains one of the pillars representing Indigenous sovereignty. Community-managed landscapes have been shown to be sustainable and capable of maintaining biodiversity, but ensuring customary land tenure systems is key to this crucial factor (Lawrence et al., 2019). In this regard, Indigenous communities should be at the forefront of land-use governance, ensuring that their rights, knowledge, and practices shape conservation and agricultural policies (ibid.).

The Food and Agriculture Organization (FAO) recognizes shifting cultivation as crucial for environmental preservation and biodiversity, advocating for policies that support semi-domesticated and domesticated species in local ecosystems (FAO et al., 2021). However, over the past four to five decades, increasing regulatory barriers have negatively impacted Indigenous Peoples, reducing their food security and local biodiversity (ibid.).

The future of shifting cultivation requires adaptive governance - one that acknowledges its ecological value, its cultural significance, and its role in maintaining biodiversity. Indigenous empowerment, land rights, and co-management strategies are essential to ensuring that shifting cultivation continues to provide economic, ecological, and cultural benefits in an evolving global landscape (Lawrence et al., 2019).

2.5. Indigenous Agroforestry[31]

2.5.1. Key Attributes and Types of Indigenous Agroforestry Systems

Indigenous agroforestry, as understood in Indigenous knowledge systems, refers to traditional, locally adapted systems that integrate trees, crops, and sometimes livestock within a landscape. While agroforestry is widely used in Western scientific literature, Indigenous agroforestry differs significantly in its integration of cultural, ecological, and spiritual elements, which are often overlooked in conventional definitions (Gliessman, 2015). These systems are deeply rooted in the cultural and ecological knowledge of Indigenous communities (Vallejo et al., 2014; Schulz et al., 1994), balance agricultural productivity with ecological sustainability, and often contribute to biodiversity conservation, cultural heritage, and local livelihoods (Soto-Pinto et al., 2010; Deb et al., 2009). The major features and specific elements of Indigenous agroforestry are presented in Table 2.5, whereas the different forms of Indigenous agroforestry systems are categorized in Table 2.6.

[31]Agroforestry is a sustainable land use management system in which trees or shrubs are grown around or among crops or pastureland in a simultaneous or sequential manner (Leakey, 2017). This system is specifically suitable for marginal areas and low-input systems (Altieri, 1995).

Key Features	Specific Elements	Description
Diversity and Polyculture	Multiple species cultivation	Integration of a variety of plant species, including trees, crops, and sometimes animals, in the same area
	Natural regeneration	Indigenous people often allow trees to regenerate naturally within their agroforestry systems
	Species richness	Older agroforestry systems tend to have greater species richness and diversity, sometimes even surpassing nearby natural forests
Traditional Ecological Knowledge	Time-tested techniques	Developed and refined over centuries, incorporating deep understanding of local ecosystems
	Cultural significance	Agroforestry practices are often intertwined with the cultural identity and traditional lifestyles of Indigenous communities
Ecosystem Mimicry	Forest-like structure	Designed to mimic the structure and function of natural forests
	Vertical stratification	Different plants occupy various vertical layers, like natural forest ecosystems
Multi-functionality	Food security	Provide diverse food sources, including fruits, vegetables, and traditional crops.
	Income generation	May serve as sources of supplementary income for households
	Ecosystem services	Contribute to biodiversity conservation, carbon sequestration, and sustainable land management
Adaptability and Resilience	Site-specific practices	Different communities have developed unique agroforestry systems adapted to their specific environmental and cultural contexts
	Climate resilience	Often more resilient to climate variations and extreme weather events compared to monoculture systems
Integration with Landscape	Land use mosaic	Part of a broader land management strategy that includes spaces for residence, farming, and food collection
	Ecosystem connectivity	Often maintain connectivity with surrounding natural ecosystems, supporting wildlife and ecological processes

TABLE 2.5: KEY FEATURES OF INDIGENOUS AGROFORESTRY SYSTEMS

(Integrated sources: Islam et al., 2017; Parihaar et al., 2015; Vallejo et al., 2014; Soto-Pinto et al., 2010; Deb et al., 2009; Hellin et al., 1999)

No.	Types of Indigenous Agroforestry Systems	Description	Examples
1.	**Multilayered Forest Gardens**	Systems mimicking natural forest structures with multiple canopy layers, combining trees, shrubs, and crops for ecological and economic benefits.	**Eastern Brazil**: Native and commercial species (eg. cocoa), managed with minimal external inputs (Schulz et al., 1994). **Tehuacán Valley, Mexico**: Preservation of perennial native plants for food, medicine, and shade (Vallejo et al., 2014).
2.	**Polyculture Agroforestry**	Systems that interplant diverse annual and perennial crops with trees to enhance ecological stability and productivity.	**Amazon Basin:** Millennia-old polyculture systems combine crops like maize with edible and medicinal trees, contributing to biodiversity conservation and food security (Miller & Nair, 2006).
3.	**Shifting Cultivation with Tree Integration**	Rotational farming where fallow periods include deliberate tree planting or retention to enrich soil and provide resources like timber and fuelwood.	**Nyishi Tribe (India)**: Indigenous shifting cultivation integrates fruit and timber trees during fallow phases for soil enrichment and ecosystem services (Deb et al., 2009).
4.	**Home gardens**	Small, diverse plots near households that integrate trees, shrubs, crops, and sometimes livestock. These systems provide food, medicine, and cultural value.	**Miao Home gardens (China)**: Feature medicinal plants, food crops, and fodder trees (Huai & Hamilton, 2009). **Ethiopia**: Integration of food crops with coffee and native trees (Yinebeb et al., 2022). **India (Arunachal Pradesh)**: Integration of fruit trees, vegetables, and medicinal plants (George & Christopher, 2020).
5.	**Silvopastoral Systems**	Integration of trees with grazing systems to provide shade, fodder, and additional ecological benefits.	**Kashmir Valley**: Indigenous silvopastoral systems integrate trees like Salix spp. and Populus spp. with livestock grazing areas (Islam et al., 2017).

No.	Types of Indigenous Agroforestry Systems	Description	Examples
6.	**Boundary Plantations**	Trees planted along field edges, roads, or canals for erosion control, windbreaks, and resource production (e.g., timber, fuelwood).	**Kashmir Valley**: Populus and Salix species are planted along boundaries to support fuelwood and timber needs (Islam et al., 2017). **Kumaun Himalaya, India**: Multipurpose trees (eg. *Tectona grandis*) along boundaries for ecological and economic benefits (Parihaar et al., 2015).
7.	**Riparian Agroforestry**	Systems established along rivers and streams to stabilize banks, prevent erosion, and protect water resources.	**Kumaun Himalaya, India**: Indigenous farmers plant trees along canals and waterways to safeguard soil and water (Parihaar et al., 2015).
8.	**Carbon-Sequestration-Oriented Agroforestry**	While modern in intent, certain Indigenous systems inherently contribute to carbon sequestration through the deliberate inclusion of high-biomass trees.	**Chiapas, Mexico**: Indigenous polyculture shade-grown coffee systems contribute significantly to carbon storage while maintaining biodiversity (Soto-Pinto et al., 2010).
9.	**Enriched Fallows**	Fallow phases in shifting cultivation systems are enhanced with managed tree planting or retention to accelerate soil regeneration and provide additional resources.	**Amazon Basin**: Pre-Columbian enriched fallows include edible and timber trees, with evidence of long-term soil and biodiversity improvements (Miller & Nair, 2006).

TABLE 2.6: TYPES OF INDIGENOUS AGROFORESTRY SYSTEMS

From the literature, there appear to be overlaps between the different categories of Indigenous agroforestry systems. Although home gardens and multilayered forest gardens share common features such as species diversity and ecological mimicry; however, home gardens are smaller in scale and centered around households, while forest gardens typically encompass larger areas. Polyculture agroforestry and enriched fallows also overlap, with enriched fallows often representing a phase within polyculture systems where trees are retained to enhance soil fertility and biodiversity. Similarly, boundary plantations and riparian agroforestry both involve linear tree planting. Still, they differ in location and primary purpose — boundary plantations focus on demarcating land and providing resources such as timber, whereas riparian agroforestry prioritizes erosion control and water resource protection.

Home gardens and shifting cultivation are important and major components of Indigenous agroforestry systems, which have long been utilized by Indigenous communities, historically preceding experimental agroforestry as propounded by contemporary scientists (Olofson, 1983). They are not developed randomly and are based on a deep understanding of agricultural interactions guided by complex ethnobotanical classification systems (Altieri, 1995). Indigenous agroforestry is deeply integrated into real-life and ongoing agricultural practices, as opposed to being limited to experimental fields (Olofson,1983). These systems are also intricately integrated with local ecosystems, featuring diverse biodiversity that promotes sustainable nutrient cycling and agricultural productivity (ibid.). Agroforestry is widely practiced by Indigenous and traditional societies (Table 2.6) throughout the tropics (Dagar & Tewari, 2018).

Indigenous agroforestry practices are vital for food security, income generation, and biodiversity preservation, deeply integrated into the cultural and spiritual lives of Indigenous communities (Gonçalves et al., 2021). These systems are economically viable and support subsistence by enabling surplus sale in local markets and the development of value-added products such as herbal teas and crafts. Studies have shown that traditional polycultures often outperform monocultures in total productivity per unit area when considering all outputs, such as food, medicine, fuel, and fiber (Altieri, 2004, as cited in Gonçalves, 2021). Furthermore, these systems rely on local resources, minimizing external inputs and thus reducing production costs while enhancing resilience against environmental and market shocks. They offer significant environmental and social benefits, including ecosystem services and community well-being. Indigenous agroforestry systems also contribute to hybrid livelihood models that include agroecological tourism and diversified income strategies. They provide invaluable lessons in ecological sustainability, cultural integration, and resilience, showcasing diverse structures and functions that adapt to local ecological and socio-economic conditions. By effectively integrating traditional knowledge with modern environmental goals, Indigenous agroforestry systems highlight the potential for sustainable land use (ibid.).

However, these systems face considerable challenges and vulnerabilities. The loss of traditional knowledge due to modernization and external pressures is a critical challenge, as exemplified by the introduction of monocultures that threaten the biodiversity and sustainability of specific agroforestry systems (Vallejo et al., 2014). Economic marginalization also hinders these systems, as many, while ecologically sound, struggle to compete economically with modern agricultural practices. For instance, in Chiapas, Mexico, traditional agroforestry systems require external support to remain viable (Soto-Pinto et al., 2010). Institutional neglect further limits the scaling and adoption of agroforestry. In Arunachal Pradesh, India, farmers are reluctant to transition from traditional systems without adequate institutional support (Deb et al., 2009). Moreover, despite extensive documentation, critical knowledge gaps persist, particularly in understanding the socio-economic dynamics and scalability of these systems. In Chiapas, while the carbon sequestration potential of agroforestry is well-documented, the socio-economic impacts are less explored (Soto-Pinto et al., 2010).

Addressing these vulnerabilities requires greater institutional support, enhanced valuation of traditional knowledge, and policies that integrate ecological, cultural, and economic priorities. Furthermore, additional research on the economic impacts and adoption factors of Indigenous agroforestry systems is essential to inform public policy while centering Indigenous concerns.

2.5.2. Olofson's Framework for Harmonic and Disharmonic Indigenous Agroforestry Systems

Olofson's (1983) foundational conceptual framework for Indigenous agroforestry systems is a valuable tool for assessing Indigenous swiddens. Olofson categorizes these systems into two distinct types: (1) harmonic, and (2) disharmonic swiddens. These classifications form a basis for evaluating how traditional agricultural practices align with ecological sustainability and cultural integration. Harmonic swiddens, as Olofson defines, represent a synergy between human activity and natural ecosystems, prioritizing biodiversity, resource regeneration, and long-term environmental balance. In contrast, disharmonic swiddens are characterized by practices that degrade ecological systems, reduce biodiversity, and overexploit land resources. This framework provides a structured method to assess traditional swidden systems. Table 2.7 comprehensively summarizes Olofson's criteria for harmonic and disharmonic swiddens based on his definitions.

Criterion	Harmonic Swiddens	Disharmonic Swiddens
Ecological Integration	Strong integration with local ecosystems, resembling natural forest structures.	Weak integration with local ecosystems, often involving large-scale clearing.
Biodiversity	High biodiversity with multiple plant and crop species.	Low biodiversity, often dominated by monoculture or a few crop species.
Soil Management	Soil fertility preserved through fallow periods, organic recycling, and minimal disturbance.	Soil fertility declines due to overuse, short fallow periods, and reliance on external inputs.
Land Use Intensity	Moderate intensity, with sufficient fallow periods for ecological recovery.	High intensity, with short or no fallow periods leading to land degradation.
Crop Rotation and Intercropping	Practice of crop rotation and intercropping to mimic natural ecosystems.	Reliance on single cropping (monoculture), reducing ecosystem resilience.
Environmental Impact	Minimal environmental degradation, with practices like controlled burning enhancing ecological balance.	Significant environmental impact, including deforestation, soil erosion, and biodiversity loss.
Cultural and Social Practices	Deeply integrated with cultural rituals and community norms, fostering sustainable practices.	Minimal integration of cultural values, with economic pressures often driving practices.
Pest Management	Non-violent, ecosystem-based pest management strategies that maintain harmony with fauna.	Reliance on chemical or destructive pest control methods, disrupting ecological balance.
Long Term Sustainability	Practices are sustainable over generations, ensuring a balance between use and regeneration of resources.	Unsustainable practices that exhaust land resources over short periods, forcing shifts to new areas.
External Inputs	Limited or no use of chemical fertilizers or pesticides, relying on natural cycles.	High dependence on external inputs, including chemicals and machinery, to maintain productivity.
Human-Nature Relationship	Symbiotic, with humans perceived as stewards of the land.	Exploitative, prioritizing short-term gains over long-term ecological health.

Criterion	Harmonic Swiddens	Disharmonic Swiddens
Adaptation to Local Conditions	Practices are adapted to local climatic, ecological, and social conditions.	Practices are often imported or unsuitable for local conditions, leading to inefficiencies and ecological imbalance.

TABLE 2.7: OLOFSON'S (1983) CRITERIA FOR HARMONIC AND DISHARMONIC SWIDDENS

(Source: Olofson, 1983)

Olofson's framework for assessing Indigenous swiddens offers a valuable method for evaluating the sustainability of traditional agricultural practices. By distinguishing harmonic systems, which integrate with natural ecosystems, from disharmonic systems, which degrade them, it highlights ecological, cultural, and social dimensions. Its emphasis on biodiversity, intercropping, long fallow periods, and cultural rituals makes it a flexible tool for understanding transitions in swidden systems and guiding sustainable policy and conservation efforts (Olofson, 1983).

However, the framework has notable limitations. Its binary classification oversimplifies complex systems, many of which exhibit mixed traits. It assumes static conditions, overlooking how swiddens adapt to factors like land scarcity or climate change. The focus on internal practices neglects external pressures, such as market demands and government policies, while reliance on qualitative terms like "integration" introduces subjectivity. Additionally, it fails to address power dynamics, including the impacts of state interventions and land tenure conflicts.

To improve its utility, the framework should incorporate quantitative metrics such as biodiversity indices and soil fertility measures for greater objectivity. Expanding its scope to account for external pressures and adopting a spectrum approach would better reflect the complexity of swiddens. Adding dynamic analysis to capture temporal changes and addressing governance issues, such as land tenure, would provide a more comprehensive understanding. These refinements would enhance its relevance for assessing the resilience and sustainability of swidden systems in diverse and evolving contexts.

2.5.3. Indigenous Agriculture versus Indigenous Agroforestry Systems

Indigenous agriculture and Indigenous agroforestry are closely related but distinct systems. They share similarities in their use of traditional knowledge and sustainability goals. Still, the inclusion of woody perennials and the emphasis on ecosystem services are defining characteristics that set Indigenous agroforestry apart. To address concerns about terminology, Table 2.8 differentiates Indigenous agriculture from Indigenous agroforestry, ensuring that Indigenous knowledge systems are centered in this classification. While Western agroforestry models emphasize economic and ecological functions, Indigenous agroforestry systems are deeply embedded in social, spiritual, and environmental relationships, making them distinct in both practice and philosophy.

Aspect	Indigenous Agriculture	Indigenous Agroforestry
Definition	A traditional system of cultivating crops using Indigenous methods, often relying on local knowledge of soils, climate, and plants.	A traditional system that integrates trees, shrubs, crops, and sometimes livestock in a managed landscape.
Components	Primarily involves crops (e.g., grains, tubers, vegetables) with little or no deliberate inclusion of woody perennials.	Includes trees, shrubs, crops, and sometimes livestock, deliberately arranged for mutual benefits.
Ecological Role	Focuses on soil fertility through practices like crop rotation and fallows; limited emphasis on long-term ecological interactions.	Enhances biodiversity, carbon sequestration, and soil health by combining plant species with complementary functions.
Productivity	Primarily aimed at food production, with some secondary benefits such as fodder or fuelwood.	Balances food, timber, fuel, fodder, and other ecosystem services (e.g., shade, erosion control).
Examples	Swidden (shifting) cultivation, terraced farming, and wetland agriculture.	Multi-story gardens, silvopastoral systems, and boundary plantations.
Cultural Connection	Closely tied to subsistence and rituals but often seen as seasonal or temporal activities.	Often a more permanent or semi-permanent system deeply tied to cultural and ecological continuity.
Impact on Biodiversity	May reduce biodiversity due to monoculture cropping or intensive cultivation practices.	Enhances biodiversity through the deliberate inclusion of diverse species and ecological niches.
Carbon Sequestration	Limited due to focus on crops and short-term vegetation cycles.	Significant due to the inclusion of trees and shrubs, which store carbon long-term.

TABLE 2.8: KEY DIFFERENCES BETWEEN INDIGENOUS AGRICULTURE AND INDIGENOUS AGROFORESTRY SYSTEMS

(Source: Author's Interpretation)

Shifting cultivation is primarily a form of Indigenous agriculture but can overlap with agroforestry when the fallow stage involves the deliberate use or management of trees. This distinction depends on the presence or absence of tree management during the cultivation and fallow phases. Table 2.9 provides a framework for understanding the nuanced differences between these two systems.

Characteristic	Shifting Cultivation as Agriculture	Shifting Cultivation as Agroforestry
Fallow Phase	Natural regrowth without human intervention.	Deliberate planting, retention, or management of trees during the fallow phase.
Tree Role in Cultivation	Minimal or incidental (e.g., trees cut down or burned before cropping).	Integral, with specific trees retained or added for soil improvement, shade, or timber.
Management Objective	Focuses on crop cycles with fallow periods to regenerate soil fertility.	Combines crop production with long-term ecological and economic benefits from trees.
Ecological Emphasis	Short-term soil fertility regeneration through natural processes.	Enhances biodiversity, carbon sequestration, and soil health through active tree inclusion.

TABLE 2.9: FRAMEWORK FOR UNDERSTANDING THE DIFFERENCES BETWEEN SHIFTING CULTIVATION AS AGRICULTURE VS SHIFTING CULTIVATION AS AGROFORESTRY

(Source: Author's Interpretation)

When shifting cultivation focuses purely on cropping during the cultivation phase and relies on natural regrowth during fallow periods without active tree management, it is categorized as Indigenous agriculture. A common example is slash-and-burn farming, where trees or woody perennials are not actively managed in the fallow stage, relying instead on natural ecological processes for soil recovery.

In contrast, shifting cultivation becomes a type of agroforestry when it includes the deliberate planting, retention, or management of trees during both the cropping and fallow phases. These systems integrate trees into the agricultural cycle to enhance soil fertility, provide resources like timber or fruit, and improve ecosystem stability. Examples include systems where farmers retain or plant fruit, timber, or nitrogen-fixing trees during fallow periods, such as the Amazon polyculture systems (Maezumi et al., 2018b) or traditional agroforestry practices in Arunachal

Pradesh (Deb et al., 2009). These practices illustrate the seamless integration of agriculture and forestry to achieve economic and ecological benefits.

2.5.4. Contemporary versus Indigenous Agroforestry

Agroforestry has been practiced since the inception of agriculture and involves techniques developed through traditional Indigenous knowledge (Dagar & Tewari, 2018). These time-tested methods continue to be used across various agroecological zones. The traditional knowledge and ecological principles of Indigenous agroforestry systems have been instrumental in creating improved agroforestry systems found at present. Modern agroforestry practices, including improved fallows, home gardens, and park systems, have evolved from these ancient roots (ibid.). However, it is important to note that there are clear differences between the two agroforestry systems, which may be understood in terms of their origins, methodologies, purposes, and cultural integration, as shown in Table 2.10.

Elements	Indigenous Agroforestry	Contemporary Agroforestry
Origins and development	Developed through intergenerational traditional knowledge within local communities. The result of centuries of adaptation to local environmental conditions and cultural practices.	Often developed through scientific research and formal experimentation. The result of modern agricultural studies and innovations designed to optimize specific outcomes such as yield, sustainability, or ecological benefits.
Methodologies	Relies on natural and local resources, traditional farming techniques, and a holistic understanding of the ecosystem. It often involves practices that naturally maintain soil fertility and use biodiversity to manage pests and diseases.	Typically employs scientific methods, modern agricultural techniques, and often includes the use of advanced technologies, genetically modified organisms, or synthetic inputs to enhance productivity and sustainability.
Purposes and goals	While sustainable, primary goal often revolves around community subsistence, cultural preservation, and maintaining a balance with the local ecosystem. These systems are designed to sustain local populations and cultural traditions.	Often aims to address specific global challenges such as climate change, deforestation, or food security. The focus can be on maximizing outputs while minimizing environmental impacts.

Elements	Indigenous Agroforestry	Contemporary Agroforestry
Cultural integration	Deeply integrated into the cultural fabric of the communities that practice them, reflecting local beliefs, customs, and social structures. These systems are not only about food production but are also part of the community's identity and heritage.	While culturally sensitive approaches are increasingly common, many contemporary systems are designed to be universally applicable, sometimes overlooking local social or cultural dynamics.
Ecological impact	Generally exhibits a high degree of ecological integration, promoting biodiversity and sustainability through practices that have coevolved with the local environment over generations.	Designed with ecological benefits in mind, such as carbon sequestration, biodiversity conservation, and erosion control, these systems can be highly effective but sometimes lack adaptation to specific local conditions.
Scalability and adaptability	Typically localized and highly adapted to specific micro-environments. They might not be as easily scalable or applicable to areas outside their region of origin without significant adaptation.	Often scalable and designed to be adapted across different regions with modifications. These systems can be part of large-scale agricultural operations.

TABLE 2.10: A COMPARISON OF INDIGENOUS AND CONTEMPORARY AGROFORESTRY

(Source: Dagar & Tewari, 2018; Gliessman, 2015)

Indigenous agroforestry systems should be recognized within their own knowledge frameworks, rather than imposed Western classifications that risk misrepresenting their complexity (Swiderska et al., 2022). While the term ‘agroforestry’ encompasses certain aspects of Indigenous land use, it often fails to account for the broader cultural, ecological, and spiritual dimensions that are foundational to these systems (Gliessman, 2015). This oversight can result in the misinterpretation or oversimplification of complex, culturally enriched practices that are integral to iundigenous communities. Recognizing the holistic integration of ecological, cultural, and spiritual elements within Indigenous agroforestry highlights the need for a decolonial approach that respects Indigenous knowledge systems and governance structures, rather than imposing external categorizations that may undermine their significance.

2.6. Indigenous Mixed Subsistence Strategies

Historically, Indigenous communities worldwide have relied on a combination of hunting, gathering, and farming, creating a diverse and resilient food base that adapts to seasonal and environmental changes (Sierra, 2016). Today, this mixed subsistence strategy persists, although the balance between foraging and farming may vary greatly based on local conditions and external influences like market access and land rights. Integrating hunting-gathering with farming often enhances ecological sustainability, as seen in agroforestry systems that mimic natural forests, supporting biodiversity and nutrient cycling. These practices are embedded in cultural traditions and knowledge systems, regulated by rituals and customary laws, ensuring sustainable resource management and the transmission of ecological knowledge (ibid.). For example, the Rarámuri people of Mexico have developed intricate local knowledge and strategies for sustainable harvesting, which contribute to biodiversity conservation (LaRochelle & Berkes, 2003). These practices include selective harvesting, environmental modification, and domestication, which are found in their cultural and spiritual beliefs (ibid.). Employing a mixed subsistence economy also enhances food security and economic resilience by diversifying sources of nutrition, reducing dependency on a single food source, and acts as a buffer against crop failures or game scarcity (Billong Fils et al., 2020).

2.7. Indigenous Food Sovereignty

Indigenous food sovereignty refers to the right of Indigenous Peoples to define their own food and agricultural systems (Huambachano, 2019). It emphasizes the importance of traditional ecological knowledge (TEK), cultural practices, and spiritual relationships with the land and environment. This concept goes beyond the legal and human rights frameworks associated with food sovereignty, focusing instead on collective and cultural responsibilities. Indigenous food sovereignty emphasizes sustainable and ecologically sound methods of food production that are culturally appropriate and contribute to the well-being of the community and the environment (ibid.). Despite facing challenges such as economic inequality, environmental degradation, and cultural erosion, Indigenous and peasant agricultural practices in regions such as New Zealand, Peru, and Latin America are shown to be resilient, and offer sustainable alternatives to industrial agriculture (Price et al., 2022; Huambachano, 2018; Parraguez-Vergara et al., 2018). These studies advocate for supportive policies that recognize and uphold Indigenous rights, promote community-based practices, and ensure the continuation of traditional knowledge and sustainable food production methods. Overall, Indigenous food sovereignty is an important component in the aspirations for environmental justice and sustainable development (ibid.).

2.8. Indigenous Food Security

While Indigenous food sovereignty focuses on the political and cultural rights to define food systems, food security reflects the tangible conditions and challenges affecting food access, use, and sustainability. Both are interlinked yet distinct components of Indigenous food systems and are discussed here separately to preserve analytical clarity.

Indigenous food security encompasses not only the availability, access, utilization, and stability of food but also integrates cultural practices, community involvement, and environmental sustainability (Shafiee et al., 2022). It emphasizes the importance of traditional and Indigenous food crops (van der Merwe et al., 2016) and ecological knowledge (Ogundiran, 2019b) in ensuring healthy food systems in Indigenous population. The impact of external factors like climate change (Chanza & Musakwa, 2022) and extractive industrial activities (Blanco et al., 2023) lead to serious environmental degradation, thus jeopardizing Indigenous food systems that depend on the integrity of a healthy agroecosystem. A major threat to Indigenous food security is the loss of TEK and cultural practices from encroaching modernization and the influence and eventual reliance on a globalized food system (incorporation of Western diets) that results in a decline in the understanding and use of traditional foods (Shafiee et al., 2022).

While market access has made food more practical and affordable, this shift has also reduced food sovereignty and increased dependency on external food sources instead of self-sufficiency (Erni, 2015). This trend is exacerbated by the displacement of Indigenous communities from ancestral lands disrupts traditional food practices and access to natural resources that are crucial for food security (Sidiq et al., 2022). As such, sustainable management of natural resources and the need for policies that integrate environmental and food security considerations are integral for Indigenous food security (Dirgahayu et al., 2023). It is also important to recognize the role of youth in reviving Indigenous food systems (Bagelman, 2018).

In an extensive study involving First Nations Peoples, Davies et al. (2023) elucidate the lessons from various food security programs and emphasize the importance of culturally sensitive approaches in setting up food security programs for Indigenous Peoples. This necessitates a participatory research and community governance approach. The study also stressed the need to include traditional food systems to enhance food sovereignty. Overall, a holistic approach will ensure that Indigenous food security addresses cultural relevance, community governance, and resilience against disruptions, providing a comprehensive framework for the well-being of Indigenous communities (Shafiee et al., 2022).

2.9. Indigenous Climate Change Vulnerabilities and Adaptation

Multiple studies have discussed the relevance of Indigenous knowledge to planetary health, particularly climate change adaptations (Petzold et al., 2020; Son et al., 2019; Kodirekkala, 2018; Singh & Singh, 2017). Indigenous Peoples are also especially vulnerable to the impacts of climate change (Porcuna-Ferrer et al., 2024; Whyte, 2014; Bardsley & Wiseman, 2012; Ford, 2012). These vulnerabilities and existing adaptation strategies are summarized in Table 2.11.

Vulnerabilities	**Adaptation**
Reliance on natural resources	**Livelihood Diversity**
Heavy dependence on natural resources for livelihoods (agriculture, fishing & forestry)	Diversify income sources; sustainable agricultural activities; diversity land/site to mitigate risks; migration
Geographic Location	**Physical Infrastructure**
Located in isolated & vulnerable areas (coastal regions, small islands & high-altitude zones) susceptible to extreme weather events, sea level rise, other climate-related hazards	Build & strengthen infrastructure against extreme weather; Improve access to resources
Limited Access to Modern Technology	**Technology-Assisted**
Limited access to agricultural tools, technologies & infrastructure for climate change - increased vulnerability to climate variability and extreme weather events	Using traditional & modern technologies (e.g. radios & early warning systems)
Socioeconomic Challenges	**Government & Organization Support**
Livelihood disruption, poverty, limited access to education & healthcare, marginalization from mainstream economic activities reduces adaptation capacity	Socioeconomic & environmental support (e.g. training programs)
Cultural & Knowledge Erosion	**Cultural & Institutional Embeddedness**
Globalization, industrialization & changing lifestyles weakens adaptive capacity. Undervaluation of traditional practices by younger generations leads to loss of TEK. Loss of cultural and spiritual practices, affecting social cohesion	Reliance on traditional practices for hunting, fishing & farming. Using environmental indicators to predict weather changes & manage resources. Cultural & institutional embeddedness of TEK

Vulnerabilities	Adaptation
Policy & Institutional Gaps	**Endogenous Development Approach**
Inadequate integration of TEK into national & regional climate policies & adaptation strategies due to lack of recognition & support from formal institutions	Building on Indigenous knowledge systems; community education; mobilization & participatory responses to climate change; gender mainstreaming into climate change policies; promotion of community advocacy and education to address inequalities and ensure inclusive adaptation strategies
Environmental Degradation	**Soil & Water Conservation; Agroforestry**
Deforestation, mining, industrial activities on Indigenous lands undermines ecosystems that are important for Indigenous livelihoods, cultural practices.	Using traditional methods (contour plowing, mulching); locally developed methods (cost-effective & suitable); agroforestry & windbreaks for shade, fruits & income

TABLE 2.11: INDIGENOUS CLIMATE CHANGE VULNERABILITIES AND ADAPTATION

(Integrated sources: Legide et al., 2024; File & Derbile, 2020; Mohamed Shaffril et al., 2020)

Legide et al. (2024) highlighted the decline in the use of Indigenous knowledge amongst Indigenous communities due to industrialization, negative perceptions, insufficient documentation, and limited support from younger and educated individuals. Key vulnerabilities for Indigenous communities are: (1) food and water security: The changing climate affects crop yields, water availability, and food production systems, directly threatening the food and water security of Indigenous populations; (2) health risks: Increased prevalence of climate-related diseases, such as malaria and water-borne diseases, poses significant health risks to Indigenous communities; (3) livelihood disruption: Traditional livelihoods based on agriculture, fishing, and pastoralism are highly susceptible to climatic changes, leading to economic instability and reduced resilience; and (4) Adverse cultural impact: Threats to cultural heritage, traditional knowledge, and social cohesion, as environmental changes disrupt the cultural and spiritual practices (ibid.). In their review, Mohamed Shaffril et al. (2020) highlighted the importance of integrating Indigenous knowledge into modern adaptation strategies as crucial for effective climate change adaptation. In this regard, traditional knowledge is useful in policy development and planning that aligns with the needs and abilities of Indigenous communities.

However, the effective integration of Indigenous knowledge into climate adaptation frameworks is often constrained by dominant neoliberal governance models (Ford et al, 2016; Böhm et al, 2015). These models emphasize market-based mechanisms, cost-efficiency, and privatized resource control - logics that frequently conflict with the communal, place-based, and relational character of TEK (Whyte, 2013; McGregor, 2004). While TEK is adaptive, experimental, and deeply rooted in spiritual and ecological relationships, neoliberal frameworks tend to prioritize scalability, performance metrics, and commodified outcomes, which marginalize knowledge systems that resist standardization (Berkes, 2012; Escobar, 2008). As a result, TEK is often undervalued in formal adaptation planning, not because of its inadequacy, but because of its incompatibility with prevailing institutional logics (Nadasdy, 2005; Agrawal, 2002). Recognizing this tension is crucial to ensuring that climate adaptation is not only technically effective but also socially just and culturally respectful (Whyte, 2017; Ford et al, 2016).

2.10. Economic Challenges and Barriers to Market Access

Indigenous communities everywhere face significant, multifaceted economic challenges that are deeply intertwined with social, cultural, and political factors, as shown in Table 2.12.

Legal & institutional barriers	**Weak Legal Protections**: In many countries, there are insufficient legal protections for Indigenous rights, leading to exploitation and abuse.
	Bureaucratic Hurdles: Complex and inaccessible bureaucratic processes can prevent Indigenous communities from accessing government support and resources.
Land tenure issues	**Unclear Land Rights**: Indigenous communities frequently face challenges in obtaining clear and legal recognition of their land rights, leading to disputes and insecurity.
	Land Grabbing: Lands traditionally owned or used by Indigenous Peoples are taken over by external parties for commercial purposes without fair compensation.
	Lack of Legal Protection: Insufficient legal frameworks and enforcement mechanisms to protect Indigenous land rights exacerbate their vulnerability.

Economic exploitation	**Exploitation by Corporations**: Large corporations often exploit natural resources on Indigenous lands without fair compensation or consultation. Exploitation of TEK for commercial gain without fair recognition or compensation to the knowledge-bearer, raising ethical and legal concerns about biopiracy and Indigenous rights.
	Unfair Trade Practices: Indigenous producers may face unfair trade practices, including being paid low prices for their goods.
	Labor Exploitation: Indigenous individuals can be subjected to exploitative labor practices, including low wages and poor working conditions.
Lack of education & skills development	**Limited Access to Quality Education**: Experiences of othering, facing bullying and discrimination due to cultural differences. This exacerbates their limited access to quality education, resulting in lower literacy rates and limited skills development.
	Cultural Barriers in Education: Educational curricula and methods may not be culturally relevant or sensitive, leading to high dropout rates and disengagement from the formal education system.
Social exclusion	**Social Marginalization**: Persistent social exclusion and prejudice can undermine economic participation and access to resources and services.
Environmental degradation	**Resource Depletion**: Industrial activities such as mining, logging, and agriculture can deplete natural resources that Indigenous communities rely on for their livelihoods.
	Climate Change: Indigenous communities are disproportionately affected by climate change, which can disrupt traditional agricultural practices and reduce food security.
Market information asymmetry	**Lack of Market Knowledge**: Indigenous producers often lack information about market trends, prices, and demands, leading to inefficiencies and exploitation by intermediaries.

	Limited Networking Opportunities: Isolation from major economic centers restricts opportunities to network and collaborate with other market players.
Political underrepresentation	**Lack of Political Influence**: Indigenous communities often have limited representation in political decision-making processes, affecting their ability to advocate for their economic interests.
	Policy Neglect: National policies may not adequately address the specific needs and circumstances of Indigenous communities.
Dependency on external aid	**Unsustainable Aid Models**: Reliance on external aid and support can create dependency and undermine local initiative and self-sufficiency.
	Misaligned Aid Programs: Aid programs may not always align with the actual needs and cultural practices of Indigenous communities, leading to ineffective outcomes.
Cultural erosion	**Loss of Traditional Knowledge**: Economic pressures can lead to the erosion of traditional knowledge and practices, which are often crucial for sustainable resource management and community cohesion. **Cultural Commodification**: While cultural heritage can be an economic asset, its commodification can lead to exploitation and loss of cultural integrity.
Barriers to market access	**Geographical isolation**: Many Indigenous communities are in remote areas, making it difficult to access markets and resources. However, this could be a "given" scenario to work with as some communities prefer to be in isolation. **Infrastructure deficiencies**: Lack of roads, transportation, and communication infrastructure hampers the ability to participate in broader markets. **Limited Financial Services**: Access to banking and credit services is often restricted, limiting the ability to invest in business ventures.

TABLE 2.12: ECONOMIC CHALLENGES AND BARRIERS TO MARKET ACCESS

(Integrated sources: Feiring, 2013; Gebara, 2018; Parraguez et al., 2013; United Nations, 2009; Plant & Hvalkof, 2001)

Empowerment strategies for Indigenous communities in response to the above challenges must be holistic, culturally sensitive, and community-driven (United Nations, 2009). By addressing the specific challenges faced by these communities through education, legal protections, market access, political representation, and preservation of cultural heritage, sustainable and equitable development can be achieved. These strategies not only improve economic conditions but also enhance social and cultural well-being of Indigenous communities (ibid.).

2.11. Indigenous Agriculture and Contribution to Livelihoods

Although most Indigenous food production systems are subsistence-focused, several studies have collectively underscored the critical role of Indigenous fruits and vegetables in enhancing rural livelihoods and food security across various regions. Kalaba et al. (2009) highlight the significant contribution of Indigenous fruit trees to rural households in Zambia for food, medicinal purposes, and biodiversity conservation, despite facing challenges like deforestation and inadequate processing knowledge. Ayanwale & Amusan (2014) demonstrate that women vegetable farmers in Nigeria rely heavily on vegetable production for income, recommending diversification into other economic activities to improve livelihoods. Another study discussed the impact of COVID-19 on smallholder farmers in Ecuador, noting that local markets thrived while broader agribusiness sectors struggled (McBurney et al., 2021). Olowo et al. (2022) found that Indigenous fruits and vegetables in Nigeria significantly boost farm revenue and livelihoods, with education and access to subsidies being key influencing factors. Overall, these findings advocate for better support, sustainable practices, and policy reforms to maximize the benefits of Indigenous crops for rural communities.

2.12. Indigenous Women in Agriculture

Indigenous women play a crucial role in their communities, especially in agricultural labor, and knowledge transmission which are gender-disaggregated in many Indigenous communities (Lope-Alzina, 2020; Feiring, 2013). Indigenous women's expertise in cultivating and processing a wide variety of plant species is vital for food security and biodiversity (Lope-Alzina, 2020; Olatokun & Ayanbode, 2008). They are also primarily responsible for home gardens, while men manage larger agricultural fields (Lope-Alzina, 2020). However, Indigenous women face significant challenges in accessing land and resources due to discriminatory customary practices and legal frameworks (Feiring, 2013). Often, women are the primary food providers, yet their land ownership remains minimal. For example, in Nepal, women own only 8 percent of the land despite constituting 66 percent of the agricultural workforce (ibid.). Despite their key role, women face significant challenges such as longer working hours and limited participation in decision-making about species selection and management (Gonçalves et al., 2021). In Latin America, Indigenous women face poverty, exclusion, and violence (Lope-Alzina, 2020). Furthermore, gender biases rooted in historical and cultural norms often undermine the contributions of Indigenous women, classifying their work as domestic and reproductive rather than productive. Various international efforts have been made and frameworks such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) have been set up to emphasize equal rights and empower Indigenous women in agriculture, yet significant gender biases remain. Nevertheless, grassroots movements and international policies are increasingly recognizing the contributions of these women (ibid.).

2.13. Indigenous Agricultural Practices: Preservation and Transitions

A few traditional agricultural management and knowledge systems still endure (Altieri, 1995). Indigenous communities are witnessing their livelihoods becoming more varied due to the pressures of land scarcity, integration into markets, and influences from education and the media (Erni, 2015). As such, livelihood diversification is driven by both necessity and voluntary choices (ibid.). The following sections discuss how Indigenous agriculture is being preserved at present and the transitions that are occurring in existing systems.

2.13.1. Agroforestry Transitions in Shifting Cultivation

As discussed briefly in Section 2.1.4.3., globally, it is accepted that Indigenous agroforestry is a viable alternative to intensive shifting cultivation that is no longe sustainable in terms of the long fallows required for soil regeneration or clearing forests for new cultivation. In this regard, several studies have discussed the transitions from Indigenous agriculture (mainly subsistence-based shifting agriculture) to a more market-oriented agroforestry approach within Indigenous agricultural systems globally. The findings from seven studies across various regions (South Asia, Southeast Asia, and Amazonia) highlight the benefits, challenges and future transitions in shifting cultivation are summarized in Table 2.13.

Perceived Benefits to Agroforestry Transitions	Potential Challenges	Recommendation
Integration of Indigenous Practices & TEK: Enhances & maintains cultural heritage & practices; maintains traditional beliefs & customs; encourages community involvement; improve resilience and productivity (Nonglait et al., 2024; Mathur & Bhattacharya, 2022)	With the adoption of new crops & market-oriented practices, potential loss of TEK related to traditional agriculture & practices that are less marketable	Integrating agroforestry with traditional practices requires careful adaptation to preserve cultural heritage and maintain community support (Mathur & Bhattacharya, 2022; Grogan et al., 2013; Hariyadi & Ticktin, 2012)
	Integration of cash crops and market-oriented agriculture can reduce reliance on barter systems and subsistence practices (less reliance on locally produced food, medicinal plants & other necessities) (Grogan et al., 2013)	Effective institutional framework & strong policy support to facilitate the adoption of agroforestry practices (Hazarika et al., 2024; van der Meer Simo et al., 2020)
Social: Community involvement is crucial for the successful implementation of agroforestry practices, ensuring that cultural practices are respected and maintained; enhances livelihoods (Grogan et al., 2013; Hazarika et al., 2024; Nonglait et al., 2024)	Shifts in traditional social structures & relationships within the community (e.g. wealth differentiation); changes in cultural practices; (Grogan et al., 2013)	Address potential socioeconomic inequities & ensuring active community participation (Hazarika et al., 2024; Nonglait et al., 2024; van der Meer Simo et al., 2020)
	Resistance to new sustainable methods: Shifting from traditional practices (Hepp et al., 2018)	Community engagement to ensure that the community understands the benefits and willing to adopt new practices (Hepp et al., 2018)

Perceived Benefits to Agroforestry Transitions	Potential Challenges	Recommendation
Environmental & Soil Health: Diverse AF practices improve soil organic carbon concentrations and stocks, enhances biodiversity, and supports long-term ecosystem sustainability; reduces deforestation (Hazarika et al., 2024; Mathur & Bhattacharya, 2022)	Financial constraints: Implementing sustainable practices alongside short fallow periods (for shifting cultivation) requires financial resources for inputs (cover crops, organic fertilisers, and other soil amendments) that may not be affordable to resource-poor farmers (Hepp et al., 2018)	Access to credit and microfinance options tailored to suit the needs of smallholders (Hepp et al., 2018)
	Increased labour demand and competition with other farming activities in labour-limited households may potentially lead to lower productivity in the short-term (Hepp et al., 2018)	Community-based programmes to share knowledge and best practices among farmers (Hepp et al., 2018)
	Limited access to resources (agricultural inputs, technical knowledge, extension services) in remote areas pose as barriers to adopting integrated sustainable practices (Hepp et al., 2018)	Access to technical knowledge, training & extension services (Hepp et al., 2018)
Food Security: Crop diversification in agroforestry improves food security (Grogan et al., 2013)	Shift of focus from purely subsistence-based to crops with market value (Grogan et al., 2013). Less focus on subsistence crops to grow market-oriented crops.	Community-based food reserves to buffer against food shortages. Technical training on sustainable intensification and climate resilience to enhance productivity and food security.
Economic: Market integration enhances livelihoods; higher financial returns compared to traditional swidden agriculture; increased economic opportunities (Hazarika et al., 2024; van der Meer Simo et al., 2020)	Increased reliance on market participation; economic vulnerability from market failures (Grogan et al., 2013);	Ensuring fair market access and economic stability (van der Meer Simo et al., 2020; Grogan et al., 2013; Hariyadi & Ticktin, 2012);

Perceived Benefits to Agroforestry Transitions	Potential Challenges	Recommendation
	Significant investments & extensive training required to transition into agroforestry (Hazarika et al., 2024; Mathur & Bhattacharya, 2022; Grogan et al., 2013;)	Provision of financial incentives & support to offset initial transition costs (Hazarika et al., 2024)

TABLE 2.13: BENEFITS, CHALLENGES, AND WAY FORWARD FOR AGROFORESTRY TRANSITIONS IN SHIFTING CULTIVATION FOR MAJOR REGIONS OF THE WORLD

The studies described in Table 2.13 collectively highlight the numerous benefits of transitioning from traditional shifting cultivation to agroforestry and other sustainable land management practices. Key findings indicate improvements in soil health, biodiversity, and economic returns, which contribute to better livelihoods and environmental conservation. Supportive policies and an understanding of local contexts are foundational to ensure the successful implementation and sustainability of these practices. Steps should also be taken to prioritize integrating traditional knowledge, enhancing community participation, and providing infrastructural support when considering transitions to agroforestry. Table 2.23 also foregrounds challenges to the adoption of agroforestry systems. Addressing these challenges will require coordinated efforts from governments, NGOs, and local communities to develop and implement policies that support sustainable agroforestry practices while respecting and integrating traditional knowledge and cultural practices.

Despite the socioeconomic and environmental gains with the transition to agroforestry, it is not clear to what extent agroforestry practices will have an impact on cultural practices and rituals that are intimately linked with the traditional practice of shifting cultivation. For many Indigenous communities, their specific forms of traditional agriculture represent their identity, cosmology, and worldview. The transition necessitates careful integration of traditional knowledge and practices to ensure cultural preservation. Rituals, land use practices, and social structures may change, but with active community involvement and respect for traditional ecological knowledge, agroforestry may be adapted to support both sustainable development and cultural heritage.

2.13.2. Transitions in the Barahnaja Mixed Cropping Cultivation System

Barahnaja is a traditional mixed cropping system Indigenous to the Himalayan region, particularly in Uttarakhand, India (Gururani et al., 2021). It involves the simultaneous cultivation of a diverse range of crops, including cereals, pulses, oilseeds, vegetables, and spices, on the same terraced fields. This system relies on the natural interactions between the different crops to enhance soil fertility, prevent erosion, and ensure food and nutritional security. Barahnaja is deeply rooted in the cultural practices of local communities and is designed to be ecologically sustainable and economically viable, providing resilience against climatic variability. It promotes organic farming by minimizing chemical inputs and using natural pest control methods, thereby maintaining agro-biodiversity and supporting the health and livelihoods of small and marginal farmers in the region (ibid.).

The preservation of the Barahnaja system faces several challenges, primarily due to the fragmented and small land holdings of farmers in the hill states, which complicates the practice of diversified cropping (Gururani et al., 2021). Poor infrastructure and limited connectivity limit market access for their produce. Additionally, there is a declining market demand for the traditional crops of the Barahnaja system, which results in lower economic returns compared to commercial high-yielding varieties. Economic pressure and the widespread adoption of intensive agricultural practices that rely heavily on chemical inputs lead to soil degradation and reduced biodiversity. Moreover, the shift towards modern farming practices, such as monoculture and the use of genetically uniform crops, is replacing traditional systems like Barahnaja, threatening its sustainability and resilience (ibid.).

2.13.3. Case Study: The Adoption of Mechanization by Indigenous Smallholders in Northern Ghana

Kansanga et al. (2019) have described the adoption of mechanized technologies (especially tractors) among smallholder farmers in northern Ghana which has significantly increased farm sizes on average from 1.07 hectares in 2005 to 2.15 hectares in 2016. This shift has led to the replacement of traditional staple crops like pearl millet and sorghum with market-oriented crops such as maize, rice, and groundnuts, driven by economic pressures and the technical limitations of mechanized farming. The unsuitability of tractors for traditional methods has led to the use of fertilizers and herbicides, along with continuous cultivation practices requiring the annual use of inorganic fertilizers. This transition has significant cultural implications, risking the extinction of traditional foods and agricultural practices central to the social and cultural heritage of these farming communities. While modernization aids in timely land preparation and productivity, it reduces crop diversity, potentially diminishing farmers' resilience to climate change. The study advocates for a reconsideration of agricultural policies to include local knowledge and values, emphasizing the importance of maintaining native staple crops to preserve cultural identity and enhance sustainability. Thus, agricultural mechanization presents a paradox of increased farm sizes at the expense of traditional practices and crop diversity, necessitating a more balanced policy approach for cultural and ecological sustainability.

2.13.4. The Adoption of Precision Agriculture

According to Montalvo-Romero et al. (2023) and Gill & Chawla (2021)**,** traditional agriculture faces several challenges, including limited technological integration, labor shortages, and environmental sustainability. Embracing new technologies can help address these challenges and lead to improved crop yields and enhanced food security. There is a growing trend in China and India to adopt intelligent systems such as the Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and sensors (often integrated into drones and Arduino systems) for crop management (Montalvo-Romero et al., 2023). Five key technologies have been identified as beneficial for traditional agriculture: drones, algorithms, decision support systems (DSS), sensors, and Arduino technology. These tools increase crop yield, quality, and resource management. Despite their potential, the practical implementation and adoption of these technologies in traditional agricultural settings can vary and require further exploration. Barriers to adoption include socioeconomic factors such as access to technology and training. Additionally, it is essential to ensure that the integration of new technologies does not lead to unsustainable practices (ibid.). Another study, by God Oy et al. (1998) highlights the importance of considering village dynamics, income, education, and cultural factors in promoting the adoption of modern agricultural technologies among Indigenous households in Bolivia. Market-integrated households and those with higher income and education in isolated villages were more likely to adopt chemical herbicides and insecticides, indicating the need for nuanced, community-focused, and culturally sensitive approaches (ibid.).

2.13.5. Land Use Change, Loss of Traditional Practices and Its Impact on Indigenous Wellbeing

A recent study involving the declining shifting cultivation landscape of the Indian Himalayan region revealed an adverse impact on the psychological well-being of Indigenous people (Pandey et al., 2023). Specifically, the downtrend in shifting cultivation (a reduction of about 88 percent over 15 years) had a detrimental effect on land ownership, food system, social cohesion, cultural fulfillment, and the biodiversity of cultivated and wild plants. This trend also caused an outmigration amongst the Indigenous population. The decline in shifting cultivation is attributed to forest conservation policies and the promotion of plantation agriculture such as rubber and oil palm. Moreover, the transition from shifting cultivation to market-oriented cash crop agriculture has led to significant challenges to traditional gender roles and social structures. Women's control over income and participation in decision-making have diminished, social cohesion has weakened, and traditional family dynamics are disrupted. Additionally, reduced dietary diversity and cultural practices linked to shifting cultivation have adversely affected health and social wellbeing. These challenges underscore the need for policies that consider the socio-cultural dimensions of development and support the integration of traditional practices and gender equity (ibid.).

2.14. Conclusion

Indigenous agriculture represents a complex, adaptive system that has sustained communities for generations. It has been shown to be resilient in terms of biodiversity conservation, climate adaptation, and food security. This chapter has highlighted how traditional agricultural practices, including shifting cultivation, agroforestry, and mixed cropping, offer sustainable alternatives to industrial agriculture. However, these systems are increasingly marginalized due to land tenure insecurity, policy restrictions, and socio-economic transformations. Despite growing academic recognition, Indigenous agricultural practices remain underrepresented in mainstream sustainability frameworks. Addressing this gap requires an inclusive approach that integrates Indigenous knowledge into global agricultural policies while ensuring that local communities retain autonomy over their food systems. This study builds on these discussions, offering a critical evaluation of Indigenous agricultural sustainability and its broader implications for food sovereignty and environmental governance.

Summary

This chapter provides an in-depth review of Indigenous agricultural systems worldwide, focusing on their historical evolution, ecological significance, and contemporary challenges. It examines the role of traditional agricultural practices methods in biodiversity conservation, soil fertility, and climate resilience, demonstrating their viability in sustainable food production. The chapter also explores how modernization, land tenure conflicts, and restrictive policies threaten the continuity of these practices. While research has increasingly acknowledged the value of Indigenous agriculture, gaps remain in integrating Indigenous knowledge into formal agricultural and environmental policies. This review sets the foundation for further exploration into sustainable and culturally responsive agricultural systems that balance traditional wisdom with modern ecological needs.

References

Abbo, S., Lev-Yadun, S., Heun, M., & Gopher, A. (2013). On the 'lost' crops of the neolithic Near East. *Journal of Experimental Botany*, *64*(4), 815–822. https://doi.org/10.1093/jxb/ers373

Agrawal, A. (2002). Indigenous knowledge and the politics of classification. *International Social Science Journal*, 54(173), 287–297. [https://doi.org/10.1111/1468-2451.00382

Ajl, M., & Sharma, D. (2022). The Green Revolution and transversal countermovements: recovering alternative agronomic imaginaries in Tunisia and India. *Canadian Journal of Development Studies*, *43*(3), 418–438. https://doi.org/10.1080/02255189.2022.2052028

Altieri, M. A. (1995). *Agroecology: The Science of Sustainable Agriculture* (Second). Westview Press.

Altieri, M. A. (2004). Linking ecologists and traditional farmers in the search for sustainable agriculture. *Frontiers in Ecology and the Environment*, *2*(1), 35–42. https://doi.org/10.1890/1540-9295(2004)002[0035:leatfi]2.0.co;2

Altieri, M. A., & Koohafkan, P. (2004). Globally Important Ingenious Agricultural Heritage Systems (GIAHS): extent, significance, and implications for development. *Proceedings of the Second International Workshop and Steering Committee Meeting for the Globally Important Agricultural Heritage Systems (GIAHS) Project. FAO, Rome, Italy*, 1–44.

Altieri, M. A., Funes-Monzote, F. R., & Petersen, P. (2012). *Agroecologically efficient agricultural systems for smallholder farmers. Agronomy for Sustainable Development, 32*, 1–13. https://doi.org/10.1007/s13593-011-0065-6

Altieri, M. A., Nicholls, C. I., Henao, A., & Lana, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development*, *35*(3), 869–890. https://doi.org/10.1007/s13593-015-0285-2

Altieri, M. A., & Nicholls, C. I. (2017). The Adaptation and Mitigation Potential of Traditional Agriculture in a Changing Climate. *Climatic Change*, *140*(1), 33–45. https://doi.org/10.1007/s10584-013-0909-y

Alzate, C., Mertens, F., Fillion, M., & Rozin, A. (2019). The Study and Use of Traditional Knowledge in Agroecological Contexts. *Rev. FCA UNCUYO*, *51*(1), 1853–8665.

Amare, G., & Gacheno, D. (2021). Indigenous Knowledge for Climate Smart Agriculture—A Review. *International Journal of Food Science and Agriculture*, *5*(2), 332–338. https://doi.org/10.26855/ijfsa.2021.06.019

Ameen, A., & Raza, S. (2017). Green Revolution: A Review. *International Journal of Advances in Scientific Research*, *3*(12), 129–137. https://doi.org/10.7439/ijasr

Anderson, C. R., Bruil, J., Chappell, M. J., Kiss, C., & Pimbert, M. P. (2019). From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems through Agroecology. *Sustainability (Switzerland)*, *11*(19). https://doi.org/10.3390/su11195272

Anderson, C. R., & Maughan, C. (2021). "The Innovation Imperative": The Struggle Over Agroecology in the International Food Policy Arena. *Frontiers in Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.619185

Angelakis, A. N., Zaccaria, D., Krasilnikoff, J., Salgot, M., Bazza, M., Roccaro, P., Jimenez, B., Kumar, A., Yinghua, W., Baba, A., Harrison, J. A., Garduno-Jimenez, A., & Fereres, E. (2020). Irrigation of world agricultural lands: Evolution through the Millennia. In *Water (Switzerland)* (Vol. 12, Issue 5). MDPI AG. https://doi.org/10.3390/W12051285

Anseeuw, W. (2013). The rush for land in Africa: Resource grabbing or green revolution? *South African Journal of International Affairs*, *20*(1), 159–177. https://doi.org/10.1080/10220461.2013.780326

Arcand, M. M., Bradford, L., Worme, D. F., Strickert, G. E. H., Bear, K., Dreaver Johnston, A. B., Wuttunee, S. M., Gamble, A., & Shewfelt, D. (2020). Sowing a way towards revitalizing Indigenous agriculture: creating meaning from a forum discussion in Saskatchewan, Canada. *Facets*, *5*(1), 619–641. https://doi.org/10.1139/FACETS-2020-0004
Arceneaux, C. L. (2022). The Struggle for Identity: Autonomy and the Indigenous. In *Political Struggle in Latin America* (pp. 45–81). https://doi.org/10.1007/978-3-031-07904-7_2
Ashraf, Q., & Michalopoulos, S. (2010). *The Climatic Origins of the Neolithic Revolution: Theory and Evidence*. www.carloalberto.org/working_papers
Astier, M., Argueta, J. Q., Orozco-Ramírez, Q., González, M. V., Morales, J., Gerritsen, P. R. W., Escalona, M. A., Rosado-May, F. J., Sánchez-Escudero, J., Martínez Saldaña, T., Sánchez-Sánchez, C., Arzuffi Barrera, R., Castrejón, F., Morales, H., Soto, L., Mariaca, R., Ferguson, B., Rosset, P., Ramírez, H., … González-Esquivel, C. (2017). Back to the roots: understanding current agroecological movement, science, and practice in Mexico. *Agroecology and Sustainable Food Systems*, *41*(3–4), 329–348. https://doi.org/10.1080/21683565.2017.1287809
Athayde, S., Silva-Lugo, J., Schmink, M., & Heckenberger, M. (2017). The Same, but Different: Indigenous Knowledge Retention, Erosion, and Innovation in the Brazilian Amazon. *Human Ecology*, *45*(4), 533–544. https://doi.org/10.1007/s10745-017-9919-0
Atkins, P. J. (Peter J.), Simmons, I. G. (Ian G., & Roberts, B. K. (1998). Chapter 2: The Origins and Spread of Agriculture. In *People, Land and Time* (p. 286). Arnold.
Avni, Y. (2022). The Emergence of Terrace Farming in the Arid Zone of the Levant—Past Perspectives and Future Implications. *Land*, *11*(10). https://doi.org/10.3390/land11101798
Ayanwale, A. B., & Amusan, C. A. (2014). Livelihood Strategies of Female Indigenous Vegetable Farmers' in Osun State, Nigeria. *Journal of Agricultural Science*, *6*(10). https://doi.org/10.5539/jas.v6n10p96
Bagelman, C. (2018). Unsettling Food Security: The Role of Young People in Indigenous Food System Revitalisation. *Children and Society*, *32*(3), 219–232. https://doi.org/10.1111/chso.12268
Bardsley, D. K., & Wiseman, N. D. (2012). Climate Change Vulnerability and Social Development for Remote Indigenous Communities of South Australia. *Global Environmental Change*, *22*(3), 713–723. https://doi.org/10.1016/j.gloenvcha.2012.04.003
Barker, G., & Richards, M. B. (2013). Foraging-Farming Transitions in Island Southeast Asia. *Journal of Archaeological Method and Theory*, *20*(2), 256–280. https://doi.org/10.1007/s10816-012-9150-7
Batie, S. S., & Taylor, D. B. (1991). Assessing the Character of Agricultural Production Systems: Issues and Implications. *American Journal of Alternative Agriculture*, *6*(4), 184–187. https://doi.org/10.1017/S0889189300004240
Bebbington, D. H. (2013). Extraction, inequality and Indigenous Peoples: Insights from Bolivia. *Environmental Science and Policy*, *33*, 438–446. https://doi.org/10.1016/j.envsci.2012.07.027
Bender, B. (1978). Gatherer-hunter to farmer: A social perspective. *World Archaeology*, *10*(2), 204–222. https://doi.org/10.1080/00438243.1978.9979731
Berkes, F. (2012). Sacred ecology (3rd ed.). Routledge.
Berkes, F. (2018). Sacred Ecology. In *Local Economy* (Vol. 33, Issue 2). Routledge. https://doi.org/10.1177/0269094218762345

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications*, *10*(5), 1251–1262. https://doi.org/https://doi.org/10.1890/1051-0761(2000)010[1251:ROTEKA]2.0.CO;2
Billong Fils, P. E., Afiong Nana, N., Betti, J. L., Farick Njimbam, O., Tientcheu Womeni, S., Ávila Martin, E., Ros Brull, G., Okale, R., Fa, J. E., & Funk, S. M. (2020). Ethnobotanical Survey of Wild Edible Plants used by Baka people in Southeastern Cameroon. *Journal of Ethnobiology and Ethnomedicine*, *16*(1). https://doi.org/10.1186/s13002-020-00413-0
Blanco, G. D., Fernández-Llamazares, Á., Blanco, G. D., Baker, J., Tagliari, M. S. M., Hayata, M. A., Campos, M. L., & Hanazaki, N. (2023). The impacts of mining on the food sovereignty and security of Indigenous Peoples and local communities: A global review. *Science of the Total Environment*, *855*. https://doi.org/10.1016/j.scitotenv.2022.158803
Boafo, J., & Lyons, K. (2022). The Rhetoric and Farmers' Lived Realities of the Green Revolution in Africa: Case Study of the Brong Ahafo Region in Ghana. *Journal of Asian and African Studies*, *57*(3), 406–423. https://doi.org/10.1177/00219096211019063
Bogaard, A., Allaby, R., Arbuckle, B. S., Bendrey, R., Crowley, S., Cucchi, T., Denham, T., Frantz, L., Fuller, D., Gilbert, T., Karlsson, E., Manin, A., Marshall, F., Mueller, N., Peters, J., Stépanoff, C., Weide, A., & Larson, G. (2021). Reconsidering domestication from a process archaeology perspective. *World Archaeology*, *53*(1), 56–77. https://doi.org/10.1080/00438243.2021.1954990
Böhm, S., Bharucha, Z. P., & Pretty, J. (2015). Ecovalue: Valuing ecological stewardship in an era of neoliberal conservation. *Environmental Values*, 24(5), 529–552. [https://doi.org/10.3197/096327115X14345368709929
Boillat, S., & Bottazzi, P. (2020). Agroecology as a Pathway to Resilience Justice: Peasant Movements and Collective Action in the Niayes Coastal Region of Senegal. *International Journal of Sustainable Development and World Ecology*, *27*(7), 662–677. https://doi.org/10.1080/13504509.2020.1758972
Borrell, F., Junno, A., & Barceló, J. A. (2015). Synchronous environmental and cultural change in the emergence of agricultural economies 10,000 years ago in the levant. *PLoS ONE*, *10*(8). https://doi.org/10.1371/journal.pone.0134810
Bowles, S. (2011). Cultivation of cereals by the first farmers was not more productive than foraging. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(12), 4760–4765. https://doi.org/10.1073/pnas.1010733108
Bowles, S., & Choi, J.-K. (2019). *The Neolithic Agricultural Revolution and the Origins of Private Property*.
Brodt, S. B. (2001). *A Systems Perspective on the Conservation and Erosion of Indigenous Agricultural Knowledge in Central India*. *29*(1), 99–120.
Buckland, A. W. (1878). Primitive Agriculture. *Source: The Journal of the Anthropological Institute of Great Britain and Ireland*, *7*, 2–20. https://www.jstor.org/stable/2840930
Burchfield, E. K. (2022). Shifting cultivation geographies in the Central and Eastern US. *Environmental Research Letters*, *17*(5). https://doi.org/10.1088/1748-9326/ac6c3d
Cairns, M. (2007). *Voices from the forest : integrating Indigenous knowledge into sustainable upland farming*. Resources for the Future.
Çakmakçı, R., Salık, M. A., & Çakmakçı, S. (2023). Assessment and Principles of Environmentally Sustainable Food and Agriculture Systems. In *Agriculture (Switzerland)* (Vol. 13, Issue 5). MDPI. https://doi.org/10.3390/agriculture13051073
Cameron, D. (1993). Uniformitarianism And Prehistoric Archaeology. *Australian Archaeology*, *36*(1), 42–49. https://doi.org/10.1080/03122417.1993.11681481

Carmenta, R., Vermeylen, S., Parry, L., & Barlow, J. (2013). Shifting Cultivation and Fire Policy: Insights from the Brazilian Amazon. In *Human Ecology* (Vol. 41, Issue 4, pp. 603–614). https://doi.org/10.1007/s10745-013-9600-1

Chanza, N., & Musakwa, W. (2022). Revitalizing Indigenous ways of maintaining food security in a changing climate: review of the evidence base from Africa. In *International Journal of Climate Change Strategies and Management* (Vol. 14, Issue 3, pp. 252–271). Emerald Group Holdings Ltd. https://doi.org/10.1108/IJCCSM-06-2021-0065

Chen, Q. L., Hu, H. W., He, Z. Y., Cui, L., Zhu, Y. G., & He, J. Z. (2021). Potential of Indigenous crop microbiomes for sustainable agriculture. *Nature Food*, *2*(4), 233–240. https://doi.org/10.1038/s43016-021-00253-5

Civán, P., Craig, H., Cox, C. J., & Brown, T. A. (2015). Three geographically separate domestications of Asian rice. *Nature Plants*, *1*. https://doi.org/10.1038/nplants.2015.164

Corr, R., & Powers, K. V. (2012). Ethnogenesis, Ethnicity, and 'Cultural Refusal': The Case of the Salasacas in Highland Ecuador. *Latin American Research Review*, *47*(SPEC ISSUE), 5–30. https://doi.org/10.1353/lar.2012.0058

Curran, M., Maynard, D., Heninger, R., Terry, T., Howes, S., Stone, D., Niemann, T., & Miller, R. E. (2007). Elements and Rationale for a Common Approach to Assess and Report Soil Disturbance. *The Forestry Chronicle*, *83*(6), 852–866.

Dagar, J. C., & Tewari, V. P. (2018). Agroforestry: Anecdotal to Modern Science. In *Agroforestry: Anecdotal to Modern Science*. Springer Singapore. https://doi.org/10.1007/978-981-10-7650-3

Dagar, P. (2022). Vocational education and training for Indigenous women in India: toward a participatory planning approach. *International Journal of Training Research*, *20*(1), 43–57. https://doi.org/10.1080/14480220.2021.1959379

Davies, A., Gwynn, J., Allman-Farinelli, M., Flood, V., Dickson, M., Turner, N., Porykali, B., & Lock, M. (2023). Programs Addressing Food Security for First Nations Peoples: A Scoping Review. *Nutrients*, *15*(14). https://doi.org/10.3390/nu15143127

Deb, S., Arunachalam, A., & Das, A. K. (2009). Indigenous knowledge of Nyishi tribes on traditional agroforestry systems. In *Indian Journal of Traditional Knowledge* (Vol. 8, Issue 1).

Dirgahayu, D., Karman, & Budhirianto, S. (2023). Potential of Indonesian Indigenous community local wisdom for food security. *IOP Conference Series: Earth and Environmental Science*, *1230*(1). https://doi.org/10.1088/1755-1315/1230/1/012023

Dove, M. R. (1983). *Theories of Swidden Agriculture, and the Political Economy of Ignorance*.

Duthie-Kannikkatt, K., Shukla, S., Rao M.L, S., Sakkhari, K., & Pachari, D. (2019). Sowing the seeds of resilience: a case study of community-based Indigenous seed conservation from Andhra Pradesh, India. *Local Environment*, *24*(9), 843–860. https://doi.org/10.1080/13549839.2019.1652800

Erickson, C. L. (2008). Amazonia: The Historical Ecology of a Domesticated Landscape. In H. Silverman & William. H. Isbell (Eds.), *Handbook of South American Archaeology* (pp. 157–183). Springer. https://doi.org/https://doi.org/10.1007/978-0-387-74907-5_11

Erickson, C. L. (2010). The transformation of environment into landscape: The historical ecology of monumental earthwork construction in the Bolivian Amazon. *Diversity*, *2*(4), 618–652. https://doi.org/10.3390/d2040619

Erni, C. (2015). *Shifting Cultivation, Livelihood and Food Security: New and Old Challenges for Indigenous Peoples in Asia*.

Escobar, A. (2008). Territories of difference: Place, movements, life, redes. Duke University Press.

Falvey, J. L. (2017). Policies Impacting Shifting Cultivation: Getting them right. In *Shifting cultivation policies: balancing environmental and social sustainability* (pp. 43–63). https://doi.org/10.1079/9781786391797.0043
FAO. (2019a). *Assessments (2019): The State of the World's Biodiversity for Food and Agriculture*. https://openknowledge.fao.org/items/b355c300-72ed-4a63-be07-8295c80ec7f1
FAO. (2019b). *Report on the work of the FAO Indigenous Peoples Unit 2019*. https://www.fao.org/fileadmin/user_upload/faoweb/2020/Indigenous/2019_Report_of_Activities_FAO_Indigenous_Peoples_Unit.pdf
FAO, Alliance of Biodiversity International, & CIAT. (2021). Indigenous Peoples' Food Systems. In *Indigenous Peoples' food systems*. Food and Agriculture Organization of the United Nations, Alliance of Bioversity International, and CIAT. https://doi.org/10.4060/cb5131en
Feiring, B. (2013). *Indigenous Peoples' Rights to Lands, Territories, and Resources*. International Land Coalition.
File, D. J. M., & Derbile, E. K. (2020). Sunshine, Temperature and Wind: Community Risk Assessment of Climate Change, Indigenous Knowledge and Climate Change Adaptation Planning in Ghana. *International Journal of Climate Change Strategies and Management*, *12*(1), 22–38. https://doi.org/10.1108/IJCCSM-04-2019-0023
Flannery, K. V. (1973). The Origins of Agriculture. *Annual Review of Anthropology*, 271–310. https://doi.org/https://doi.org/10.1146/annurev.an.02.100173.001415
Ford, J. D. (2012). Indigenous Health and Climate Change. *American Journal of Public Health*, *102*(7), 1260–1266. https://doi.org/10.2105/AJPH.2012.300752
Ford, J. D., Cameron, L., Rubis, J., Maillet, M., Nakashima, D., Willox, A. C., & Pearce, T. (2016). Including Indigenous knowledge and experience in IPCC assessment reports. *Nature Climate Change*, 6(4), 349–353. [https://doi.org/10.1038/nclimate2954
Fu, Q., Rudan, P., Pääbo, S., & Krause, J. (2012). Complete mitochondrial genomes reveal neolithic expansion into Europe. *PLoS ONE*, *7*(3). https://doi.org/10.1371/journal.pone.0032473
Fuller, D. Q., & Qin, L. (2009). Water management and labour in the origins and dispersal of Asian rice. *World Archaeology*, *41*(1), 88–111. https://doi.org/10.1080/00438240802668321
Gao, Y., Dong, G., Yang, X., & Chen, F. (2020). A review on the spread of prehistoric agriculture from southern China to mainland Southeast Asia. In *Science China Earth Sciences* (Vol. 63, Issue 5, pp. 615–625). Science in China Press. https://doi.org/10.1007/s11430-019-9552-5
Gebara, M. F. (2018). Tenure Reforms in Indigenous Lands: Decentralized Forest Management or Illegalism? *Current Opinion in Environmental Sustainability*, *32*, 60–67. https://doi.org/10.1016/j.cosust.2018.04.008
George, M. V., & Christopher, G. (2020). Structure, diversity and utilization of plant species in tribal homegardens of Kerala, India. *Agroforestry Systems*, *94*(1), 297–307. https://doi.org/10.1007/s10457-019-00393-5
Gilbert, J. (2017). *Land Grabbing, Investments & Indigenous Peoples' Rights to Land and Natural Resources*. www.iwgia.org
Gill, R., & Chawla, P. (2021). A Review on Various Techniques to Transform Traditional Farming to Precision Agriculture. In *Turkish Journal of Computer and Mathematics Education* (Vol. 12, Issue 2).
Giraldo, O. F., & Rosset, P. M. (2018). *Agroecology as a territory in dispute*. *Journal of Peasant Studies, 45(3)*, 545–564. https://doi.org/10.1080/03066150.2017.1353496

Gliessman, S. (2018). Defining Agroecology. In *Agroecology and Sustainable Food Systems* (Vol. 42, Issue 6, pp. 599–600). Taylor and Francis Inc. https://doi.org/10.1080/21683565.2018.1432329

Gliessman, S. (2015). *The Ecology of Sustainable Food Systems* (E. W. Engles, Ed.). CRC Press, Taylor & Francis Group.

God Oy, R. O., Fran, J. R., Alvarad, M., & Dio, C. (1998). Adoption of Modern Agricultural Tech nologies by Lowlan d Indigen ou s Group s in Bolivia: Th e Role of Households, Villages, Eth n icity, an d Markets. In *Hum an Ecology* (Vol. 26, Issue 3).

Gonçalves, C. de B. Q., Schlindwein, M. M., & Martinelli, G. D. C. (2021). Agroforestry systems: A systematic review focusing on traditional Indigenous practices, food and nutrition security, economic viability, and the role of women. In *Sustainability (Switzerland)* (Vol. 13, Issue 20). MDPI. https://doi.org/10.3390/su132011397

González, N. C., & Kröger, M. (2020). *The potential of Amazon Indigenous agroforestry practices for rethinking global forest governance*. *Forest Policy and Economics, 118*, 102251. https://doi.org/10.1016/j.forpol.2020.102251

Gonzalez de Molina, M. (2025). Notes on autonomy as an agroecological principle. Agroecology and Sustainable Food Systems. https://doi.org/10.1080/21683565.2025.2502092

Greaves, R. D., & Kramer, K. L. (2014). Hunter-Gatherer Use Of Wild Plants And Domesticates: Archaeological Implications For Mixed Economies Before Agricultural Intensification. *Journal of Archaeological Science*, *41*, 263–271.https://doi.org/10.1016/j.jas.2013.08.014

Gregorio de Souza, J., Alcaina-Mateos, J., Lancelotti, C., Vidal-Torrado, P., Calegari, M. R., Teixeira, W. G., Martins, G., Macedo, R. S., & Madella, M. (2025). Spatial analysis of Amazonian Dark Earth formation supports an anthropic origin at the Caldeirão site, Brazil. *Journal of Archaeological Science*, *176*. https://doi.org/10.1016/j.jas.2025.106169

Guo, J., Wang, W., Zhao, K., Li, G., He, G., Zhao, J., Yang, X., Chen, J., Zhu, K., Wang, R., Ma, H., Xu, B., & Wang, C. C. (2022). Genomic insights into Neolithic farming-related migrations in the junction of east and southeast Asia. *American Journal of Biological Anthropology*, *177*(2), 328–342. https://doi.org/10.1002/ajpa.24434

Gururani, K., Sood, S., Kumar, A., Joshi, D. C., Pandey, D., & Sharma, A. R. (2021). Mainstreaming Barahnaja cultivation for food and nutritional security in the Himalayan region. *Biodiversity and Conservation*, *30*(3), 551–574. https://doi.org/10.1007/s10531-021-02123-9

Harris, D. R. (2015). An Evolutionary Continuum of People Plant Interaction. In *Foraging and Farming: The Evolution of Plant Exploitation* (2015th ed., Vol. 31, pp. 11–24). Routledge.

Harris, D. R., & Fuller, D. Q. (2014). Agriculture: Definition and Overview. In *Encyclopedia of Global Archaeology* (pp. 104–113). Springer New York. https://doi.org/10.1007/978-1-4419-0465-2_64

Harwood, J. (2020). Could the adverse consequences of the green revolution have been foreseen? How experts responded to unwelcome evidence. In *Agroecology and Sustainable Food Systems* (Vol. 44, Issue 4, pp. 509–535). Taylor and Francis Inc. https://doi.org/10.1080/21683565.2019.1644411

Hazarika, A., Kurmi, B., Francaviglia, R., Weldesemayat Sileshi, G., Paramesh, V., Kumar Das, A., & Jyoti Nath, A. (2024). The transition from shifting cultivation to Indigenous agroforestry as nature-based solution for land restoration in the Indian Eastern Himalayas. *Ecological Indicators*, *162*. https://doi.org/10.1016/j.ecolind.2024.112031

Hellin, J., Welchez, L. A., & Cherrett, I. (1999). *The Quezungual System: an Indigenous agroforestry system from western Honduras*.
Hernandez, A. (2020). The Emergence of Agroecology as a Political Tool in the Brazilian Landless Movement. *Local Environment*, *25*(3), 205–227. https://doi.org/10.1080/13549839.2020.1722990
Hodder, I. (2018). Things and the Slow Neolithic: the Middle Eastern Transformation. *Journal of Archaeological Method and Theory*, *25*(1), 155–177. https://doi.org/10.1007/s10816-017-9336-0
Hole, F. (1984). A Reassessment of the Neolithic Revolution. *Paleorient*, *10*(2), 49–60. https://www.jstor.org/stable/41489605
Hu, D. (2013). Approaches to the Archaeology of Ethnogenesis: Past and Emergent Perspectives. *Journal of Archaeological Research*, *21*(4), 371–402. https://doi.org/10.1007/s10814-013-9066-0
Huai, H., & Hamilton, A. (2009). Characteristics and functions of traditional homegardens: A review. *Frontiers of Biology in China*, *4*(2), 151–157. https://doi.org/10.1007/s11515-008-0103-1
Huambachano, M. (2018). Agroecology and Sustainable Food Systems Enacting food sovereignty in Aotearoa New Zealand and Peru : revitalizing Indigenous knowledge , food practices and ecological philosophies Enacting food sovereignty in Aotearoa New Zealand and Peru : revitalizing . *Agroecology and Sustainable Food Systems*, *00*(00), 1–26. https://doi.org/10.1080/21683565.2018.1468380
Huambachano, M. A. (2019). Indigenous Food Sovereignty. *New Zealand Journal of Ecology*, *43*(3), 1–6. https://doi.org/10.2307/26841826
Hutterer, K. L. (1983). The Natural and Cultural History of Southeast Asian Agriculture: Ecological and Evolutionary Considerations. *Anthropos*, *78*, 169–212.
Iriarte, J., Elliott, S., Maezumi, S. Y., Alves, D., Gonda, R., Robinson, M., Gregorio de Souza, J., Watling, J., & Handley, J. (2020). The origins of Amazonian landscapes: Plant cultivation, domestication and the spread of food production in tropical South America. *Quaternary Science Reviews*, *248*. https://doi.org/10.1016/j.quascirev.2020.106582
Islam, M. A., Qaisar, K. N., & Bhat, G. M. (2017). Indigenous Knowledge in Traditional Agroforestry Systems of Kashmir Valley: Current Challenges and Future Opportunities. *International Journal of Forestry and Crop Improvement*, *8*(1), 68–77. https://doi.org/10.15740/has/ijfci/8.1/68-77
John, D. A., & Babu, G. R. (2021). Lessons From the Aftermaths of Green Revolution on Food System and Health. In *Frontiers in Sustainable Food Systems* (Vol. 5). Frontiers Media S.A. https://doi.org/10.3389/fsufs.2021.644559
Johnson, A. W., & Earle, T. (1987). The Evolution of Human Societies: From Foraging Groups to Agrarian State. In *Economic Geography* (Issue 2). Stanford University Press.
Jones, G., Kluyver, T., Preece, C., Swarbrick, J., Forster, E., Wallace, M., Charles, M., Rees, M., & Osborne, C. P. (2021). The origins of agriculture: Intentions and consequences. *Journal of Archaeological Science*, *125*. https://doi.org/10.1016/j.jas.2020.105290
Jordon, P. (2018). Hunters and Gatherers. In *The Oxford Handbook of the Archaeology and Anthropology of HUnters-Gatherers* (pp. 447–465). https://alex-bentley.com/yahoo_site_admin/assets/docs/ch26_Jordan.27200747.pdf
Kagawa, M. (1973). *Primitive Agriculture in Japan: Latest Jōmon Agricultural Society and Means of Production Author(s): MITSUO KAGAWA*. 1–15. https://www.jstor.org/stable/42927796

Kalaba, F. K., Chirwa, P. W., & Prozesky, H. (2009). The contribution of Indigenous fruit trees in sustaining rural livelihoods and conservation of natural resources. In *Journal of Horticulture and Forestry* (Vol. 1, Issue 1). http://www.academicjournals.org/jhf

Kansanga, M., Andersen, P., Kpienbaareh, D., Mason-Renton, S., Atuoye, K., Sano, Y., Antabe, R., & Luginaah, I. (2019). Traditional agriculture in transition: examining the impacts of agricultural modernization on smallholder farming in Ghana under the new Green Revolution. *International Journal of Sustainable Development and World Ecology*, *26*(1), 11–24. https://doi.org/10.1080/13504509.2018.1491429

Kellogg, C. E. (1963). Shifting cultivation. *Soil Science*, *95*(4), 221–230. https://doi.org/10.1097/00010694-196304000-00002

Khatri, S., Khanal, S., & Kafle, S. (2021). Perceived attributes and adoption of Indigenous Technological Knowledge on agriculture - a case study from Bhirkot municipality of Syangja District, Nepal. *Cogent Food and Agriculture*, *7*(1). https://doi.org/10.1080/23311932.2021.1914384

Kilawe, C. J., Mertz, O., Silayo, D. S. A., Birch-Thomsen, T., & Maliondo, S. M. (2018). Transformation of shifting cultivation: Extent, driving forces and impacts on livelihoods in Tanzania. *Applied Geography*, *94*, 84–94. https://doi.org/10.1016/j.apgeog.2018.03.002

Kodirekkala, K. R. (2015). External Intervention, Local Environment, and Knowledge Erosion: A Forest-Based Community of South India. *Culture, Agriculture, Food and Environment*, *37*(2), 124–129. https://doi.org/10.1111/cuag.12059

Kodirekkala, K. R. (2018). Cultural Adaptation to Climate Change among Indigenous People of South India. *Climatic Change*, *147*(1–2), 299–312. https://doi.org/10.1007/s10584-017-2116-8

Köhler-Rollefson, I. (1988). The Aftermath of the Levantine Neolithic Revolution in the light of Ecological and Ethnographic Evidence. *PALÉORIENT*, *14*(1), 87–93. https://www.jstor.org/stable/41492272

Lamino Jaramillo, P., & Boren-Alpízar, A. E. (2023). Agricultural Identity of Indigenous Salasacas in Ecuador. *AlterNative*, *19*(4), 882–891. https://doi.org/10.1177/11771801231197979

LaRochelle, S., & Berkes, F. (2003). Traditional Ecological Knowledge and Practice for Edible Wild Plants: Biodiversity Use by the Rarámuri, in the Sirerra Tarahumara, Mexico. *International Journal of Sustainable Development and World Ecology*, *10*(4), 361–375. https://doi.org/10.1080/13504500309470112

Larsen, C. S. (2006). The agricultural revolution as environmental catastrophe: Implications for health and lifestyle in the Holocene. *Quaternary International*, *150*(1), 12–20. https://doi.org/10.1016/j.quaint.2006.01.004

Lawrence, T. J., Stedman, R. C., Morreale, S. J., & Taylor, S. R. (2019). Rethinking Landscape Conservation: Linking Globalized Agriculture to Changes to Indigenous Community-Managed Landscapes. *Tropical Conservation Science*, *12*. https://doi.org/10.1177/1940082919889503

Leakey, R. R. B. (2017). Definition of Agroforestry Revisited. *Multifunctional Agriculture*, *8*(1), 5–6. https://doi.org/10.1016/b978-0-12-805356-0.00001-5

Legide, Y. Y., Feyissa, G. S., & Karo, T. M. (2024). Revitalizing Indigenous Practices Employed by Farmers to Reduce Agriculture's Vulnerability to Climate Change: A Systematic Review. *Journal of Environmental Studies and Sciences*, *14*(2), 400–414. https://doi.org/10.1007/s13412-024-00888-3

Lemke, S., & Delormier, T. (2017). Indigenous Peoples' food systems and gender**.** Maternal & Child Nutrition, 13(S3). https://doi.org/10.1111/mcn.12499

Leppard, T. P. (2019). Social complexity and social inequality in the prehistoric mediterranean. *Current Anthropology*, *60*(3), 283–308. https://doi.org/10.1086/703174
Lertzman, D. A., & Vredenburg, H. (2005). Indigenous Peoples, Resource Extraction and Sustainable Development: An Ethical Approach. *Journal of Business Ethics*, *56*, 239–254.
Li, H.-L. (1970). The Origin of Cultivated Plants in Southeast Asia. *Economic Botany*, *24*(1), 3–19. https://www.jstor.org/stable/4253102
Locay, L. (1989). From Hunting and Gathering to Agriculture. *Economic Development and Cultural Change*, 737–756. https://doi.org/10.1086/451758
Lope-Alzina, D. G. (2020). INDIGENOUS WOMEN IN AGRICULTURE: Focus on Latin America. In C. E. Sachs, L. Jensen, P. Castellanos, & K. Sexsmith (Eds.), *Routledge Handbook of Gender and Agriculture* (1st ed., pp. 336–347). Taylor & Francis Group. http://ebookcentral.proquest.com/lib/nottingham/detail.action?docID=6351691.
Maezumi, S. Y., Alves, D., Robinson, M., de Souza, J. G., Levis, C., Barnett, R. L., Almeida de Oliveira, E., Urrego, D., Schaan, D., & Iriarte, J. (2018a). The legacy of 4,500 years of polyculture agroforestry in the eastern Amazon. *Nature Plants*, *4*(8), 540–547. https://doi.org/10.1038/s41477-018-0205-y
Maezumi, S. Y., Alves, D., Robinson, M., de Souza, J. G., Levis, C., Barnett, R. L., Almeida de Oliveira, E., Urrego, D., Schaan, D., & Iriarte, J. (2018b). The Legacy of 4,500 years of Polyculture Agroforestry in the Eastern Amazon. *Nature Plants*, *4*(8), 540–547. https://doi.org/10.1038/s41477-018-0205-y
Malli, A., Monteith, H., Hiscock, E. C., Smith, E. V., Fairman, K., Galloway, T., & Mashford-Pringle, A. (2023). Impacts of colonization on Indigenous food systems in Canada and the United States: a scoping review. *BMC Public Health*, *23*(1). https://doi.org/10.1186/s12889-023-16997-7
Malmstrom, C. M., & Alexander, H. M. (2016). Effects of crop viruses on wild plants. In *Current Opinion in Virology* (Vol. 19, pp. 30–36). Elsevier B.V. https://doi.org/10.1016/j.coviro.2016.06.008
Martin, K., & Sauerborn, J. (2013). Origin and Development of Agriculture. In *Agroecology* (pp. 9–48). Springer Netherlands. https://doi.org/10.1007/978-94-007-5917-6_2
Mazoyer, M., & Roudart, L. (2006). *A History of World Agriculture: From the Neolithic to the Current Crisis*.
McBurney, M., Tuaza, L. A., Ayol, C., & Johnson, C. A. (2021). Land and livelihood in the age of COVID-19: Implications for Indigenous food producers in Ecuador. *Journal of Agrarian Change*, *21*(3), 620–628. https://doi.org/10.1111/joac.12417
McCune, N., & Giraldo, O. F. (2019). Can the state take agroecology to scale? Agroecology and Sustainable Food Systems, 43(7-8)**,** 785–809. https://doi.org/10.1080/21683565.2019.1585402
McElwee, P. (2022). Shifting policies for shifting cultivation: A history of anti-swidden interventions in Vietnam. *Journal of Southeast Asian Studies*, *53*(1–2), 153–182. https://doi.org/10.1017/S0022463422000194
McGregor, D. (2004). Coming full circle: Indigenous knowledge, environment, and our future. *American Indian Quarterly*, 28(3), 385–410. [JSTOR]
Mcnicol, I. M., Ryan, C. M., & Williams, M. (2015). *How resilient are African woodlands to disturbance from shifting cultivation?* (Vol. 25, Issue 8).
Mertz, O., & Bech Bruun, T. (2017). Shifting Cultivation Policies in Southeast Asia: A need to work with, rather than against, smallholder farmers. In *Shifting cultivation policies: balancing environmental and social sustainability* (pp. 27–42). https://www.cabidigitallibrary.org/doi/abs/10.1079/9781786391797.0027

Mertz, O., Bruun, T. B., Jepsen, M. R., Ryan, C. M., Zaehringer, J. G., Hinrup, J. S., & Heinimann, A. (2021). Ecosystem Service Provision by Secondary Forests in Shifting Cultivation Areas Remains Poorly Understood. *Human Ecology*, *49*(3), 271–283. https://doi.org/10.1007/s10745-021-00236-x

Miller, R. P., & Nair, P. K. R. (2006). Indigenous Agroforestry Systems in Amazonia: From Prehistory to Today. *Agroforestry Systems*, *66*(2), 151–164. https://doi.org/10.1007/s10457-005-6074-1

Mirazón Lahr, M., & Foley, R. A. (1998). Towards a theory of modern human origins: Geography, demography, and diversity in recent human evolution. *American Journal of Physical Anthropology*, *107*(S27), 137–176. https://doi.org/10.1002/(sici)1096-8644(1998)107:27+<137::aid-ajpa6>3.0.co;2-q

Mohamed Shaffril, H. A., Ahmad, N., Samsuddin, S. F., Samah, A. A., & Hamdan, M. E. (2020). Systematic Literature Review on Adaptation Towards Climate Change Impacts among Indigenous People in the Asia Pacific Regions. *Journal of Cleaner Production*, *258*, 120595. https://doi.org/10.1016/j.jclepro.2020.120595

Mollett, S. (2016). The Power to Plunder: Rethinking Land Grabbing in Latin America. *Antipode*, *48*(2), 412–432. https://doi.org/10.1111/anti.12190

Montalvo-Romero, N., Montiel-Rosales, A., Purroy-Vasquez, R., & Quechulpa-Perez, P. (2023). Agro-Technological Systems in Traditional Agriculture Assistance: A Systematic Review. *IEEE Access*, *11*, 123047–123069. https://doi.org/10.1109/ACCESS.2023.3329087

Morales, A. J., & Rodriguez-Lara, I. (2020). *An Experiment on the Neolithic Agricultural Revolution. Causes An Experiment on the Neolithic Agricultural Revolution. Causes and Impact on Inequality and Impact on Inequality*. https://digitalcommons.chapman.edu/esi_working_papers

Moura, L. C., Scariot, A. O., Schmidt, I. B., Beatty, R., & Russell-Smith, J. (2019). The legacy of colonial fire management policies on traditional livelihoods and ecological sustainability in savannas: Impacts, consequences, new directions. *Journal of Environmental Management*, *232*, 600–606. https://doi.org/10.1016/j.jenvman.2018.11.057

Mt.Pleasant, J. (2016). Food yields and nutrient analyses of the three sisters: A Haudenosaunee cropping system. *Ethnobiology Letters*, *7*(1), 87–98. https://doi.org/10.14237/ebl.7.1.2016.721

Nadasdy, P. (2005). The anti-politics of TEK: The institutionalization of co-management discourse and practice. *Anthropologica*, 47(2), 215–232. [JSTOR]

Nascimento, M. N., Heijink, B. M., Bush, M. B., Gosling, W. D., & McMichael, C. N. H. (2022). Early to mid-Holocene human activity exerted gradual influences on Amazonian forest vegetation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1849). https://doi.org/10.1098/rstb.2020.0498

Nath, A. J., Reang, D., & Sileshi, G. W. (2022). The Shifting Cultivation Juggernaut: An Attribution Problem. *Global Challenges*. https://doi.org/10.1002/gch2.202200051

Ngapo, T. M., Bilodeau, P., Arcand, Y., Charles, M. T., Diederichsen, A., Germain, I., Liu, Q., Mackinnon, S., Messiga, A. J., Mondor, M., Villeneuve, S., Ziadi, N., & Gariépy, S. (2021). Historical Indigenous food preparation using produce of the three sisters intercropping system. In *Foods* (Vol. 10, Issue 3). MDPI AG. https://doi.org/10.3390/foods10030524

Nixon Njau, M. (2014). Colonialism and Marginalization of African Indigenous Knowledge on land and Soil Conservation in Kenya, a case of the Kikuyu Community. In *Asian Journal of Humanities and Social Studies*. www.ajouronline.com

Nongrum, M. S., & Syiem, B. J. (2022). How traditional agriculture contributes to the global narrative for sustainability: A case from a community in northeast India. *Journal of Agriculture, Food Systems, and Community Development*, *11*(3), 19–25. https://doi.org/10.5304/jafscd.2022.113.018

Norton-Smith, K., Lynn, K., Chief, K., Cozzetto, K., Donatuto, J., Redsteer, M. H., Kruger, L. E., Maldonado, J., Viles, C., & Whyte, K. P. (2016). *Climate Change and Indigenous Peoples: A Synthesis of Current Impacts and Experiences*. http://www.ascr.usda.gov/complaint_filing_cust.html

Nunn, N., & Qian, N. (2010). The Columbian exchange: A history of disease, food, and ideas. *Journal of Economic Perspectives*, *24*(2), 163–188. https://doi.org/10.1257/jep.24.2.163

Ogundiran, A. (2019a). Food Security, Food Sovereignty, and Indigenous Knowledge. In *African Archaeological Review* (Vol. 36, Issue 3, pp. 343–346). Springer New York LLC. https://doi.org/10.1007/s10437-019-09349-7

Ogundiran, A. (2019b). Food Security, Food Sovereignty, and Indigenous Knowledge. In *African Archaeological Review* (Vol. 36, Issue 3, pp. 343–346). Springer New York LLC. https://doi.org/10.1007/s10437-019-09349-7

Olatokun, W. M., & Ayanbode, O. F. (2008). Agriculture and Food Production: Use of Indigenous Knowledge by Rural Women in the Development of Ogun State. *INDILINGA - African Journal of Indigenous Knowledge Systems*, *7*(1), 47–63. https://hdl.handle.net/10520/EJC61540

Olofson, H. (1983). Indigenous Agroforestry Systems. *Philippine Quarterly of Culture and Society*, *11*(2/3), 149–174. https://www.jstor.org/stable/29791792

Olowo, S. F., Omotayo, A. O., Lawal, I. O., & Aremu, A. O. (2022). Improving Rural Livelihood through the Cultivation of Indigenous Fruits and Vegetables: Evidence from Ondo State, Nigeria. *Agriculture (Switzerland)*, *12*(3). https://doi.org/10.3390/agriculture12030372

Pandey, D. K., Dubey, S. K., Verma, A. K., Wangchu, L., Dixit, S., Devi, C. V., & Sawargaonkar, G. (2023). Indigenous Peoples' Psychological Wellbeing Amid Transitions in Shifting Cultivation Landscape: Evidence from the Indian Himalayas. *Sustainability (Switzerland)*, *15*(8). https://doi.org/10.3390/su15086791

Pandey, D. K., Kumar De, H., Dubey, S. K., Kumar, B., Dobhal, S., & Adhiguru, P. (2020). Indigenous people's attachment to shifting cultivation in the Eastern Himalayas, India: A cross-sectional evidence. *Forest Policy and Economics*, *111*(April 2018), 102046. https://doi.org/10.1016/j.forpol.2019.102046

Parihaar, R. S., Bargali, K., & Bargali, S. S. (2015). Status of an Indigenous agroforestry system: A case study in Kumaun Himalaya, India. In *Indian Journal of Agricultural Sciences* (Vol. 85, Issue 3).

Parraguez, E., And, V., Barton, J. R., & Vergara, E. P. (2013). Poverty and Dependency in Indigenous Rural Livelihoods: Mapuche Experiences in the Andean Foothills of Chile. In *Journal of Agrarian Change* (Vol. 13, Issue 2).

Parraguez-Vergara, E., Contreras, B., Clavijo, N., Villegas, V., Paucar, N., & Ther, F. (2018). Does Indigenous and campesino traditional agriculture have anything to contribute to food sovereignty in Latin America? Evidence from Chile, Peru, Ecuador, Colombia, Guatemala and Mexico. *International Journal of Agricultural Sustainability*, *16*(4–5), 326–341. https://doi.org/10.1080/14735903.2018.1489361

Patel, R. (2013). The Long Green Revolution. *Journal of Peasant Studies*, *40*(1), 1–63. https://doi.org/10.1080/03066150.2012.719224

Petzold, J., Andrews, N., Ford, J. D., Hedemann, C., & Postigo, J. C. (2020). Indigenous Knowledge on Climate Change Adaptation: A Global Evidence Map of Academic

Literature. *Environmental Research Letters*, *15*(11). https://doi.org/10.1088/1748-9326/abb330
Pimentel, D., & Pimentel, M. (1990). Comment: Adverse Environmental Consequences of the Green Revolution. *Population and Development Review*, *16*, 329–332. https://www.jstor.org/stable/2808081
Plant, R., & Hvalkof, S. (2001). *Sustainable Development Department Technical Papers Series: Land Titling and Indigenous Peoples*. www.iadb.org/sds/ind
Pluciennik, M., & Zvelebil, M. (2008). The Origins and Spread of Agriculture. In R. A. Bentley, H. D. G. Maschner, & C. Chippindale (Eds.), *Handbook of Archaeological Theories* (pp. 467–486). Altamira Press. https://www.researchgate.net/publication/32886760
Pohl, M. D., Pope, K. O., Jones, J. G., Jacob, J. S., Piperno, D. R., deFrance, S. D., Lentz, D. L., Gifford, J. A., Danforth, M. E., & Josserand, J. K. (1996). Early Agriculture in the Maya Lowlands. *Latin American Antiquity*, *7*(4), 355–372. https://doi.org/10.2307/972264
Pokharia, A. K., Mani, B. R., Spate, M., Betts, A., & Srivastava, A. (2018). Early Neolithic agriculture (2700–2000 bc) and Kushan period developments (ad 100–300): macrobotanical evidence from Kanispur in Kashmir, India. *Vegetation History and Archaeobotany*, *27*(3), 477–491. https://doi.org/10.1007/s00334-017-0645-8
Pope, K., Pohl, M. E. D., Jones, J. G., Lentz, D. L., von Nagy, C., Vega, F. J., & Quitmyer, Irvy. R. (2001). Origin and Environmental Setting of Ancient Agriculture in the Lowlands of Mesoamerica. *Science*, *292*, 1370–1373. https://doi.org/10.1126/science.292.5520.1370
Porcuna-Ferrer, A., Calvet-Mir, L., Faye, N. F., Klappoth, B., Reyes-García, V., & Labeyrie, V. (2024). Drought-Tolerant Indigenous Crop Decline in the Face of Climate Change: A Political Agroecology Account from South-Eastern Senegal. *Journal of Rural Studies*, *105*. https://doi.org/10.1016/j.jrurstud.2023.103163
Price, M. J., Latta, A., Spring, A., Temmer, J., Johnston, C., Chicot, L., Jumbo, J., & Leishman, M. (2022a). Agroecology in the North: Centering Indigenous food sovereignty and land stewardship in agriculture "frontiers". *Agriculture and Human Values*, *39*(4), 1191–1206. https://doi.org/10.1007/s10460-022-10312-7
Price, M. J., Latta, A., Spring, A., Temmer, J., Johnston, C., Chicot, L., Jumbo, J., & Leishman, M. (2022b). Agroecology in the North: Centering Indigenous food sovereignty and land stewardship in agriculture "frontiers". *Agriculture and Human Values*, *39*(4), 1191–1206. https://doi.org/10.1007/s10460-022-10312-7
Purugganan, M. D. (2019). Evolutionary Insights into the Nature of Plant Domestication. *Current Biology*, *29*(14), R705–R714. https://doi.org/10.1016/j.cub.2019.05.053
Rajagopal, I., Cuevas Sánchez, J. A., Baca Del Moral, J., Montejo, D. A., Gómez Hernández, T., Luis, J., & Lozano, R. (2021). The Scope and Constraints of Homegardens for Sustainable Development: A Review. *Tropical and Subtropical Agroecosystems*, *24*(76), 1–24.
Rivera-Ferre, M. G. (2018). The resignification process of agroecology**.** Agroecology and Sustainable Food Systems, 42(6*)***,** 666–685.
Robinson, G. M. (2018). *Globalization of Agriculture*. https://doi.org/10.1146/annurev-resource
Rosen, A. M. (2008). The impact of environmental change and human land use on alluvial valleys in the Loess Plateau of China during the Middle Holocene. *Geomorphology*, *101*(1–2), 298–307. https://doi.org/10.1016/j.geomorph.2008.05.017

Rowley-Conwy, P., & Layton, R. (2011). Foraging and farming as niche construction: Stable and unstable adaptations. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1566), 849–862. https://doi.org/10.1098/rstb.2010.0307

Runnels, C. N. (1995). *Environmental Degradation in Ancient Greece*. *272*(3), 96–99. https://doi.org/10.2307/24980377

Sambo, B. E. (2014). Endangered, Neglected, Indigenous Resilient Crops: A Potential against Climate Change Impact for Sustainable Crop Productivity and Food Security. *IOSR Journal of Agriculture and Veterinary Science*, *7*(2), 34–41. www.iosrjournals.orgwww.iosrjournals.org

Sangha, K. K. (2014). Modern agricultural practices and analysis of socioeconomic and ecological impacts of development in agriculture sector, Punjab, India - A review. *Indian Journal of Agricultural Research*, *48*(5), 331–341. https://doi.org/10.5958/0976-058X.2014.01312.2

Schulz, B., Becker, B., & Gotsch, E. (1994). Indigenous knowledge in a 'modern' sustainable agroforestry system-a case study from eastern Brazil. In *Agroforestry Systems* (Vol. 25, Issue 9). KluwerAcademic Publishers.

Shafiee, M., Keshavarz, P., Lane, G., Pahwa, P., Szafron, M., Jennings, D., & Vatanparast, H. (2022). Food Security Status of Indigenous Peoples in Canada According to the 4 Pillars of Food Security: A Scoping Review. *Advances in Nutrition*, *13*(6), 2537–2558. https://doi.org/10.1093/advances/nmac081

Shavit, A., & Sharon, G. (2023). Can models of evolutionary transition clarify the debates over the Neolithic Revolution? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *378*(1872). https://doi.org/10.1098/rstb.2021.0413

Sheikh, H. (2020). RE: 'onColonial Histories, Racism and Health—The Experience of Māori and Indigenous Peoples'. *Public Health*, *182*, 80. https://doi.org/10.1016/j.puhe.2020.01.018

Shilomboleni, H. (2018). African Green Revolution, food sovereignty and constrained livelihood choice in Mozambique. *Canadian Journal of African Studies*, *52*(2), 115–137. https://doi.org/10.1080/00083968.2018.1483833

Shiva, V. (1991). The Violence of the Green Revolution. In *The Journal of Value Inquiry* (2nd ed., Vol. 27). Zed Books Ltd. https://www.academia.edu/31972793/The_Violence_of_the_Green_revolution_Vandana_Shiva

Sidbury, J., & Cañizares-Esguerra, J. (2011). Mapping Ethnogenesis in the Early Modern Atlantic. *The William and Mary Quarterly*, *68*(2), 181–208. https://doi.org/10.5309/willmaryquar.68.2.0181

Sidiq, F. F., Coles, D., Hubbard, C., Clark, B., & Frewer, L. J. (2022). The Role of Traditional Diets in Promoting Food Security for Indigenous Peoples in Low- and Middle-Income Countries: A Systematic Review. *IOP Conference Series: Earth and Environmental Science*, *978*(1). https://doi.org/10.1088/1755-1315/978/1/012001

Sierra, R. (2016). Food Production Systems in the Amazon. In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (pp. 1–15). Springer Netherlands. https://doi.org/10.1007/978-94-007-3934-5_9901-2

Singh, R., & Singh, G. S. (2017). Traditional Agriculture: A Climate-Smart Approach for Sustainable Food Production. *Energy, Ecology and Environment*, *2*(5), 296–316. https://doi.org/10.1007/s40974-017-0074-7

Sithole, A. (2019). Women's Use Of Indigenous Knowledge Systems To Cope With Climate Change. *Advances in Social Sciences Research Journal*, *6*(6). https://doi.org/10.14738/assrj.66.6470

Skelly, E., Kapellas, K., Cooper, A., & Weyrich, L. S. (2018). Consequences of colonialism: A microbial perspective to contemporary Indigenous health. *American Journal of Physical Anthropology*, *167*(2), 423–437. https://doi.org/10.1002/ajpa.23637
Son, H. N., Chi, D. T. L., & Kingsbury, A. (2019). Indigenous Knowledge and Climate Change Adaptation of Ethnic Minorities in the Mountainous Regions of Vietnam: A Case Study of the Yao People in Bac Kan Province. *Agricultural Systems*, *176*. https://doi.org/10.1016/j.agsy.2019.102683
Songqiao, Z. (1993). The Spread of Agriculture in China. *CHinese Geographical Science*, *3*(3), 194–202. https://doi.org/https://doi.org/10.1007/BF02664272
Soto-Pinto, L., Anzueto, M., Mendoza, J., Ferrer, G. J., & de Jong, B. (2010). Carbon sequestration through agroforestry in Indigenous communities of Chiapas, Mexico. *Agroforestry Systems*, *78*(1), 39–51. https://doi.org/10.1007/s10457-009-9247-5
Stavenhagen, R. (2006). Indigenous Peoples: Land, Territory, Autonomy, and Self-Determination. In P. Rosset, R. Patel, & M. Courville (Eds.), *Promised Land: Competing Visions of Agrarian Reform* (pp. 208–217). First Food Books.
Sujarwo, W., Arinasa, I. B. K., Salomone, F., Caneva, G., & Fattorini, S. (2014). Cultural Erosion of Balinese Indigenous Knowledge of Food and Nutraceutical Plants. *Economic Botany*, *68*(4), 426–437. https://doi.org/10.1007/s12231-014-9288-1
Svizzero, S. (2017). Persistent Controversies about the Neolithic Revolution. *Journal of Historical Ar-Chaeology & Anthropological Sciences*, *1*(2). https://doi.org/10.15406/jhaas.2017.01.00013ï
Svizzero, S., & Tisdell, C. A. (2014). *The Neolithic Revolution and Human Societies: Diverse Origins and Development Paths* (192; Working Papers on Economics, Ecology and the Environment). https://hal.univ-reunion.fr/hal-02153090
Swiderska, K., Argumedo, A., Wekesa, C., Ndalilo, L., Song, Y., Rastogi, A., & Ryan, P. (2022). Indigenous Peoples' Food Systems and Biocultural Heritage: Addressing Indigenous Priorities Using Decolonial and Interdisciplinary Research Approaches. *Sustainability (Switzerland)*, *14*(18). https://doi.org/10.3390/su141811311
Swiderska, K., Song, Y., Li, J., Reid, H., & Mutta, D. (2011). Adapting agriculture with traditional knowledge. *Climatic Changes*, *october*, 4. http://pubs.iied.org/17111IIED
Thrupp, L. A. (2000). Linking agricultural biodiversity and food security: the valuable role of agrobiodiversity for sustainable agriculture. *International Affairs*, *76*(2), 265–281. www.wri.org
Timmermann, C., & Félix, G. F. (2015). Agroecology as a Vehicle for Contributive Justice. *Agriculture and Human Values*, *32*(3), 523–538. https://doi.org/10.1007/s10460-014-9581-8
Tomory, L. (2016). Technology in the British Industrial Revolution. *History Compass*, *14*(4), 152–167. https://doi.org/10.1111/hic3.12306
United Nations. (2009). *State of the World's Indigenous Peoples*. https://www.un.org/esa/socdev/unpfii/documents/SOWIP/en/SOWIP_web.pdf
Upreti, B. R., & Upreti, Y. G. (2002). Factors leading to agro-biodiversity loss in developing countries: the case of Nepal. *Biodiversity and Conservation*, *11*, 1607–1621.
Vallejo, M., Casas, A., Blancas, J., Moreno-Calles, A. I., Solís, L., Rangel-Landa, S., Dávila, P., & Téllez, O. (2014). Agroforestry systems in the highlands of the Tehuacán Valley, Mexico: Indigenous cultures and biodiversity conservation. *Agroforestry Systems*, *88*(1), 125–140. https://doi.org/10.1007/s10457-013-9660-7
van der Merwe, J. D., Cloete, P. C., & van der Hoeven, M. (2016). Promoting food security through Indigenous and traditional food crops. *Agroecology and Sustainable Food Systems*, *40*(8), 830–847. https://doi.org/10.1080/21683565.2016.1159642

Vos, R., & Bellù, L. G. (2018). Global Trends and Challenges to Food and Agriculture into the 21st Century. In *Sustainable Food and Agriculture: An Integrated Approach* (pp. 11–30). Elsevier. https://doi.org/10.1016/B978-0-12-812134-4.00002-9
Voss, B. L. (2015). What's New? Rethinking Ethnogenesis in the Archaeology of Colonialism. *American Antiquity*, *80*(4), 655–670. https://doi.org/10.7183/0002-7316.80.4.655
Wang, W., Nguyen, K. D., Le, H. D., Zhao, C., Carson, M. T., Yang, X., & Hung, H. C. (2022). Rice and millet cultivated in Ha Long Bay of Northern Vietnam 4000 years ago. *Frontiers in Plant Science*, *13*. https://doi.org/10.3389/fpls.2022.976138
Warner, K. (1991). *Shifting Cultivators: Local Technical Knowledge and Natural Resource Management in the Humid Tropics*. https://openknowledge.fao.org/server/api/core/bitstreams/dc55dad6-ad4c-4652-ab0e-c48670704f29/content
Weik, T. M. (2014). The Archaeology of Ethnogenesis. *Annual Review of Anthropology*, *43*, 291–305. https://doi.org/10.1146/annurev-anthro-102313-025920
Werndl, C. (2016). On Defining Climate and Climate Change. *British Journal for the Philosophy of Science*, *67*(2), 337–364. https://doi.org/10.1093/bjps/axu048
Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., & David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, *29*(4), 503–515. https://doi.org/10.1051/agro/2009004
Wezel, A., Gemmill Herren, B., Kerr, R. B., Barrios, E., Luiz, A., Gonçalves, R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, *40*(40), 1–13. https://doi.org/10.1007/s13593-020-00646-z/Published
Wezel, A., & Soldat, V. (2009). A quantitative and qualitative historical analysis of the scientific discipline of agroecology. *International Journal of Agricultural Sustainability*, *7*(1), 3–18. https://doi.org/10.3763/ijas.2009.0400
Whyte, K. P. (2013). On the role of traditional ecological knowledge as a collaborative concept: A philosophical study. *Ecological Processes*, 2(1), 1–12. [https://doi.org/10.1186/2192-1709-2-7
Whyte, K. P. (2014). Indigenous Women, Climate Change Impacts, and Collective Action. *Hypatia*, *29*(3), 599–616.
Whyte, K. P. (2017). Indigenous climate change studies: Indigenizing futures, decolonizing the Anthropocene. *English Language Notes*, 55(1–2), 153–162. [https://doi.org/10.1215/00138282-55.1-2.153
Winterhalder, B. (1981). Optimal Foraging Strategies and Hunter-Gatherer Research in Anthropology: Theory and Models. *UC Davis Previously Published Works*, 13–36. https://escholarship.org/uc/item/67g8h7r2
Yang, B., & He, J. (2021). Global land grabbing: A critical review of case studies across the world. In *Land* (Vol. 10, Issue 3). MDPI AG. https://doi.org/10.3390/land10030324
Yang, X., Wan, Z., Perry, L., Lu, H., Wang, Q., Zhao, C., Li, J., Xie, F., Yu, J., Cui, T., Wang, T., Li, M., & Ge, Q. (2012). Early millet use in northern China. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(10), 3726–3730. https://doi.org/10.1073/pnas.1115430109
Yinebeb, M., Lulekal, E., & Bekele, T. (2022). Composition of Homegarden Plants and Cultural Use in an Indigenous Community in Northwest Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, *18*(1). https://doi.org/10.1186/s13002-022-00545-5
Zeder, M. A. (2011). The Origins of Agriculture in the Near East. *Current Anthropology*, *52*(SUPPL. 4). https://doi.org/10.1086/659307

Zeder, M. A. (2015). Core questions in domestication research. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3191–3198. https://doi.org/10.1073/pnas.1501711112

Zhao, Z. (2010). New data and new issues for the study of origin of rice agriculture in China. *Archaeological and Anthropological Sciences*, *2*(2), 99–105. https://doi.org/10.1007/s12520-010-0028-x

Zizumbo-Villarreal, D., & Colunga-GarcíaMarín, P. (2010). Origin of agriculture and plant domestication in West Mesoamerica. *Genetic Resources and Crop Evolution*, *57*(6), 813–825. https://doi.org/10.1007/s10722-009-9521-4

Zong, Y., Chen, Z., Innes, J. B., Chen, C., Wang, Z., & Wang, H. (2007). Fire and flood management of coastal swamp enabled first rice paddy cultivation in east China. *Nature*, *449*(7161), 459–462. https://doi.org/10.1038/nature06135

Zvelebil, M. (1994). Plant Use in the Mesolithic and its Role in the Transition to Farming. *Proceedings of the Prehistoric Society*, *60*, 35–74. https://doi.org/10.1017/S0079497X00003388

Zvelebil, M., & Pluciennik, M. (2011). *The Role of Food, Agriculture, Forestry and Fisheries in Human Nutrition Vol I: Historical Origins of Agriculture* (V. R. Squires, Ed.; Vol. 1). UNESCO-EOLSS. https://www.eolss.net/ebooklib/bookinfo/role-food-agriculture-forestry-fisheries-human-nutrition.aspx

Chapter 3 : Methodological Framework

3.1. Introduction

This chapter outlines the study's methodological framework, which consists of a mixed-methods approach with decolonizing and Indigenous-centered methodologies. Grounded in Decolonizing Methodologies (Smith, 2012) and Critical Indigenous Theory (Simard, 2020), it prioritizes Jah Hut knowledge and traditions. A key feature is a research protocol tailored for the Orang Asli, emphasizing respectful engagement, ethical reciprocity, and Free, Prior, and Informed Consent (FPIC). The chapter also details the research design, case study approach, sampling strategies, and data collection methods, including archival research, interviews, surveys, and participatory discussions. Ethical considerations, particularly community autonomy, trust-building, and knowledge ownership, are central to this approach.

3.2. Research Framework

This research is guided by Decolonizing Methodologies (Smith, 2012) and Critical Indigenous Theory (Simard, 2020), which together provide a theoretical lens for analyzing Jah Hut agriculture as both a knowledge system and a site of resilience amid historical and contemporary pressures. These theories inform the conceptual frameworks used in the study, including Olofson's (1983) framework for harmonic and disharmonic swiddens (Olofson, 1983), the Modified IDEA Framework (Vilain et al., 2008), and the Sustainable Livelihoods Framework (Scoones, 1998). The research framework (Figure 9) illustrates how these theories and frameworks interact to achieve the study's objectives: (i) tracing the historical evolution of Jah Hut agriculture, (ii) assessing its sustainability, and (iii) examining its impact on livelihoods and food security.

3.2.1. Decolonizing Methodologies

Rooted in Linda Tuhiwai Smith's (1999) work on decolonizing research, this study prioritizes Jah Hut worldviews, epistemologies, and participation throughout the research process. Held (2019) argues that decolonization requires collaborative research paradigms, where Indigenous knowledge is not merely an object of study but a central framework for analysis. This research challenges colonial narratives that have historically dismissed Indigenous agriculture and instead foregrounds Jah Hut agency, land relations, and knowledge systems. However, as Barnes (2018) warns, decolonizing methodologies risk becoming academic trends rather than truly transformative practices unless they actively confront institutional constraints and epistemic hierarchies.

Through this lens, Jah Hut perspectives shape data collection, interpretation, and dissemination. Reflexivity requires a continuous examination of power dynamics and positionality in engaging with the community (Thambinathan & Kinsella, 2021). Recognizing that decolonization must go beyond research methods, Ndlovu-Gatsheni (2019) argues that it should involve the broader restructuring of knowledge hierarchies that continue to marginalize Indigenous epistemologies. This includes adopting an ethical and reciprocal research approach, wherein knowledge production is not extractive but mutually beneficial to both researcher and participants.

Several studies provide examples of how decolonizing methodologies have been applied in practice. Campbell-Chudoba (2024) employed métissage and duoethnography, narrative-based methods that disrupt hierarchical researcher-participant relationships by co-creating knowledge through shared storytelling. Similarly, research in Kenya using community-based participatory research (CBPR) approaches ensured that Indigenous communities determined how knowledge was collected, interpreted, and applied, reinforcing their agency in research processes. (Lincoln & González y González, 2008) explored decolonization by critically reflecting on how Western qualitative methods can be transformed to center Indigenous perspectives, advocating for methodological flexibility that aligns with Indigenous ways of knowing.

To operationalize decolonization in methodology, this study draws on narrative-based and participatory approaches that allow Jah Hut knowledge-holders to guide discussions in their own terms (Campbell-Chudoba, 2024). These methods recognize Indigenous cosmologies and land relations as valid sources of knowledge that challenge dominant Western frameworks (Berkes, 2018). However, as many scholars note, the effectiveness of decolonizing methodologies depends on academic institutions' willingness to embrace non-traditional research practices. Given these constraints, this study balances rigorous academic inquiry with Indigenous-led frameworks, ensuring that research findings are interpreted and applied in ways that serve Jah Hut priorities rather than external agendas.

3.2.2. Critical Indigenous Theory

Critical Indigenous Theory (CIT) has been employed in various studies to challenge dominant colonial frameworks and advocate for Indigenous sovereignty, self-determination, and epistemological autonomy. It positions Indigenous Peoples not merely as subjects of colonial oppression, but as knowledge holders and active agents in shaping their socio-political realities. In this study, CIT forms the foundational lens through which Indigenous agriculture is examined - not just as an ecological practice, but as a site of political resistance, cultural continuity, and relational accountability.

The studies reviewed demonstrate that CIT is not simply a theoretical critique, but a methodology rooted in decolonial ethics. Kovach (2009) emphasizes that Indigenous methodologies must emerge from Indigenous worldviews, integrating oral traditions, storytelling, and cultural protocols. Wilson (2008) proposes "relational accountability" as a core methodological principle, arguing that knowledge is produced through, and accountable to, relationships - whether with people, land, or non-human entities.

An important way CIT has been applied in empirical research is by challenging the epistemological dominance of Western academic disciplines. Champagne (as cited in Andersen, 2009) argues that Indigenous epistemologies are often distorted or erased within disciplinary silos. CIT, therefore, reclaims Indigenous intellectual traditions as rigorous, relational, and politically relevant. In the field of accounting, Bujaki et al. (2023) apply CIT to critique how accounting systems have served as tools of colonial control, disempowering Indigenous communities through bureaucratic governance and economic marginalization. Their research reframes accounting as a site of relational accountability, prioritizing Indigenous ontologies and community-defined values.

Best practices also suggest a commitment to epistemological pluralism, such as the "Two-Eyed Seeing" approach (Bartlett et al., 2012), which integrates Indigenous and Western knowledge systems without hierarchizing them. Similarly, Gaudry (2015) calls for insurgent research methods that place Indigenous governance and data sovereignty at the center of inquiry. These principles reinforce the methodological adjustments made in this study - such as privileging traditional knowledge systems, incorporating local definitions of well-being and productivity, and ensuring the inclusion of elders and community voices in data validation. Furthermore, CIT is crucial for unpacking how land tenure policies intersect with Indigenous agricultural sustainability. However, as Andersen (2009) warns, CIT must also avoid rigid binaries between "Indigenous" and "Western" systems.

In summary, the integration of CIT allows for a more nuanced understanding of sustainability - one that incorporates land ethics, knowledge pluralism, and Indigenous political aspirations. It also safeguards the research process from becoming extractive, by grounding it in relational accountability and epistemological respect.

3.2.3. Conceptual Framework for Assessing Indigenous Agriculture

The research framework (Figure 3.1) illustrates the dynamic relationships between historical evolution, sustainability, and Indigenous livelihoods, integrating Traditional Ecological Knowledge (TEK), Olofson's Swidden Framework (discussed in section 2.5.5, Chapter 2), the Modified IDEA Framework, and the Sustainable Livelihoods Framework (SLF). These frameworks provide a structured approach to analyzing how Indigenous agriculture has evolved, how sustainability can be assessed, and how it contributes to community livelihoods and well-being.

The modified IDEA Framework evaluates agricultural sustainability (Chapter 6), integrating ecological, economic, and social factors, while the SLF (Chapter 7) situates agriculture within Jah Hut livelihood strategies, highlighting its contributions to food security, income, and well-being. Critical Indigenous Theory links agricultural transformations to broader land rights struggles, while Decolonizing Methodologies ensure Indigenous agency in knowledge production. Through this integrated framework, the study provides a comprehensive analysis of how Jah Hut agriculture has evolved, how it remains sustainable, and how it contributes to community resilience despite systemic challenges.

Traditional Ecological Knowledge (TEK) forms the foundation of Jah Hut agricultural practices, encompassing land-use strategies, crop selection, soil management, and ecological adaptation. TEK represents accumulated knowledge passed down through generations, developed through observation, experimentation, and cultural understandings of the environment (Berkes, 2018). Indigenous agricultural systems are shaped by cosmological worldviews that emphasize reciprocity, biodiversity, and sustainability. TEK informs agricultural decision-making, determining planting cycles, soil fertility management, and pest control methods (ibid.). It is integral to understanding how Jah Hut farmers engage with the land and how their practices are maintained, adapted, or challenged over time.

To understand how Indigenous agriculture has evolved, the study situates Jah Hut agricultural practices within a historical trajectory, considering changes across pre-colonial, colonial, and post-colonial periods. These phases provide a necessary framework for analyzing land tenure, agricultural sustainability, and socio-political influences over time. The pre-colonial period serves as a reference point for customary land tenure systems and Indigenous farming traditions. The colonial period is analyzed for its impact on land access, agricultural transitions, and economic shifts. The post-colonial period is examined in relation to modernization policies, conservation laws, and land tenure reforms. By structuring the analysis around these historical phases, the study aims to assess how past and present forces shape Indigenous agricultural sustainability and governance.

To assess the sustainability of Indigenous agriculture, the Modified IDEA Framework provides an evaluation of agroecological, socio-territorial, and economic sustainability (Vilain et al., 2008). Unlike conventional sustainability assessments that emphasize market-based productivity, this framework considers culturally specific indicators such as land-use flexibility, ecological regeneration, and community food security. Agroecological sustainability examines the impact of shifting cultivation on soil fertility, biodiversity, and resilience to environmental change. Socio-territorial sustainability considers the role of land tenure, policy interventions, and Indigenous governance structures in supporting or limiting agricultural viability. Economic sustainability explores how Indigenous agricultural practices intersect with broader economic systems, examining shifts between subsistence production and market integration. This analysis will be further expanded in Chapter 6, where sustainability dimensions are assessed in relation to Jah Hut agriculture.

The Sustainable Livelihoods Framework (SLF) contextualizes Indigenous agriculture within broader livelihood strategies, analyzing its contributions to food security, income generation, and social well-being. Indigenous agriculture is not solely a means of subsistence but is also embedded in economic stability, cultural identity, and social cohesion (Scoones, 1999). The SLF considers multiple livelihood assets, including natural capital (land, forests, and biodiversity), human capital (knowledge, skills, and labor availability), and social capital (community governance and networks). Financial capital is also examined in relation to income from Indigenous farming, market engagement, and economic resilience. This framework will be discussed in Chapter 7, where the study evaluates how Jah Hut agriculture interacts with broader socio-economic realities.

Through the integration of TEK, historical agricultural transitions, sustainability assessments, and livelihood frameworks, this conceptual framework provides a structured methodology for examining Indigenous agriculture. By incorporating both Indigenous knowledge systems and analytical frameworks, the study ensures that Jah Hut agricultural practices are analyzed within their full ecological, historical, and socio-economic context.

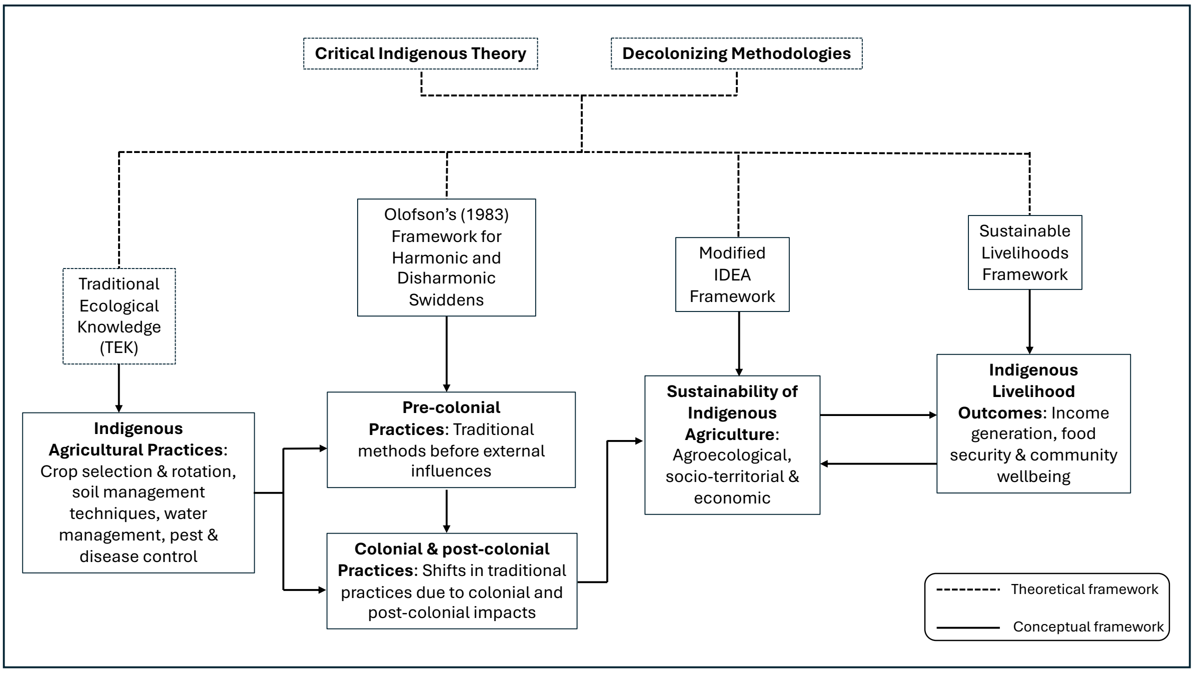

FIGURE 3.1: RESEARCH FRAMEWORK FOR ANALYZING JAH HUT AGRICULTURE

3.3. Research Design

This study employs a mixed-methods approach, integrating both qualitative and quantitative methodologies to provide a comprehensive analysis of past and present Jah Hut agricultural practices (Creswell & Plano Clark, 2018). This methodological choice is particularly well-suited for studying Indigenous communities, as it allows for a holistic exploration of socio-economic, cultural, and environmental dimensions. Similar approaches have been employed in studies of Indigenous livelihoods and land use, such as Bauer et al. (2022), which examined

Indigenous resilience using both survey data and qualitative interviews, and Nath & Inoue (2014), which combined quantitative livelihood assessments with participatory qualitative methods to study Khasia forest villagers in Bangladesh. The integration of qualitative and quantitative data ensures a well-rounded perspective, capturing both practical, measurable aspects of agriculture and the lived experiences of community members, as demonstrated in studies of rubber agroforestry and Indigenous tenure rights (Barletti et al., 2021; T. K. Nath et al., 2013).

A case study approach (Yin, 2014) further refines this methodology, focusing on three Jah Hut villages - Berdut, Sungai Mai, and Pasu - located within or near the Tengku Hassanal Wildlife Reserve (TWR, formerly Krau Wildlife and Forest Reserve) in Pahang, Peninsular Malaysia. Case studies are particularly effective in researching Indigenous communities, where local context is crucial in understanding the complexity of cultural and agricultural practices (Bhushan et al., 2024; T. K. Nath et al., 2013). The selection of these villages was based on the persistence of shifting cultivation practices and accessibility, ensuring an in-depth examination of agricultural transitions. Similar village-based case studies have been successfully applied in Bolivia (Bauer et al., 2022) and the Peruvian Amazon (Barletti et al., 2021) to analyze how land-use policies and ecological pressures shape Indigenous livelihoods.

Employing a mixed-methods research design within a case study framework is essential for gaining a nuanced understanding of the Jah Hut community's agricultural transitions. This approach strengthens the study's validity through triangulation, a strategy also used in comparative analyses of smallholder farming systems in South Asia (Nath et al., 2013) and in conservation-linked livelihoods of forest-dependent communities (Nath & Inoue, 2014). Furthermore, it upholds ethical research standards by incorporating Indigenous perspectives, aligning with methodologies that ensure community participation and local knowledge integration (Barletti et al., 2021; Bhushan et al., 2024). As demonstrated in prior research, this methodological framework is particularly effective in studying the connections between Indigenous land use, socio-economic adaptation, and environmental sustainability.

3.4. Data Collection Methods

Data collection for this study was structured to capture both qualitative and quantitative data, ensuring a comprehensive understanding of the Jah Hut community's agricultural practices.

By using a variety of methods - including archival research, surveys, interviews, and participant observations - both types of data were gathered concurrently.

3.4.1. Archival Research and Historical Data Collection

Archival research, as defined by Ventresca & Mohr (2002), is a systematic approach to analyzing historical records that enables scholars to trace social and organizational evolution through documentary evidence. It is particularly useful in studying institutional structures, policy shifts, and historical transformations that shape contemporary social systems. Archival research is not limited to direct engagement with primary sources; it also encompasses the analysis of secondary archival materials, such as historical studies, ethnographic accounts, and past theses, which provide a synthesized view of historical developments.

In Indigenous research, the use of secondary archives is particularly significant due to the lack of written documentation and the systemic erasure of Indigenous voices in colonial records (Gilliland & McKemmish, 2018; Namhila, 2016). These alternative sources—community oral histories, academic narratives, and grey literature—help recover knowledge that is historically marginalized. This approach aligns with recommendations by McKemmish et al. (2011), who stress the importance of community-grounded records when working with Indigenous histories, and Russell (2006), who emphasizes how archival silences can be addressed through inclusive methodologies.

This chapter details the archival research process undertaken for the first research objective: to determine the historical evolution of traditional agricultural practices of the Orang Asli Jah Hut in Peninsular Malaysia. This historical inquiry provides essential background for understanding the long-term changes in Jah Hut shifting cultivation systems, particularly in the absence of extensive written records (which is discussed further in Chapter 4). It contributes to building a historically situated narrative about the agricultural knowledge systems, land use, and community governance of the Jah Hut.

Archival research is used to establish the historical context of Jah Hut agricultural practices, especially their shifting cultivation systems. While primary archival documents such as government land records, colonial reports, and official policy documents were not accessed directly due to institutional restrictions and time constraints, the study relied on secondary archival sources housed in key institutions such as the Orang Asli Library and the Forest Research Institute Malaysia (FRIM) Library. These included published academic works, ethnographic records, and historical studies that together reconstruct the evolution of Indigenous agricultural systems in Peninsular Malaysia (Russell, 2006; Luker, 2020).

Similar methodologies - focusing on published academic literature, ethnographic reports, and institutional documents - have been used in other archival studies on land tenure, Indigenous livelihoods, and shifting cultivation (Barletti et al., 2021; Nath & Inoue, 2014). Such approaches are now widely accepted as valid and rigorous when direct archival excavation is not possible, particularly in Indigenous contexts where history is often preserved through oral and community-based knowledge.

3.4.1.1. Identifying and Accessing Historical Materials

The study identified and accessed relevant archival materials through both physical and digital repositories. The Orang Asli Library in Gombak provided academic theses and scholarly works focusing on Indigenous communities, while the FRIM Library housed historical journals and colonial-era studies on forest-dependent livelihoods. The National Library of Malaysia contributed manuscripts and periodicals, offering additional historical perspectives on the Jah Hut and broader Orang Asli communities.

Although government archives and primary policy documents were not directly examined, reports and studies from agencies such as the Department of Orang Asli Development (JAKOA) and the Department of Wildlife and National Parks (PERHILITAN) provided historical overviews of land management, conservation policies, and Indigenous livelihoods. The integration of published literature, ethnographic reports, and institutional records facilitated a comprehensive historical reconstruction, even in the absence of direct archival excavation. This method also aligns with Luker (2020), who argues that in decolonial research, accessing institutional archives is often less productive than engaging with local and academic sources that capture Indigenous perspectives.

3.4.1.2. Data Collection and Organization

The archival materials utilized in this study - primarily past theses, ethnographic research, and scholarly historical narratives - were systematically reviewed, categorized, and analyzed based on thematic relevance. The collected materials were examined for insights into historical agricultural transitions, socio-political influences, and land tenure changes affecting the Jah Hut community. Where permitted, relevant sections of documents were scanned or documented for further analysis. This process enabled the study to triangulate data across multiple sources to ensure reliability and context specificity. Following the advice of Namhila (2016), data collection was approached with reflexivity and awareness of the limitations of existing records.

3.4.1.3. Documenting and Citing Historical Sources

To ensure transparency and academic rigor, all archival sources used in this research are clearly cited, specifying the repositories accessed, types of documents reviewed, and the ethical considerations involved in data collection. While reliance on secondary historical literature is acknowledged as a limitation, it is justified within the context of restricted access to formal archival collections.

This approach is supported by archival research frameworks that distinguish between primary excavation and secondary historical synthesis (Ventresca & Mohr, 2002; Gilliland & McKemmish, 2018). The use of community libraries, ethnographic repositories, and grey literature is an accepted practice, particularly when studying Indigenous and marginalized communities whose histories are often undocumented in formal state archives (McKemmish et al., 2011; Russell, 2006).

By employing these methods, the study provides a historically contextualized foundation for analyzing Jah Hut agricultural sustainability, while ensuring that the research remains methodologically sound, ethically informed, and grounded in appropriate archival best practices.

3.4.2. Household Interviews

A total of 104 household interviews were conducted across three villages - Berdut, Sungai Mai, and Pasu - selected for their representation of diverse agricultural practices within the Jah Hut community, including swidden farming, rubber cultivation, oil palm farming, and home gardens. Since these villages share similar agricultural systems, data were analyzed as a single sample rather than at the village level. Local guides fluent in Malay and the Jah Hut language facilitated survey administration to ensure cultural appropriateness and clarity.

3.4.2.1. Sampling Method and Rationale

The sampling method for this study was designed to ensure sufficient statistical reliability and representation across the three villages while balancing logistical and contextual challenges.

3.4.2.2. Sample Size and Distribution Across Villages

A total of 104 households were sampled from the three villages - Berdut, Sungai Mai, and Pasu - ensuring that each village sample approached or exceeded 30 households, a widely accepted threshold for statistical reliability and meaningful comparisons. According to (Qualls et al., 2010), small sample sizes increase the risk of type II errors, where real differences may go undetected due to insufficient statistical power. By maintaining $n \approx 30$ per village, this study enhances the validity of both parametric and nonparametric analyses of Jah Hut agricultural practices. The sample sizes were distributed as follows:

i. **Berdut:** n=29 households out of 43 (67.4% of the total households).
ii. **Sungai Mai:** n=30 households out of 68 (44.1% of the total households).
iii. **Pasu:** n=45 households out of 112 (40.2% of the total households).

With 104 total households and a balanced distribution across villages, the sample was deemed statistically sufficient for comparative analysis of four agricultural systems practiced in the three villages. This ensured robust quantitative and qualitative insights while accounting for variability in household-level agricultural practices.

3.4.2.3. Sampling Strategy

Households were selected using a pragmatic, guide-assisted sampling approach, where visits were directed by local guides and participant willingness, rather than a strictly randomized process. While randomization is ideal for minimizing bias, this approach was necessary to ensure participation, accessibility, and community trust, aligning with context-sensitive methodologies often used in research with Indigenous and rural communities (Barletti et al., 2021; T. K. Nath et al., 2013). Similar approaches have been employed in studies where local knowledge played a key role in identifying representative participants while maintaining diversity within the sample (Al Mamun et al., 2023).

Data collection continued until response saturation was reached in each village, ensuring that no new or significant information emerged from additional interviews. This method is widely recognized in qualitative research, where saturation indicates data completeness and reliability (Barletti et al., 2021; T. K. Nath et al., 2013). The combination of pragmatic participant selection and saturation-based data collection ensured that this study captured both depth and representativeness in examining Jah Hut agricultural practices and community adaptations.

3.4.2.4. Logistical and Environmental Constraints

Sampling in Pasu was concluded at 45 households due to the imminent threat of flooding caused by the overflow of the Krau River. This decision was made to prioritize safety while ensuring sufficient coverage of the village population. Data collection across all villages was conducted over an extended period (May 2022 - January 2023) to span a complete hill rice cultivation cycle, ensuring the inclusion of seasonal variations in agricultural practices.

3.4.3. Farm and Home Garden Surveys

Agrobiodiversity data was collected on the types of crops grown, including vegetables, fruits, and oilseed crops, as well as seed sources and traditional seed preservation methods. A comprehensive household questionnaire assessed the variety of plant species in farms and home gardens, distinguishing between Indigenous and non-Indigenous varieties. This aligns with methodologies used in on-farm biodiversity research, such as Conversa et al. (2020), where assessments of vegetable landraces provided insights into crop diversity and genetic resource conservation.

Although the initial aim was to document the cultural and practical significance of these species in detail, this proved challenging due to community reluctance to share in-depth traditional knowledge, stemming from concerns over potential misuse or exploitation. As a result, only general purposes - such as food, medicinal use, and broad traditional applications - were recorded, rather than specific preparation methods, ritual uses, or symbolic meanings.

Despite these limitations, the study still enabled comparative analysis of biodiversity patterns and agricultural practices, providing valuable insights into ecological diversity and general plant utilization within Jah Hut farming systems.

3.4.4. Key Informant Interviews and Group Discussions

Key informant interviews were conducted with community elders, spiritual leaders, and other influential figures, generating qualitative data on traditional knowledge, particularly regarding the spiritual and ritual aspects of hill rice cultivation. Studies on Orang Asli agricultural and spiritual practices have documented the role of traditional custodians and rituals in sustaining Indigenous farming systems, where land spirits, rice souls, and seasonal ceremonies shape cultivation cycles (Hill, 1970). These interviews also gathered demographic information and settlement profiles, reinforcing the importance of place-based knowledge in understanding agricultural transitions (Hanafi et al., 2009a).

Group discussions explored themes such as intergenerational knowledge transmission and community resilience, blending qualitative narratives with structured questions. This aligns with prior research showing that oral knowledge-sharing among elders and younger generations is central to Indigenous adaptation strategies, particularly in contexts where shifting cultivation is threatened by modernization and policy shifts (A. G. Gomes, 2016). Studies on Semelai and Temiar communities highlight that traditional agricultural knowledge is closely tied to community identity, and disruptions in this transmission can impact farming resilience and sustainability (Gianno & Bayr, 2009).

While some literature refers to similar techniques as Focus Group Discussions (FGDs), this study intentionally uses the term group discussions to reflect the flexible, community-led, and culturally embedded nature of the sessions conducted. Unlike structured FGDs that are guided by external facilitators with pre-set agendas, these group discussions were often fluid and dialogic, shaped by the participants themselves and grounded in relational and oral knowledge-sharing traditions. This approach aligns more closely with Indigenous research paradigms, which prioritize community rhythms, informal exchange, and non-hierarchical participation, particularly important when exploring ritual knowledge and intergenerational transmission within Jah Hut society.

Group discussions were also gender-sensitive, with separate sessions conducted for women, ensuring their voices and experiences were adequately represented. In some cases, informal mixed-gender discussions were held to incorporate broader perspectives. Research on gendered participation in Indigenous governance has shown that women-only discussions often reveal unique concerns regarding land use, resource access, and knowledge transmission, as observed in studies on Amazonian and Southeast Asian Indigenous groups (Barletti et al., 2021). These studies highlight that women's participation in community decision-making is often constrained by social norms, making separate focus groups an effective strategy for capturing diverse perspectives while ensuring inclusive community engagement.

This methodological approach enabled a comparative analysis of traditional knowledge retention, agricultural rituals, and social resilience, deepening the understanding of Jah Hut farming systems within a broader ecological and cultural framework.

3.4.5. Questionnaire Development and Pre-Testing

Two questionnaires were developed: one for household interviews (Appendix 3.1) and another for group discussions (Appendix 3.2). The household questionnaire was heavily influenced by Nath et al. (2013), who utilized the sustainable livelihoods framework to design a comprehensive assessment covering livelihood capitals, settlement profiles, and agricultural sustainability. The household questionnaire was used to collect both quantitative and qualitative household data for all three objectives: documenting Jah Hut agricultural practices, assessing sustainability using the modified IDEA framework, and analyzing livelihood strategies through the Sustainable Livelihoods Framework (SLF). The questionnaire incorporated agroecological, socio-territorial, and economic sustainability indicators for the IDEA framework and captured five livelihood capitals - human, natural, social, financial, and physical - for SLF analysis. This approach streamlined data collection while ensuring a clear distinction between variables relevant to each objective.

The group discussion questionnaire was adapted from (Kerr, 2014), whose research on participatory agricultural initiatives provided a structured approach to exploring community resilience, farming challenges, and adaptation strategies. Additional refinements were made based on personal communications with Kerr, allowing for better alignment with the specific cultural and agricultural context of the study villages.

These drafts were reviewed by six experts (local and international), including experienced anthropologists familiar with Orang Asli communities in Peninsular Malaysia. Their feedback was incorporated to improve cultural relevance and clarity. Ethical approval was obtained from the University of Nottingham Malaysia's Science and Engineering Research Ethics Committee (SEREC reference: VA05052022), and the questionnaires were subsequently translated into Malay.

A pre-test was conducted with six household heads or their representatives in Kampung Berdut, accompanied by informal group discussions loosely structured around the group discussion questionnaire. While the initial plan involved structured focus group discussions, it became evident that informal, flexible conversations were more effective in this setting. This aligns with previous research, which has found that rigid interview techniques can be less effective in Indigenous contexts, where knowledge is often shared organically through storytelling and unstructured dialogue rather than direct questioning.

Group discussions were diverse in format, sometimes involving at least five participants in gender-segregated or mixed settings, ensuring broader representation. Studies on community engagement and Indigenous research methodologies have highlighted the importance of contextual flexibility, particularly when addressing sensitive topics related to traditional agricultural knowledge and cultural identity.

By adopting a flexible, culturally appropriate approach, this study ensured that participants felt comfortable sharing their insights, ultimately enhancing the depth and authenticity of the collected data while maintaining methodological rigor.

3.5. A Protocol for Conducting Fieldwork with Orang Asli

Based on the research conducted with the Jah Hut community, this protocol was developed to guide respectful and culturally sensitive engagement with the Orang Asli community. The development of the protocol is an attempt to ensure that the research process upholds the autonomy, cultural traditions, and spiritual beliefs of the community. Rather than imposing external perspectives, this approach sought to position the Jah Hut community as active participants throughout the research.

The protocol is organized into three key phases: Preparation Phase (Pre-Data Collection), Execution Phase (During Data Collection), and Concluding Phase (Post-Data Collection). Each phase was designed to foster trust, ensure ethical rigor, and facilitate a collaborative research process that centered on the community's perspectives. The following sections provide a detailed description of how these phases were implemented (as represented by Figure 3.2), ensuring that the research was culturally appropriate and aligned with the community's values, while also contributing to the advancement of both academic knowledge and the community's well-being.

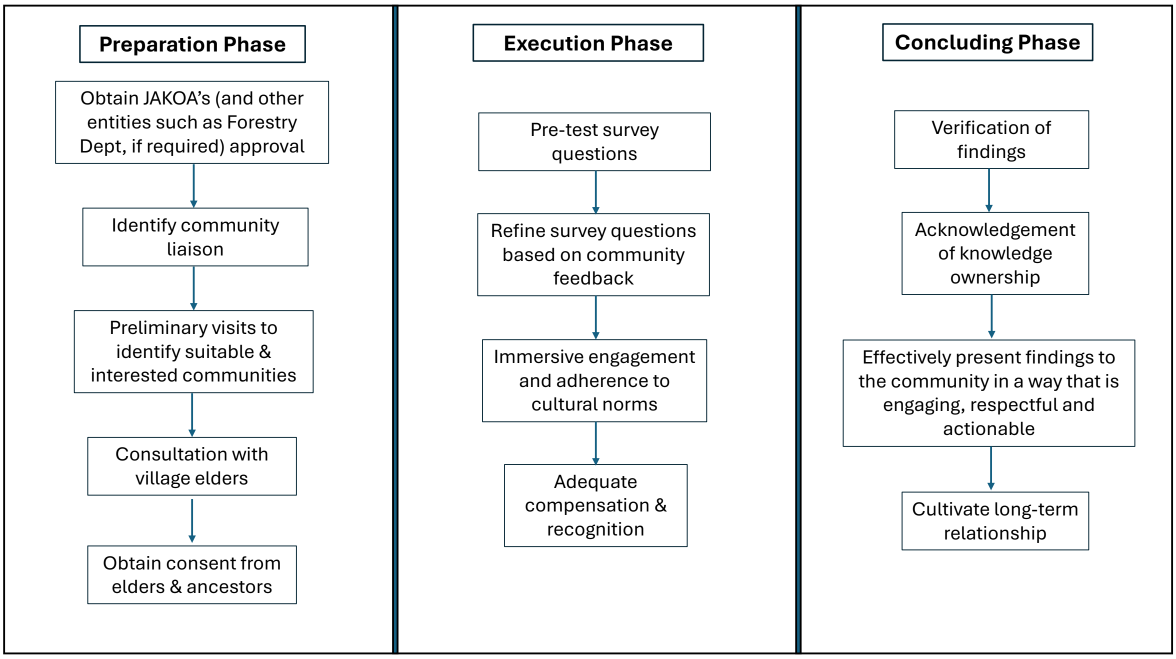

FIGURE 3.2: PROTOCOL FOR CONDUCTING FIELDWORK WITH THE ORANG ASLI

3.5.1. Preparation Phase (Pre-Data Collection)

The preparation phase of this research focused on establishing trust with the community, especially in light of their past experiences with academic extractivism[32] and being over-researched by external parties. These negative encounters have understandably made the community wary of outsiders. Building trust was therefore crucial to ensuring that the research design aligned with the community's values and expectations while respecting their knowledge systems and traditions, and demonstrating that this research would not replicate the extractive practices of the past.

[32]Cruz & Luke (2020) critique how academic research perpetuates neo-colonial extractivism, where data from marginalized communities in the Global South is exploited by scholars in the Global North. The authors argue that traditional research methodologies reinforce colonial power dynamics by treating the Global South as a source of raw data, with little benefit or collaboration for local communities. They call for a shift towards reflexive, dialogical research that centers the voices and experiences of marginalized groups, urging for a decolonial approach to methodology that challenges extractive academic practices.

3.5.1.1. Obtaining Approval from JAKOA

The initial step in the preparation phase was to secure the necessary permissions from the Jabatan Kemajuan Orang Asli (JAKOA[33]). This process can take several months[34], so it is crucial to begin well in advance. JAKOA requires several key documents, including a detailed research proposal, proof of scholarship or academic affiliation, and other supporting materials. Additionally, it is possible that access is considered differently for local and overseas researchers, which may influence the timeline and approval process.

In the case of Berdut, a permit from the Department of Wildlife and National Parks Peninsular Malaysia (PERHILITAN) was specifically required, as the village is located within the TWR, which falls under PERHILITAN's jurisdiction. Securing approval from both entities was essential to ensuring that the research complied with local regulations, respected administrative protocols, and prioritized the community's safety. In this context, it was also critical to ensure that no outside diseases were introduced to the community, given their heightened vulnerability to external health threats. Extra precautions were necessary to safeguard the community's health and well-being during interactions.

3.5.1.2. Identifying Community Liaisons

A trusted individual from within the community was identified as a liaison, typically drawing on personal networks, such as those established by researchers who had previously engaged with these individuals in their work. The process of selecting an appropriate liaison requires careful consideration and should be initiated early, as it involves identifying someone with sufficient standing within the community and a willingness to take on the role. Furthermore, it is crucial to discuss compensation early on, as serving as a liaison often necessitates taking time away from regular livelihood activities, such as farming. In my experience, the Jah Hut do not dictate the compensation they expect and instead accept any amount offered. However, it is both important and ethical to compensate them fairly, based on current local rates, or

[33]JAKOA plays a key role in managing access to Orang Asli communities by overseeing external engagements such as research and development projects

[34] Because the research began during the extensive COVID-19 lockdowns in Malaysia between 2020 and 2021, JAKOA did not permit any direct contact with Orang Asli communities at this time to protect them from potential outbreaks. The communities themselves also enforced strict entry restrictions, allowing only essential services such as food supplies and healthcare to enter. As a result, permission to conduct research was only granted after the lifting of the lockdowns in late 2021, when restrictions were eased.

significantly more if funding allows. Fair compensation ensures their contributions are appropriately valued. The liaison plays a vital role in facilitating access to the community, bridging communication, and ensuring that all interactions adhere to cultural and social norms. Their involvement was essential in fostering trust and guiding the research process, ensuring that all engagements were conducted in a culturally sensitive and respectful manner.

3.5.1.3. Preliminary Visits to Identify Suitable and Interested Communities

With the guidance of the community liaison, scoping visits were conducted to assess the suitability and willingness of communities to participate in the research. These visits provided firsthand insight into the socio-cultural and ecological contexts while establishing preliminary contact with the Jah Hut community. Given that the Orang Asli are often reserved when engaging particularly those who are not from their own or other Indigenous communities, this process required multiple visits to build trust and create a sense of comfort within the community. The liaison's knowledge and opinion were invaluable in screening out communities that might not be suitable or potentially unfavorable for the research due to pre-existing relationships or dynamics within the community. It is therefore essential to allocate sufficient time and resources for these interactions, as research involving the Orang Asli cannot be rushed and must follow these careful, gradual steps to ensure respectful and meaningful engagement.

3.5.1.4. Consultation with Village Elders

Extensive consultations with the community elders were conducted to explain the purpose of the research and gather their feedback on the proposed approach. These sessions were crucial in seeking guidance on navigating social norms, taboos, and spiritual practices, as the elders serve as the custodians of the community’s traditional knowledge and cultural heritage, making their approval central to gaining meaningful access to the community. As shown in Figure 3.3, the first consultation with the Berdut Village elders took place on 16 May 2022, where discussions were initiated in a relaxed setting. In my experience, the elders reveal their knowledge in layers across multiple visits, only sharing deeper insights once they feel comfortable and trust has been established. All is not disclosed within a single session, which underscores the importance of patience and sustained engagement.

Before any consultations can take place, it was crucial to check with the elders regarding their availability and obtain their agreement to meet, as respecting their time is paramount. Typically, the community liaison facilitated these initial arrangements to ensure that the sessions were scheduled at convenient times for the elders. As a sign of respect for their time and sharing, refreshments were provided during each session. Additionally, sharing a meal, a valued tradition within the Orang Asli culture, helped to strengthen relationships and foster trust, creating a more comfortable environment for open dialogue.

FIGURE 3.3: FIRST CONSULTATION WITH BERDUT VILLAGE ELDERS (16 MAY 2022)

3.5.1.5. Obtaining Consent from Elders and Ancestors

In alignment with Orang Asli cosmology and spiritual beliefs, consent was sought not only from the living elders but also from the ancestors. Within the Orang Asli worldview, ancestral spirits hold a vital role as guardians of the land and guides for the community. Their approval is seen as crucial for ensuring that activities conducted on the land honor the spiritual and cultural connections that bind the people, land, and the ancestors. This process is elaborated in the following section:

Ancestral Guidance: A Spiritual Turning Point in Gaining Access to the Jah Hut Community

Gaining access to the Jah Hut community was a reflective and spiritually grounded process, based on an understanding of their socio-spiritual values and deep respect for their ancestors. Although no formal ritual was observed, I engaged in a personal and meditative process to seek guidance and approval from the ancestors before starting data collection. This internal reflection mirrored the community's belief that their ancestors continue to influence decisions related to the land and well-being.

A significant turning point came when I shared a dream where the Jah Hut ancestors communicated directly with me. In the dream, ancestral figures appeared in their homeland and gave a clear message: I was instructed to meet with the villagers and engage in open dialogue. Initially, the community was hesitant to allow an outsider into their circle, given the sacred nature of their relationship with the land and ancestors. However, upon hearing the details of the dream, their response shifted. They interpreted the dream as a sign of goodwill and ancestral approval, viewing it as validation of my presence and intentions.

This moment was crucial in building trust and gaining access to the community. The dream was seen as not only a meaningful connection with their ancestors but also as confirmation that my research aligned with their spiritual and cultural values. It became a powerful catalyst for further engagement and collaboration. This interaction underscores the Jah Hut's belief in the interconnectedness between the living, the land, and their ancestors, who are seen as guardians of the land's spiritual balance. By honoring this relationship, the research process upheld the community's spiritual integrity, recognizing ancestral involvement as central to their decisions about land and culture.

Dreams as conduits for ancestral communication became a key aspect of my research methodology. Rowe (2014) noted that dreams are vital catalysts for knowledge in Indigenous research methodologies, offering spiritual, intellectual, and emotional guidance, connected to relational accountability and personal transformation. Goulet (1993) echoes this, adding that dreams are deeply intertwined with social and spiritual life in many Indigenous communities, where the boundaries between the physical and spiritual realms are fluid. He emphasizes that ethnographers who immerse themselves in these societies may experience dreams that reflect the Indigenous worldview, facilitating deeper engagement with local culture. By participating in and sharing these dreams, anthropologists can connect more meaningfully with the people they study, incorporating their own dream experiences into their research to enhance understanding. (den Boer, 2012) extends these findings, underscoring that dreams are a legitimate way to engage with the environment and ancestors, offering insights that inform both personal lives and collective practices.

I integrated dream-based knowledge into my research, respecting the holistic, interconnected nature of Indigenous ways of knowing, which value intuitive insights alongside empirical understanding. By incorporating the ancestral guidance received in the dream, my approach aligned with the community's cosmological views. This respectful engagement with the Jah Hut's spiritual dimensions ensured that the research honored their worldview and maintained the spiritual integrity they safeguard. The dream facilitated access to the community's knowledge, land, and stories in a way that was both culturally sensitive and academically respectful.

3.5.2. Execution Phase (During Data Collection)

Data collection was conducted in a flexible and adaptive manner, respecting the social, cultural, and spiritual traditions of the Jah Hut community. Given that several generations often live together in a single household, interviews were sometimes answered collectively by multiple family members, while in other cases, the head of household - either male or female - or a couple responded together. The interview process was not rigidly structured, allowing participants to contribute based on their comfort level and familial dynamics. This aligns with previous studies on Indigenous community engagement, where household-level responses often reflect a shared, rather than individual, decision-making process (Nath et al., 2013).

In many instances, younger family members assisted elderly respondents, particularly when recalling historical agricultural practices, reinforcing the intergenerational transmission of knowledge observed in other studies on traditional land use and Indigenous agricultural resilience (Kerr, 2014). The interview setting varied - sometimes conducted inside homes, other times outdoors, depending on the preference of the respondents. At all times, the research process remained respectful of community norms, avoiding intrusive questioning and ensuring that topics of spiritual or ritual significance were approached with sensitivity and discretion.

Throughout the data collection process, methodologies were continuously adapted based on the needs and comfort of participants, reflecting a community-centered approach rather than an externally imposed research structure. This ensured that responses were authentic and meaningful, fostering trust between the researcher and the Jah Hut community.

3.5.2.1. Pre-testing the Questionnaire

Prior to initiating formal data collection, the questionnaires were pre-tested with a small sample of the community to ensure cultural appropriateness and clarity. The community's reactions to the questions were also gauged. The pre-test exercise provided a platform for initial dialogue about the research goals, ensuring transparency and inclusion from the beginning. It is paramount that the questionnaire is kept simple to prevent interviewees from becoming fatigued, as lengthy or overly complex questions may hinder engagement. Additionally, the local terms used by the community may differ from the researcher's understanding, so it is crucial to ensure that the session is clear and accessible, both in terms of language and cultural context. This approach helps ensure that the questions are fully understood, enhancing the quality and reliability of the responses.

3.5.2.2. Refining Survey Questions Based on Community Feedback

Based on the results of the pre-test, the survey questions were refined to better reflect the community's perspectives and realities. Feedback from the community liaison and elders was instrumental in shaping the final version of the questionnaire, ensuring that it respected local values and avoided any potential misunderstandings.

3.5.2.3. Immersive Engagement and Adherence to Cultural Norms

Throughout the data collection process, the cultural norms and spiritual practices of the Jah Hut community was paramount. Guidance from the community liaison and elders was followed to ensure that interactions were respectful and appropriate. However, a crucial aspect of the research's success was the willingness of the community to accept the researcher into their fold. This acceptance was not automatic; it was earned through trust-building, respect for cultural practices, and demonstrating a genuine interest in the community's way of life.

By spending a large amount of time with the community during the data collection process, the researcher had the opportunity to participate in their daily activities, such as agricultural tasks, ceremonies, and social gatherings. These casual, everyday encounters allowed for deeper integration into the community, strengthening relationships and facilitating richer, more meaningful exchanges. The community's acceptance and openness played a significant role in the researcher’s ability to immerse fully, offering insights that would not have been possible through formal interviews alone.

3.5.2.4. Adequate Compensation and Recognition

In recognition of the community's participation, compensation and other forms of acknowledgment were provided in ways that were meaningful and culturally appropriate. Transparent communication regarding the compensation process helped ensure that the community felt valued and that their contributions were respected. In addition to monetary compensation to key informants, providing practical items such as dried food—particularly rice, canned sardines or condensed milk, and cooking oil—was highly appreciated by the community, reflecting their daily needs and reinforcing the reciprocal relationship established throughout the research process. Although the community appreciated the compensation, it was clear that they never expected to be compensated for the interviews, as their participation was given freely and without any expectation of material reward. This further emphasized the importance of showing respect and gratitude for their time and knowledge.

3.5.3. Concluding Phase (Post-Data Collection)

The post-data collection phase focused on validating the research findings with the community and ensuring the long-term integrity of the relationships established during the fieldwork. This phase upheld ethical standards by recognizing the community’s ownership of the knowledge shared during the research process.

3.5.3.1. Verification of Findings

Preliminary research findings were presented to the community elders for validation. This step was vital in ensuring that the community's perspectives were accurately reflected in the research. By engaging the elders in reviewing the data, the researcher acknowledged their role as custodians of traditional knowledge and created space for their feedback on the interpretation of findings.

3.5.3.2. Acknowledgment of Knowledge Ownership

The ownership of knowledge shared by the community was formally recognized through appropriate credits, such as acknowledging community members in research publications. This step respected the community's intellectual property rights and emphasized reciprocity in the research process.

3.5.3.3. Effective Presentation of Findings to the Community

It will be essential to ensure that the information shared is accessible, culturally relevant, and delivered in the Jah Hut language, enabling elders and the broader community to fully engage with and apply the research outcomes. Findings will be presented through oral discussions, visual storyboards, and translated summaries, ensuring clarity and resonance with their lived experiences. Rather than a one-way presentation, these sessions will foster reciprocal dialogue, allowing the community to validate, refine, and expand upon the findings while also exploring how this knowledge can be integrated into their own initiatives. This approach will support community-led interpretations and responses, ensuring that the knowledge generated remains meaningful, actionable, and beneficial to them.

3.5.3.4. Cultivating Long-Term Relationships

Even after fieldwork was completed, efforts were made to maintain long-term relationships with the community. This included ongoing communication and visits, ensuring that the community remained informed about the progress of the research and its outcomes. This sustained engagement forms the basis for enduring relationships beyond the research project, rather than treating Indigenous communities as temporary subjects.

The protocol for conducting fieldwork with the Orang Asli community is rooted in ethical principles that prioritize respect for cultural traditions, autonomy, and the lived experiences of Indigenous Peoples. A key strength lies in its focus on trust-building and immersive engagement, which are essential for cultivating meaningful relationships. Additionally, the protocol underscores the importance of allocating sufficient resources, particularly time and fair compensation for community members and liaisons. While the value of the knowledge shared by the community is immeasurable, recognizing and compensating their contributions is critical for maintaining ethical research practices.

Although developed in the context of the Orang Asli, this protocol is adaptable for use with other Indigenous Peoples. It fosters long-term relationships by positioning the community at the heart of the research process and establishing lasting ties. This approach not only enhances the research but also transforms it into a collaborative journey of mutual respect, understanding, and meaningful exchange.

3.6. Analytical Frameworks

3.6.1. The IDEA Method for Farm Sustainability Assessment

The IDEA (*Indicateurs de Durabilité des Exploitations Agricoles*) method is a structured sustainability assessment tool that evaluates agroecological, socio-territorial, and economic sustainability in farming systems (Vilain et al., 2008). Originally developed in France, it has been applied globally, including in small-scale farming contexts (Agossou et al., 2017; Biret et al., 2019). Given the small-scale and community-centered nature of Jah Hut agriculture, the IDEA method was adapted to reflect local realities, including crop diversity, organic practices, communal labor, and economic self-sufficiency. Modifications ensured that local ecological, social, and economic conditions were accurately captured. Full details on the application and modifications of the IDEA method in this study are provided in Chapter 6.

3.6.2. Utilizing the Sustainable Livelihood Framework to Assess Jah Hut Livelihoods

To assess the impact of Jah Hut agriculture on community livelihoods, this study applies the Sustainable Livelihood Framework (SLF) proposed by Scoones (1998), which provides a holistic approach to understanding rural livelihoods by examining access to different forms of capital (natural, financial, human, social) and the strategies people use to sustain themselves. The framework is widely used in marginalized and Indigenous communities as it considers institutional and power dynamics that influence livelihood sustainability (Levine, 2014). Given the Jah Hut's reliance on local natural resources and vulnerability to external pressures, SLF offers a structured way to identify strengths, vulnerabilities, and adaptive strategies within their agricultural and socio-economic systems. Full details on the application and adaptation of SLF in this study are provided in Chapter 7.

3.7. Quantitative Data Analysis

Quantitative data from household surveys was analyzed using R programming for multiple variables, according to the objectives of the study. Treatment of data are explained in detail in Chapters 6 and 7.

3.8. Qualitative Data Analysis

3.8.1. Thematic Analysis

Thematic analysis was applied to qualitative data from interviews, group discussions, and observations, following structured approaches for identifying, coding, and analyzing key themes (Tong et al., 2007). Themes emerged around core issues such as the sacredness of agriculture, shifts to cash cropping, and the socio-cultural impacts of land tenure policies. Additionally, thematic analysis was used to examine the role of Traditional Ecological Knowledge (TEK) in maintaining ecological sustainability. The COREQ (Consolidated Criteria for Reporting Qualitative Research) framework was consulted to ensure comprehensive and transparent reporting of the data collection and analysis process (Tong et al., 2007).

3.8.2. Historical Data Interpretation and Analysis

Archival data analysis involved qualitative interpretation of historical documents to extract key themes relevant to the study's research questions. Documents were contextualized and triangulated with interviews and field observations to construct a comprehensive picture of historical influences on contemporary Jah Hut agricultural practices. This method aligns with previous research emphasizing the integration of qualitative and historical data to strengthen findings (Paul et al., 2021).

3.8.3. Triangulation with Other Data Sources

To validate archival findings, data from oral histories, key informant interviews, and field observations were triangulated. This ensured that historical narratives were corroborated with lived experiences of Jah Hut elders, reducing potential biases inherent in archival records. As recommended in qualitative research guidelines, triangulation enhances the credibility and robustness of findings by cross-verifying sources (Tong et al., 2007).

3.9. Ethical Considerations

3.9.1. Free, Prior, and Informed Consent (FPIC)

This study followed the principles of Free, Prior, and Informed Consent (FPIC) to ensure that participants were fully informed about the research objectives, risks, and benefits before participating. Consent was obtained through continuous dialogue with community leaders and individuals, a best practice for ethical engagement with Indigenous communities (Tong et al., 2007). Research was conducted in a culturally sensitive manner, respecting Jah Hut customs and knowledge systems, aligning with prior studies emphasizing the importance of trust and cultural competence in qualitative research (Paul et al., 2021). Additionally, participants were made aware that their contributions would benefit their community, supporting ethical research practices that promote reciprocity and local empowerment (ibid.).

3.9.2. Data Protection and Reciprocity

Strict data protection measures were followed to maintain the confidentiality and anonymity of participants, ensuring that no sensitive information was disclosed inappropriately. The research also emphasized reciprocity, ensuring that knowledge shared by the community was documented and preserved for future generations. This aligns with ethical research recommendations that advocate for ensuring tangible benefits for participants, particularly when working with marginalized and Indigenous groups (Tong et al., 2007). The study followed ethical protocols to protect participant identities, as outlined in prior qualitative research on sensitive data collection and ethical considerations (Paul et al., 2021).

3.10. Conclusion

In summary, this chapter has outlined a comprehensive methodological approach that integrates theory with relevant frameworks to study the Jah Hut's agricultural practices. By combining qualitative and quantitative methods, the research not only illuminates the socio-cultural and ecological dimensions of these practices but also underscores the importance of respecting Indigenous knowledge systems. The use of participatory methods and FPIC ensures that the research remains ethically grounded, aligning with the Jah Hut community's values and aspirations for self-determination and cultural preservation.

References

Al Mamun, A., Islam, A. R. M. T., Alam, G. M. M., Sarker, M. N. I., Erdiaw-Kwasie, M. O., Bhandari, H., & Mallick, J. (2023). Livelihood vulnerability of char land communities to climate change and natural hazards in Bangladesh: an application of livelihood vulnerability index. *Natural Hazards*, *115*(2), 1411–1437. https://doi.org/10.1007/s11069-022-05599-y

Andersen, C. (2009). Critical Indigenous Studies: From Difference to Density. *Cultural Studies Review*, *15*(2), 80–100. https://search.informit.org/doi/abs/10.3316/INFORMIT.699370924819299

Barletti, J. P. S., Begert, B., & Loza, M. A. G. (2021). Is the Formalization of Collective Tenure Rights Supporting Sustainable Indigenous Livelihoods? Insights from Comunidades Nativas in the Peruvian Amazon. *International Journal of the Commons*, *2021*(1), 381–394. https://doi.org/10.2307/48656886

Barnes, B. R. (2018). Decolonising research methodologies: opportunity and caution. *South African Journal of Psychology*, *48*(3), 379–387. https://doi.org/10.1177/0081246318798294

Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together Indigenous and Western knowledges. *Journal of Environmental Studies and Sciences*, 2(4), 331–340. https://doi.org/10.1007/s13412-012-0086-8

Bauer, T., de Jong, W., Ingram, V., Arts, B., & Pacheco, P. (2022). Thriving in turbulent times: Livelihood resilience and vulnerability assessment of Bolivian Indigenous forest households. *Land Use Policy*, *119*. https://doi.org/10.1016/j.landusepol.2022.106146

Berkes, F. (2018). Sacred Ecology. In *Local Economy* (Vol. 33, Issue 2). Routledge. https://doi.org/10.1177/0269094218762345

Bhushan, S., Dincă, I., & Shikha, S. (2024). Evaluating local livelihoods, sustainable forest management, and the potential for ecotourism development in Kaimur Wildlife Sanctuary, India. *Frontiers in Forests and Global Change*, *7*. https://doi.org/10.3389/ffgc.2024.1491917

Bujaki, M., Lento, C., Butt, I., Anderson, N., & Ogima, C. (2023). A systematic literature review of Indigenous Peoples and accounting research: critical Indigenous theory as a step toward relationship and reconciliation. In *Accounting Forum* (Vol. 47, Issue 3, pp. 307–332). Taylor and Francis Ltd. https://doi.org/10.1080/01559982.2022.2051295

Campbell-Chudoba, R. (2024). Decolonizing Research Methodologies: Weaving a Third Space With Métissage and Duoethnography. *International Journal of Qualitative Methods*, *23*. https://doi.org/10.1177/16094069241260127
Conversa, G., Lazzizera, C., Bonasia, A., Cifarelli, S., Losavio, F., Sonnante, G., & Elia, A. (2020). Exploring on-farm agro-biodiversity: a study case of vegetable landraces from Puglia region (Italy). *Biodiversity and Conservation*, *29*(3), 747–770. https://doi.org/10.1007/s10531-019-01908-3
Cruz, M., & Luke, D. (2020). Methodology and academic extractivism: the neo-colonialism of the British university. *Third World Thematics: A TWQ Journal*, *5*(1–2), 154–170. https://doi.org/10.1080/23802014.2020.1798275
den Boer, E. (2012). Spirit conception: Dreams in aboriginal Australia. *Dreaming*, *22*(3), 192–211. https://doi.org/10.1037/a0028402
Gaudry, A. (2015). Researching the resurgence: Insurgent research and community-engaged methodologies in contemporary Indigenous studies. *Indigenous Research Methodologies*, 10(2), 12–31.
Gianno, R., & Bayr, K. J. (2009). Semelai agricultural patterns: Toward an understanding of variation among Indigenous cultures in southern peninsular Malaysia. *Journal of Southeast Asian Studies*, *40*(1), 153–185. https://doi.org/10.1017/S0022463409000071
Gilliland, A. J., & McKemmish, S. (2018). Archival and recordkeeping research: Past, present and future. In W. L. Wildemuth (Ed.), Research Methods: Information, Systems, and Contexts (2nd ed., pp. 85–114). Chandos Publishing.
Gomes, A. G. (2016). Semai Ecological Epistemologies: Lessons for a Sustainable Future. In K. Endicott (Ed.), *Malaysia's Original People* (pp. 291–310). NUS Press Singapore.
Goulet, J.-G. A. (1993). Dreams and Visions in Indigenous Lifeworlds: An Experiential Approach. *Canadian Journal of Native Studies 13.2 (1993): 171-198.*, *13*(2), 171–198. https://cjns.brandonu.ca/wp-content/uploads/13-2-goulet.pdf
Hanafi, M. M., Hartinie, A., Shukor, J., & Mahmud, T. M. M. (2009). Upland Rice Varieties in Malaysia: Agronomic and Soil Physico-Chemical Characteristics. *Pertanika J. Trop. Agric. Sci*, *32*(2), 225–246. http://agrolink.
Held, M. B. E. (2019). Decolonizing Research Paradigms in the Context of Settler Colonialism: An Unsettling, Mutual, and Collaborative Effort. *International Journal of Qualitative Methods*, *18*. https://doi.org/10.1177/1609406918821574
Hill, R. D. (1970). Peasant Rice Cultivation Systems with some Malaysian Examples. In J. Kostrowicki & W. Tyszkiewwicz (Eds.), *Geographica Polonica 19: Essays on Agricultural Typology and Land Utilization* (pp. 91–98). PWN Polish Scientific Publishers. http://rcin.org.pl
Kerr, R. B. (2014). Lost and Found Crops: Agrobiodiversity, Indigenous Knowledge, and a Feminist Political Ecology of Sorghum and Finger Millet in Northern Malawi. *Annals of the Association of American Geographers*, *104*(3), 577–593. https://doi.org/10.1080/00045608.2014.892346
Kovach, M. (2009). *Indigenous Methodologies: Characteristics, Conversations, and Contexts*. University of Toronto Press.
Levine, S. (2014). *How to study livelihoods: bringing a sustainable livelihoods framework to life*. *September*, 1–23.
Lincoln, Y. S., & González y González, E. M. (2008). The search for emerging decolonizing methodologies in qualitative research: Further strategies for liberatory and democratic inquiry. *Qualitative Inquiry*, *14*(5), 784–805. https://doi.org/10.1177/107780040831830
Luker, T. (2020). Decolonising archives: Indigenous challenges to record keeping in 'reconciling' settler colonial states. In K. B. Anderson & R. O'Neill (Eds.), Decolonising the Archive (pp. 108–124). Routledge.

McKemmish, S., Faulkhead, S., & Russell, L. (2011). Distrust in the archive: Reconciling records. Archival Science, 11(3–4), 211–239.

Namhila, E. N. (2016). Content and use of colonial archives: An under-researched issue. Archival Science, 16(2), 111–123.

Nath, T. K., & Inoue, M. (2014). Forest Villagers in Northeastern Hill Forests of Bangladesh: Examining Their Livelihoods, Livelihood Strategies and Forest Conservation Linkages. *Small-Scale Forestry*, *13*(2), 201–217. https://doi.org/10.1007/s11842-013-9249-z

Nath, T. K., Inoue, M., & De Zoysa, M. (2013). Small-Scale Rubber Planting for Enhancement of People's Livelihoods: A Comparative Study in Three South Asian Countries. *Society and Natural Resources*, *26*(9), 1066–1081. https://doi.org/10.1080/08941920.2013.779342

Ndlovu-Gatsheni, S. J. (2019). Provisional Notes on Decolonizing Research Methodology and Undoing Its Dirty History. *Journal of Developing Societies*, *35*(4), 481–492. https://doi.org/10.1177/0169796X19880417

Olofson, H. (1983). Indigenous Agroforestry Systems. *Philippine Quarterly of Culture and Society*, *11*(2/3), 149–174. https://www.jstor.org/stable/29791792

Paul, A., Sikdar, D., Mahanta, J., Ghosh, S., Jabed, M. A., Paul, S., Yeasmin, F., Sikdar, S., Chowdhury, B., & Nath, T. K. (2021). Peoples' understanding, acceptance, and perceived challenges of vaccination against COVID-19: A cross-sectional study in Bangladesh. *PLoS ONE*, *16*(8 August). https://doi.org/10.1371/journal.pone.0256493

Qualls, M., Pallin, D. J., & Schuur, J. D. (2010). Parametric versus nonparametric statistical tests: The length of stay example. *Academic Emergency Medicine*, *17*(10), 1113–1121. https://doi.org/10.1111/j.1553-2712.2010.00874.x

Rowe, G. (2014). Implementing Indigenous Ways of Knowing Into Research: Insights Into the Critical Role of Dreams as Catalysts for Knowledge Development. *Journal of Indigenous Social Development*, *3*(2), 1–17. http://www.hawaii.edu/sswork/jisdhttp://scholarspace.manoa.hawaii.edu/handle/10125/34168

Russell, L. (2006). Indigenous records and archives. Archives & Manuscripts, 34(1), 10–24.

Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. *IDS Working Paper*, *72*(May), 22. http://forum.ctv.gu.se/learnloop/resources/files/3902/scoones_1998_wp721.pdf

Scoones, I. (1999). Sustainable Rural Livelihoods: A Framework for Analysis. In *IDS* (Vol. 72, Issue 2). https://doi.org/10.1057/palgrave.development.1110037

Simard, E. (2020). Critical Indigenous Ways of Knowing: Research, Narratives, and Self-Actualisation. *International Journal of Critical Indigenous Studies*, *13*(2), 139–158. https://ijcis.qut.edu.au/article/download/1636/1002/1636-Article%20Text-6581-2-10-20210702.pdf

Smith, L. T. (2012). Decolonizing Methodologies: Research and Indigenous Peoples. In *Zed Books*. https://doi.org/10.4324/9781315700779-29

Thambinathan, V., & Kinsella, E. A. (2021). Decolonizing Methodologies in Qualitative Research: Creating Spaces for Transformative Praxis. *International Journal of Qualitative Methods*, *20*. https://doi.org/10.1177/16094069211014766

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, *19*(6), 349–357. https://doi.org/10.1093/intqhc/mzm042

Ventresca, M. J., & Mohr, John. W. (2002). The Blackwell Companion to Organizations, First Edition. Edited. In J. A. C. Baum (Ed.), *The Blackwell Companion to Organizations* (1st ed.). Blackwell PublishersLtd.

Vilain, L., Boisset, K., Guillaumin, A., Mouchet, C., Viaux.P, & Zahm.P. (2008). *La méthode IDEA (The IDEA Method: Sustainability Indicators for Agricultural Holdings: User Guide)* (M. Poillot, Ed.; 3rd ed., Issue September 2021). Educagri éditions.

Wilson, S. (2008). *Research is Ceremony: Indigenous Research Methods*. Fernwood Publishing.

Yin, Robert. K. (2014). *Case Study Research: Design and Methods*. SAGE.

Chapter 4 : The Evolution of Agriculture in Southeast Asia and Orang Asli Agriculture in Peninsular Malaysia

4.1. Introduction

This chapter supports the first objective of the study, which is to trace the historical evolution of traditional agricultural practices among the Orang Asli, beginning with broader regional patterns of early agriculture in Southeast Asia. By situating Orang Asli agriculture within this wider historical and ecological context, the chapter provides the necessary foundation for understanding how indigenous farming systems have developed, adapted, and endured over time.

The chapter is organized into two interconnected sections: (1) early agricultural practices in Southeast Asia; and (2) the historical trajectory of Orang Asli agriculture in Peninsular Malaysia. Drawing on a multidisciplinary review of published literature and historical records, it integrates anthropological, ecological, and historical sources to highlight the interplay of traditional ecological knowledge, cultural belief systems, and external pressures - including colonialism, land policies, and modernization.

Archival and secondary materials, discussed in Chapter 3, are used here to establish the regional and historical context that shaped Orang Asli agriculture. This contextual grounding is essential for later chapters that assess the sustainability of contemporary practices. Overall, Chapter 4 lays the groundwork for critically evaluating how Orang Asli agricultural systems have persisted, adapted, or transformed in response to changing socio-political and environmental conditions.

4.2. Early Agriculture in Southeast Asia

4.2.1. Ecological Foundations of Early Agriculture in Southeast Asia

Southeast Asia's agricultural roots are deeply intertwined with its unique ecological landscape. Early inhabitants employed diverse subsistence strategies, from foraging to managing forest ecosystems for cultivating valuable plants. Hunt & Rabett (2014) argue that forest disturbance and biomass burning began as early as 50,000 years ago, framing these landscapes as 'cultural artifacts' shaped by human activity rather than pristine natural environments. Unlike the structured agricultural systems in Europe, these flexible practices allowed local adaptations, blending hunting, gathering, and semi-cultivation with intensive rice farming (ibid.).

From a human ecology perspective, Hutterer (1983) observes that farmers and hunters actively shape their environments. Hunters modify their surroundings, often to enhance productivity, through plant dispersal, vegetation clearance, and canal digging. The distinction between hunters and farmers lies in the degree of environmental manipulation rather than the methods themselves (ibid.).

Expanding this in 1985, Hutterer highlights the fragility of tropical ecosystems, noting their poor soil quality despite high primary productivity. Once disturbed, these ecosystems, especially rainforests, recover slowly. Early agricultural societies thus developed specialized ecological knowledge for sustainable management. Rituals and symbols were crucial in transmitting this knowledge, serving as mechanisms for maintaining ecological balance within human ecosystems. Agriculture in Southeast Asia, therefore, evolved as a complex response to environmental conditions rather than mere technological advancement. This aligns with Hunt and Rabett's view of Southeast Asia's actively managed landscapes, distinct from structured, large-scale agriculture elsewhere (ibid.).

Hutterer (1983) further contends that Southeast Asian agriculture was shaped by environmental factors such as climate, soil quality, and topography rather than external cultural influences. Subsistence strategies reflected adaptations to ecological changes rather than population migrations or foreign techniques, reinforcing the notion of these landscapes as distinctively human-managed yet fundamentally different from structured agrarian systems.

4.2.2. Transition to Neolithic Farming in Southeast Asia

Ellen (1994) adds complexity to the narrative by presenting evidence of early rice domestication in mainland Southeast Asia between 12,000 and 8,000 BP (Before Present), positioning the region as one of the earliest to transition to rice-based agriculture. Ellen highlights archaeological findings from southern Thailand, dated between five and six thousand years ago, that indicate the development of sedentary settlements. This suggests that early forms of sedentism in mainland Southeast Asia were sustained through a combination of wild resources and emerging agricultural practices rather than a complete shift to intensive farming (Ellen, 1994). The persistence of such systems suggests that Southeast Asia supported diverse and adaptable subsistence strategies (ibid.).

Hutterer (1985) echoes Ellen's finding by noting that the fragile nature of tropical soils and the complex biodiversity of rainforests constrained the implementation of intensive agricultural practices. Instead, Southeast Asian agricultural societies incorporated wild resources and cultivated plants to sustain themselves. This aligns with the gradual shift towards agriculture in the region, reflecting an adaptive response to the ecological constraints of the tropics.

Despite the early practices of forest management and semi-cultivation, the introduction of more intensive agricultural practices, especially rice and millet farming, eventually made their way to Southeast Asia. Bellwood (2004) posited that the migration of Austroasiatic-speaking groups into Southeast Asia occurred around 6,000 to 7,000 years ago and introduced the cultivation of millet and rice, marking the onset of a Neolithic farming era in the region. This was later confirmed by Oxenham & Buckley (2015), who argued that Neolithic farming from central China, which began around 7,000 BCE, had a transformative impact on Mainland Southeast Asia. Millet spread to the southern Indo-China Peninsula around 4,400 years ago, while japonica rice from China reached Mainland Southeast Asia, particularly Thailand, around 3,400 years ago (Gao et al., 2020b). This expansion led to a significant cultural and genetic exchange with Indigenous Australo-Melanesian foraging populations. By 4,000 BCE, Neolithic farming supported the establishment of emerging agricultural societies in the region, gradually assimilating or displacing Indigenous populations. Even as rice and millet cultivation spread from China into Southeast Asia, local populations continued to rely on traditional resources such as tubers, yams, taros, and tree crops, which were more closely related to arboricultural practices (Li, 1970).

Therefore, as Hutterer (1983) points out, the transition to Neolithic farming was not simply a replacement of foraging practices but a blending of Indigenous and external methods. Indigenous communities continued to adapt their subsistence strategies in response to local ecological conditions, suggesting that earlier foraging and semi-cultivation methods persisted, even as more intensive agricultural systems were introduced. Ellen's (1994) evidence of early sedentary life, reliant on wild and cultivated resources, reinforces this view of a gradual and adaptable shift toward agriculture. The complexity and diversity of Southeast Asian environments allowed for multiple subsistence strategies to coexist rather than a monolithic shift to agriculture.

4.2.3. Shifting Cultivation Systems in Southeast Asia

Hutterer (1983) discusses shifting cultivation systems in Southeast Asia, highlighting both its ecological and cultural aspects. Also known as swidden agriculture, this practice involves clearing natural vegetation using slash-and-burn techniques, followed by cultivation and a fallow period to restore soil fertility. It is commonly practiced in areas where wet-field agriculture is either impractical or too costly due to environmental conditions (ibid.).

Hutterer (1985) provides further insights into the sustainability of shifting cultivation, noting that it promotes the regeneration of tropical ecosystems, which are otherwise slow to recover from disturbances. Despite its reputation as a primitive practice, swidden agriculture is a sophisticated system integrating ecological knowledge with sustainable land use. This method is not solely about productivity; it also helps maintain long-term ecological balance, especially in fragile tropical environments.

A key feature of shifting cultivation is the burning process, which not only clears the land but also releases nutrients from the burned vegetation into the soil. However, the productivity of swidden fields declines quickly, as natural processes fail to replenish nutrients at the rate they are depleted by crops. This nutrient loss, combined with the proliferation of weeds after one or two years of cultivation, typically leads to the abandonment of fields and the clearing of new plots.

Hutterer suggests that while swidden agriculture existed earlier, its expansion into tropical rainforests likely occurred later in prehistory, especially after the introduction of metal tools, which made large-scale forest clearing more feasible. These tools allowed for the expansion of shifting cultivation into dense rainforests, where clearing land was otherwise labor-intensive and challenging. Swidden plots in such environments tend to be smaller due to the labor required to clear forests using traditional methods.

He also references Clifford Geertz's observation that shifting cultivation creates new ecosystems that are similar to the native ones they replace. While swidden systems replace natural vegetation with cultivated crops, they minimize ecological disturbance by maintaining a balance between the two systems. However, Hutterer cautions that many swidden systems accelerate cultivation cycles by reusing areas covered by secondary forests, as clearing primary forests is more labor-intensive.

Hutterer challenges the notion that shifting cultivation is merely a Neolithic relic. He argues that shifting cultivation has dynamically adapted to changing ecological and technological conditions. He points out that this system is not only a response to prehistoric practices but has evolved, particularly with the introduction of New World crops such as maize, sweet potato, and cassava, during the European colonial period. These crops have been integrated into the agricultural systems of Southeast Asian societies, demonstrating the adaptability and innovation within these agricultural economies.

This nuanced view of shifting cultivation reveals that while it is often considered primitive or outdated, it is a highly adaptable system that responds to ecological constraints and new agricultural opportunities. Far from being static, it has undergone significant changes over time, driven by both local ecological conditions and the introduction of new technologies and crops. The importance of this observation is relevant to the following sections on the agricultural history of the Orang Asli.

4.2.4. Analysis: Ecological Harmony and Adaptation in Early Southeast Asian Agriculture

The agricultural practices of early Southeast Asian societies reveal a profound integration of human activity with ecological systems. Rather than a linear progression from foraging to farming, these practices reflect adaptive strategies - both cultural and ecological - that respond flexibly to the diverse environmental conditions of the tropics. This notion of adaptation refers not merely to technical adjustments, but to a co-evolutionary process involving belief systems, subsistence practices, and ecosystem management, as framed in historical ecology (Ellen, 1994; Hutterer, 1983).

Early communities demonstrated a sophisticated understanding of ecological interdependence and environmental feedback loops. Such knowledge was embedded in cultural institutions - rituals, taboos, and cosmological systems - that functioned as mechanisms for ecological regulation (Hutterer, 1985). For example, the seasonal timing of agricultural activities was governed by both environmental indicators and ritual calendars, aligning production cycles with ecological renewal (Hutterer, 1983). This integration reflects what Ellen terms "symbolic adaptation," where cosmological beliefs directly inform and shape sustainable land-use decisions.

Crucially, the adaptive capacity of these systems lies in their flexibility: practices like shifting cultivation and polyculture were not static traditions but dynamic responses to shifting resource availability, forest ecology, and demographic pressures. These strategies minimized ecological disruption by aligning human needs with the regenerative capacities of the landscape (Hunt & Rabett, 2014; Hutterer, 1985), in contrast to the extractive monocultures that characterize much of modern agriculture.

Although primarily subsistence-oriented, evidence of context-specific surplus production and trade suggests that these systems also adapted socially, responding to opportunities for redistribution and exchange in line with ecological surplus (Hutterer, 1983). This further underscores that adaptation in this context includes not only ecological fit but also socio-cultural flexibility, allowing communities to mediate between ecological constraints and emerging social complexities.

Ultimately, these systems exhibit resilience through culturally mediated ecological adaptation - a concept that resists reductionist models of linear agricultural evolution. Instead, they represent complex, historically situated forms of Indigenous ecological knowledge and adaptation, offering enduring insights into sustainable human-environment relations (Ellen, 1994).

4.3. The Origins of Orang Asli and Farming in the Malay Peninsula

4.3.1. The Origins of Orang Asli

The origins of the Orang Asli, their relationship to the Hoabinhian culture, and the introduction of farming into the Malay Peninsula are deeply connected (Fix, 2016; Bulbeck, 2016; Bellwood, 2004). The Orang Asli trace their ancestry to ancient human populations that arrived in Southeast Asia as part of the early out-of-Africa dispersals. Fix (2016) highlights that the

Orang Asli's mitochondrial DNA (mtDNA) shows deep lineages, with divergence estimated between 44,000 and 63,000 years ago. This makes the Orang Asli one of the region's oldest populations, surviving through the last glacial maximum in climatic refugia, such as the Malay Peninsula (Fix, 2008). Similarly, Bulbeck (2016) situates the Orang Asli's deep ancestry within Southeast Asia, arguing that their genetic diversity reflects their long-standing presence in the region, predating major cultural shifts such as the Neolithic transition.

The Orang Asli are not a monolithic group but are divided into three subgroups: (1) Semang, (2) Senoi, and (3) Melayu Asli (Benjamin, 2013). Fix (2016) emphasizes that the Semang, often associated with a "Negrito" phenotype, are the most archaic subgroup, retaining the highest proportion of ancient mtDNA haplotypes and cultural traits indicative of early hunter-gatherer societies. The Senoi, in contrast, represent a blend of Indigenous ancestry and later Austroasiatic influences, while the Melayu Asli exhibit genetic and cultural connections to more recent Malay populations (Fix, 2016; Bulbeck, 2016).

4.3.2. Relationship to the Hoabinhian Culture

The Hoabinhian culture, a foraging tradition characterized by flaked stone tools, is widely distributed across mainland Southeast Asia, including the Malay Peninsula, and spans from around 10,000 to 4,000 BP (Fix, 2016). Predominantly nomadic, Hoabinhian groups practiced mobile hunting and gathering, adapting flexibly to tropical forest environments without establishing permanent settlements (Higham, 2013; Shoocongdej, 2001). While the Hoabinhian represents a significant cultural phase, it does not fully encapsulate the ancestry of the Orang Asli. Bulbeck (2016) argues that the Orang Asli's roots predate the Hoabinhian period, as their genetic lineages suggest continuity with populations that existed before this cultural phase. However, the Semang, in particular, exhibit a strong cultural and geographic overlap with Hoabinhian sites, suggesting some degree of continuity or interaction (Fix, 2016).

Bellwood (2004) provides a broader regional context for the Hoabinhian, describing it as a widespread Southeast Asian foraging tradition that persisted in parallel with the spread of early farming. He notes that the Hoabinhian's persistence in areas such as the Malay Peninsula likely reflects the resilience of foraging societies in tropical environments, where the advantages of farming were less pronounced. This perspective aligns with Bulbeck's interpretation of the

Semang as descendants of pre-Hoabinhian populations who maintained foraging traditions well into the Holocene (Bulbeck, 2016).

4.3.3. Orang Asli Pre-Farming Activities

The Orang Asli's survival in the extensive pre-farming period (between 40,000 and 75,000 years ago) depended mainly on a foraging lifestyle, which included hunting, gathering, and fishing (Baer, 2014). Their diet included various food items such as wild game, aquatic species, roots, insect larvae, fruits, nuts, edible plants such as ferns, palm hearts, *petai* beans (*Parkia speciosa*), and bamboo shoots. They derived proteins from hunting animals, collecting turtles, catching fish, and gathering shellfish, as well as from eggs. Sugars came from fruits such as sugarcane, sugar palm, and honey, while complex carbohydrates were sourced from tubers, nuts, and sago palm. This diverse foraging strategy provided them a nutritionally balanced diet (ibid.).

Over time, they developed methods for encouraging the growth of valuable plants without formal agriculture (Baer, 2014). This included transplanting bamboo roots, bananas, and taro, as well as pruning sago palms to promote regrowth (Baer, 2014, p.15). They also used controlled burning to clear patches in the forest, encouraging the growth of edible plants such as gingers and ferns. These clearings, in turn, attracted herbivorous animals such as deer and buffalo, making hunting more productive. Regarding hunting, the Orang Asli used forest management techniques to boost game availability (Baer, 2014, p.29). By creating clearings in the forest through burning, they made it easier for animals to gather, which improved their hunting success. Additionally, they would selectively plant fruit trees at their campsites, which over time led to the emergence of small-scale food production systems, or proto agriculture, as seeds from such as durian would take root and grow into trees (Baer, 2014, p.15).

There were differences in the foraging strategies between groups living near the coast and those in the interior (Baer, 2014). Coastal regions and estuaries provided a wealth of easily accessible food, particularly protein-rich sources, while inland areas required more effort, as resources were spread out. Inland groups, facing these challenges, supplemented their foraging activities by engaging in rudimentary farming. Foragers were not stationary; they frequently moved from one location to another to prevent the overuse of local resources. This nomadic lifestyle also helped them avoid the spread of diseases, such as malaria, which was more prevalent in areas with more permanent settlements. This way of life persisted for thousands of years as they adapted to the natural environment without engaging in systematic agriculture (ibid.).

Between approximately 10,000 and 3,000 years ago, the first signs of farming or horticultural settlements emerged on the peninsula (Baer, 2014). This shift from foraging to farming was gradual and driven by population pressures that made foraging alone insufficient for the growing communities. Early forms of agriculture likely focused on small-scale activities, such as planting tubers such as taro and cultivating groves of fruit trees, including durian, rather than large-scale crop production.

4.3.4. The Introduction of Farming and Austroasiatic Migration

The arrival of agriculture in the Malay Peninsula is attributed to southward migrations of Austroasiatic-speaking populations from mainland Southeast Asia around 4,000 years ago . Bellwood (2004) situates this migration within the broader "demic diffusion" of farming across Southeast Asia, where expanding farming populations introduced rice cultivation, polished stone tools, and sedentary lifestyles [35]. Fix (2016), however, emphasizes a "trickle" model of migration, where Austroasiatic farmers gradually intermarried with local populations rather than displacing them entirely.

The cultural and genetic impact of these migrations varied among the Orang Asli subgroups. The Senoi, for instance, reflect a significant Austroasiatic influence, both genetically and culturally (Bulbeck, 2016). Bulbeck identifies the Senoi as incorporating farming practices and technologies introduced by Austroasiatic migrants, blending these with Indigenous traditions to form a mixed subsistence economy. In contrast, the Semang appear to have retained their foraging lifeways, with minimal integration of agricultural practices (Fix, 2016). Bellwood (2004) notes that such diversity in responses to farming migrations is common across Southeast Asia, where ecological and cultural factors shape the extent of agricultural adoption.

Interactions between incoming farming populations and Indigenous foragers in the Malay Peninsula were multifaceted. Fix (2016) highlights that the mobility of the Semang allowed

[35] Evidence of agricultural development is seen in the discovery of carbonized rice at the Gua Cha site in Kelantan, dating back approximately 2,200 years (Baer, 2014). This suggests that by this time, rice farming had become an established practice in the region (ibid.)

them to preserve their foraging traditions, while intermarriage facilitated genetic exchanges, particularly among the Senoi, who incorporated Austroasiatic haplotypes. Bulbeck (2016) supports this view, emphasizing the gradual coexistence and interaction between farmers and foragers over millennia.

Bellwood (2004) situates these dynamics within Southeast Asia's Neolithic transition, noting that farming adoption was neither immediate nor universal, varying with ecological and cultural contexts. Foraging persisted, especially among groups such as the Semang, who resisted agricultural integration (Bulbeck, 2016; Bellwood, 2004).

The introduction of farming did not erase the cultural or genetic legacy of the Orang Asli. Fix (2016) emphasizes that the Semang, in particular, represent a direct link to ancient foraging populations, with minimal influence from later migrations. The Senoi, while incorporating Austroasiatic elements, also retained significant aspects of their Indigenous heritage, reflecting a dynamic process of cultural blending rather than displacement (Fix, 2016). Bulbeck (2016) and Bellwood (2004) both underscore the resilience of foraging traditions in the Malay Peninsula, where ecological conditions and cultural preferences allowed for the coexistence of diverse subsistence strategies.

4.3.5. The Ecological and Cultural Adaptations of the Orang Asli

The longstanding interactions between foragers and farmers in the Malay Peninsula laid the groundwork for the Orang Asli's subsistence strategies and their nuanced relationship with the environment. As these groups adapted to external influences and local conditions, they developed a sophisticated set of ecological practices rooted in cultural traditions. These adaptations, as explored by Rambo (1984) and Benjamin (1985), reveal how the Orang Asli have not only preserved but also actively shaped their rainforest ecosystems, balancing environmental stewardship with cultural identity.

Rambo (1984) categorizes the Orang Asli's modifications of the rainforest into four distinct methods: direct selection, seed dispersal, habitat modification, and domestication. Through these practices, the Orang Asli have shaped biodiversity and maintained the forest's structure. For example, the direct selection of plant and animal species for food and materials has influenced species survival and abundance (Rambo, 1984). This aligns with Benjamin's (1985) finding that the Orang Asli, such as the Semang and Temiar, have persisted in foraging and resource collection as vital subsistence strategies, despite facing external pressures such as colonialism and modernization. Benjamin (1985) points out that these practices were not purely 'survivalist' but were also tied to cultural values, which played a role in how environmental resources were managed.

Seed dispersal, as described by Rambo (1984), demonstrates the Orang Asli's contribution to forest regeneration. By consuming fruits and dispersing seeds, they unintentionally enhance biodiversity, allowing for cross-pollination between wild and cultivated varieties. Benjamin (1985) provides a cultural dimension, demonstrating how the Semang and Temiar's interaction with their environment was not only driven by subsistence needs but also by a desire to maintain ecological and cultural boundaries. Their foraging and horticultural practices, while distinct, were part of a broader societal balance between environmental management and cultural identity.

One of the most critical ways the Orang Asli have altered the rainforest is through habitat modification. Rambo (1984) highlights how the practice of swidden agriculture, or slash-and-burn farming, creates a mosaic of habitats at various stages of regrowth, enhancing species diversity. This modification aligns with Benjamin's (1985) description of the Temiar's use of shifting agriculture to maintain both cultural diversity and environmental sustainability. While both Rambo and Benjamin acknowledge the benefits of swidden agriculture in promoting biodiversity, they also hint at its potential drawbacks. Rambo warns of soil depletion through overuse, and Benjamin highlights the long-term uncertainty of these practices, noting that while they appear sustainable in the short term, the broader ecological consequences—such as resource depletion—are difficult to predict.

Plant domestication and resource management represent perhaps the most deliberate form of environmental manipulation by the Orang Asli. Rambo (1984) describes how the Orang Asli domesticate and manage plant species such as cassava, durians, and *petai* to ensure sustainable growth. This human intervention reflects a deep understanding of the ecosystem and demonstrates the Orang Asli's role as active agents in shaping their environment. Benjamin (1985) further develops this theme by emphasizing how these practices are embedded in a cultural framework that values long-term stewardship over short-term gains. He argues that the

Semang and Temiar manage their environmental interactions in ways that not only reflect their cultural priorities but also promote ecological harmony and biodiversity.

A critical aspect of Rambo's and Benjamin's analyses is the resilience of the Orang Asli's cultural values in the face of external pressures. Despite the onset of colonialism, industrialization, and the shift toward permanent-field agriculture, Benjamin (1985) argues that the Orang Asli's core values have remained remarkably stable. This cultural resilience has enabled them to adapt to changing environmental and economic conditions without losing their traditional ecological practices. Rambo (1984) supports this view, noting that the Orang Asli's long-term ecological strategies have been crucial to their survival. However, both scholars caution that modern development, particularly the expansion of agricultural land, threatens this delicate balance. Rambo (1984) highlights how encroachment on Orang Asli lands could disrupt their traditional practices, while Benjamin (1985) underscores the unpredictability of long-term ecological consequences, particularly when cultural priorities such as lifestyle preservation guide environmental decisions.

What emerges from the integration of these two perspectives is a picture of the Orang Asli as adaptive, resilient, and deeply engaged with their environment. Rambo (1984) documents how the Orang Asli have shaped the rainforest ecosystem, while Benjamin (1985) provides insight into how these practices are intertwined with cultural values and power dynamics. Benjamin's emphasis on the connection between cultural values and environmental stewardship adds a layer of complexity to Rambo's ecological analysis. Rather than viewing these practices as purely subsistence-driven, Benjamin suggests that they are tied to broader societal goals, which have helped the Orang Asli maintain ecological stability and cultural identity.

However, both scholars also recognize the uncertainty of long-term ecological outcomes. While the Orang Asli's practices appear sustainable in the short term, Rambo (1984) and Benjamin (1985) acknowledge the unpredictability of human-environment interactions over time. For example, Benjamin highlights how even well-intentioned practices such as foraging and swidden agriculture might lead to unforeseen consequences such as resource depletion or shifts in ecosystem stability. This uncertainty underscores the complexity of managing environmental resources in a way that balances cultural preservation with ecological sustainability.

In conclusion, integrating Rambo's (1984) and Benjamin's (1985) works provides a multifaceted view of the Orang Asli's relationship with the rainforest. Both scholars illustrate how the Orang Asli, through practices such as direct selection, seed dispersal, habitat modification, and domestication, have played a critical role in shaping their environment. Benjamin's focus on cultural resilience and power dynamics deepens Rambo's ecological analysis, revealing how these practices are not only sustainable but also reflective of the Orang Asli's broader societal and political goals. Together, their insights emphasize the need for conservation efforts incorporating traditional ecological knowledge and cultural values to ensure the long-term sustainability of the rainforest ecosystem and the Orang Asli way of life. However, the uncertainty of environmental outcomes highlights the challenges of predicting the full impact of human-environment interactions, making it crucial to approach ecological management with flexibility and adaptability.

4.4. Historical Transformation of Orang Asli Agriculture: From Ecological Transitions to Policy-Driven Change (Pre-Colonial Era to 1980s)

The Orang Asli's traditional ecological practices, such as swidden agriculture, were deeply rooted in cultural and environmental resilience. However, land-use transformations began disrupting these practices as early as the late 19th century, long before government-driven resettlement policies of the 1950s. The expansion of rubber estates, gambier plantations, and logging operations significantly altered the landscape and impacted Orang Asli communities (Hashim, 2014, p.86). By the early 20th century, rubber had become the dominant cash crop, leading to increased deforestation and labor shifts that affected traditional subsistence patterns (Hashim, 2014, pp. 86–87).

By the mid-20th century, government-led resettlement policies aimed at curbing communist insurgencies sought to further integrate the Orang Asli into permanent agricultural settlements (Rambo, 1988). While these policies reinforced structured farming systems, they were not the first major shift in Orang Asli agricultural practices. The preceding decades of rubber estate expansion, gambier cultivation, and logging had already profoundly altered traditional land-use strategies, affecting Orang Asli access to forest resources and influencing patterns of economic participation (Hashim, 2014, p. 88).

Thus, while the 1950s anti-communist resettlement programs were pivotal in restructuring Orang Asli livelihoods, they were part of a longer trajectory of agrarian change that began in the late 19th century with commercial plantations and logging operations (Hashim, 2014, pp. 86–88). Recognizing this broader history is essential for understanding the depth and duration of land-use pressures on Orang Asli communities.

Traditionally, the Orang Asli practiced subsistence agriculture, focusing on shifting cultivation (also known as swidden agriculture) of crops such as rice, bananas, and root crops such as cassava and yams (Rambo, 1988). These practices, rooted in the pre-colonial era, persisted into the early 20th century, emphasizing their sustainability and cultural importance. However, from the 1950s onward, government resettlement schemes sought to replace swidden agriculture with more sedentary farming methods, fundamentally altering traditional livelihoods (Rambo, 1988, p. 280).

In the 1960s and 1970s, national development policies further encouraged Orang Asli participation in commercial agriculture, particularly through rubber and oil palm cultivation (Rambo, 1988, p. 281). While these initiatives aimed to integrate the Orang Asli into the mainstream economy, they also represented profound social and cultural shifts. Many communities struggled with cash-crop dependencies and economic instability, as market-driven agriculture often failed to provide stable livelihoods (Rambo, 1988, p. 282).

By the 1980s, a clear division had emerged between communities that continued subsistence farming and those that had transitioned to commercial agriculture (Rambo, 1988, p. 283). Some Orang Asli groups in remote areas maintained traditional agricultural practices, while others, especially those near urbanized regions, became more reliant on cash crops. However, many faced challenges adapting to market fluctuations and economic pressures, highlighting the complexity of this agricultural transformation (Rambo, 1988, p. 284).

Group	**Economy**	**Areas**	**Period**
Senoi (one of the largest OA groups)	Subsistence farming using swidden techniques (hill rice and root crops)	Upland regions (steep terrain and poor soil quality for permanent agriculture)	Until the 20th century. With the government's push for more settled and modern agriculture post-1950s, some of the Senoi were introduced to

Group	Economy	Areas	Period
			rubber cultivation as part of resettlement schemes.
Negrito	More reliant on hunting and gathering. Small scale agriculture, combine horticulture with foraging in forested areas. Least developed agriculture compared to other OA groups.	Remote forested areas of Perak, Kelantan and Kedah. Less accessible and relatively isolated. The terrain made large-scale agricultural development more challenging, thus they were able to preserve their traditional way of life longer.	Farming activities expanded in the 20th century as they were resettled into more permanent agricultural communities.
Proto Malay	More involved in trade and advanced agriculture. Adopted wet rice cultivation in certain areas, greater integration into mainstream Malaysian agricultural systems. More settled compared to the Negrito and Senoi.	Fertile lowland areas (better access to irrigation)	Grew commercial crops (rubber and oil palm) from the 1960s onwards.

TABLE 4.1: ECONOMIC PRACTICES AND SETTLEMENT PATTERNS OF ORANG ASLI SUBGROUPS (PRE-20TH CENTURY TO 1980S)

(Source: Rambo, 1988)

Table 4.1 highlights how different Orang Asli subgroups adapted to these changes. For instance, the Senoi transitioned from upland swidden agriculture to rubber cultivation under resettlement schemes, while the Negrito, inhabiting remote forested areas, preserved traditional foraging and small-scale horticulture for longer. By contrast, the Proto Malay, settled in fertile lowland regions, adopted wet rice and commercial crop farming earlier, integrating more extensively into Malaysia's agricultural systems (Rambo, 1988).

This shift from traditional subsistence farming to commercial agriculture had significant environmental and social consequences. The expansion of plantations led to extensive deforestation, reducing the forest resources the Orang Asli had historically relied on for hunting and gathering. Socially, the transition disrupted community structures and deepened economic dependencies on volatile cash-crop markets (Rambo, 1988). These challenges underscore the tension between modernization and cultural continuity, as the Orang Asli continue to navigate the evolving dynamics of land use and agricultural practices.

4.5. Impact of European Colonization and the Introduction of Alien Crops in Southeast Asia

Hutterer[36] (1983) discusses the introduction of alien crops to Southeast Asia, particularly those originating from different phytogeographic regions, often in the Americas or Africa. With European exploration and colonization in the late 15th century, several vital crops (listed in Table 4.2) from the New World and Africa were introduced to Southeast Asia, dramatically altering the agricultural landscape.

No.	Common Name	Taxonomic Name	Origin
1.	Maize	*Zea mays*	Americas
2.	Sweet potato[37]	*Ipomoea batatas*	South America (via Pacific trade)
3.	Manioc/Cassava	*Manihot esculenta*	South America
4.	Peanut	*Arachis hypogea*	South America
5.	Pineapple	*Ananas comosus*	South America
6.	Papaya	*Carica papaya*	Americas
7.	Avocado	*Persea americana*	Americas
8.	Tomato	*Solanum lycopersicum*	Americas
9.	Chilli pepper	*Capsicum spp.*	Americas
10.	Tobacco	*Nicotiana tabacum*	South America

TABLE 4.2: IMPORTANT ALIEN CROPS INTRODUCED TO SOUTHEAST ASIA (15TH CENTURY)

In the 18th and 19th centuries (during the colonial period), three major alien crops significantly shaped the agricultural landscape of Southeast Asia (K. L. Hutterer, 1983). Rubber (*Hevea brasiliensis*), originally from South America, became highly important as large plantations were established in Malaysia and Sumatra. Similarly, oil palm (*Elaeis guineensis*) from Africa became another major plantation crop. Coffee (*Coffea spp*.), also from Africa, emerged as a valuable cash crop, further contributing to the region's economic transformation. The introduction and cultivation of crops such as rubber and oil palm played a transformative role in Southeast Asia, especially in Malaysia and Sumatra, which became critical areas for large-scale plantations. These crops not only reshaped the landscape but also contributed to the

[36] Roy Hutterer's work has been foundational in understanding the development of agricultural systems in Southeast Asia. His comprehensive analysis of subsistence patterns, particularly shifting cultivation provides critical insights that inform much of the discussion in this chapter section. Frequent references to his research are essential to support the arguments presented here.

[37] While European exploration and colonization in the late 15th century introduced many vital crops, the spread of sweet potato into parts of Southeast Asia likely predates European contact. Genetic and historical evidence suggests that Polynesian voyagers carried sweet potato from South America across the Pacific, reaching New Guinea and Southeast Asia before European arrival (Roullier et al., 2013). European explorers and traders may have later reinforced its presence, expanding its cultivation in Malaya and beyond.

region's economic development as significant export commodities. The expansion of these plantations reflects broader agricultural changes during the colonial era, where alien crops were integrated into local economies, altering both the farming and social landscape (ibid.).

According to Hutterer (1983) the success of these alien crops can be attributed to several key factors. First, the absence of natural pests allowed these crops to thrive, as they were no longer subjected to the pests and diseases that plagued them in their native regions, resulting in improved vigor and productivity. Additionally, the similarity in environmental conditions between Southeast Asia and their original habitats made it easier for these crops to grow and flourish. Finally, their adaptation to local ecological systems enabled them to integrate well, often outperforming local species due to their resilience and ability to fit into the existing agroecosystems. The introduction of these alien crops, particularly those from the Americas and Africa, played a transformative role in reshaping Southeast Asian agriculture, beginning in the late 15th century and continuing through the following centuries (ibid.).

In his later work, Hutterer (1985) examines the broader ecological implications of these alien crops, emphasizing how their introduction often displaced local, ecologically adapted crops that had been cultivated for generations. While these alien crops thrived due to the absence of pests and diseases, they also disrupted the intricate ecological balance that had previously sustained Indigenous agriculture in tropical regions. The introduction of alien species during the colonial period, therefore, not only reshaped the agricultural landscape but also led to the ecological degradation of many tropical ecosystems.

4.6. Orang Asli Shifting Cultivation (Swiddening)

4.6.1. Early Colonial Accounts of Orang Asli Shifting Cultivation

British colonial foresters Strong (1932) and Wyatt-Smith (1958) attributed environmental degradation to the shifting cultivation, emphasizing its regulation as a key land-use challenge. Strong (1932) examined the Sakai[38] ladang system, where forested areas were cleared for

[38] The term "*Sakai*" is a colonial-era label used to describe the Indigenous Peoples of Peninsular Malaysia, particularly Temiar and Semai (Senoi ethnic group). Today, this term is considered derogatory. Instead, specific names of the Indigenous groups or the general term Orang Asli are used, which is a more accurate and respectful representation.

cultivation and later abandoned due to soil depletion. He argued that this process led to deforestation and timber loss, posing a challenge to sustainable land use. In response, the colonial administration introduced the *taungya* system, promoting organized land use and replanting.

Nearly three decades later, Wyatt-Smith expanded on these concerns, categorizing three primary groups engaged in shifting cultivation in Malaya: (1) Orang Asli, who cleared hilly land for subsistence crops such as rice, tapioca, and bananas, with these practices later constrained by resettlement policies; (2) Malays, who used shifting cultivation in lowland areas to supplement wet rice farming but transitioned to rubber plantations and irrigation-based agriculture; and (3) Chinese farmers, whose shifting cultivation was more commercial, focusing on pineapples, tobacco, and tapioca, often financed by urban industrialists.

Both authors noted the limited success of colonial land-use regulations, such as issuing Temporary Occupation Licenses (TOL), particularly in controlling the nomadic tendencies of Indigenous groups. Wyatt-Smith highlighted the challenges of resettlement programs during and after the Malayan Emergency (1948–1960), which aimed to permanently settle the Orang Asli but yielded mixed results. Industrial financing of large-scale Chinese cash-crop plantations further complicated land management, accelerating deforestation and soil degradation.

Although both authors framed shifting cultivation as environmentally inefficient, they ignored its sustainability within Indigenous systems. Wyatt-Smith warned of long-term deforestation risks in the absence of scientific land management, yet neither author accounted for the extensive deforestation driven by colonial timber industries. Strong's emphasis on timber loss - *"It is not only the total loss of valuable timber that must be considered..."* - focused on economic extraction rather than long-term ecological consequences. His support for the *taungya* system prioritized plantation forestry at the expense of Indigenous autonomy.

4.6.1.1. Flawed Assumptions About Forest Regeneration and Indigenous Impact

Strong (1932) and Wyatt-Smith (1958) assumed that forests regenerate quickly after shifting cultivation, overlooking the fundamental differences between primary and secondary forests. As Sheil & Wunder (2002) explain, secondary forests are dominated by fast-growing pioneer species, whereas primary forests contain a high diversity of slow-growing, shade-tolerant trees, requiring centuries to fully recover. Some estimates suggest it could take up to 500 years for a regenerated forest to become indistinguishable from a primary one in terms of canopy structure, soil composition, and biodiversity networks (Sheil & Wunder, 2002).

Additionally, dipterocarps - one of the most valuable timber groups - are almost exclusively found in primary forests. Their loss through deforestation is effectively irreversible in the short term (Sheil & Wunder, 2002). Many economically significant resin-producing trees are also primary forest species, meaning deforestation results in long-term depletion of these resources. Wyatt-Smith's portrayal of shifting cultivation as environmentally destructive ignored these ecological distinctions, framing Indigenous land use as the primary driver of forest loss, rather than considering the impacts of colonial land policies and resource extraction.

4.6.1.2. Colonial Bias in Land-Use Critiques

Strong (1932) and Wyatt-Smith (1958) also framed shifting cultivation as economically unsustainable by Western standards, without recognizing the broader colonial context that had already disrupted Indigenous practices. Cole's assertion that, *"Attempts at persuasion have not been conspicuously successful, largely because the Sakai cannot appreciate what harm he is doing,"* reflects the colonial assumption that Indigenous people needed education and intervention to adopt "proper" land-use methods. Similarly, Wyatt-Smith disproportionately blamed the Orang Asli for deforestation, despite the far greater impact of industrial logging sanctioned by the colonial government. While Indigenous communities practiced small-scale, sustainable farming, commercial timber extraction cleared vast forest areas for export profits.

The colonial prioritization of timber exports shaped both authors' critiques of shifting cultivation, yet they failed to hold large industries accountable for environmental damage. Instead, they advocated government interventions such as regulated farming and resettlement, portraying Indigenous practices as outdated and in need of reform. Their paternalistic approach overlooked the sustainability and cultural significance of traditional land management.

4.6.2. The First Systematic Study of Shifting Cultivation in Malaya

By the time Cole (1959), a British forester, published his work, a marked shift was observed in how colonial foresters approached shifting cultivation, particularly in his detailed analysis of the Temiar *Jerami* system. Rather than dismissing the practice outright, Cole provides a systematic account of the process, explaining the rationale behind shifting cultivation and acknowledging its role in sustaining the Temiar's food security and economic livelihood.

Cole's study focused on the Temiar (Senoi group) living along the Nenggiri River in the Ulu Kelantan district, where around 1,000 people resided. The region's geographical features, especially the river valleys and forested mountains, shaped the tribe's agricultural methods and way of life to a large extent. Temiar social organization revolves around villages spread across a forty-mile stretch of the Nenggiri River. Each village, led by a headman, comprises 30 to 160 people, forming extended kinship groups. Shamans provide spiritual guidance, protect the group from evil spirits, interpret dreams, and play an integral role in both the social and spiritual fabric of Temiar society. This cohesive structure enables the Temiar to manage their communal activities, particularly concerning their hereditary tribal areas, where they have exclusive rights to hunt, fish, gather jungle produce, and cultivate the land via shifting cultivation practices in (then) Malaya.

Shifting cultivation (known as *jerami*) is central to Temiar agricultural life, with fields rotated to preserve soil fertility and prevent degradation (Cole, 1959b). The primary crops are cassava, the main food source, and rice, cultivated in a three-to-one ratio with cassava. The system allows two rice crops per field before leaving the land fallow, balancing yield maximization with soil preservation. Variations of Jerami, such as Modified, Partial, Converted, and Abandoned Jerami, reflect its adaptability to different environmental conditions. The Jerami agricultural cycle includes land clearing, planting, harvesting, and crop rotation, which help maintain soil quality. However, while the system aids forest regeneration, Cole noted that stubble clearing during the second cultivation cycle negatively impacts forest recovery (ibid.).

The largest farms (*Selai Ba*) are primarily for rice and are located in primary or secondary forests, aiming for two harvests before fallowing. Smaller cassava farms (*Selai Rusuk*), untended and farther from the village, are crucial for food security (Cole, 1959b). Closer to the villages, village gardens are cultivated with maize, bananas, sugarcane, and vegetables for immediate consumption. This diversity of farm types demonstrates the Temiar's adaptability and reliance on varied food sources to sustain their community. Agricultural activities are accompanied by rituals and rites, reflecting their spiritual connection to the land and underscoring the importance of spiritual beliefs in their farming practices (ibid.).

In addition to farming, the Temiar engage in hunting and gathering, supplementing their diet by hunting small game such as monkeys and birds, and fishing using traditional methods (Cole, 1959a). They also gather jungle produce, such as timber, rattans, and tree resins, which they trade for goods such as steel tools and cloth. This balance of agricultural and non-agricultural activities is critical for their survival and highlights their deep connection to the forest. Their housing, constructed from bamboo and palm leaves, reflects their resourcefulness, with stilted homes providing protection from wildlife such as tigers. These homes, often built in a longhouse style, serve both practical and social functions for the community (ibid.).

Cole concluded that Temiar economic and social stability is closely tied to their agricultural system, which supports their traditional way of life while facilitating a gradual shift towards permanent settlements, driven by activities such as timber logging and jungle produce collection. However, challenges such as land degradation and overpopulation threaten the sustainability of the Jerami system, leading to calls for reorganized agricultural methods to prevent further deforestation and ensure long-term viability (ibid.).

4.6.3. Evolving Colonial Perspectives on Shifting Cultivation: Environmental, Economic, and Political Shifts in Malayan Forestry

By 1959, colonial administrators had dealt with shifting cultivators for decades, and efforts to eradicate the practice had largely failed (Wyatt-Smith, 1958). For Indigenous communities, shifting cultivation remained essential. Cole's account acknowledged the ecological rationale behind shifting cultivation, for example the rotation of rice and cassava farms to prevent permanent land degradation by the Temiar. This shift in perspective reflects a growing recognition of the adaptability of Indigenous agricultural systems to the natural environment.

This evolving understanding of agricultural systems in Malaya paralleled broader transformations occurring in Malaysian agriculture during the colonial period (Roland, 1970). The colonial era marked a period of structural transformation, with innovations such as bunded fields and gravity-fed irrigation systems significantly increasing the efficiency of flat land permanent cultivation. In the Menangkabau community, irrigation pumps were introduced; however, their use declined after World War II due to resource limitations. During this time, rice farming became more organized and integrated with market systems, although the benefits were unevenly distributed. While lowland regions with better irrigation infrastructure thrived, upland communities continued practicing subsistence farming, highlighting the socio-economic disparities inherent in colonial policies (ibid.).

At the same time, economic pressures played a significant role in shaping the colonial foresters' approach. By the late 1950s, the Malayan economy was still heavily dependent on resource extraction, especially timber (Harper, 1999). Colonial foresters such as Cole recognized that outright condemnation of shifting cultivation was impractical and counterproductive to integrating Indigenous Peoples into the colonial economy. Instead, they sought to incorporate Indigenous agricultural practices into broader economic policies. The political context of the time also influenced this shift. In the post-war period, particularly during the Malayan Emergency[39] (1948 to 1960), there was increasing political instability and rising calls for independence (Harper, 1999). Colonial authorities were more focused on securing the cooperation of Indigenous populations rather than enforcing strict control. Cole's detailed study reflects an attempt to document and understand Indigenous practices more thoroughly as part of a broader strategy to integrate Indigenous Peoples into the post-colonial economy. Understanding shifting cultivation in greater detail allowed colonial administrators to engage in development schemes to improve Indigenous agricultural productivity, aligning with efforts to stabilize Indigenous communities and secure their cooperation during a politically volatile period (Harper, 1999).

In addition to political and economic motivations, there was a growing academic interest in Indigenous knowledge systems by the late 1950s, particularly in the fields of anthropology and ecology (Williams-Hunt, 1952a, 1952b). Cole's detailed account of the Temiar's shifting cultivation practices reflects this broader academic movement, which sought to understand Indigenous agriculture as an adaptive strategy rather than an outdated or destructive practice. This shift represented a departure from purely economic and environmental concerns to a more ethnographic and ecological understanding of Indigenous livelihoods.

[39] The Malayan Emergency was a guerrilla war fought between Commonwealth armed forces and the Malayan National Liberation Army (MNLA), the military arm of the Malayan Communist Party (MCP). The conflict was triggered by the communist insurgency aiming to establish a communist state in Malaya, and it marked a key period in Malayan history as the British colonial government sought to suppress the rebellion (Harper, 1999).

In contrast to earlier colonial views, such as those of Strong and Wyatt-Smith, Cole's analysis respected the complexity of the Jerami system and acknowledged the logic of the Temiar's agricultural practices. This reflects a more nuanced colonial anthropological approach, where the goal was to document and understand Indigenous systems rather than simply dismiss and replace them. The implications for colonial policy and Indigenous integration are evident in Cole's 1959 article. His work marks an evolution in colonial thinking, recognizing the importance of understanding and documenting Indigenous agricultural systems.

Although Cole (1959) provided a detailed and ecological perspective on the Temiar, it was (Hill, 1970) who first brought attention to the spiritual significance of rice cultivation among the Orang Asli. Hill highlighted the reverence for the rice soul, which extends beyond the act of harvesting and is expressed through communal rituals and ceremonies during planting, growing, and harvesting cycles. These rituals often involve offerings and prayers, reflecting a profound spiritual connection between farmers and their environment. According to Hill, rice cultivation among the Orang Asli is not merely agricultural but a deeply spiritual engagement with nature. Their farming methods integrate traditional ecological knowledge with spiritual dimensions, promoting sustainable and harmonious interactions with the land.

As highlighted by the structural agricultural changes during the colonial era (Hill, 1970), innovations such as improved irrigation systems and organized rice farming provided insights into managing the dichotomy between modernized and subsistence systems. Similarly, shifting cultivation was no longer framed solely as a threat to the environment, but rather as a culturally embedded practice with the potential for adaptation and integration into broader colonial policies. Economic pragmatism was a key driver, as Cole's analysis of the Jerami system provided a foundation for development schemes that allowed for the controlled use of land without undermining timber production. Additionally, while still critical of deforestation, Cole's article suggested that shifting cultivation could offer a sustainable balance between agriculture and environmental conservation if practiced with long fallow periods and rotational methods. Furthermore, the shift in tone reflected a growing awareness of Indigenous land rights and traditional land use systems, signaling a prelude to post-colonial discussions about Indigenous autonomy and land management rights.

4.6.4. Semelai Agriculture

The following detailed account of Semelai agriculture is derived from Gianno & Bayr's (2009) work. The article investigates the agricultural patterns and broader subsistence practices of the Orang Asli Semelai through ethnographic analysis, historical records, and aerial photographic evidence from the mid-20th century. It contextualizes these practices within the ecological, cultural, and socio-political landscape of southern Peninsular Malaysia, providing an in-depth understanding of how the Semelai adapted to their environment and responded to historical changes.

The Semelai people of southern Peninsular Malaysia historically practiced a distinct form of agriculture that reflects their environmental adaptation and cultural identity. Their primary agricultural practice was shifting cultivation, focusing on dry rice as a staple crop and cassava as an essential backup. Each household typically cultivated a new swidden (field) each year, often adjacent to the previous year's plot. These swiddens were situated in primary forest areas, which provided fertile soil and optimal conditions for their crops. Proximity to navigable waterways was another critical factor in selecting swidden locations, facilitating transportation and irrigation.

Rice held a prominent place in Semelai culture, not only as a food source but also as a symbol of their heritage and societal status. The Semelai language includes over 37 distinct names for rice varieties and 24 rice growth stages, highlighting the crop's significance. Rituals and magic were central to their agricultural practices, as they believed these ensured successful harvests and protected their crops from pests and natural threats. These rituals, along with the physical process of cultivation, symbolized their deep connection to the land.

Cassava, introduced later in Semelai history, became a reliable insurance crop. Its ability to thrive even under adverse conditions offered a safety net against the risks associated with rice cultivation. Despite its practicality, cassava never supplanted rice's cultural and symbolic importance. The Semelai's agriculture was labor-intensive, with practices such as manually clearing forests and creating elongated swiddens extending down slopes to maximize sunlight exposure for their crops[40].

Historically, the Semelai's agricultural lifestyle was deeply intertwined with their settlement patterns. Families constructed temporary houses near their swiddens, reflecting the semi-nomadic nature of shifting cultivation. They maintained autonomy over their cultivated land and water resources, underscoring a sense of ownership tied to their agricultural endeavors. However, their reliance on primary forests for both agriculture and the collection of forest products made them vulnerable to external pressures and environmental changes.

The Semelai’s agricultural practices evolved under various historical and environmental influences. During the Malayan Emergency (1948–60), their traditional lifestyle was disrupted when they were resettled near colonial forts. This resettlement marked a significant shift in their agricultural methods, as government policies restricted cultivation in primary forests. The eventual commercial exploitation of their land further diminished their access to traditional farming areas, pushing them to adopt alternative economic strategies such as rubber tapping.

In summary, Semelai agriculture exemplified a sophisticated adaptation to their environment and a profound cultural attachment to rice cultivation. Despite external pressures and environmental challenges, their agricultural practices reflect a deep understanding of sustainability, resource management, and cultural expression. Over time, however, these practices faced profound transformations, driven by socio-political changes and the encroachment of modernization.

4.6.5. Swidden Agriculture and its Decline Among the Orang Asli in Peninsular Malaysia

A comprehensive UNESCO (1983) study highlights swidden (shifting) agriculture in Malaysia, primarily associated with the Orang Asli in Peninsular Malaysia concentrated in the highland regions along the Main Range. Pahang, Kelantan, and Perak have the most significant areas under swidden cultivation, though the practice has declined from 2.93% of agricultural land in

[40] According to Rosemary Gianno (personal communication, 24 December 2024), an additional reason for this practice was that trees felled at the top of the slope would help knock down those below, reducing the labor required for clearing the land

1966 to 1.22% in 1974. At that time, it was found that several Orang Asli groups engaged in swidden agriculture as follows:

i. Temiar (Perak and Kelantan): Practice migratory and settled swiddening, with long fallow periods (7-15 years), and mainly cultivate hill rice, maize, cassava, and plantains.
ii. Semai (Perak and Pahang): Follow a similar pattern, mixing migratory and settled swiddening depending on location.
iii. Jah Hut (Pahang): Focus on localized, settled swiddening, rotating fields without relocating.

The Jakun and Semelai Proto-Malay groups also practice swidden agriculture, while the Mah Meri have shifted to permanent farming due to land constraints (ibid.).

Since the Fourth Malaysia Plan (1981-1985), the government has encouraged the transition to permanent agriculture, with programs promoting rubber, coconut plantations, and animal husbandry (UNESCO, 1983). Resettlement programs aimed to replace swidden agriculture, but many Orang Asli communities resisted, as swiddening remains culturally and economically significant, especially in remote areas where government influence is limited. However, the report found that increasing land pressures have shortened fallow periods, leading to concerns about soil degradation and sustainability.

Swiddening goes beyond agriculture and represents a communal and cultural system for the Orang Asli (UNESCO, 1983). The land is often managed collectively, and trees spared during clearing are considered communal resources. Rituals accompany critical stages of the cultivation process, reinforcing the community's spiritual connection to the land. Despite the environmental sustainability traditionally afforded by long fallow periods, increasing population pressure and government interventions have shortened these periods, causing environmental degradation. Government policies, which have been more effective in discouraging swidden agriculture among non-Orang Asli communities, have contributes to the decline of traditional agricultural practices. As of 1983, swidden agriculture remained a vital cultural and economic practice for many Orang Asli communities in Peninsular Malaysia. While government policies have promoted permanent agriculture, swiddening continues in remote areas due to its cultural importance and lack of alternatives (ibid.).

The decline of swidden agriculture among the Orang Asli in Peninsular Malaysia is deeply rooted in colonial policies and perceptions, as British foresters Strong (1932) and Wyatt-Smith (1958) outlined. These colonial critiques framed shifting cultivation as environmentally destructive, focusing on deforestation, soil degradation, and the loss of valuable timber. Government interventions during colonial rule, such as resettlement programs and regulated farming, aimed to control Indigenous land use, often disregarding the sustainability and cultural significance of swiddening for the Orang Asli. This colonial narrative shifted the blame for environmental degradation onto Indigenous communities while overlooking the larger impact of industrial logging driven by colonial economic interests.

Post-colonial government policies, such as the push for permanent agriculture under the Fourth Malaysia Plan, extended these colonial strategies by promoting rubber and coconut plantations to replace swiddening. Despite these efforts, many Orang Asli communities resisted these changes, maintaining swidden agriculture as a vital cultural and economic practice. The colonial and post-colonial approaches both reflect a paternalistic attitude toward Indigenous practices, focusing on reform rather than understanding. The decline of swidden agriculture is thus a product of both internal land pressures and external forces such as industrial logging and government interventions that failed to respect the cultural and ecological knowledge of the Orang Asli.

4.6.7. Semai Shifting Cultivation

In 1971, Dentan documented the Semai's reliance on swidden agriculture. The primary crops at the time included rice, maize, and tapioca, with rice being the preferred staple in most areas. Other crops, such as beans, sweet potatoes, and various vegetables, were intercropped in a highly diverse manner to minimize risks of crop failure and hunger. The Semai cultivated various plants in their fields as part of a deliberate strategy to maintain agricultural diversity, which they believed was essential for safeguarding against potential misfortune.

Fields were cultivated for one or two seasons before being left fallow, allowing natural regeneration, a hallmark of sustainability in their traditional practices. Clearing began with the selection of sites based on factors like soil appearance and vegetation type. Dentan emphasized that the Semai avoided rigid calendrical cycles, instead relying on natural indicators such as plant flowering and lunar phases to time agricultural activities. Rituals played a minor but present role, with practices like asperging rice with magical paste and planting specific cultivars to ensure the crop's fertility.

The actual planting involved digging holes with dibble sticks (*chotnot*) and sowing seeds, with men and women often collaborating to expedite the process. Intercropping was done strategically, with cereals occupying the central fields and other plants like millet, beans, and vines planted on the periphery to avoid competition. The Semai's focus on sustainability was evident in their preference for secondary forests, which allowed for easier clearing and less ecological disturbance compared to primary forests.

By 2016, Gomes noted significant changes in Semai agricultural practices, largely driven by socio-economic and cultural transformations over the intervening decades. While swidden agriculture remained a part of their livelihood, its importance had diminished due to increasing integration into the market economy and external pressures. One of the major shifts was the rise of commodity production, with some Semai adopting cash crops to participate in the regional economy. This transition led to a decline in traditional communal land-use systems as individual land ownership became more prevalent. The shortened fallow periods and intensified land use associated with these changes began to undermine the sustainability that characterized their earlier practices.

Gomes (2016) highlighted the erosion of traditional spiritual connections to agriculture, such as rituals performed to honor land spirits (*nyani kawul*) and the rice soul, which were central to the Semai's approach in Dentan's time. By 2016, these rituals had become less frequent or were entirely abandoned among many groups, coinciding with a decline in the collective respect for spiritual custodians of the land.

Additionally, Gomes observed the fragmentation of cooperative labor groups. Extended family networks, which once collaborated on clearing and planting large swiddens, were increasingly replaced by smaller nuclear family units focused on individual fields. This change not only affected agricultural efficiency but also disrupted the social fabric that underpinned traditional practices.

Despite these shifts, Gomes acknowledged that many Semai retained elements of their traditional knowledge and practices, demonstrating resilience and adaptability. However, the sustainability of their swidden agriculture was increasingly threatened by external pressures, including land commodification and deforestation driven by broader market demands.

Dentan's 1971 account captures a period when Semai swidden agriculture was deeply rooted in tradition, emphasizing sustainability and spiritual harmony. By 2016, Gomes's observations reflected a community navigating the complexities of modernization, with traditional practices adapting or fading in response to external economic and cultural forces. These changes highlight the dynamic interplay between tradition and transformation in the Semai's agricultural practices over the decades.

4.6.8. Limited Insights into Jah Hut Agricultural Practices

Despite the significant gap in research on Orang Asli agriculture, as noted by Rambo (1979) over four decades ago, the scarcity of academic work persists. While the Semelai, Temiar and Semai shifting cultivation has been studied reasonably well, the literature on Orang Asli Jah Hut is notably lacking. Jah Hut agriculture, specifically their practice of shifting cultivation, has only been briefly mentioned as late as 1983 (UNESCO, 1983). The only study with a substantial focus on Jah Hut agriculture is an unpublished master's thesis (Haji Mohd Isa, 1986) housed at the Orang Asli Library Headquarters in Gombak, Kuala Lumpur, Malaysia. Although JAKOA's (Department of Orang Asli Development in Malaysia) provides general information on the socioeconomic activities of the Jah Hut, no specific data is available on Jah Hut swiddeners or other Orang Asli sub-groups.

A rare insight into Jah Hut agriculture by Hanafi et al., (2009) and (Zaharah & Hanafi, 2009) provide valuable insights into the agronomic practices and biological traits of Malaysian upland rice. The first study highlights sustainable practices in two Jah Hut villages, Sungai Mai and Kiol, where intercropping, slash-and-burn, and minimal use of inputs such as NPK fertilizers are prevalent. Specific rice varieties, Liba Pasir (Sg Mai) and Siam (Kiol), demonstrate the adaptability of traditional farming systems in resource-constrained environments. Complementing this, the second study examines six upland rice landraces of the Jah Hut, including Bertih and Satang from Jerantut, Pahang. It reveals significant genotypic differences in root architecture between the two varieties. Together, these studies underscore the importance of understanding traditional practices and root traits to improve upland rice cultivation, though both lack exploration of broader socioeconomic and field-specific challenges.

Hanafi et al., (2009) based on observations of Sungai Mai and Kiol villages. This study offers valuable insights into the agronomic practices of Jah Hut communities in those villages, emphasizing sustainable, low-input methods such as intercropping and slash-and-burn. While it enriches the limited literature on Indigenous upland rice cultivation, it falls short in exploring socioeconomic factors, challenges faced by farmers, and broader policy implications. The lack of methodological transparency and absence of interdisciplinary analysis limits the depth and applicability of its findings.

A significant proportion of the remaining existing literature focuses on Jah Hut ethnobotany (Howell et al., 2010; Ong, Faezah, et al., 2012), folklore (Holiday et al., 2003), customs and cultural practices (Abdullah Sani, 2021; Md Adam & Yusop, 2020), and wood carving as well as artistic traditions (Couillard, 1979). Unfortunately, even this aspect of their heritage is fading, as wood carving has been reported as a dying art form within the community. In contrast, Jah Hut linguistics has been reasonably well-explored (Benjamin, 2012; Dunn et al., 2011; Matisoff, 1982; Diffloth, 1976). Therefore, there is a clear need for more comprehensive and focused research on their agriculture and efforts to preserve their cultural traditions.

4.6.9. Analysis: The Historical Trajectory of Orang Asli Agriculture

The historical development of Orang Asli agriculture encapsulates a dynamic interplay between ecological adaptation and socio-political pressures. The transition from foraging to horticulture among Orang Asli communities reveals a nuanced strategy for maintaining ecological balance. Shifting cultivation was not merely a subsistence technique but a sophisticated system that integrated ecological knowledge to regenerate resources and preserve biodiversity (Hutterer, 1983). By allowing secondary forests to recover during fallow periods, these systems sustained soil fertility and mitigated environmental degradation, offering a sustainable response to the fragile tropical ecosystem.

The disruptions to these traditional systems underscore the profound impact of colonial and post-colonial policies. As highlighted in the findings, these policies eroded access to traditional lands, leading to shortened fallow periods and over-cultivation. The introduction of cash crops, such as rubber, further disrupted the ecological balance. Rubber monoculture, while economically incentivized, introduced a dependency on external markets and reduced the diversity that previously safeguarded communities against crop failures and environmental risks (Hutterer, 1985).

Despite these challenges, the resilience of Orang Asli agricultural practices reflects their adaptability to changing circumstances. The adaptation of New World crops such as cassava and maize reflect their ability to integrate new resources into existing systems while preserving key elements of traditional ecological knowledge. This resilience highlights the dynamic nature of their systems, which continually evolve in response to ecological and socio-political pressures (Geertz, as cited in Hutterer, 1983). However, this adaptability also underscores the delicate balance between maintaining traditional systems and mitigating external influences. The persistence of shifting cultivation within Orang Asli communities highlights its ecological and cultural significance. While historically sustainable due to long fallow cycles, its viability today is increasingly debated, as shortened cycles, land pressures, and policy restrictions challenge its long-term sustainability in some tropical regions.

Historically, shifting cultivation has functioned as a sustainable agricultural system in many Orang Asli communities. However, its viability today varies, as factors such as forest degradation, land constraints, and changing economic priorities have led some groups, including the Semelai, to move away from swiddening where it is no longer practical. At the same time, shifting cultivation remains a battleground for socio-political contestation, reflecting broader struggles over land use and autonomy. This integrated perspective contextualizes the following exploration of Jah Hut agriculture and its position within this dynamic history, emphasizing its relevance to discussions of sustainability and resilience in subsequent chapters.

4.7. Conclusion

The evolution of agriculture in Southeast Asia, particularly among the Orang Asli, reflects a complex interplay of ecological, cultural, and socio-political factors. Traditional practices like shifting cultivation demonstrate a sophisticated understanding of sustainability and resource management, providing valuable lessons for contemporary ecological challenges. However, external pressures - colonial interventions, economic modernization, and land commodification

- have significantly disrupted these systems. While some Orang Asli communities have adapted to these changes, the persistence of traditional knowledge underscores its relevance for addressing modern sustainability concerns. This chapter emphasizes the importance of integrating traditional ecological knowledge with contemporary conservation and development efforts. Recognizing and preserving the cultural and environmental heritage of communities such as the Orang Asli is critical for fostering resilience in the face of ongoing ecological and social challenges.

Summary

Chapter 4 provides the historical and ecological context of Southeast Asian agriculture, highlighting sustainable practices such as shifting cultivation and the disruptions caused by colonial and modern interventions. This sets the stage for Chapter 5, which focuses on Jah Hut agriculture, illustrating how these broader themes - ecological knowledge, cultural integration, and external pressures - manifest uniquely within the Jah Hut community, offering a deeper understanding of their resilience and adaptation.

References

Abdullah Sani, N. E. (2021). Keunikan Majlis Berkhatan Dalam Masyarakat Orang Asli Suku Kaum Jah Hut Di Pahang (The Uniqueness of the Circumcision Ceremony in the Jah Hut Indigenous Community in Pahang). *Journal of Educational Research & Indigenous Studies*, *3*(1), 156–169. https://web.archive.org/web/20110102121050/https://tspace.library.utoronto.ca/bitstream/1807/7588/1/ms05023.pdf

Baer, A. S. (2014). Human History and the Orang Asli in Southeast Asia. In *Faculty Research Publications (Integrative Biology)*. Oregan State University Archive. https://ir.library.oregonstate.edu/concern/defaults/8336h325p?locale=en

Bellwood, P. (2004). The Origins and Dispersals of Agricultural Communities in Southeast Asia. In *Southeast Asia: From Prehisotry to History* (pp. 21–40).

Benjamin, G. (1985). In the Long Term: Three Themes in Malayan Cultural Ecology. In K. Hutterer, T. A. Rambo, & G. Lovelace (Eds.), *Cultural Values and Human Ecology in Southeast Asia* (pp. 219–278). University of Michigan Centre for Southeast Asian Studies. https://doi.org/10.3998/mpub.19463

Benjamin, G. (2012). *The Aslian languages of Malaysia and Thailand: an assessment*. *11*, 136–230. http://www.elpublishing.org

Benjamin, G. (2013). Why Have the Peninsular " Negritos " Remained Distinct? *Human Biology*, *85*(1–3), 445–484. https://doi.org/10.13110/humanbiology.85.1-3.0445

Bulbeck, D. (2016). The Neolithic Gap in the Southern Thai-Malay Peninsula and Its Implications for Orang Asli Prehistory. In *Malaysia's Original People* (pp. 123–152). NUS Press Singapore.
Cole, R. (1959a). Temiar Senoi Agriculture: A Note on Aboriginal Shifting Cultivation in Ulu Kelantan, Malaya (Part I). *Malayan Forester*, *4*, 191–271.
Cole, R. (1959b). Temiar Senoi Agriculture: A Note on Aboriginal Shifting Cultivation in Ulu Kelantan, Malaya (Part II). *Malayan Forester*, 260–271.
Couillard, M.-A. (1979). A Jah Hut Community and its Wood Carvings. In *wedwe*.
Dentan, R. K. (1971). Some Senoi Semai Planting Techniques. *Economic Botany*, *25*(2), 136–159. https://doi.org/https://doi.org/10.1007/BF02860075
Diffloth, G. (1976). Jah-Hut, An Austroasiatic Language of Malaysia. In *Southeast Asian linguistic studies* (Vol. 2, pp. 73–118). https://doi.org/10.15144/PL-C42.73
Dunn, M., Burenhult, N., Kruspe, N., Tufvesson, S., & Becker, N. (2011). Aslian linguistic prehistory. *Diachronica*, *28*(3), 291–323. https://doi.org/10.1075/dia.28.3.01dun
Ellen, R. (1994). Modes of Subsistence: Hunting and Gathering to Agriculture and Pastoralism. In T. Ingold (Ed.), *Companion Encyclopedia of Anthropology225* (p. 197). Routledge.
Fix, A. (2016). Malaysia's "Original People": Do They Represent a "Relict Population" Surviving from the Initial Dispersal of Modern HUmans from Africa? In *Malaysia's Original People* (pp. 101–122). NUS Press Singapore.
Fix, A. G. (1995). Malayan Paleosociology: Implications for Patterns of Genetic Variation among the Orang Asli. *American Anthropologist*, *97*(June), 313–323. https://www.jstor.org/stable/681964
Fix, A. G. (2008). Genes, Language, and Ethnic Groups: Reconstructing Orang Asli Prehistory. *Bulletin of the Indo-Pacific Prehistory Association*, *19*, 11–16. https://journals.lib.washington.edu/index.php/BIPPA/article/view/11716/10345
Gao, Y., Dong, G., Yang, X., & Chen, F. (2020). A review on the spread of prehistoric agriculture from southern China to mainland Southeast Asia. In *Science China Earth Sciences* (Vol. 63, Issue 5, pp. 615–625). Science in China Press. https://doi.org/10.1007/s11430-019-9552-5
Gianno, R., & Bayr, K. J. (2009). Semelai agricultural patterns: Toward an understanding of variation among Indigenous cultures in southern peninsular Malaysia. *Journal of Southeast Asian Studies*, *40*(1), 153–185. https://doi.org/10.1017/S0022463409000071
Gomes, A. G. (2016). Semai Ecological Epistemologies: Lessons for a Sustainable Future. In K. Endicott (Ed.), *Malaysia's Original People* (pp. 291–310). NUS Press Singapore.
Haji Mohd Isa, N. (1986). *Proses Pertanian Masyarakat Jah Het: Kajian Kes Di Kampung Sungai Kiul, Jerantut, Pahang (Agricultural Process of Jah Het Community: A Case Study in Sungai Kiul Village, Jerantut, Pahang)* [Unpublished Master's Thesis]. Universiti Kebangsaan Malaysia.
Hanafi, M. M., Hartinie, A., Shukor, J., & Mahmud, T. M. M. (2009). Upland Rice Varieties in Malaysia: Agronomic and Soil Physico-Chemical Characteristics. *Pertanika J. Trop. Agric. Sci*, *32*(2), 225–246. http://agrolink.
Harper, T. N. (1999). The End of Empire and the Making of Malaya. In *The End of Empire and the Making of Malaya*. Cambridge University Press. https://doi.org/10.1017/cbo9780511585517
Hashim, N. R. (2014). *Land Use History and Secondary Forest Creation in Negeri Sembilan (Late 19th - Early 21st Century)*. *2*(2), 80–95. https://web.archive.org/web/20180510183921id_/http://www.myjurnal.my/filebank/published_article/34859/7.pdf

Higham, C. (2013). Hunter-Gatherers in Southeast Asia: From Prehistory to the Present. Human Biology, 85(1–3), 21–44. https://doi.org/10.3378/027.085.0303

Hill, R. D. (1970). Peasant Rice Cultivation Systems with some Malaysian Examples. In J. Kostrowicki & W. Tyszkiewwicz (Eds.), *Geographica Polonica 19: Essays on Agricultural Typology and Land Utilization* (pp. 91–98). PWN Polish Scientific Publishers. http://rcin.org.pl

Holiday, D., Chin, W. P., & Teoh, B. S. (2003). *Batin Long bin Hok's BÉS HYANG DNÈY and other Jah Hut Stories*. Center for Orang Asli Concerns.

Howell, C. J., Schwabe, K. A., & Samah, A. H. A. (2010). Non-timber forest product dependence among the Jah Hut subgroup of Peninsular Malaysia's Orang Asli. *Environment, Development and Sustainability*, *12*(1), 1–18. https://doi.org/10.1007/s10668-008-9176-x

Hunt, C. O., & Rabett, R. J. (2014). Holocene landscape intervention and plant food production strategies in island and mainland Southeast Asia. *Journal of Archaeological Science*, *51*, 22–33. https://doi.org/10.1016/j.jas.2013.12.011

Hutterer, K. (1985). People and Nature in the Tropics: Remarks Concerning Ecological Relationships. In G. Lovelace & A. T. Rambo (Eds.), *Cultural Values and Human Ecology in Southeast Asia* (pp. 55–76). University of Michigan Centre for Southeast Asian Studies. https://doi.org/10.3998/mpub.19463

Hutterer, K. L. (1983). The Natural and Cultural History of Southeast Asian Agriculture: Ecological and Evolutionary Considerations. *Anthropos*, *78*, 169–212.

Matisoff, J. A. (1982). Aslian: Mon-Khmer of the Malay Peninsula. *Language*, *I*, 1–68. https://stedt.berkeley.edu/pdf/JAM/Matisoff_2003_Aslian.pdf

Md Adam, N. F., & Yusop, M. S. (2020). Sejarah, Adat dan Warisan Orang Asli Jahut di Pahang (History, Customs and Legacy of Orang Asli Jahut in Pahang). *Melayu: Jurnal Antarabangsa Dunia Melayu*, *13*(1), 83–108. https://doi.org/10.37052/jm.13(1)no4

Ong, H. C., Faezah, A. W., & Milow, P. (2012). Medicinal plants used by the Jah Hut Orang Asli at Kampung Pos Penderas, Pahang, Malaysia. *Studies on Ethno-Medicine*, *6*(1), 11–15. https://doi.org/10.1080/09735070.2012.11886414

Oxenham, M., & Buckley, H. R. (2015). The Population History of Mainland and Island Southeast Asia. In *The Routledge Handbook of Bioarchaeology in Southeast Asia and the Pacific Islands* (1st ed., pp. 1–20). https://www.researchgate.net/publication/288101179

Rambo, A. T. (1979). Human Ecology of the Orang Asli: A Review of Research on the Environment Relations of the Aborigines of Peninsular Malaysia. *Federation Museums Journal*, *24*, 41–74.

Rambo, A. T. (1984). Part III Integrative Case Studies. In *An Introduction to human ecology research on agricultural systems in Southeast Asia* (pp. 237–253). East-West Center. https://scholarspace.manoa.hawaii.edu/bitstream/10125/30618/3/IntroductionToHumanEcologyResearchOnAgriculturalSystemsInSoutheastAsiaPartIII1984%5Bpdfa%5D.PDF

Rambo, A. T. (1988). Chapter 18: People of the Forest. In Earl of Cranbrook (Ed.), *Key Environments: Malaysia* (pp. 273–288). Pergamon Press. https://doi.org/https://doi.org/10.1016/B978-0-08-028866-6.50024-6.

Roland, D. H. (1970). Peasant Rice Cultivation Systems with some Malaysian Example. In J. K. and W. Tyszkiewicz (Ed.), *Essays on Agricultural Typology and Land Utilization* (pp. 91–98). https://rcin.org.pl/dlibra/publication/13463/edition/4510

Sheil, D., & Wunder, S. (2002). The Value of Tropical Forest to Local Communities: Complications, Caveats, and Cautions. In *Ecology* (Vol. 6, Issue 2). https://www.jstor.org/stable/26271895?seq=1&cid=pdf-

Shoocongdej, R. (2001). Hoabinhian. In Encyclopedia of Prehistory: Volume 3: East Asia and Oceania (pp. 118–124). Springer.
Strong, T. A. (1932). The Sakai and Shifting Cultivation. *The Malayan Forester*, 243–246.
UNESCO. (1983). Swidden Cultivation in Asia - Content Analysis of the Existing Literature: A Stocktaking Exercise. In *Swidden Cultivation in Asia: Vol. 1,2,3*. UNESCO Regional Office for Education in Asia and the Pacific.
Williams-Hunt, P. D. R. (1952a). *An Introduction to the Malayan Aborigines* (1st ed.). Government Press: Kuala Lumpur.
Williams-Hunt, P. D. R. (1952b). Recent Archaeological Discoveries in Malaya, (1951). *Journal of the Malayan Branch of the Royal Asiatic Society*, *25*, 181–190. https://www.jstor.org/stable/41502945
Wyatt-Smith, J. (1958). Shifting Cultivation in Malaya. *Malayan Forester*, *3*, 139–154.
Zaharah, A. R., & Hanafi, M. M. (2009). Upland Rice Root Characteristics and Their Relationship to Nitrogen Uptake. *Pertanika J. Trop. Agric. Sci*, *32*(2), 261–266.

Chapter 5 : Jah Hut Traditional Agricultural Practices

5.1. Introduction

This chapter continues from Chapter 4, which explored the evolution of agriculture in Southeast Asia and the traditional agricultural practices of the Orang Asli. Within the Jah Hut community, various agricultural practices coexist, including oil palm and rubber cultivation, home gardens, and shifting cultivation. This chapter focuses specifically on shifting cultivation, where rice is the primary crop, complemented by Indigenous vegetables. Additionally, the role of home gardens in Jah Hut agricultural systems will be discussed briefly.

To capture the intricacies of Jah Hut shifting cultivation, this study employs a multi-method approach, including qualitative interviews, participant observation, and analysis of oral histories. Interviews with community elders and farmers provide insight into their lived experiences and the symbolic meanings embedded in their practices, while historical and ecological data offer a broader contextual understanding.

An in-depth account of the Jah Hut's shifting cultivation system is presented, covering its spiritual foundations, land management techniques, and the gendered division of labor. The chapter also examines the challenges the community faces, including the impact of modernity, climate change, and shifting cultural values, and how these factors influence their traditional practices. By exploring these aspects, the chapter highlights the resilience and adaptability of Jah Hut agriculture, positioning it as a vital part of their cultural heritage and a sustainable way of life.

5.2. Jah Hut Settlements: Land Use, Access and Tenure

Jah Hut settlements vary in size and land allocation, balancing agricultural activities with reliance on forest resources. Berdut Village covers 2,000 acres, of which 600 acres are dedicated to agriculture, including rubber, oil palm, and agroforestry. The remaining land consists of secondary growth forests (*belukar*) and areas within the Krau Wildlife Reserve. Sungai Mai Village spans 1,060 acres, the majority of which is gazetted as an Orang Asli reserve. Of this, 400 acres are cultivated with oil palm and rubber, while shifting cultivation and foraging in belukar remain essential subsistence activities. Pasu Village occupies 497 hectares (1,228 acres) of gazetted land, where rubber, oil palm, and shifting cultivation are practiced.

Historically, shifting cultivation (primarily hill rice and mixed cropping of local Indigenous vegetables) was the dominant agricultural practice among the Jah Hut. Over time, government incentives and market integration have driven a transition toward cash crop cultivation, particularly rubber and oil palm. Despite this shift, secondary-growth forests remain crucial for subsistence activities, including foraging, mixed cropping, and supplemental farming. These forests continue to provide essential resources, ensuring that traditional agricultural knowledge persists alongside modern farming influences.

Jah Hut land tenure operates within a dual system of gazetted Orang Asli reserve land and customary land, each with distinct implications. Seventy-two percent (72.8%) of their land is officially gazetted, offering some degree of legal security for agriculture and foraging. However, 27.2% of their land remains unrecognized, making it vulnerable to encroachment and state acquisition. The lack of legal recognition restricts access to institutional support for resource management and agricultural development, limiting long-term security for traditional livelihoods.

The Jah Hut community depends heavily on secondary-growth forests, which account for 78.6% of their resource access. These forests are essential for foraging, shifting cultivation, and mixed cropping, serving as a primary subsistence base. In contrast, primary forest usage is limited (21.4%), reflecting both its inaccessibility and the community's preference for secondary forests as a more practical and ecologically valuable resource.

5.3. Classifying the Jah Hut Traditional Agricultural System

The Jah Hut's agricultural system can be interpreted as a hybrid of shifting cultivation and Indigenous agroforestry, encompassing elements of both practices. This characterization is described in Table 5.1.

Shifting Cultivation Characteristics	Indigenous Agroforestry Characteristics
Rotational Cropping	**Biodiversity and Intercropping**
The Jah Hut rely on shifting cultivation principles, such as rotational cropping and fallow periods, to restore soil fertility. They move to new plots after two rice cycles, consistent with traditional swidden practices. This approach helps manage soil depletion and aligns with shifting cultivation methods of land use.	The Jah Hut system incorporates diverse species, including rice, corn, Indigenous vegetables, and long-term crops such as bananas, durian, and rubber trees. This multi-layered planting mimics natural forest structures, a defining feature of agroforestry.
Clearing and Burning	**Perennial Integration**
The system involves controlled burning of vegetation to fertilize the soil, a hallmark of shifting cultivation. Clearing land with minimal mechanization also reflects traditional swidden methods.	Planting border crops and integrating perennials such as oil palm and rubber trees demonstrates the agroforestry principle of combining short-term and long-term crops for sustainable land use.
Short-Term Crop Focus	**Cultural Integration**
The emphasis on hill rice and fast-growing crops such as corn and vegetables in rotation mirrors the staple-focused nature of shifting cultivation.	Rituals, spiritual practices, and respect for natural features (e.g., mounds) align with Indigenous agroforestry's holistic approach, embedding agriculture within ecological and cultural contexts.

TABLE 5.1: CHARACTERIZATION OF JAH HUT TRADITIONAL AGRICULTURAL SYSTEM

The classification of the Jah Hut system as a hybrid of shifting cultivation and Indigenous agroforestry stems from the overlap in practices, its transition under pressure, and the system's dynamic nature. Shifting cultivation is typically characterized by its transient nature, focusing on short-term crop cycles and land rotation, while Indigenous agroforestry emphasizes the integration of trees and long-term crops for ecological sustainability. The Jah Hut system combines these traits by rotating land for short-term crops while maintaining perennial plants on the edges of farms and in fallow plots, blending the characteristics of both systems.

External pressures such as land scarcity, market demands for cash crops, and climate variability are influencing the Jah Hut system, pushing it toward a more permanent, agroforestry-like structure in some areas. This transition is evident in the integration of perennial crops such as rubber and oil palm, signaling a shift from traditional shifting cultivation to managed agroforestry. These adaptations reflect the community's response to external challenges while maintaining elements of traditional practices.

The dynamic nature of the Jah Hut system further supports its hybrid classification. Its ability to combine rotational cropping with tree-based practices highlights a continuum rather than a strict dichotomy between shifting cultivation and agroforestry. While it operates as shifting cultivation in active plots, it simultaneously aligns with agroforestry principles through its management of fallow land and perennial crops over time. This flexibility ensures its resilience and adaptability in changing ecological and socio-economic contexts.

5.4. The Jah Hut Shifting Cultivation System

5.4.1. Planting Calendar and Seasonal Activities

The Jah Hut shifting cultivation calendar and rituals are tied to specific agricultural seasons and moon phases, as shown in Table 18. The typical planting season for the Jah Hut community usually spans from June to September. However, in 2022, due to irregular weather patterns, the planting season was delayed until October, which is considered late for planting. Traditionally, heavier rice varieties that require a longer growing period are planted first in June.

Month	Activity	Gender
February	*Menebas* (clearing undergrowth/brush)	Men
	Menebang (felling trees)	
March - April	Logs are left to dry to aid burning at a later date	
May	*Memerun* (clearing and piling up the logs and other debris in preparation for burning)	
	Bakar (Controlled burning of logs and debris)	
June	*Merumput* (weeding is a continuous activity from the time the land is cleared till the paddy is knee high)	Women
	Planting of corn and Indigenous vegetables	
September	*Menugal* (dibbling)	Men
	Pepel (sowing)	Women
	Merumput (weeding)	
January - February	*Tuai* (harvest)	
February	Transporting harvest home	Male
	Post-harvest processing	Female
February (second planting season)	Land is cleared again (removal of undergrowth)	Male

TABLE 5.2: JAH HUT PLANTING CALENDAR AND GENDER-BASED AGRICULTURAL ROLES

In recent years, weather changes have significantly impacted planting patterns. For 2022, the key activities started in October, with the harvest (*tuai*) expected to take place in February 2023, depending on the rice variety. Typically, planting would have occurred in September, but the unpredictable weather led to delays. This situation was further complicated by a shortage of seed stock in Berdut, preventing many farmers from planting rice. As a result, they now need to rebuild their seed reserves by engaging in multiple cycles of planting, even if it means consuming less rice in the interim to ensure a sufficient seed supply for future planting seasons.

Looking more closely at the Jah Hut planting calendar, agricultural activities follow a detailed gender-segregated schedule. For instance, in February, men take on roles such as *menebas* (clearing undergrowth/brush) and *menebang* (felling trees), while March and April are dedicated to allowing the felled logs to dry in preparation for controlled burning (*bakar*) in May, both also performed by men. In June, weeding (*merumput*) becomes a continuous task performed primarily by women, who also plant corn and Indigenous vegetables.

By September, men resume *menugal* (dibbling), and women continue with *pepel* (sowing) and *merumput* (weeding), emphasizing a gendered division of labor. January and February mark the harvest period (*tuai*), primarily handled by women. Once the harvest is complete, men are responsible for transporting it home, while women take on post-harvest processing duties. The year concludes with land clearing for the second planting season. This cyclical and gender-segregated pattern of activities highlights the complex and collaborative nature of the Jah Hut community's agricultural practices, which are now facing new challenges due to shifting weather conditions and seed stock shortages.

5.4.2. Farm Characteristics

The farms in this study exhibit varied topography, with almost flat terrain more common in Pasu and Sungai Mai, whereas Berdut (Figure 5.2) tends to have moderate to steep slopes.

FIGURE 5.1: TOPOGRAPHY OF BERDUT, 21 JULY 2022 - A SLOPED LANDSCAPE WITH CLEARED LAND FOR SHIFTING CULTIVATION, SURROUNDED BY SECONDARY FOREST, SCATTERED LOGS AND A TEMPORARY HUT

Shelters are traditionally built on stilts using timber and *atap* (roof made of palm leaf material) and serve as resting places for the farmers who own the plots (Figure 5.3). These shelters typically are close to water sources from nearby streams or wells, as rainwater is not collected for use. Local vegetables are planted close to the shelters for immediate consumption. Wells are dug on rice farms for consumption, not for irrigation. Rainwater harvesting is not practiced, neither for agriculture nor drinking, as rainwater is considered unclean - particularly due to concerns over cloud seeding chemicals.

FIGURE 5.2: TEMPORARY SHELTERS (PONDOK) BUILT ON FARM PLOTS (BERDUT; 29 JULY 2022)

As noted by Altieri (1995), Indigenous communities tend to locate their farms contiguous to each other, yet they leave room for future expansion in specific directions. This is also the case for Jah Hut traditional farmers. Farmers explained that isolated farms tend to attract and become the focus of pests in the area. To mitigate this risk, plots are clustered together, allowing pest pressure to be distributed among multiple farmers. This grouping also influences whether a village decides to begin planting or refrain from doing so. If others are starting a rice plot during a given season, additional farmers will join to collectively reduce pest threats. Conversely, in some cases, farmers intentionally use small, isolated plots to minimize pest problems. Vegetables are strategically planted near the shelters to minimize pest invasions and facilitate easier pest management.

An unusual feature of farms in Berdut is the presence of *busut* or mounds (Figure 5.4), which are naturally occurring and hold cultural significance. These mounds are never levelled, as they may serve as resting spots for the *penunggu* (mound spirits) and are considered ancient natural components of the landscape. While houses cannot be built on these mounds, paddy may be planted.

FIGURE 5.3: MOUNDS ARE A COMMON FEATURE IN A JAH HUT SHIFTING CULTIVATION PLOT (BERDUT; 28 JULY 2022)

5.4.3. Access to Farms

The farms are located in secondary forests surrounding the village and are accessed by dirt roads (Figure 5.5), either on foot or by motorbike. In earlier times (up till the 1980s), families would live directly on the swidden plots, eliminating the need for travel and allowing them to keep a close watch over their crops. However, as the community has shifted to more sedentary living in villages (*kampung*), women often walk or are transported by motorbike to the fields, usually on narrow earth trails.

FIGURE 5.4: A DIRT ROAD IN BERDUT PROVIDES ACCESS TO FARMS (25 JULY 2022)

5.4.4. Work Hours

The community works every day to ensure sufficient food for their families, with the only exceptions being heavy rain (which prevents rubber tapping), major events such as death, marriage, and *kenduri arwah* (ceremonies for the deceased), or rare festivals. Daily activities vary according to the season. For example, fishing methods such as *menanguk, mengail, menjaring,* and *menjala* are practiced during appropriate times of the year.

5.4.5. Spiritual Foundations of Jah Hut hill Rice Cultivation

Rice cultivation is central to Jah Hut society, representing their spiritual, cultural, and ecological identity. Beyond its role as sustenance, rice symbolizes a connection to ancestors, the divine, and the natural world. This section briefly explores its sacred origins, spiritual significance, and associated rituals.

5.4.5.1. The Origin of Rice: A Sacred Narrative

The Jah Hut origin story of hill rice (*bak* in Jah Hut or *padi bukit* in Malay) is a sacred narrative passed down for generations, particularly preserved in Berdut village. According to this oral history, in the earliest days, Adam and Hawa's (Eve's) children lived without hunger in a paradisiacal world. However, Hawa longed to bear a child through natural means. Despite divine warnings of pain and hardship, she insisted and gave birth to the first human child. As the child grew hungry, Adam sought divine guidance. God instructed him to sacrifice the child, scattering its remains across the land and sea. From its flesh and bones, staple crops such as rice, tubers, and corn emerged, while fragments adhered to wood, transforming into squirrels, and others cast into the sea became fish. Heartbroken, Hawa nurtured the first rice shoots with her milk, imbuing rice with humanity's essence. This act established rice as sacred, with deep reverence in Jah Hut culture. Due to this sacred origin, food holds profound spiritual significance. It is a major taboo (*cerlan*) to sing or play music while cooking or eating, as all food is linked to the first human sacrifice. Such actions are believed to be a form of mockery or disrespect upon the ultimate sacrifice that gave rise to sustenance. Rice is believed to have a soul (*roh*), and consuming it transfers its *semangat padi* (spirit), offering nourishment and healing (Djunatan, 2024).

5.4.5.2. Universal Themes of Sacrifice and Spirituality

The Jah Hut origin story aligns with agrarian myths worldwide, where sacrifice leads to the emergence of staple crops. In Sumba's *Biri Koni* story, the body of a girl transforms into maize, rice, and cassava, signifying the origins of agriculture (Fowler, 2005). Similarly, in Balinese and Sundanese traditions, deities or sacred figures become rice, reinforcing the idea of sustenance through sacrifice (Djunatan, 2024; Sunarti et al., 2022). Contreras (2024) highlights how this theme is prevalent in Mesoamerican traditions, where staple crops like maize are viewed as divine offerings, reflecting a universal belief in agricultural sacrifice.

Rice is revered as a spiritual entity in multiple cultures. Among the Orang Asli, the *semangat padi* (rice spirit) is believed to require care and ritual attention, a concept also observed in post-colonial studies of Orang Asli agriculture (Hill, 1970). In Sundanese culture, rice is personified through the Paddy Goddess, symbolizing fertility and life (Djunatan, 2024). Similarly, in Nepal's Kailash Sacred Landscape, heirloom grains play a pivotal role in rituals affirming human-nature relationships (Castagnetti et al., 2021). These parallels reinforce the perception of staple crops as divine gifts requiring ritual care (Contreras, 2022).

5.4.5.3. The Role of the *Pawang Padi*

The *pawang padi* (agricultural shaman) plays a central role in Jah Hut hill rice cultivation, overseeing rituals, maintaining spiritual harmony, and guiding farming practices. They communicate with spirits, interact with the *semangat padi*, and influence local weather conditions. From planting to harvest, their knowledge - passed down for generations - forms the foundation of Jah Hut hill rice cultivation. However, this role is declining, as younger generations increasingly favor cash crops and urban jobs over traditional practices. In Berdut, only four *pawang padi* remain, with even fewer in Sungai Mai and none left in Pasu. Elders lament that the younger generation lacks interest in continuing the tradition, as it requires dedication and patience, unlike the immediate financial gains offered by commercial agriculture. The decline of the *pawang padi* threatens the continuity of Jah Hut spiritual agricultural practices, reflecting a broader cultural shift away from traditional ecological knowledge.

5.4.6. Family Traditions and the Decision to Cultivate Rice

In the Jah Hut tradition, the decision to cultivate rice is always made by the couple to provide for their family. Every parent, when their child gets married, will tell them: *"Kamu dah kahwin, kamu kena buka tanah, tanam ubi, tanam keledek, tanam apa sahaja untuk makanan kamu dan keluarga. Maknanya, kita yang baru kahwin ni kena ikutlah. Kena ikut warisanlah*" meaning "Now that you're married, you must cultivate the land, plant yams, plant sweet potatoes, and grow whatever is needed to feed yourself and your family. This means that newlyweds are expected to follow this tradition, continuing the legacy passed down through generations". Both husband and wife must agree, as they have distinct roles in the farming system. If one is unwilling, the effort will not succeed. While this tradition still exists in Berdut, in other villages such as Sungai Mai and Pasu, farming partnerships extend to sisters, aunts and nieces, mothers and sons, and other family members. Therefore, the previously husband-wife only endeavor has changed to accommodate current realities.

5.4.7. New *Ladang*[41] Selection

Sites for a new *ladang* or *tek cerang* (swidden/ shifting cultivation farm) are selected from old fallow plots (*belukar*[42]) in various stages of regrowth. Since the introduction of rubber by JAKOA (formerly JHEOA) in the 1960s, these cash crops have been consistently integrated into new *ladang* sites, alongside rice and other vegetable crops, continuing the agroforestry tradition. As a result, fallow plots are not left idle (contrary to historical practices); instead, they are populated with productive rubber trees and remnants of previous vegetable, fruit, and tuber crops. However, over time, these crops are overtaken by wild species, which compete for nutrients, causing the vegetables to gradually diminish.

Table 5.3 outlines the Jah Hut's categorization of *belukar*. Historically, Jah Hut ancestors cleared pockets (between three and five acres) of virgin forests (*brek lepas*) for cultivation, but this practice has ceased due to the establishment of Protected Areas (PA) by PERHILITAN, which limits virgin forest access.

Categories of potential farming plots	Characteristics
Brek Lepas	Virgin forest
Helai Lakik/Belukar Lama	Secondary forest/ old fallow plot (More than 7 years old)
Helai / Belukar	Intermediate fallow plot (under 7 years old)
Repuh	Young *belukar* that grows immediately after a harvest (under a year old)

TABLE 5.3: JAH HUT CHARACTERIZATION OF SECONDARY GROWTH

According to the elders of Berdut, before clearing a *helai lama*, permission must first be sought from the supernatural beings believed to occupy the land after the long fallow period. This ritual, known as *berbahasa* (communicating with the supernatural), involves felling exactly seven trees from the intended plot and waiting for three days. During this time, the community

[41] The terms "*ladang*," "swidden plot," and "shifting cultivation plot" are used interchangeably throughout this chapter to refer to areas cleared for temporary cultivation before being left to regenerate.
[42] *Belukar* are considered a component of Indigenous agroforestry systems.

looks for signs of objections from the beings in the form of a bad omen communicated through dreams. If no such signs occur, it is considered safe to proceed with the land clearing. This practice appears to be unique to the Jah Hut community. Cole (1959) recounts that the Temiar people rely on their headman for guidance during the land selection.

Another important factor for consideration in site selection is the careful evaluation of soil condition. Farmers assess whether the soil is *kering* (dry) or *basah* (wet) to determine its suitability for planting. Interestingly, *hutan dara* (virgin or primary forest) may not always present the most fertile option, as it can contain clay or dry soil, making cultivation difficult. The ideal soil for hill rice cultivation is a black, moist mix of clay and sand. Areas with excessive roots, known as *mabuk akar*, are considered infertile and unsuitable for farming. To ensure fertile ground, the community typically prefers using *helai* that have been left for at least three years.

Figure 5. outlines the traditional agricultural process of the Jah Hut people, beginning with plot selection, rituals, and land clearing. The process progresses through the cultivation of crops such as hill rice, corn, and Indigenous vegetables, alongside the planting and harvesting of rubber and oil palm. The plot is left to fallow after productive use, with continuous clearing and maintenance throughout. This process is explained in further detail in the following sections.

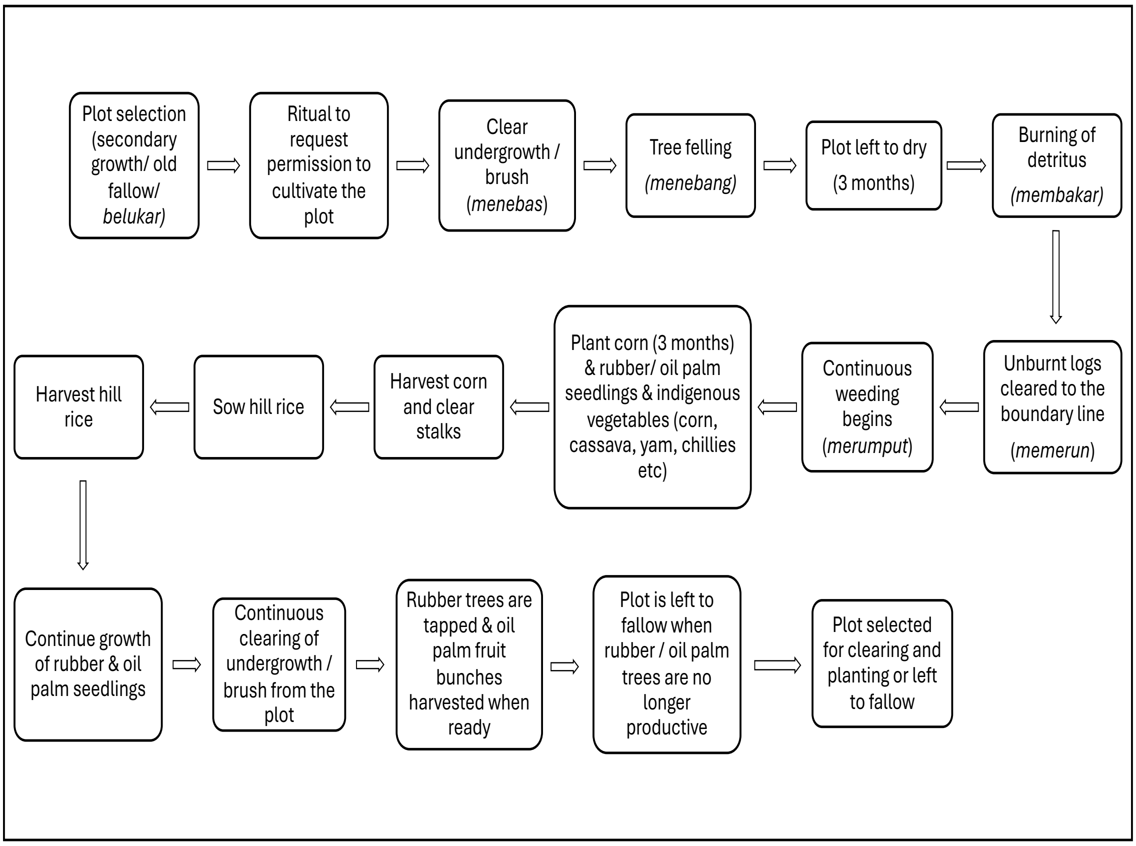

FIGURE 5.5: JAH HUT SHIFTING CULTIVATION CYCLE

5.4.8. Site Preparation for a New *Ladang*

In the past, farming plots were typically around five acres (approximately 0.02 km^2) and were located within a contiguous community farming zone, although the overall settlement was expansive. However, due to the labor-intensive nature of land clearing and the lack of heavy machinery, the average plot size today has decreased to one to three acres (0.004 to 0.012km^2).

The process of clearing a *belukar* for new farms follows several key steps. First is *menebas*, or clearing the undergrowth. Herbicides or weed killers may be used to simplify this task. Next, the process of *menebang* (felling trees) begins. Afterward, the felled wood is left to dry for three months; this process requires dry weather, and in the past, *pawangs* mediate to perform rituals to control the climate. Once dry, the next step is *membakar* (controlled burning), which is carefully managed by a *pawang* to ensure that the fire remains within the plot's perimeter. This controlled burn also helps to render the soil fertile. After burning, the remaining unburnt logs are moved manually to the plot's edges in a process called *memerun* (Figure 5.7). These large logs are too heavy to be entirely removed from the plot, and mechanization is not used due to access limitations. Additionally, heavy machinery is avoided as it compacts the soil, reducing its arability. While the initial clearing removes most weeds, *merumput* (manual weeding) remains necessary until the plot is fully planted. This ongoing task, exclusively carried out by women using a small machete (Figure 5.8 and Figure 5.9), ensure that weeds do not regrow and compete with crops. An example of a cleared plot is shown in Figure 5.10.

The tasks of *menebas, menebang,* and *memerun* are undertaken by the men, which is why couples must agree to plant rice together - it is a collaborative effort that cannot be completed by one person alone. Preparing the land for planting typically takes at least six months. Land clearing according to the Jah Hut traditional system requires minimal mechanization. The only modern tool used is the petrol-fueled chainsaw for felling trees. This practice is relatively new; previous generations relied on a traditional tool called the *beliung* (Figure 5.11), a kind of stone axe, possibly a relic of ancient times. Using the *beliung* required a specific technique no longer practiced in favor of the more efficient petrol-powered chainsaw. Weed killers and herbicides remove unwanted plants during the weeding phase, including wild banana stems. However, no pesticides are used in the process.

Land clearing for rice cultivation is a communal effort, requiring assistance from the entire village to complete the task. Clearing land is highly labor-intensive, and among older cultivators, although a *belukar* lama plot may measure around three acres, less than one acre is typically cleared for planting. Over time, the size of cleared plots has been scaled down to match the physical capacity of the farmers. During weeding of the new plot Jah Hut women farmers leave out selected edible weeds (such as wild spinach), providing food during the crop season. This practice has also been noted in other Indigenous communities such as in the Tarahumara (Altieri, 1995).

FIGURE 5.6: LARGE TRUNKS ARE BURNT, ENHANCING SOIL FERTILITY IN THE PLOT (BERDUT; 29 JULY 2022)

FIGURE 5.7: A PLOT HAS BEEN CLEARED FOR PLANTING, AND A JAH HUT FARMER MANUALLY WEEDS THE PLOT (BERDUT; 29 JULY 2022)

FIGURE 5.8: A SMALL MACHETE USED BY JAH HUT WOMEN FOR MANUAL WEEDING (BERDUT; 28 JULY 2022)

FIGURE 5.9: PANORAMIC VIEW OF A CLEARED SHIFTING CULTIVATION PLOT (BERDUT; 28 JULY 2022)

FIGURE 5.10: ANCIENT STONE AXE (OR BELIUNG), A RELIC PRECIOUSLY KEPT BY A PAWANG PADI IN SUNGAI MAI. IT WAS LIKELY USED BY JAH HUT ANCESTORS TO CLEAR THE FOREST FOR SHIFTING CULTIVATION

5.4.9. The Planting of Indigenous Vegetables

After clearing the land, the cultivators begin planting *tanaman kontan* (short-term food crops) and *tanaman kekal* (perennials) before planting begins. An elder in the community explains that this approach is deeply rooted in tradition, stating, "*Kerana mudah tumbuh dan cepat ada isi. Dan dah termaktublah, dah tertulis, kami kena buat macam ni, macam ni. Disamping itu pula kalau ada daging, bolehlah dimasak sama-sama, dengan rempah-rempah untuk melazatkan makanan. Tak semestinya makan ubi sahaja. Ianya makanan seimbang*." meaning "The vegetables are easy to grow and quick to harvest. It has been established by our elders that we must do it this way. These crops ensure a balanced diet, often cooked with available meats and spices, preventing a monotonous diet of only cassava". The Jah Hut practice of double crop system of maize/weeds/ other vegetables and hill rice has also been noted in other Indigenous communities (Altieri, 1995).

The method of sowing is straightforward, where seeds are scattered by hand over the plot. Due to the richness of the soil, these seeds take root and grow without the need for fertilizers. Corn (Indigenous) is typically planted first (Figure 5.12) after the land is cleared, taking about three months to grow. Along with corn, in other sections of the plot, vegetables such as chilies, long beans, pumpkins, and okra, are grown from seeds stored from the previous harvest (Figure 5.13). This system of reusing seeds, particularly heirloom varieties, helps preserve the biodiversity of the crops. Hill rice (*Oryza sativa*), Indigenous corn (*Zea mays*), several varieties of roots (typically sweet potatoes, *Ipomea batatas*), tubers (cassava/tapioca, *Manihot esculenta*), local bird peppers (*lada kampung*, *Capsicum spp.*), yard-long beans (*Vigna unguiculata*) local bottle gourd (*Lagenaria siceraria*), amaranth (maman hijau, *Amaranthus spp.*) and several varieties of eggplant (*Solanum spp.*) are also propagated from seeds stored in a *belukar* or from the previous harvest (Figure 5.14 and Figure 5.15). Local cassava varieties such as *ubi puyu, kabu, lulon,* and *kiaiteng*[43] are often referred to as *makanan daif* (poor man's food), yet they serve as an essential food source, especially during difficult times.

[43] The local sweet potato varieties - *ubi Puyu, Kabu, Lulon,* and *Kiaiteng* (and many other Jah Hut Indigenous vegetables discussed here) - do not appear to be widely documented in scientific literature or formal taxonomic records. However, further verification is needed to determine whether they have been identified under different names or classified in botanical studies

FIGURE 5.11: MAIZE IS PLANTED FIRST AFTER THE LAND IS CLEARED (BERDUT; 1 AUGUST 2022)

FIGURE 5.12: DRIED MAIZE COBS ARE HUNG TO PRESERVE SEEDS FOR THE NEXT PLANTING SEASON (BERDUT; 28 JULY 2022)

FIGURE 5.13: LOCAL BRINJAL (L) AND CHILLIES (R) ARE CORE VEGETABLES PLANTED ALONGSIDE MAIZE (BERDUT; 28 JULY 2022)

FIGURE 5.14: LOCAL BOTTLE GOURD (L) (SG MAI; 23 SEPTEMBER 2022) AND LOCAL GREEN SPINACH (BERDUT; 21 JULY 2022)

Hill rice, a staple, has limitations, as its seeds are only viable for about 18 months. The Jah Hut community practices annual cropping, where rice and maize are planted in cycles, ensuring food security. Oil palm (Figure 5.16) and rubber[44] (Figure 5.17) seedlings are often planted alongside these crops at the start of the planting season, and border crops such as areca, betel leaves, durian, rambutan, and bananas mark the farm boundaries.

FIGURE 5.15: MIXED CROPPING OF INDIGENOUS VEGETABLES WITH OIL PALM SEEDLINGS (BERDUT; 28 JULY 2022)

FIGURE 5.16: IN ANOTHER PLOT IN BERDUT, RUBBER SEEDLING IS PLANTED FIRST. TRADITIONAL CROPS WILL BE INTRODUCED SUBSEQUENTLY. (BERDUT; 21 JULY 2022)

The Jah Hut do not practice crop rotation but rely heavily on intercropping, except maize. Once maize is harvested, its stalks are destroyed to prepare the land for paddy planting. The typical planting order follows a cycle: maize and vegetables are planted alongside rubber or oil palm seedlings, followed by rice, and eventually, the continued growth of rubber or oil palm dominates the plot. Swidden vegetables are harvested on an as-needed basis. One farmer explained, "*Kita ambil sikit-sikit untuk kegunaan seharian. Tapi cukup untuk setahun. Sebab tahun kedua, kita pusing balik (tanam semula). Ikut pada haiwan liar juga. Babi suka makan ubi. Kalau banyak babi, habislah. Makanan yang terakhir ditanam selepas padi adalah*

[44] According to the elders interviewed, the integration of oil palm and rubber planting alongside other crops in their shifting cultivation plots began only a generation ago, initiated by their parents as a strategy to enhance their livelihoods. Subsequently, in the case of Berdut, which is situated within a Protected Area (PA), this practice evolved into a regulation mandated by PERHILITAN to ensure continuous forest cover, as required within the PA.

keledek. Di tanam dicelah-celah padi. Bila belukar naik, keledek masih ada lagi. Pisang juga begitu. Ubi dan keledek tumbuh sepanjang tahun." meaning "We harvest a little for daily use, but the supply from the farm is sufficient for a year. Because in the following year, we will replant. It also depends on pests. Wild animals, particularly wild boars, can pose a threat to crops, especially root vegetables. Wild boars prefer them. If there is a huge number of wild boars, we lose our crops to them. The last crop to be planted is sweet potatoes. They are planted between the growing rice plants. Even after harvesting and with the undergrowth taking over, the sweet potatoes and cassava still thrive. It is the same for bananas too. These crops grow all year". It is common for small bands of womenfolk to forage for sweet potatoes in a former plot (*belukar*), as shown in Figure 5.18.

FIGURE 5.17: JAH HUT WOMEN FORAGING FOR SWEET POTATOES IN A BELUKAR (FALLOW PLOT) (BERDUT; 28 JULY 2022)

The last crop planted after rice is typically sweet potato, which grows interspersed with the rice. Even when the undergrowth begins to take over the plot, the sweet potatoes remain. Bananas, cassava, and sweet potatoes are essential crops that grow throughout the year, ensuring a consistent food supply. Another farmer emphasized the self-sufficiency of the farm, explaining, *"Cukuplah, kalau ada kebun.Tak perlu beli dah. Sayur ini berhasil sepanjang tahun. Melainkan kalau nak merasa sayur lain. Kalau macam betik, dah tak perlu tanam. Kalau dah buka tanah baru (bersih), ia akan tumbuh sendiri. Kerana dah berperingkat-peringkat, dah berkali-kali buka. Cili pun boleh tumbuh semula tanpa perlu ditanam. Bila dah* *tumbuh tu, kita jagalah tanaman tu, supaya tak dibuang."* meaning "It's enough, if you have a farm. You don't need to buy vegetables. The vegetables flourish all year round. Unless you want to taste other vegetables (not grown in the farm). If it's like papaya, you don't need to plant it. If you clear new land, it will grow by itself. Because it has been grown multiple times, and in many stages. Likewise, chilies also self-propagate. When they grow, we take care of the plant so that it is not destroyed when clearing the land."

The importance of root crops to the Jah Hut is underscored by a farmer from Pasu, who described the hardships of the 1970s, stating, "It was tough in those days. Roots (such as cassava[45]) and tubers (local sweet potato varieties) have always been very important to us. These crops were the go-to source of sustenance, mainly before rice was harvested. In the past, families also relied on foraging for bananas and edible ferns, as market access was limited. Today, with closer access to shops, rice can be bought for RM20-30, reducing the reliance on self-cultivated rice, though whether individuals continue planting rice is often a matter of personal interest.

With regard to land ownership, unlike the Temiar (Cole, 1959a), who have a more communal approach to farm plots, a Jah Hut farmer acquires full rights to the produce and plots, even after the rice harvest. The rights to the produce extend beyond the initial harvest, affirming the strong connection the Jah Hut have with their land and the crops they grow.

5.5. Jah Hut Hill Rice Cultivation

5.5.1. Processes in the Pre-Planting and Planting Phases

Before sowing rice seeds, a ritual is performed to cast a spell over the tools, particularly the dibbler or dibble stick (*bedak*), and the 'mother rice' (*ibu padi*) that will be sown. This ritual is conducted by the *pawang padi* (rice shaman) the day before the actual sowing. The purpose is to invoke blessings and protection over the tools and seeds, ensuring a bountiful and successful harvest.

[45] Cole (1959) notes in his study of the Temiar that the Temiar's acquisition of cassava as a crop is unknown. But since cassava is a native of South America, it was probably introduced via the Malays by European traders of the 18th century. The Temiar were the first millet planters; rice came later.

On the day of the sowing, the *pawang padi* begins the rituals before dawn. He erects a pole at a carefully chosen spot and places bags of rice seeds from the previous year's harvest (Figure 5.19). These *ibu padi* (mother seeds) are significant, as they will be completely sown in the current plot. This ritual is an essential part of the process, marking the connection between past and present harvests.

FIGURE 5.18: SACRED SPOT FOR THE RITUAL BEFORE SOWING OF THE MOTHER SEEDS (BERDUT; 21 AUGUST 2022)

The sowing of rice follows a traditional method. The type of rice selected must be *serasi* (compatible) with the owner (head of household) of the plot, ensuring a harmonious and prosperous crop. The process involves two essential tasks: *menugal* and *pepel*. *Menugal*, which consists in making two-inch-deep holes with a *bedak* (dibble stick), about 9 to 10 inches apart in the ground for planting, is carried out by the men using wooden poles with pointed ends (Figure 5.20). The men lead the way, creating the holes needed for the seeds.

Following behind, the women sow the seeds (*pepel)*, carefully placing about five grains of rice seeds into each hole. The seeded holes are left uncovered (Figure 5.21). This division of labor - men creating the holes and women sowing the seeds - has been part of the traditional practice for generations, and everyone joins in without needing to be asked, as it is deeply ingrained in the community's culture.

The rice is grown using a rain-fed system, with no irrigation. However, too much rain after sowing can wash away the seeds, posing a risk to the crop. Sowing a plot of around three acres usually takes the entire morning (between three to four hours), with the work starting at dawn. The goal is to complete the sowing before noon, as the midday sun becomes too intense to work in comfortably.

FIGURE 5.19: JAH HUT MENFOLK IN PASU MAKING HOLES IN THE GROUND WITH DIBBLE STICKS (25 SEPTEMBER 2022)

FIGURE 5.20: (L) A JAH HUT FARMER FILLING THE HOLE WITH RICE SEEDS; (R) CLOSE-UP PHOTO OF SOWN RICE SEEDS IN AN UNCOVERED HOLE (BERDUT; 21 AUGUST 2022)

5.5.2. Paddy Growth Phase

Weeding, or *merumput*, is an essential task in the early stages of rice growth. It continues until the rice reaches knee height. By this stage, the paddy has outgrown the weeds, making further weeding unnecessary. However, if *merumput* is not done while the rice plants are young, the weeds will overtake the paddy, competing for nutrients and significantly reducing the yield. The rice plot requires constant attention during the paddy's growth. Without regular weeding, the weeds will compete with the seedlings for essential nutrients, resulting in a poor harvest. Weeding is primarily done by women, either individually or in groups, depending on who is available to help. This work is often carried out cooperatively, with women assisting each other in tending their plots based on reciprocity. The sense of camaraderie and mutual support helps make this labor-intensive and back-breaking job more manageable, especially when done together in a spirit of *gotong-royong* (community cooperation).

As the rice plants grow and dominate the plot, other vegetable crops such as *bayam* (local spinach, Amaranthus spp.), *maman* (wild spinach, *Amaranthus spp.*), and *terung* (brinjal, *Solanum lasiocaroum*, etc) - which were cultivated before the rice was sown – naturally decline at the end of their productivity due to competition for nutrients. This natural progression is part of the rice cultivation cycle, as the rice plants dominate the land.

5.5.3. Rice Harvesting Protocols

The rice harvest typically takes place between 3 to 6 months after sowing, depending on the variety of rice (Figure 5.22). Knowing when the rice is ready for harvest is crucial, and this is identified by the color of the grains, which turn yellow, red, or white (Figure 5.23). The first stalks of rice harvested are treated with special care. These stalks, known as *ibu padi*, are set aside and not processed. They will be used in rituals and for planting in the next season. Harvesting is carried out using a traditional tool called *tuai*, and the rice is collected in an *ibong* (a fine mesh basket), both of which are handmade from forest materials (Figure 5.24).

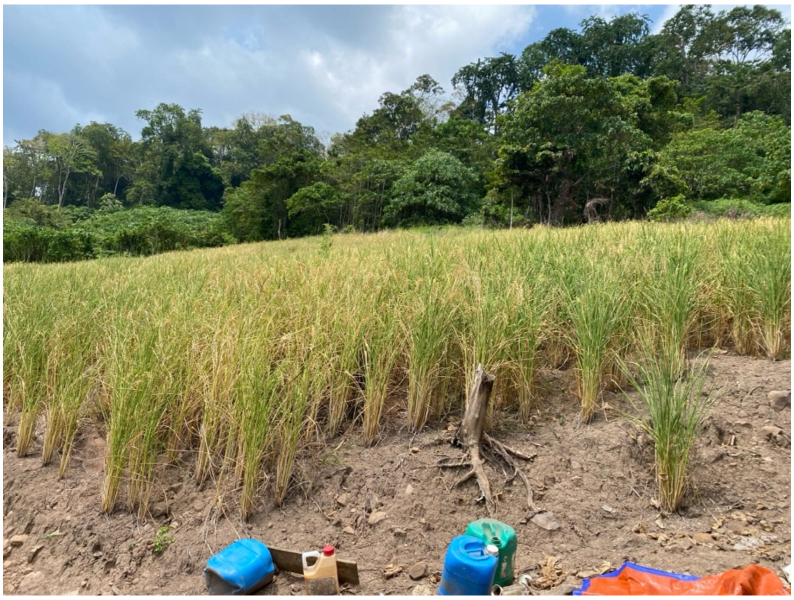

FIGURE 5.21: FULLY GROWN HILL RICE READY FOR HARVESTING (SG MAI; 12 JANUARY 2022)

FIGURE 5.22: PADI BECUR, NOT YET RIPE FOR HARVESTING (BERDUT; 10 JANUARY 2023)

FIGURE 5.23: (L) TUAI, JAH HUT RICE HARVESTING TOOL; (L) A JAH HUT WOMAN DEMONSTRATING HOW THE IBONG IS WORN FOR HARVESTING RICE (BERDUT; 21 AUGUST 2022)

Hill (1970) observed a similar approach to rice harvesting among Indigenous and Malay communities in Peninsula Malaysia, paralleling the traditional methods of the Jah Hut. Jah Hut farmers typically harvest rice by cutting the panicles individually, deliberately avoiding the use of sickles, which would sever the culms at their base. This meticulous technique reflects a cultural belief that abrupt, mechanical cutting could disturb the *semangat padi* or the spiritual essence of the rice. By harvesting panicles manually, farmers aim to preserve this spiritual connection. Additionally, this method offers practical benefits in traditional agricultural contexts. Since rice fields often ripen unevenly, selective harvesting allows farmers to reap each panicle at its peak ripeness. This harmonious blend of spiritual reverence and ecological practicality exemplifies how cultural beliefs and farming practices are intricately intertwined. Hill's (1970) earlier documentation highlights this alignment, illustrating the enduring significance of these practices.

Sometimes, during harvest, there is a mixture of different rice varieties, referred to as *padi berkelas*. The work is divided among men and women, with the women responsible for the harvesting and the men carrying the sacks of rice back home. The women endure long hours of labor under the scorching sun, which becomes intense as early as 10:30 a.m. Despite the heat, they continue working until noon or even 1 p.m. As a reward for their hard work, the women are treated to a meal prepared by the young women of the planter's family. As a token of appreciation, each harvester who participates in the *gotong-royong* (community cooperation) takes home a full *ibong* of rice, which can later be used as seeds for their own plots in the next planting season. The remaining harvest is given to the plot owner. Harvesting is a physically demanding and time-consuming process, often lasting several weeks depending on the size of the field, the yield, and the number of people helping. The women, skilled in harvesting, can gather large quantities of rice in a short period (Figure 5.25). Meanwhile, young children can often be seen accompanying their mothers as they work. In terms of social norms, it is considered impolite to join the harvesting without an invitation. People would feel embarrassed to help unless they are formally asked, as it is a practice rooted in respect and tradition.

FIGURE 5.24: RICE IS HARVESTED EXCLUSIVELY BY WOMEN. IN THIS PHOTO, A HARVESTER IS DEMONSTRATING THE USE OF THE TUAI TO CUT INDIVIDUAL RICE PANICLES (BERDUT; 16 JANUARY 2023)

5.5.4. Taboos Surrounding Rice Harvesting

There are several taboos and rituals observed during the rice harvesting process, which are believed to protect the *semangat padi* (rice spirit) and ensure a successful harvest. One important rule is that no harvesting is allowed after 6 p.m. Additionally, the *ibong* (harvest basket) must never be allowed to fall over, and it is forbidden to step on the paddy stalks as these actions are seen as disrespectful to the rice spirit.

For the first three days of the harvest, the owner of the rice plot is not permitted to leave the house. This custom is meant to safeguard the *semangat padi*, and someone must always remain at home during this time. Visitors are also not allowed to enter the house during these three days. However, if someone does stop by, they must leave behind a piece of clothing as a representative of their presence and return later to collect it.

The presence of the *semangat padi* is believed to affect the weight of the *ibong*. If the rice spirit remains, the basket feels heavy, but if the spirit is gone, the basket will feel light. During this three-day *pantang* (prohibition) period, several other rules must be followed: the wood fire fuelling the stove must not be extinguished until the ritual is completed, and the plot owner is not allowed to handle or use oil, lend out any household items, or let the cooked rice in the pot run out. Furthermore, during these three days, it is forbidden to unnecessarily handle knives or make excessive noise, as these actions are believed to disturb the rice spirit and negatively affect the harvest. These taboos and rituals reflect the deep cultural and spiritual significance of rice cultivation, ensuring harmony and respect for the *semangat padi*.

5.5.5. Post-Harvest Phase Land Processes

After the rice is harvested, the *jerami* (rice stalks without the grains) are typically left in the ground (Figure 5.26). In some cases, they are burned. This leftover organic matter serves as compost, enriching the soil and helping to fertilize it for future planting cycles. However, hill rice can only be grown a maximum of two cycles on the same plot of land because the soil fertility declines after two planting cycles. The practice is summed up in the saying, "*Padi dibuat dua kali setahun. Dua kali tanam, dua kali tuai untuk satu tapak. Enam bulan kira setahun padi. Jadi satu tapak tu diguna untuk dua tahun padi*," meaning "Plant twice, reap twice for one site. Six months is a calendar year for rice cultivation. However, each plot is used for two rice-years". This means that rice is cultivated in two cycles in a single plot, after which the farmers move on to a new location to ensure better crop yields, as no commercial fertilizers are used to replenish soil nutrients.

FIGURE 5.25: HARVESTED HILL RICE PLOT WITH EMPTY RICE STALKS STREWN ABOUT. THE YOUNG OIL PALM TREES (ABOUT 6 MONTHS OLD) SEEN HERE WERE FIRST PLANTED WHEN THE PLOT WAS FRESHLY CLEARED (BERDUT; 16 JANUARY 2023)

Traditionally, after two harvests, the land would be left fallow for at least two years, a practice followed by the previous generation to allow the soil to recover. However, due to limited land availability, villagers no longer allow the land to lie fallow. Instead, they plant rubber[46] or oil palm seedlings. In the past, rice was grown twice on the same plot, but now on average it is only planted once, followed by rubber or oil palm cultivation (Figure 5.26). Nevertheless, depending on soil fertility, farmers may sometimes plant rice on the same plot for anywhere between two to five cycles before moving to a new location. Regardless of the planting frequency, traditional farmers always reserve a portion of their rice harvest to use as seed for the next planting season. They never consume their entire harvest to ensure the sustainability of their farming cycle.

Between the rice harvest and the next planting, food becomes scarce. Farmers mostly rely on root vegetables, such as *dudur*, *keledek* (sweet potatoes), and *ubi kayu* (cassava), which grow abundantly. They also forage wild edibles such as *kangkong* (water convolvulus) from riverbanks or gather wild vegetables from *beluga lama* (old secondary forests). This foraging practice helps sustain the community during the gap between harvests.

5.5.6. Processing and Storage of Rice Post-Harvest

Preparing rice after the harvest follows a series of traditional steps (Figure 5.27), beginning with the harvesting (*tuai*) of the rice. Once the rice panicles are harvested (Figure 5.28), it is transported home for further processing. The next step is threshing (known as *irik/pijak)*, where the rice grains are separated from the panicles. This is typically done by hand or by treading on the panicles (Figure 5.29). After the grains are removed, they undergo winnowing (*tampi*), a cleaning process to remove any remaining husks, trash, or debris. Once the rice is clean from debris, it is spread out to dry under the sun (*jemur*) in the open air. This drying step is crucial for preserving the rice, preventing sprouting and spoilage during storage. After drying, the rice is dehulled by pounding using a traditional wooden mortar and pestle (*lesung*) (Figure 5.30 & 5.31). After dehulling, the rice is subjected to another round of winnowing to ensure it is thoroughly cleaned (Figure 5.32). In some cases, the rice is also roasted as part of the final processing stage.

---

[46] During the implementation of the New Economic Policy (Dasar Ekonomi Baru), rubber planting was introduced in Berdut, as well as other Orang Asli settlements, and was mandated by the government. This initiative, called the Tanaman Senula Komersial (TSK) is overseen by RISDA (Rubber Industry Smallholders Development Authority) and was set up to support smallholders by providing financial assistance and technical guidance to replant unproductive rubber or oil palm trees with higher-yielding varieties, improving productivity and economic returns (https://kms.risda.gov.my/wp-content/uploads/2019/09/1466547996.pdf). However, its implementation is problematic.

Once these steps are completed, the rice is either consumed or stored for future use, ensuring a stable supply for the household. Alternatively, due to the intensive manual labor involved, some farmers in Sungai Mai and Pasu send their harvest to Lubok Wong, another Jah Hut village, where machines are available for dehulling the rice. For example, it costs one farmer RM12 to process 15.5 kg of rice. Another relatively more affluent farmer in Sungai Mai even owns her rice processing machine. However, many agree that machine-processed rice tends to lose its flavor and fragrance compared to hand-pounded rice. Despite this, machine processing is more convenient, as hand-pounding rice requires a significant amount of labor to remove the husks.

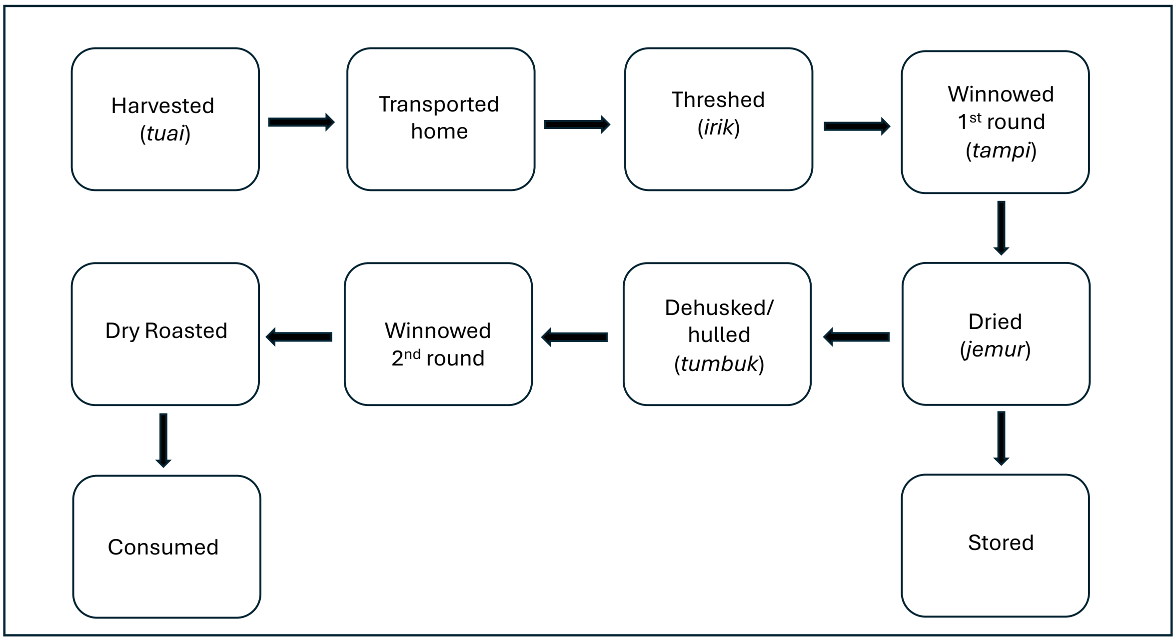

FIGURE 5.26: POST-HARVEST PROCESSING OF JAH HUT HILL RICE

FIGURE 5.27: RICE PANICLES FRESH FROM THE HARVEST, READY TO BE THRESHED. (BERDUT; 16 JANUARY 2023)

FIGURE 5.28: HARVESTED RICE PANICLES ARE THRESHED BY FEET. (BERDUT; 16 JANUARY 2023)

FIGURE 5.29: (L) THE LONG WOODEN PESTLE USED TO DEHUSK THE RICE; (TOP) THRESHED AND WINNOWED RICE IN THE WOODEN MORTAR, READY TO BE DEHULLED (BERDUT; 31 JULY 2022)

FIGURE 5.30: TWO WOMEN MANUALLY DEHUSKING THE THRESHED RICE BY POUNDING IT WITH A WOODEN MORTAR AND PESTLE (BERDUT; 31 JULY 2022)

FIGURE 5.31: (L) POUNDED RICE IS REPEATEDLY WINNOWED, AND CAREFULLY CHECKED FOR ANY REMAINING HUSKS; (R) FRESHLY PROCESSED RICE, READY FOR CONSUMPTION (BERDUT; 31 JULY 2022)

5.5.7. *De'er Merwah* Ceremony: Thanksgiving to Ancestors

At the end of the harvest season, the first household to reap a significant yield may choose to hold a De'er Merwah (also known as *kenduri moyang* or *kenduri emping*[47]), a village-wide feast. However, since organizing such an event can be expensive, not all households have the resources to do so. In Sungai Mai, it is common two or more households to pool their rice harvests and other resources in order to organize the feast. The womenfolk prepare the ingredients for the feast, but almost all of the cooking is done by the menfolk because it is a labour-intensive activity (Figure 5.33). During the feast, all Jah Hut deities, ancestors (*bahalak* and *malaikat*) along with other supernatural entities are invited to partake. After these invitations, several requests are made, including protection for the farm from animals (pests) and diseases, safeguarding the village from disease outbreaks, and ensuring peace by avoiding civil unrest and conflicts with outsiders. There are also prayers for the land to remain undisturbed by external forces, for smooth progress in all matters, and for favorable, calm weather conditions, ensuring that no mishaps or disruptions occur during this critical time.

[47] *Emping* is dry roasted flattened rice, considered a precious and rare delicacy amongst the Jah Hut.

FIGURE 5.32: IT IS CUSTOMARY FOR JAH HUT MEN TO MANAGE THE COOKING FOR THE THANKSGIVING FEAST (SG MAI; 31 JULY 2022)

5.5.8. Rice Seed Storage, Lifespan and Extinct Varieties

Jah Hut rice seed stock cannot be stored for more than 18 months post-harvest, as it begins to degrade and lose viability beyond this period. To maintain a continuous supply of seeds, farmers must replant annually; otherwise, their seeds risk becoming unusable. The original source of these rice varieties remains unknown, as Jah Hut farmers have propagated them within their communities for generations without external input.

Women in Jah Hut communities are the primary custodians of rice identification, as they have traditionally played a central role in its cultivation. They distinguish rice varieties based on hull color (*kulit*), grain length (*kepanjangan biji*), grain shape (*kebulatan biji*), and distinctive patterns (*loreng*) on the hull, which may appear in shades of yellow, white or red. Notably, the same variety may be known by different names in different villages, depending on the planter. This contributes to the challenge of documenting extinct varieties, as certain names may no longer be in use or may refer to multiple strains.

Currently, no genetic information is available on Jah Hut rice, and efforts to obtain such data from MARDI (Malaysian Agricultural Research and Development Institute) have remained unanswered. Despite the absence of formal documentation, traditional farmers practice a time-honored method of seed saving, setting aside a portion of each harvest for the next planting cycle (Figure 5.34). Under no circumstances do they consume all their rice, as this would jeopardize their seed stock and the sustainability of their farming system.

FIGURE 5.33: UNPROCESSED RICE SEEDS ARE CAREFULLY STORED AT HOME (BERDUT; 17 JANUARY 2023)

Unfortunately, several Jah Hut rice varieties have gone extinct, with at least 28 lost varieties, including 14 types of *Pulut* (glutinous rice), one variety of *Sekoi* (Indigenous millet), and *Mehilai* (whose classification remains uncertain), along with various hill and swamp rice varieties (Appendix 5.1). This extinction can be traced back to the 1990s, when many men from the community abandoned traditional hill rice cultivation to take up wage labor in Sime Darby’s oil palm plantations. The decline in cultivation led to disrupted planting cycles and seed preservation, resulting in the loss of many valuable rice and crop varieties.

Berdut elders emphasize that learning about preserved varieties in other Jah Hut villages would be immensely valuable. Such knowledge could help recover lost varieties, allowing them to be propagated once again in Berdut, ensuring their survival and the preservation of cultural heritage. Documenting these rice strains is a pressing priority, as the current list remains incomplete. Comprehensive research is essential to accurately catalog and safeguard these traditional rice varieties before they are lost entirely. The role of seed networks in sustaining and reviving these lost varieties will be explored further in Section 7.4.2.4 of Chapter 7.

5.5.9. Pest and Disease Management

The Jah Hut community faces diverse challenges in protecting their crops from both physical and metaphysical threats. Pests range from insects and animals to spiritual beings believed to interfere with cultivation. Their management strategies combine physical barriers, Indigenous ecological knowledge, and spiritual practices to maintain balance with nature.

5.5.9.1. Animal and Insect Pests

Pests vary by location. In Pasu, ants have become a significant issue, exacerbated by the spread of oil palm plantations. In Berdut, sparrows (locally known as pipit) and macaques (*Macaca fascicularis*) frequently attack crops. The macaque problem is relatively recent, as many were released into nearby forests after being captured in urban areas by the Department of Wildlife and National Parks (PERHILITAN). Macaques also cause problems in Pasu. In 2022, the Berdut community faced an unusual challenge from *kelasar* (free-tailed bats, *Mops mops*), which reside in *tualang* trees (*Koompassia excelsa*), adding complexity to pest management.

Other problematic species include wild boars (*babi hutan, Sus scrofa*), plantain squirrels (*tupai, Callosciurus notatus*), rats (*tikus, Rattus tiomanicus*), Sambar deer (*Rusa unicolor*), and macaques (*Macaca nemestrina* and *Macaca fascicularis*). Historically, wild boars were controlled using *belantik* (a type of snare), but this method has been abandoned due to safety concerns, particularly for children. Malayan tapirs (referred to as *badak* by the Jah Hut, *Tapirus indicus*) are also present but are selective feeders, only eating specific shoots. Another bird species, known to the Jah Hut as *burung kerangka* (common and scientific name unknown), nests in farm mounds, further complicating crop protection. Elephants were a major threat to crops in the 1980s, particularly in Berdut. However, after one elephant caused a community member's death, it exhibited remorseful behavior, and no elephants have returned to Jah Hut villages since.

5.5.9.2. Traditional Pest Management Strategies

The Jah Hut employ a combination of ecological, structural, and spiritual methods to manage pests.

1. **Timing of Planting**: It is taboo to plant during the crescent moon (*bulan kecil*), as this phase is believed to attract pests. Instead, planting is delayed until the moon is completely dark, reducing pest risks.
2. **Physical Barriers**: The community builds fences and boundary vegetation to deter animals. They also create *sawa* (constructed corridors) for wildlife to pass through without disturbing crops.
3. **Strategic Land Use**: *Senawar* (walls) mark land boundaries and serve as protective barriers, preventing human and animal intrusion.
4. **Use of Dogs and Hunting**: To deter wild boars, the Jah Hut keep dogs, as wild boars fear them. The community's approach to pests extends to their tools and traps. When necessary, they spear boars using *lembing*. While they know how to construct *ranjau* (traps similar to *lembing* that kill instantly), they refrain from doing so for safety reasons.
5. **Trapping for Consumption**: While the Jah Hut philosophy emphasizes coexistence and non-violence, they do trap and consume certain animals, including monkeys (*Macaca fascicularis*, *Macaca nemestrina*), wild boars (*Sus scrofa*), and squirrels (*Callosciurus prevostii*, *Callosciurus notatus*). These animals are considered valuable food sources, and their meat is incorporated into traditional dishes like *gulai*, prepared with cassava or sweet potatoes.

The community's approach to pests extends to their tools and traps. While they know how to construct *ranjau* (traps similar to *lembing* that kill instantly), they refrain from doing so for safety reasons. Despite these measures, the Jah Hut primarily avoid indiscriminate killing of pests, adhering to their belief system that emphasizes balance with nature.

5.5.9.3. Spiritual Aspects of Pest Control

The Jah Hut recognize metaphysical beings as pests. They believe that *jembalang* (evil spirits) harm crops, leaving distinct marks that farmers recognize. To ward them off, they perform *berselawat* (prayers or chants) and use *lembing* made from *pucuk pam* or *pucuk rotan* (rattan). The *jin pahangan* are spiritual guardians that protect individual farm plots. These entities recognize only the landowner and their immediate family, acting ruthlessly against intruders - including children and animals. In the past, the community actively employed *jin pahangan* to guard their land, but they have since abandoned the practice due to concerns about unintentional harm to wandering children. The *Tok Pawang* (shaman) could communicate with these beings to enforce their role.

5.5.9.4. Disease Management

When rice crops are affected by disease, the Jah Hut rely on traditional treatments rather than chemical pesticides. One of the primary methods involves *jampi* (incantations or prayers) performed over the crops. As part of the ritual, *air mawar* (rose water) is sprinkled on affected plants. This practice is accompanied by the application of a natural formula made from forest-sourced ingredients, designed to repel pests and diseases without harming the environment. The Jah Hut's disease management methods emphasize sustainability and ecological balance. Historically, they lacked access to chemical treatments, instead relying on knowledge passed down through generations. Their approach contrasts with modern agricultural methods that depend on synthetic pesticides, prioritizing environmental preservation and the protection of all living beings. While traditional methods may appear less efficient than chemical alternatives, they offer a sustainable solution that avoids the ecological harm associated with pesticides.

5.5.10. Soil Fertility and Protection

Farmers rely on traditional methods, such as using old fallow plots (*helai lama*) that are at least three years old. Farmers consistently evaluate the soil's condition, focusing primarily on whether it is dry or wet (*kering atau basah*). The soil in these areas is often a mix of clay and sand, appearing black and moist, which is ideal for planting rice. However, certain factors can hinder fertility. For instance, *mabuk akar* - a condition where there is an overabundance of roots - indicates poor soil fertility. Moreover, virgin forests (*hutan dara*) are not necessarily fertile, contrary to common assumptions the soil condition must be assessed carefully.

Soil fertility can also vary within a single plot. Areas where burning has occurred tend to have richer, more fertile soil. Burning is not done uniformly across the land, which results in observable differences in plant health - plants in the richer, burnt areas appear healthier and more robust compared to those growing in less fertile soil. It is important to note that hill rice is never cultivated in the same plot more than twice, as soil fertility declines significantly after two cycles. Farmers, therefore, rotate to new locations for planting. No commercial fertilizers are used in this process.

Paddy cultivation helps prevent soil erosion by covering the entire surface once the rice plants have grown. However, before planting, the soil is left exposed, which leads to some minimal erosion. Fortunately, this erosion is short-lived, as the paddy soon covers the ground, stabilizing the soil. Meanwhile, fertilization is traditionally achieved using wood ash, which is a byproduct of the burning process. This natural fertilizer helps improve the soil's nutrient content in the areas where burning is practiced.

The practices described reflect a deep understanding of traditional soil management techniques by the Jah Hut. The focus on soil condition and fertility highlights the farmers' reliance on natural indicators rather than modern technology. The practice of rotating rice plots after two cycles demonstrates a strong understanding of soil management. It helps prevent over-exhaustion, but further research could explore how to balance this approach with the need to minimize land clearing, ensuring that deforestation or land degradation are carefully managed. Additionally, while the use of wood ash as a natural fertilizer reflects resourcefulness and ingenuity, more studies could investigate how to enhance nutrient availability with supplementary inputs to ensure sustained long-term productivity.

These traditional techniques are effective in the short term and highlight the farmers' adaptability to their environment. However, by integrating modern techniques for soil fertility management and erosion control, there is significant potential to build on these practices, ensuring even greater sustainability and long-term soil health. Continued research into these areas could further optimize these methods for future generations.

5.5.11. Sociocultural Aspects

Transmission of agricultural knowledge to the next generation remains strong, with younger members of the community learning from their elders. The success of rice cultivation brings joy to the community, especially among the older generation, who remain committed to these labor-intensive and costly practices. Despite the challenges of feeding helpers during communal farming efforts (*gotong-royong*), the Jah Hut continue to value their rice, finding satisfaction and fulfillment in the harvest. Taboos are strictly observed (with the exception of Pasu) and are an integral part of maintaining harmony with nature.

5.6. Jah Hut Home Gardens: A Source of Food, Medicine, and Seed Conservation

Jah Hut home gardens are small-scale agricultural systems located near households, providing a diverse supply of vegetables, fruits, and medicinal plants. These biodiversity hotspots are essential for food security, biodiversity conservation, the preservation of plant varieties, and even spiritual practices. They are largely self-sustaining, with plants sprouting from dispersed seeds - either scattered by household members or through natural seed dispersal by birds and animals. Propagation methods, such as planting shoots, ensure that valuable crops continue to thrive across generations.

Home gardens serve as a convenient food source, particularly when families are unable to forage in the forest or harvest from their main plots. They primarily provide leafy greens (often shoots) from cassava and papaya plants (*pucuk ubi*, *pucuk keledek*, *pucuk betik*), local chillies and *semumuk* (a wild aromatic leafy herb with a pungent, onion-like taste) which are harvested fresh as needed. In Pasu, some families sustain their entire daily vegetable needs through their home gardens, significantly reducing their reliance on purchased food. Larger home gardens, such as those spanning one to two acres, provide a diverse range of crops, with some households cultivating up to 50 different plant species, including rare varieties. The home gardens seen in Berdut (Figure 5.35), Sungai Mai (Figure 5.36) and Pasuillustrate this diversity, with a mixture of edible, medicinal, and naturally regenerating plants integrated into the household space. Home gardens also play an important role in seed conservation. In situ seed storage is practiced through continuous propagation, particularly for crops not currently grown in the main fields. This ensures that plant varieties are not lost over time.

Beyond providing food, home gardens also serve an essential role in the preservation of medicinal plants and ingredients required for shamanic rituals. Several local varieties of turmeric or *kunyit* (*Curcuma spp.*) are commonly grown for their spiritual and healing properties. The *pawang padi* (rice shamans) and traditional healers require these plants for ritualistic purposes, including protection against metaphysical disturbances and agricultural blessings. Some of these plants originate from the forest, such as those collected from the Krau

Forest Reserve in Pasu and are cultivated in home gardens to ensure a steady supply for traditional medicine and ceremonial use. Those without home gardens often depend on neighbors or relatives for small amounts of essential herbs and vegetables, reinforcing community-sharing practices.

Despite their benefits, soil fertility in home gardens varies. Some gardens flourish when the topsoil is well covered, while others suffer from soil erosion due to frequent foot traffic around homes. In some cases, such as in Berdut and Sungai Mai, families avoid consuming root crops like cassava and tubers, believing they are unclean due to potential contamination from pet feces (dogs, cats, and chickens). This belief also influences sanitation practices, as outdoor toilets with improper drainage are commonly built near home gardens. In contrast, in Pasu, root crops are consumed more freely.

FIGURE 5.34: A TYPICAL HOME GARDEN IN BERDUT, WITH A DENSE GROWTH OF EDIBLE VEGETATION (23 JULY 2022)

FIGURE 5.35: A WELL-MAINTAINED HOME GARDEN IN SG MAI, PRIMARILY COMPRISING EDIBLE PLANTS FOR DAILY CONSUMPTION (7 SEPTEMBER 2022)

5.7. Challenges in Jah Hut Shifting Cultivation

5.7.1. Impact of External Pressures

The impact of external pressures on Jah Hut agriculture is profound, as illuminated through the lens of political ecology (described in Chapter 3). Colonial and post-colonial policies played a pivotal role in disrupting traditional systems, primarily through the forced integration of cash crops such as rubber. This economic transformation resulted in shortened fallow periods, a hallmark of sustainable swidden agriculture, and fostered a dependency on volatile, market-driven agricultural practices. These shifts signified a transition from harmonious, community-oriented practices to disharmonic systems that undermined ecological resilience and heightened socioeconomic vulnerabilities. Modernization initiatives, such as resettlement programs, further compounded these disruptions. By forcibly relocating communities and imposing new agricultural systems, these programs eroded not only traditional agricultural methods but also the spiritual and cultural ties to consecrated lands. The displacement severed Jah Hut communities from the ritualistic and ecological balance that underpinned their resilience, leaving them vulnerable to both ecological degradation and cultural disintegration.

Consequently, there is a critical need for policies that respect and integrate Indigenous knowledge and traditions into sustainable development strategies.

5.7.2. Economic Burdens and Capital-Intensive Practices

Traditional farming practices in this community have become increasingly capital-intensive. Farm owners are expected to feed extra helpers during major stages of farming, such as land clearing, planting (*menugal*), and harvesting. This requirement can deter some from continuing traditional practices, as many farmers can no longer afford to provide for these helpers. Previously, resources were more abundant and shared communally, often through potluck-style contributions where everyone brought their food, thus reducing the burden on the host. However, this practice has fallen out of favor, making it more difficult for farmers to manage the costs of maintaining these customs.

5.7.3. Climate Sensitivity and Changing Weather Patterns

Jah Hut rice farming is highly sensitive to climate conditions, requiring a careful balance of dry and wet periods for optimal growth. The community traditionally relies on the *pawang padi* (rice shamans) to maintain favorable weather conditions after harvesting (*tebang*). Ideally, a dry season lasting around three months ensures successful crop drying, and the *pawang* may be called upon to influence weather patterns. However, controlling climate has become more challenging as external factors, such as the actions of others, disrupt traditional practices. Many taboos (*pantang*) are followed to ensure success, and rituals of gratitude, such as *kenduri emping*, are performed at the end of the harvest season. Despite these efforts, modern climate unpredictability has made such control more difficult.

Climate change has significantly impacted Jah Hut rice cultivation, with recent seasons experiencing erratic weather patterns. According to Berdut elders, the 2023 harvest suffered due to unseasonal rains during the critical paddy flowering phase, causing the flowers to fall prematurely and preventing proper grain formation. The community attributes this unpredictability not only to broader climate change but also to human actions that violate traditional customs (*adat resam*). Certain taboos, such as the prohibition against intermarriage between first cousins (*sumbang*, *darah kotor*), are believed to be integral to maintaining harmony in both society and nature. When these customs are broken, those involved in rice farming are thought to disrupt the natural order, leading to poor yields. This suggests that the community views the degradation of traditional practices and taboos as contributors to the environmental challenges they face.

5.8. Comparing Jah Hut, Semai, Semelai and Temiar Agricultural Practices

The swidden agricultural practices of the Jah Hut (preceding sections), Semelai (Gianno & Bayr, 2009), Semai (Gomes, 2016; Dentan, 1971), and Temiar (Cole, 1959a, 1959b) reveal a profound integration of ecological strategies, cultural traditions, and adaptive responses to external pressures. All four groups rely on shifting cultivation with slash-and-burn methods for field preparation, emphasizing rotational cropping, intercropping, and the use of secondary forests (*belukar*) to sustain soil fertility and biodiversity.

Rice remains central to their agricultural systems, complemented by vegetables and tubers for dietary diversity. Their practices, guided by intricate land classification systems, prioritize long-term ecological balance through fallow cycles that enable natural regeneration. These approaches highlight their shared commitment to ecological stewardship and cultural preservation.

Rituals and spiritual beliefs are integral to their agricultural activities, including plot selection, land clearing, and planting. Shamans play a vital role across all groups, interpreting dreams and offering spiritual guidance to maintain harmony with land spirits. Cooperative labor, often organized through kinship and village networks, further strengthens social cohesion during key farming tasks such as clearing, sowing, and harvesting.

Despite differences, such as crop diversity (for example, the Semai focus on tapioca and maize, while Temiar balance cassava and rice) and adaptations to resource constraints, their shared strategies underscore the resilience and sustainability of these Indigenous agricultural systems. Together, these practices highlight the Orang Asli's enduring role as custodians of biodiversity and their deep-rooted connection to the environment, as outlined in Table 5.4.

<table>
<tr><th>No.</th><th>Key Themes</th><th>Jah Hut</th><th>Semai</th><th>Semelai</th><th>Temiar</th></tr>
<tr><td>1.</td><td>Shifting Cultivation as a Common Practice</td><td colspan="4">All four groups employ slash-and-burn techniques for field preparation and share a reliance on shifting cultivation to sustain agricultural productivity.</td></tr>
<tr><td>2.</td><td>Rice as a Central Crop</td><td colspan="4">Rice is the cornerstone of their agricultural systems, complemented by intercropping with vegetables and tubers to enhance dietary diversity.</td></tr>
<tr><td>3.</td><td>Soil Regeneration and Fallowing</td><td colspan="4">Fields are typically left fallow after one or two growing cycles, demonstrating a shared commitment to ecological balance and soil health.</td></tr>
<tr><td>4.</td><td>Sacred and Ritualistic Practices</td><td colspan="4">All four sub-groups emphasize rituals for plot selection and communication with land spirits, reflecting a profound respect for the supernatural forces governing their environment. The Semelai incorporate rituals and divination for agricultural success and pest protection, while the Semai perform ceremonies guided by dreams from the head soul (runyai) to seek permission for cultivation. All four sub-groups rely on shamans to interpret dreams and provide spiritual protection, with rituals accompanying activities like land clearing and planting. These practices collectively underscore their shared commitment to maintaining ecological balance and harmonious interactions with the land, deeply rooted in their animistic belief systems.</td></tr>
<tr><td>5.</td><td>Diverse Cropping Strategies</td><td>Integrate intercropping and agroforestry, including perennial crops such as rubber and oil palm.
Cultivate a variety of crops, much like the Semai.</td><td>Cultivate a variety of crops (e.g., tapioca, maize, beans) and use specific techniques to avoid interference between crops.</td><td>Historically preferred primary forests for rice but adapted to secondary forests due to land constraints.</td><td>Employ a three-to-one ratio of cassava to rice and cultivate different types of farming areas (e.g., large rice farms, village gardens).</td></tr>
<tr><td>6.</td><td>Ecological Indicators in Agricultural Timing</td><td colspan="4">Use natural ecological indicators, such as flowering plants and lunar phases, to determine agricultural schedules, demonstrating their integration of environmental knowledge.</td></tr>
</table>

No.	Key Themes	Jah Hut	Semai	Semelai	Temiar
7.	**Community and Social Organization**	Jah Hut: Demonstrate significant gender-based roles, with men clearing land and women involved in planting and weeding. All: Individual households manage their swiddens, but rely on cooperative labor for plot clearing, sowing, harvesting and post-harvesting processing phases of cultivation where communal efforts are essential. Shared rituals and collective events, like feasts or ceremonies for agricultural success, foster cooperation among community members The organization of labor often revolves around kinship ties and village-level coordination, reflecting their strong social structure.			
8.	**Adaptation to Land and Resource Availability**	Current use is exclusively on secondary forest (*belukar*). Shift from primary (historical practice) to secondary forests highlights their adaptation to changing land availability.			

TABLE 5.4: COMPARATIVE ANALYSIS OF JAH HUT, SEMAI, SEMELAI AND TEMIAR SHIFTING CULTIVATION SYSTEMS

5.9. An Analysis of Jah Hut Shifting Cultivation

5.9.1. Analysis of Jah Hut Shifting Cultivation within the Context of Olofson's (1983) Framework

Harold Olofson's (1983) framework on harmonic and disharmonic systems was used to analyze the Jah Hut approach to evaluate ecological sustainability, cultural integration, and agricultural productivity. Table 5.5 represents an analysis of the Jah Hut system's harmonic strengths and disharmonic pressures, drawing on Olofson's criteria.

Themes	Observations	Harmonic Indicators	Disharmonic Risks
Plot Management and Rotational Practices	Jah Hut farmers use rotational cropping, shifting to new plots after two rice cycles. They prefer secondary forests *(helai lama)* over virgin forests, reducing environmental degradation.	Rotation ensures soil recovery and ecological balance.	Limited land forces shorter fallow periods, introducing risks of soil depletion.
Intercropping and Biodiversity	The Jah Hut practice intercropping with rice, maize, root crops (e.g., cassava), and Indigenous vegetables. Border crops (bananas, durian) enhance biodiversity.	High crop diversity supports ecological integration and pest resistance.	Expansion of monoculture cash crops (rubber, oil palm) reduces biodiversity in some areas.
Soil Fertility and Management	Controlled burning adds nutrients through ash, and organic matter recycling (e.g., leaving rice stalks) improves soil health. Virgin forests are avoided due to inconsistent fertility.	Reliance on natural methods (burning, organic recycling) preserves fertility sustainably.	Reduced fallow periods and overuse of specific plots risk long-term soil degradation.

Themes	Observations	Harmonic Indicators	Disharmonic Risks
Pest Management	Physical (fences, dogs) and metaphysical (chants and rituals) approaches coexist. There is an emphasis on non-violence and coexistence with animals and other beings.	Non-violent pest management integrates with natural ecosystems.	Some pests (wild boars, macaques) cause significant crop loss, requiring more intensive interventions.
Cultural Knowledge and Rituals	Rituals before planting and harvesting align farming with spiritual beliefs, emphasizing harmony with nature.	Rituals and traditional practices strengthen ecological and cultural sustainability.	Modern pressures (e.g., cash crop dependency) may erode traditional practices.
Community Collaboration	Farms are clustered to reduce pest pressure and facilitate collective planting. Shared labor roles (gender-specific) enhance efficiency.	Collaboration fosters sustainable resource management and pest control.	Increasing individualism or land scarcity could disrupt communal traditions.
Environmental Sustainability	The Jah Hut system predominantly relies on natural cycles, with minimal external inputs such as fertilizers or irrigation.	Practices such as controlled burning, intercropping, and rain-fed systems support ecological balance.	Land scarcity and unpredictable weather challenge sustainability, pushing some practices toward disharmony.

TABLE 5.5: AN ANALYSES OF JAH HUT AGRICULTURE BASED ON OLOFSON'S FRAMEWORK OF HARMONIC AND DISHARMONIC SWIDDENS

Practices such as rotational cropping, intercropping, and tree-based farming exemplify harmonic systems that achieve ecological sustainability, cultural integration, and agricultural productivity. However, the balance is increasingly threatened by land scarcity, monoculture expansion (notably oil palm and rubber), and shifting economic priorities. These disharmonic forces highlight the need for targeted interventions that blend traditional knowledge with modern agroecological frameworks. Collaborative efforts among local communities, researchers, and policymakers are critical for preserving these systems' ecological and cultural integrity.

Olofson's framework further underscores the lessons Jah Hut agriculture offers for sustainability. Practices such as selective clearing and ritualized land use align with the regenerative rhythms of tropical ecosystems, offering insights for contemporary debates on sustainable land management. These practices demonstrate the potential of traditional agroforestry to contribute to ecological harmony and community resilience. Integrating the harmonic strengths of the Jah Hut system with scientific advancements can ensure the longevity of swidden agriculture in modern contexts. By fostering collaborative engagement and respecting Indigenous ecological knowledge, these systems could inform the design of sustainable and resilient agroforestry models that address both ecological challenges and cultural preservation.

Olofson's framework highlights the harmonic strengths of Jah Hut agriculture while acknowledging the disharmonic pressures that threaten its balance. These insights provide a foundation for further evaluating the sustainability of Jah Hut agricultural systems, which will be systematically assessed using the IDEA (Indicators of Sustainable Development for Agriculture) method (Vilain et al., 2008) in the following chapter.

5.9.2. Integration of Cash Crops into Jah Hut Agroforestry Systems

Conventional land-use classifications, such as agroforestry, have largely been shaped by colonial legacies, scientific institutions, and market-driven priorities (Penot & Ilahang, 2021). These frameworks dictate what is considered "sustainable" or "traditional," overlooking how Indigenous communities like the Jah Hut practice land stewardship based on their ecological knowledge and lived experiences. For example, the introduction of rubber in Indonesia in 1904 was not an organic adoption by local farmers but was facilitated by colonial networks, reinforcing external control over land-use decisions (Penot & Ilahang, 2021).

This study does not attempt to classify Jah Hut agricultural practices within pre-existing models. Instead, it seeks to observe, document, and center Jah Hut perspectives on shifting cultivation, including their integration of oil palm and rubber. Rather than positioning these crops as inherently problematic or beneficial, this research examines how Jah Hut farmers navigate economic pressures, state policies, and environmental changes while maintaining connections to their traditional land-use systems (Susanti et al., 2020; Budiadi et al., 2019).

For generations, Jah Hut farmers have managed shifting cultivation fallows as dynamic landscapes. Historically, these plots were left to regenerate naturally, but now external pressures have driven their transformation through the deliberate integration of perennial crops.

While some scholars critique oil palm and rubber for their role in deforestation and biodiversity loss, others highlight how smallholders engage with these crops in ways that diverge from plantation models imposed by colonial and corporate actors (Reiss-Woolever et al., 2021; Singh et al., 2021).

The distinction between agroforestry and monoculture has often been framed in rigid ecological and economic terms. However, these binaries risk erasing the complexities of Indigenous land-use strategies (Reiss-Woolever et al., 2021; Singh et al., 2021). Jah Hut farmers do not simply adopt external agricultural models but instead rework, appropriate, and resist dominant frameworks in ways that reflect their own priorities and histories.

Rather than presenting a prescriptive analysis, this chapter lays out the observed realities of Jah Hut land use as they unfold in practice. Following this discussion, Chapter 6 will assess the sustainability of these systems using the IDEA method, critically engaging with how sustainability is measured and whose values are prioritized in such assessments.

5.10. Conclusion

Jah Hut agricultural practices reflect a dynamic interplay between tradition, ecological adaptation, and external pressures. Shifting cultivation, centered around hill rice, remains a defining feature of their agrarian system, complemented by home gardens and agroforestry. Their agricultural knowledge integrates rotational cropping, natural soil restoration techniques, and seed conservation, ensuring sustainability despite changing environmental conditions.

Spiritual beliefs and ritual practices remain deeply embedded in their agricultural processes, shaping land use decisions, planting cycles, and pest management strategies. However, climate variability, economic challenges, and declining interest among younger generations threaten the continuity of these traditions. Modern influences - such as cash crop integration, land scarcity, and shifting labor dynamics - are gradually transforming their traditional systems, leading to a hybridized form of agriculture that incorporates elements of both shifting cultivation and managed agroforestry.

The resilience of Jah Hut agriculture lies in its flexibility and adaptive strategies. Their ability to sustain food security, preserve ecological knowledge, and maintain cultural practices amidst external pressures underscores the importance of integrating Indigenous wisdom into contemporary sustainable development policies. Without supportive interventions that recognize their unique agrarian system, these traditional practices risk erosion, potentially impacting both ecological sustainability and cultural heritage.

Summary

Jah Hut agricultural practices exemplify a resilient and adaptive system that balances traditional knowledge, ecological adaptation, and external socio-economic pressures. Their shifting cultivation system, centered around hill rice, remains integral to their cultural identity and sustenance. This system incorporates rotational cropping, natural soil restoration techniques, and intergenerational seed conservation, ensuring long-term agricultural sustainability despite the increasing constraints posed by land tenure policies, environmental changes, and shifting labor dynamics.

Spiritual beliefs and ritual practices are deeply embedded within Jah Hut agricultural cycles, shaping decisions related to land preparation, planting, and harvesting. These traditions serve not only as ecological management strategies but also as mechanisms for maintaining cultural and communal cohesion. However, this interconnected system faces growing challenges due to climate variability, economic uncertainties, and diminishing interest among younger generations. The increasing integration of cash crops such as oil palm and rubber has introduced new agricultural models that, while providing economic benefits, also alter traditional land-use patterns and ecological management strategies.

The resilience of Jah Hut agriculture lies in its flexibility and ability to adapt to external pressures while maintaining core aspects of traditional knowledge. Home gardens play a crucial role in preserving agrobiodiversity and providing supplementary food sources, yet they are also impacted by shifting socio-economic conditions. The shift towards more permanent cultivation methods, driven by external market forces and land scarcity, has led to a hybridized agricultural model that blends shifting cultivation with managed agroforestry.

While state-led agricultural programs and conservation policies often undermine the viability of shifting cultivation, the Jah Hut continue to navigate these challenges through adaptive strategies. Their practices highlight the importance of Indigenous knowledge systems in fostering ecological sustainability and community resilience. Without supportive interventions that recognize and protect their traditional agrarian systems, these practices risk erosion, leading to potential socio-cultural and environmental consequences.

The findings of this chapter underscore the need for policies that integrate Indigenous ecological knowledge into sustainable development frameworks. As Jah Hut agriculture continues to evolve, it is crucial to ensure that their land tenure rights, cultural traditions, and food sovereignty are upheld. In the following chapter, the sustainability of these systems will be systematically assessed using the IDEA (Indicators of Sustainable Development for Agriculture) method to critically examine how Jah Hut agricultural practices align with broader sustainability frameworks and whose values are prioritized in these assessments.

References

Abbas, F., Hammad, H. M., Fahad, S., Cerdà, A., Rizwan, M., Farhad, W., Ehsan, S., & Bakhat, H. F. (2017). Agroforestry: a sustainable environmental practice for carbon sequestration under the climate change scenarios—a review. *Environmental Science and Pollution Research*, *24*(12), 11177–11191. https://doi.org/10.1007/s11356-017-8687-0

Altieri, M. A. (1995). *Agroecology: The Science of Sustainable Agriculture* (Second). Westview Press.

Budiadi, B., Susanti, A., Marhaento, H., Ali Imron, M., Permadi, D. B., & Hermudananto, H. (2019). Oil palm agroforestry: An alternative to enhance farmers' livelihood resilience. *IOP Conference Series: Earth and Environmental Science*, *336*(1). https://doi.org/10.1088/1755-1315/336/1/012001

Cahyo, A. N., Dong, Y., Taryono, Nugraha, Y., Junaidi, Sahuri, Penot, E., Hairmansis, A., Purwestri, Y. A., Akbar, A., Asywadi, H., Ardika, R., Prasetyo, N. E., Agustina, D. S., Alam, T., Oktavia, F., Subandiyah, S., & Montoro, P. (2024). Rubber-Based Agroforestry Systems Associated with Food Crops: A Solution for Sustainable Rubber and Food Production? In *Agriculture (Switzerland)* (Vol. 14, Issue 7). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/agriculture14071038

Castagnetti, F., Bhatta, J., & Greene, A. (2021). An Offering of Grain: The Agricultural and Spiritual Cycle of a Food System in the Kailash Sacred Landscape, Darchula, Far Western Nepal. *Frontiers in Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.646719

Cole, R. (1959a). Temiar Senoi Agriculture: A Note on Aboriginal Shifting Cultivation in Ulu Kelantan, Malaya (Part I). *Malayan Forester*, *4*, 191–271.

Cole, R. (1959b). Temiar Senoi Agriculture: A Note on Aboriginal Shifting Cultivation in Ulu Kelantan, Malaya (Part II). *Malayan Forester*, 260–271.

Contreras, J. (2024). From the Food Myths of the Past to the Food Myths of the Present. *Signata*, *15*. https://doi.org/10.4000/127ws

Dentan, R. K. (1971). Some Senoi Semai Planting Techniques. *Economic Botany*, *25*(2), 136–159. https://doi.org/https://doi.org/10.1007/BF02860075

Djunatan, S. (2024). The Social Construction of the Myth of Paddy Goddess in Sundanese Culture. *Khazanah Sosial*, *6*(2), 238–248. https://doi.org/10.15575/ks.v6i2.25191
Fowler, C. (2005). Why is Maize a Sacred Plant? Social History and Agrarian Change on Sumba. *Journal of Ethnobiology*, *25*(1), 39–57.
Gianno, R., & Bayr, K. J. (2009). Semelai agricultural patterns: Toward an understanding of variation among Indigenous cultures in southern peninsular Malaysia. *Journal of Southeast Asian Studies*, *40*(1), 153–185. https://doi.org/10.1017/S0022463409000071
Gomes, A. G. (2016). Semai Ecological Epistemologies: Lessons for a Sustainable Future. In K. Endicott (Ed.), *Malaysia's Original People* (pp. 291–310). NUS Press Singapore.
Hill, R. D. (1970). Peasant Rice Cultivation Systems with some Malaysian Examples. In J. Kostrowicki & W. Tyszkiewwicz (Eds.), *Geographica Polonica 19: Essays on Agricultural Typology and Land Utilization* (pp. 91–98). PWN Polish Scientific Publishers. http://rcin.org.pl
Olofson, H. (1983). Indigenous Agroforestry Systems. *Philippine Quarterly of Culture and Society*, *11*(2/3), 149–174. https://www.jstor.org/stable/29791792
Penot, E., & Ilahang. (2021). Rubber Agroforestry Systems (RAS) in West Kalimantan, Indonesia: An historical perspective. *E3S Web of Conferences*, *305*. https://doi.org/10.1051/e3sconf/202130502001
Ratna, A., Van Noordwijk, M., & Lestari, T. H. (2021). Rubber Agroforestry Experiments in Jambi at the end of a 25-Year Cycle. *E3S Web of Conferences*, *305*. https://doi.org/10.1051/e3sconf/202130503005
Reiss-Woolever, V. J., Luke, S. H., Stone, J., Shackelford, G. E., & Turner, E. C. (2021). Systematic mapping shows the need for increased socio-ecological research on oil palm. In *Environmental Research Letters* (Vol. 16, Issue 6). IOP Publishing Ltd. https://doi.org/10.1088/1748-9326/abfc77
Singh, A. K., Liu, W., Zakari, S., Wu, J., Yang, B., Jiang, X. J., Zhu, X., Zou, X., Zhang, W., Chen, C., Singh, R., & Nath, A. J. (2021). A Global Review of Rubber Plantations: Impacts on Ecosystem Functions, Mitigations, Future Directions, and Policies for Sustainable Cultivation. In *Science of the Total Environment* (Vol. 796). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2021.148948
Sunarti, S., Syahrul, N., Atisah, A., & Yetti, E. (2022, February 21). *The Rice Myths in Asia: The Comparative Literature Study*. https://doi.org/10.4108/eai.15-9-2021.2315613
Susanti, A., Marhaento, H., Permadi, D. B., Hermudananto, Budiadi, Imron, M. A., Maimunah, S., Susanto, D., Bakhtiar, I., & Lembasi, M. (2020). Smallholder farmers' perception on oil palm agroforestry. *IOP Conference Series: Earth and Environmental Science*, *449*(1). https://doi.org/10.1088/1755-1315/449/1/012056
Vilain, L., Boisset, K., Guillaumin, A., Mouchet, C., Viaux.P, & Zahm.P. (2008). *La méthode IDEA (The IDEA Method: Sustainability Indicators for Agricultural Holdings: User Guide)* (M. Poillot, Ed.; 3rd ed., Issue September 2021). Educagri éditions.
Warren-Thomas, E., Nelson, L., Juthong, W., Bumrungsri, S., Brattström, O., Stroesser, L., Chambon, B., Penot, É., Tongkaemkaew, U., Edwards, D. P., & Dolman, P. M. (2020). Rubber agroforestry in Thailand provides some biodiversity benefits without reducing yields. *Journal of Applied Ecology*, *57*(1), 17–30. https://doi.org/10.1111/1365-2664.13530

Chapter 6 : The Sustainability of Jah Hut Agricultural Practices

6.1. Introduction

This chapter assesses the sustainability of Jah Hut agricultural practices using the *Indicateurs de Durabilité des Exploitations Agricoles* (IDEA) framework, a tool designed to integrate ecological, socio-territorial, and economic dimensions into sustainability assessments (Vilain et al., 2008). While the framework has been applied to small-scale farming systems (Ngo et al., 2021; Agossou et al., 2017), it was not originally developed with Indigenous agricultural contexts in mind. Its application here requires adaptation and critical engagement to ensure that it captures the realities of Jah Hut farming, rather than imposing external sustainability metrics. By highlighting the strengths and weaknesses of agricultural systems, the IDEA framework offers insights into sustainability challenges and opportunities (Biret et al., 2019; Zahm et al., 2013).

This chapter builds on the historical, cultural, and ecological foundations established in earlier chapters, which highlight the Jah Hut community's deep ties to their agricultural practices, the ecological diversity of their farming systems, and their broader socioeconomic contributions (Agossou et al., 2017; Zahm et al., 2008). Rather than treating the IDEA framework as a neutral assessment tool, this study critically engages with it - modifying and interrogating its assumptions to expose the limitations of mainstream sustainability assessments and to better reflect Jah Hut agricultural realities (Ngo et al., 2021).

6.2. Background: Assessing the Sustainability of Indigenous Agriculture

6.2.1. Rationale for Assessing the Sustainability of Indigenous Agriculture

Indigenous agricultural systems are not just production models but deeply embedded cultural, ecological, and political systems that sustain traditional knowledge, biodiversity, and self-determined livelihoods (Mgwenya et al., 2025; Abaniel et al., 2024; Leyva et al., 2021). As Indigenous communities face land dispossession, climate change, and state-imposed economic pressures, assessing the sustainability of their farming practices is critical - not to judge them by external standards, but to recognize their resilience and expose the systemic constraints that threaten their survival (Heredia-R et al., 2022 & 2020; Phondani et al., 2020).

Sustainability assessments offer insights into the adaptability of Indigenous food systems, including their ability to conserve biodiversity, respond to environmental changes, and sustain livelihoods despite external pressures (Molina Maturano et al., 2022). However, these assessments are often shaped by Western agronomic frameworks that emphasize productivity, market efficiency, and formal property ownership, which may not fully capture the communal, land-based, and spiritual dimensions of Indigenous farming. Rather than assuming that sustainability assessments naturally "balance" Western and Indigenous perspectives, it is necessary to critically examine and adapt these frameworks to reflect Indigenous priorities and sovereignty.

Assessing the sustainability of Indigenous agriculture is also crucial for exposing the economic and structural barriers that Indigenous farmers face, including land tenure insecurity, restricted access to ancestral territories, and exclusion from agricultural policy frameworks (Galappaththi & Schlingmann, 2023; Heredia-r et al., 2022; Soldi et al., 2019). While some assessments highlight market struggles (Mgwenya et al., 2025; Leyva et al., 2021; Heredia-R et al., 2020), true sustainability is not just about market access - it is about ensuring that Indigenous communities can sustain their agricultural practices on their own terms without external dependencies. This requires redefining sustainability beyond economic viability to center on food sovereignty, land autonomy, and cultural resilience (Jansen, 2015; Seligmann, 2008; Abbott, 2005). By taking a decolonial approach, sustainability assessments can shift from tools of development planning to mechanisms for advocating Indigenous land rights and agricultural sovereignty.

6.2.2. Sustainability Assessments of Indigenous Agriculture: Methods and Insights

Numerous frameworks have been developed to evaluate the sustainability of Indigenous agricultural systems, each offering unique strengths and limitations. For example, the MESMIS framework integrates 31 indicators to assess multidimensional sustainability, providing insights into adaptability challenges in Hidalgo, Mexico (Leyva et al., 2021). Similarly, the SAFA methodology, developed by the FAO, offers a holistic evaluation of sustainability, facilitating cross-system comparisons, as seen in studies conducted in Paraguay (Soldi et al., 2019).

RISE (Response-Inducing Sustainability Evaluation) complements these frameworks with its policy-oriented design, which evaluates agro-ecological, social, and economic dimensions through structured metrics. Its application in Ecuador revealed the threats of monoculture farming to smallholder agroforestry systems (Heredia-R et al., 2020). While these methods provide critical insights, each has limitations, such as the rigid structures of SAFA and RISE, which may overlook the nuanced practices of Indigenous systems. Table 6.1 summarizes these methods, highlighting their findings, advantages, and challenges, offering a comparative perspective on sustainability assessments.

Methods	Study Location	Findings	Advantages of Methods Used	Difficulties in Methods Used	Authors
MESMIS framework; 31 sustainability indicators were used.	Hidalgo, Mexico	Indigenous systems show strong adaptability but are impacted by youth migration and limited access to water and resources.	Offers a comprehensive framework to measure multidimensional sustainability aspects across social, economic, and environmental dimensions.	Difficulty in addressing the multidimensional nature of sustainability, especially reconciling modern and traditional indicators.	Leyva et al., 2021
SAIC[48] method combining Western and Indigenous sustainability indicators; surveys and focus groups.	Zapotec community, Mexico	Community rated high in sustainability but lacked in health and family planning indicators.	Combines quantitative and qualitative data, ensuring inclusivity of Indigenous perspectives while maintaining analytical rigor.	Balancing Western and Indigenous sustainability indicators proved challenging; some community-specific needs were underrepresented.	Maturano et al., 2021
Semi-structured interviews, detailed surveys, and participatory mapping of irrigation systems.	Dry Zone, Sri Lanka	Indigenous tank-based irrigation systems are vulnerable to modernization and inconsistent management decisions.	Captures local perceptions and historical practices, providing nuanced insights into traditional irrigation management.	Modernization has altered traditional systems, leading to difficulty in defining and preserving Indigenous practices.	Abeywardana et al., 2019
FAO's SAFA methodology with trade-offs among sustainability dimensions.	Amazonian regions (Yasuní Reserve)	Traditional systems are highly resilient but face challenges from migration, market pressures, and low educational levels.	Provides a holistic evaluation of trade-offs among sustainability dimensions, offering actionable insights for socio-ecological balance.	Difficulty in capturing complex interactions between social and ecological dimensions in sustainability assessment.	Heredia-R et al., 2022

[48] *The SAIC method, though focused on general social sustainability, was included as it evaluates assessment systems applicable to agricultural sustainability*

Methods	Study Location	Findings	Advantages of Methods Used	Difficulties in Methods Used	Authors
FAO's SAFA framework with interviews and comparative analysis across agricultural systems.	Paraguay	Indigenous systems show high sustainability levels compared to agribusiness systems.	Enables cross-comparison of different agricultural systems, offering a benchmark for sustainability.	Indicators may not fully reflect the unique dynamics of Indigenous systems, leading to partial evaluations.	Soldi et al., 2019
Surveys and interviews with farmers, documentation of agroforestry species, and perception analysis of sustainability indicators.	Uttarakhand, India	High reliance on traditional knowledge to manage diverse agroforestry systems.	Directly incorporates farmers' perspectives, ensuring locally relevant insights and practical solutions.	Difficulty in integrating diverse perceptions and aligning local practices with modern sustainability frameworks.	Phondani et al., 2020
RISE methodology evaluating social, economic, and ecological dimensions of traditional systems.	Ecuadorian Amazon	Agroforestry systems contribute significantly to biodiversity and local livelihoods but are under threat from market-driven monocultures.	Quantifies sustainability in a structured manner, providing clear indicators for targeted policy interventions.	Challenges in applying standardized methodologies like RISE to unique and variable Indigenous practices.	Heredia-R et al., 2020

TABLE 6.1: SUMMARY OF SELECTED METHODS FOR SUSTAINABILITY ASSESSMENTS OF INDIGENOUS AGRICULTURE

6.3. The IDEA Framework

6.3.1. Overview of the IDEA Methodology

The *Indicateurs de Durabilité des Exploitations Agricoles* (IDEA) or Indicators of Farm Sustainability (IDEA) framework is a multidimensional tool designed to assess agricultural sustainability comprehensively (Zahm et al., 2008; IDEA Guide, 2007). It evaluates agroecological, socio-territorial, and economic dimensions through 10 components, 42 indicators, and 129 elements or criteria, ensuring a detailed and holistic analysis (Zahm et al., 2008; IDEA Guide, 2007). By balancing ecological sustainability with social and economic considerations, IDEA provides actionable insights into the strengths and weaknesses of farming systems (Biret et al., 2019; Agossou et al., 2017). Figure 6.1illustrates the hierarchical structure of the IDEA framework, depicting its dimensions, components, indicators, and elements/ criteria.

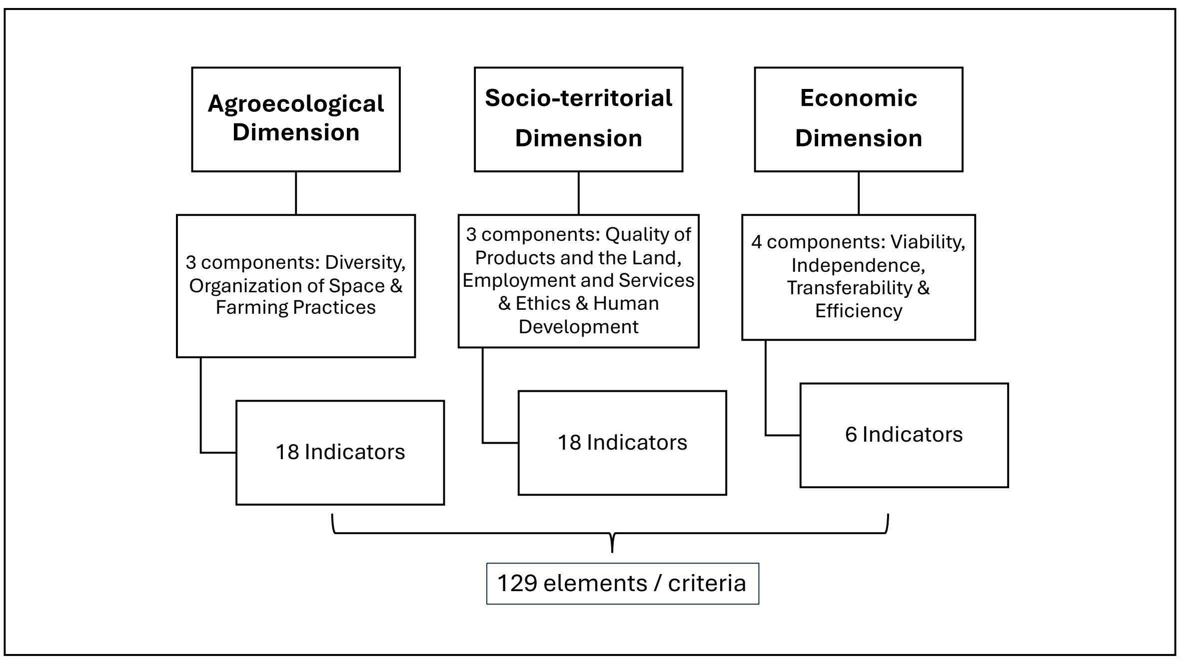

FIGURE 6.1: STRUCTURE OF THE IDEA FRAMEWORK

The framework's dimensions capture critical aspects of sustainability. The environmental dimension evaluates biodiversity, soil health, water management, and energy use, emphasizing ecological resilience (Zahm et al., 2008; Ngo et al., 2021). The socio-territorial dimension examines community integration through indicators like employment, cultural preservation, and human development (Agossou et al., 2017; M'Hamdi et al., 2009). Finally, the economic dimension assesses financial viability, efficiency, and resilience, addressing market-related challenges (Zahm et al., 2008; IDEA Guide, 2007).

The framework's indicators function as diagnostic and decision-support tools, enabling farmers to identify strengths and weaknesses in their operations and providing pathways for improvement (Agossou et al., 2017; Zahm et al., 2013). Designed to be scientifically rigorous, adaptable, and easy to implement, the IDEA framework is well-suited for diverse agricultural systems (Zahm et al., 2008; IDEA Guide, 2007).

6.3.2. Applications of the IDEA Framework

The IDEA framework has been widely applied across various agricultural contexts, demonstrating its adaptability to diverse farming systems and socio-ecological conditions (Biret et al., 2019; Zahm et al., 2008). For instance, it was adapted in Thailand to assess the sustainability of rubber family farms, uncovering both strengths and challenges across environmental, social, and economic dimensions (Biret et al., 2019). In Benin, the framework was modified to account for local conditions by adjusting indicators such as plot size and land use patterns, reflecting region-specific agricultural practices (Agossou et al., 2017). In Tunisia, the framework was applied to dairy farms, where the socio-territorial dimension revealed opportunities to enhance employment and community integration (M'Hamdi et al., 2009). These applications demonstrate the flexibility of the IDEA framework in addressing unique regional needs while maintaining methodological consistency (Zahm et al., 2008; IDEA Guide, 2007).

6.3.3. Comparative Analysis: IDEA Framework vs. Other Methods

The IDEA framework distinguishes itself from other methods such as MESMIS, SAFA, and RISE, by offering a unique combination of comprehensiveness, adaptability, and participatory design. While MESMIS and RISE provide valuable insights into multidimensional sustainability, IDEA excels in its ability to adapt indicators to local contexts, as seen in applications to Benin and Thailand (Agossou et al., 2017; Biret et al., 2019). Unlike SAFA, which focuses on standardized comparisons, IDEA emphasizes participatory approaches, involving local stakeholders to ensure context-specific relevance.

IDEA’s detailed indicators enable a granular analysis highlighting areas of weakness for targeted improvements. Its accessible design makes it a practical tool for farmers, educators, and policymakers, bridging the gap between technical rigor and user-friendliness. Table 6.2 summarizes this comparison, highlighting IDEA’s strengths in scope, adaptability, and policy relevance, which make it an ideal framework for assessing agricultural sustainability in diverse contexts.

Aspect	IDEA Framework	Other Methods
Scope of Evaluation	Covers 42 indicators grouped into 10 components across agro-ecological, socio-territorial, and economic scales. Offers a holistic and detailed analysis of farm sustainability.	MESMIS and SAFA provide multidimensional analyses but typically focus on fewer indicators, emphasizing general sustainability or specific aspects like food systems.
Context Adaptability	High adaptability; indicators can be adjusted to local contexts and agricultural systems (e.g., tropical farming in Thailand, small farms in Benin).	MESMIS and RISE allow for contextual modifications, but SAFA's standardized framework offers limited flexibility.
Level of Granularity	Uses quantitative and qualitative data to provide detailed and specific results; applies a "limiting factor rule" to highlight the weakest sustainability dimension.	Methods like MESMIS and RISE provide comparable detail but may lack the specific limiting-factor focus seen in IDEA.
Ease of Use and Training	Developed as a pedagogical tool, it is designed for use by farmers, educators, and policymakers. Provides clarity and accessibility for local-level application and stakeholder involvement.	SAFA and MESMIS are designed more for expert use or institutional application, often requiring training.
Advantages in Application	Emphasizes local stakeholder input during adaptation (e.g., participatory approaches in Benin and Thailand). Ability to diagnose weaknesses and suggest specific improvements.	Other methods, while holistic, may not integrate participatory approaches as extensively, focusing more on standardized assessment frameworks.
Policy Relevance	Highly applicable for designing localized policies due to its structured, adaptable indicators.	RISE and SAFA also provide policy-relevant insights but may lack IDEA's granularity in addressing specific components such as territorial or cultural sustainability.

TABLE 6.2: COMPARATIVE ANALYSIS OF SUSTAINABILITY ASSESSMENT METHODS FOR AGRICULTURE

6.3.4. Rationale for Selecting the IDEA Framework for this Study

The IDEA framework was selected for this study due to its structured yet adaptable methodology, allowing for a detailed assessment of sustainability across agroecological, socio-territorial, and economic dimensions. Given the diversity of Jah Hut agricultural systems - shifting cultivation, home gardens, rubber and oil palm cultivation - the framework's flexibility enabled key modifications to ensure relevance. To better capture the ecological, cultural, and economic realities of Jah Hut farming, indicators were adjusted, omitted, or introduced to reflect land-use patterns, resource management strategies, and livelihood priorities. While originally designed for commercial agricultural contexts, these modifications made the framework more applicable to Jah Hut practices, highlighting their adaptive strengths and the broader challenges they face, including state policies, market pressures, and land-use restrictions.

In this study, the IDEA framework was not used in a participatory co-development process, as the focus was on applying it as a rapid assessment tool. Extensive stakeholder engagement was beyond the scope of this research; instead, the framework was refined through detailed contextual analysis to align with the study's objectives. By customizing the indicators and maintaining the framework's core structure, the assessment provided systematic and quantifiable data on sustainability without compromising rigor. The modified framework's ability to address general sustainability dimensions and unique local practices made it particularly effective for evaluating the Jah Hut systems and generating actionable insights.

6.3.5. Adjustments for Context

The modifications to the IDEA framework for this study (Figure 6.2) were designed to better align with the Jah Hut agricultural context while maintaining the integrity of its core sustainability principles. Given that the original framework was developed within agronomic traditions that often prioritize commercial agricultural models, it was necessary to refine certain indicators to more accurately reflect the socio-ecological and cultural realities of Jah Hut farming.

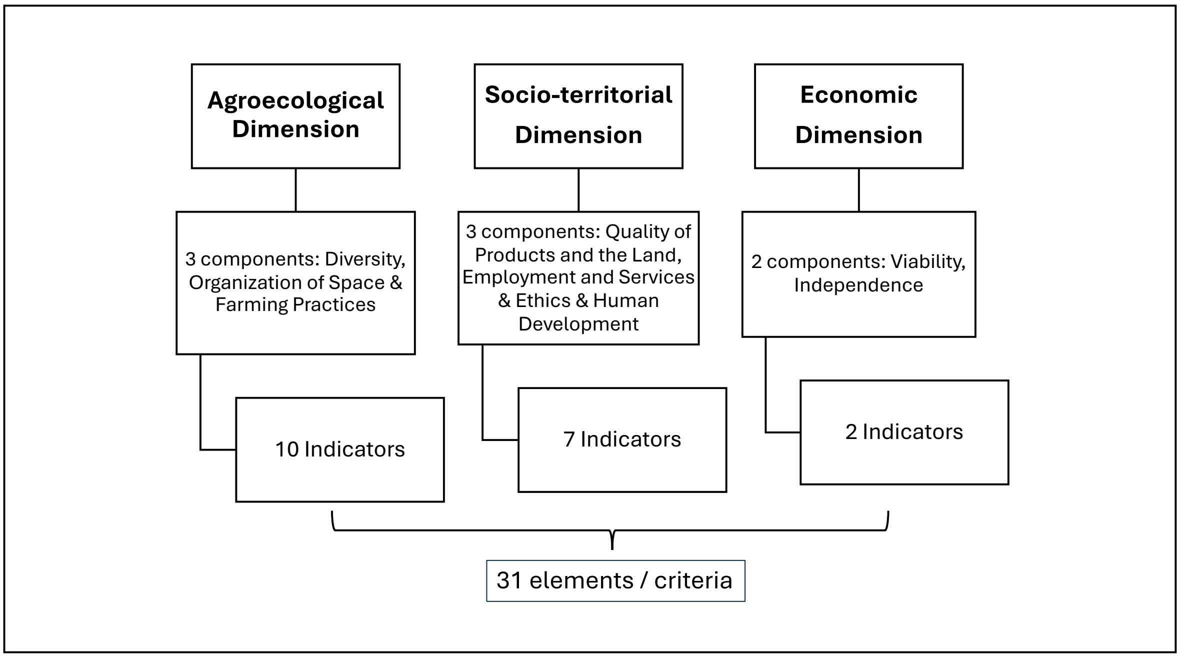

FIGURE 6.2: MODIFIED IDEA FRAMEWORK USED IN THIS STUDY

Key modifications included expanding the assessment of genetic diversity to incorporate variety-level evaluations (Indicators A1 and A2), acknowledging the Jah Hut's reliance on crop diversity as a resilience strategy in both shifting cultivation and home gardens. Similarly, crop rotation (A5) was redefined to include intercropping, a fundamental Jah Hut practice that sustains soil fertility and reduces dependence on external inputs. The original IDEA framework's emphasis on static ecological buffer zones was adapted to account for plots left fallow post-harvest, a dynamic form of regeneration that is central to swidden systems.

Controlled burning (A16) was introduced as an indicator to reflect the ecological role of fire in Jah Hut swidden agriculture. Unlike large-scale deforestation practices, controlled burning is a carefully managed process that enhances soil fertility, accelerates nutrient cycling, and reduces pest infestations (Maezumi et al., 2022; Welch et al., 2013). This practice is not merely a land-clearing method but a deeply rooted Indigenous land management strategy that maintains ecosystem balance and ensures productivity in subsequent planting cycles. The inclusion of this indicator challenges mainstream sustainability frameworks that often equate all forms of burning with environmental degradation, ignoring its role in traditional agroecological systems.

Similarly, herbicide use (A14b) was modified to distinguish between chemical dependency and strategic, minimal herbicide application in Jah Hut agriculture. While industrial plantations rely heavily on herbicides, Jah Hut farmers often employ selective use as a labor-saving measure, particularly in cases where manual weeding is infeasible due to age, labor shortages, or the expansion of oil palm and rubber plots. Recognizing this distinction prevents a one-size-fits-all assessment that penalizes Indigenous farmers without considering their lived realities and decision-making processes regarding land management.

Beyond agroecological considerations, land tenure (B4) was introduced to capture the socio-territorial significance of land access, recognizing that Jah Hut farming is shaped not just by environmental factors but also by legal and customary constraints. Existing multiactivity indicators (B8) were streamlined to focus on intergenerational continuity in farming, a critical aspect of Indigenous agricultural sustainability. By incorporating these adjustments, the framework offers a more contextually relevant tool for assessing the sustainability of Jah Hut agriculture, while simultaneously revealing the limitations of standard metrics when applied to Indigenous systems.

Table 6.3 summarizes the streamlined framework while ensuring its relevance to the Jah Hut context. Indicators irrelevant to subsistence farming, such as animal diversity (indicator A3) or veterinary treatments (indicator A15), were omitted. Justifications for all omitted indicators are provided in Appendix 6.1. Reformulations and additions were designed to capture nuanced aspects of Jah Hut practices, such as controlled burning and cooperative labor, ensuring a holistic yet practical assessment.

Aspects	Original IDEA Framework	Removed	Added	Reformulated	Total used in this study
Dimensions	3	0	0	0	**3**
Components	10	2	0	0	**8**
Indicators	42	25	1	4	**18**
Criteria	129	104	6	4	**31**

TABLE 6.3: SUMMARY OF ADJUSTMENTS TO THE IDEA FRAMEWORK

For each indicator, detailed scales were developed to evaluate sustainability across a range of practices, from unsustainable to highly sustainable. These scales were contextualized to reflect Jah Hut agricultural systems and provide practical criteria for real-world application. For example:

i. Genetic Diversity (A1): Scored based on the number of crop varieties, with higher scores indicating greater diversity and resilience.
ii. Land Tenureship (B4): Evaluated based on the security of communal or individual land access and its impact on long-term sustainability.

The criteria and scales for each indicator are described in Appendix 6.2 and 6.3 respectively, which includes the thresholds and contextual descriptions for each indicator. This approach ensured clarity, usability, and consistency across all evaluated systems. The maximum score for all criteria is shown in Table 6.4.

Reformulated IDEA Indicators	**Criteria**	**Maximum Score**
AGROECOLOGICAL DIMENSION (Total Score: 50)		
Component 1: Diversity		
A1: Diversity of annual/temporary crops by species and variety	1. Number of annual/ temporary crops by species	5
	2. Number of annual/ temporary crops by variety (new addition)	5
A2: Diversity of perennial crops by species and variety	3. Number of perennial crops by species	5
	4. Number of perennial crops by variety (new addition)	5
Component 2: Organization of Space		
A5: Crop rotation / intercropping	5. Crop rotation / intercropping	5
A8: Plots left to fallow post-harvest	**6. Plots left to fallow post-harvest (new addition)**	3
Component 3: Farming Practices		
A12: Organic fertilization	7. Organic fertilization	3
A14a: Agroecological pest management	8. Agroecological pest management	3
A14b: Weed control (new addition)	**9. Addition of herbicide (new addition)**	3
A16: Soil protection	10. No-tillage farming	5
	11. Controlled burning (new addition)	2
A17: Water resource management	12. Rainfed system / No irrigation required	3
A18: Energy dependency	13. Mechanization requirement	3
SOCIO-TERRITORIAL DIMENSION (Total Score: 54)		
Component 4: Quality of the Products and the Land		
B4: Access to the farm	**14. Land tenure (new addition)**	3
	15. Accessibility of agricultural land by trail or tracks	3
Component 5: Employment and Services		

Reformulated IDEA Indicators	Criteria	Maximum Score
B7: Autonomy and enhancement of local resources	16. Percentage of local food production	3
	17. Recovery of rainwater	3
	18. Seed production	3
B9: Contribution to livelihood	19. Contribution to livelihood	3
B11: Probable farm sustainability	20. Willingness of the next generation to continue traditional farming	5
	21. Existence of a knowledge transfer system within the community	3
	22. Belief that the farm will exist over the next 10 years	5
Component 6: Ethics and Human Development		
B15: Labour intensity	23. Farmers found their job tiring most of the time	3
	24. Community cooperation in farm work	3
B16: Quality of life	25. Provision of basic amenities (water supply, electricity, roads, telecommunication infrastructure)	3
	26. The state of means of transport (bicycle, motorbike, car, etc.)	5
B17: Self-assessment on feelings of isolation based on:	27. Geographic Isolation	3
	28. Social Isolation	3
	29. Cultural Isolation	3
ECONOMIC DIMENSION (Total Score: 6)		
Component 7: Viability		
C1: Economic viability	30. Farmer's perception on the sufficiency of their income	3
Component 8: Independence		
C4: Sensitivity to subsidies	31. Independence from government aid	3
Total Possible Score		**110**

TABLE 6.4: MAXIMUM SCORES BY CRITERIA FOR MODIFIED IDEA INDICATORS

6.3.6. Thresholds for Sustainability Classification

For this study, sustainability thresholds were established using the Modified IDEA Framework. The total possible score was 110, distributed as follows: Agroecological (50 points), Socio-Territorial (54 points), and Economic (6 points). To ensure proportional representation, all scores were normalized. The categorization of sustainability levels based on normalized scores is summarized in Table 6.5.

Sustainability Level	Normalized Score Range	Description
High Sustainability	≥ 75%	Strong alignment with sustainability principles across all dimensions
Moderate Sustainability	50–74%	Mixed performance with strengths in some dimensions, highlighting areas for targeted improvement.
Low Sustainability	< 50%	Significant challenges in achieving sustainability, with weaknesses in one or more dimensions.

TABLE 6.5: SUSTAINABILITY CLASSIFICATION BASED ON NORMALIZED SCORES

The thresholds are consistent with methodologies from the IDEA framework (Vilain et al., 2008) and adaptations for Indigenous agricultural systems (e.g. Barat et al, 2016). The ≥75% cutoff reflects the framework's emphasis on balancing agroecological, socio-territorial, and economic dimensions. While agroecological and socio-territorial factors dominate due to their centrality in Jah Hut swidden farming, economic indicators provide complementary insights into livelihood viability.

This study employed a rapid assessment approach, precluding extensive validation through stakeholder consultation or longitudinal analysis. Such constraints are consistent with the study's objective to provide preliminary evaluations rather than definitive sustainability measurements. Rapid assessment techniques are widely recognized for their utility in resource-limited contexts, offering valuable insights for guiding further research and intervention.

6.4. Data Collection

The data was collected using semi-structured questionnaires for households (explained in Chapter 3, section 3.4.2.). The collected data were then organized and coded to align with the indicators and criteria of the modified IDEA framework. This systematic approach facilitated sustainability assessment across the agroecological, socio-territorial, and economic dimensions, ensuring that the framework reflected the realities of the Jah Hut's agricultural systems.

6.5. Data Analysis

6.5.1. Quantitative Analysis

Quantitative data corresponding to the framework's criteria were analyzed using R software. Descriptive statistics summarized key findings for each agricultural system - home gardens, shifting cultivation (traditional agriculture), rubber cultivation, and oil palm cultivation. Comparative analyses across these categories identified patterns and differences in sustainability performance.

6.5.1.1. Normalization of Scores

Aggregated scores for indicators and dimensions provided an overall sustainability assessment for each agricultural system. Given that the 31 criteria varied in ranges (e.g., 0–3, 0–5), type (ordinal and binomial), and importance, normalization was applied to ensure comparability across indicators and dimensions while preventing bias in the total scores.

6.5.1.2. Rationale

The sustainability indicators used in this study had differing numerical ranges, with some criteria scored on a scale of 0–5 (e.g., crop diversity) and others on a scale of 0–3 (e.g., mechanization requirement). Without normalization, indicators with larger scales would disproportionately influence the total score, making direct comparisons between indicators and dimensions unreliable. Additionally, the dataset contained a mix of ordinal indicators, such as crop rotation (scored 0–5), and binomial indicators, such as recovery of rainwater (scored as either 0 or 3). To ensure that both ordinal and binomial indicators contributed fairly to the overall sustainability score, normalization was applied to transform all indicator values into a comparable scale before analysis. This approach ensured that indicators with larger scoring ranges did not dominate the overall assessment and that each variable's influence remained proportional.

6.5.1.3. Method

Normalization was carried out in two stages: at the indicator level and at the dimension level. At the indicator level, scores were transformed using Min-Max Scaling, which standardizes values within a 0–100 scale, allowing for meaningful comparisons across all indicators. The formula applied was:

Normalized Indicator Score = (Actual Indicator Score/Maximum Possible Indicator Score) x 100

Once individual indicators were normalized, the scores for each sustainability dimension - agroecological, socio-territorial, and economic - were calculated by averaging the normalized indicator scores within each respective dimension. This aggregation ensured that dimension scores remained proportional to their highest possible value. The formula used for computing the dimension score was:

Dimension Score = (∑Normalized Indicator Scores in Dimension/Number of Indicators in Dimension) x 100

By computing the sustainability dimension scores in this manner, all dimensions were expressed as percentages of their maximum possible score, ensuring consistency and comparability across different agricultural systems.

6.5.1.4. Statistical Testing and Visualization

To evaluate the differences in sustainability performance across agricultural systems, the Kruskal-Wallis Test was used to assess whether the median sustainability scores differed significantly among the four categories of agricultural systems. This method was chosen because all the data were ordinal or not normally distributed. To present sustainability scores effectively, tables, bar charts and boxplots were used to illustrate distributions and highlight variability within and across agricultural systems.

6.5.2. Qualitative Analysis

Qualitative data from open-ended questionnaire responses and field observations were analyzed thematically, identifying recurring patterns related to cooperative labor practices, land tenure challenges, and intergenerational knowledge transfer. These themes were systematically coded and mapped onto the socio-territorial and cultural indicators within the IDEA framework, ensuring that the assessment captured the lived realities of Jah Hut farmers. By integrating qualitative insights with quantitative findings, this approach provided a more nuanced understanding of sustainability, highlighting the social and cultural dimensions that standard evaluations often overlook.

6.6. Overview of Jah Hut Agricultural Practices

The Jah Hut community engages in four primary agricultural systems: shifting cultivation, home gardens, rubber plantations, and oil palm cultivation. Each system serves distinct purposes, contributing to livelihoods, food security, and economic stability. Shifting cultivation, as the most traditional farming system, has been examined in detail in Chapter 5, highlighting its spiritual, ecological, and cultural significance. This regenerative practice involves clearing fallow land (*belukar lama*), controlled burning, and multi-cropping of hill rice, vegetables, and tubers.

6.6.1. Rubber and Oil Palm Cultivation

Rubber (Figure 6.3) and oil palm (Figure 6.4) are the primary cash crops promoted within the Jah Hut community, providing essential income. They are cultivated on small, scattered plots, often reclaimed from former swidden fields, and largely depend on stray seedlings (*anak gampang*).

FIGURE 6.3: A JAH HUT RUBBER PLOT IN SG MAI (9 SEPTEMBER 2022)

FIGURE 6.4: A JAH HUT OIL PALM PLOT IN BERDUT (23 JULY 2022)

Figure 6.5 illustrates the reliance on different seedling sources, highlighting that 64% of oil palm and 62.6% of rubber plants originate from stray seedlings rather than high-quality commercial planting materials. Jah Hut farmers reported that the yield and quality of fresh fruit bunches (FFB) and palm oil from such sources are significantly lower than those from commercial seedlings. Consequently, farmers receive lower prices for their produce compared to FELDA settlers who use commercial planting materials. Similarly, rubber productivity declines when weed overgrowth leads to competition for nutrients, further undermining potential earnings.

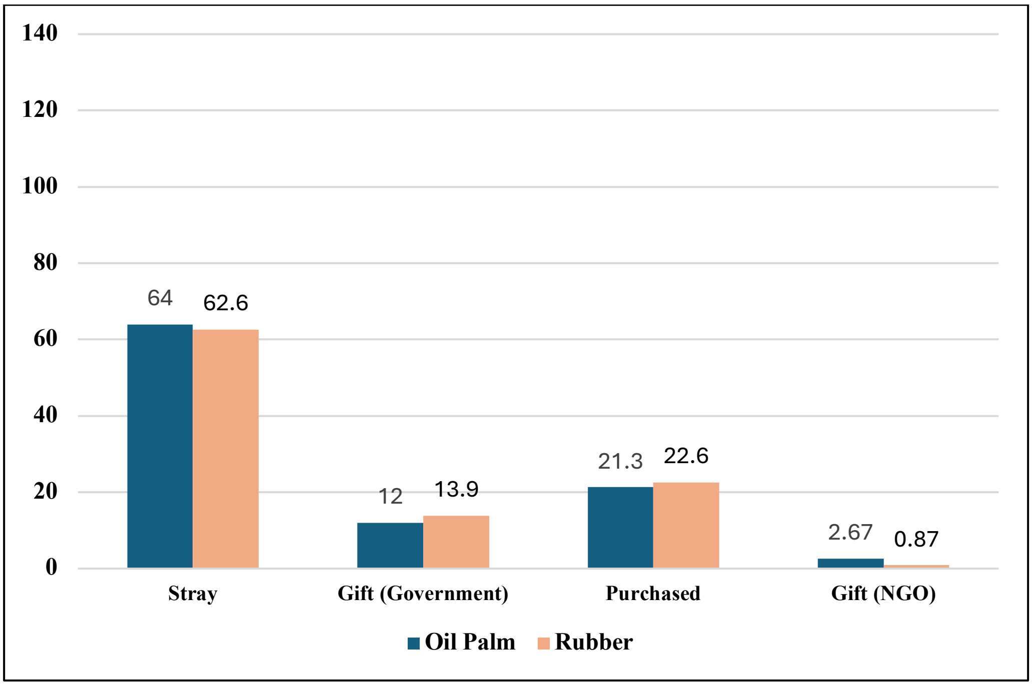

FIGURE 6.5: SOURCES OF SEEDLING FOR OIL PALM AND RUBBER CULTIVATION (%)

Government programs account for a relatively minor role in seedling supply, assisting only 12% of oil palm farmers and 13.9% of rubber farmers. This disparity underscores the unequal distribution of resources and support between Indigenous farmers and larger settler schemes. Market-purchased seedlings represent a more significant proportion, covering 21.3% of oil palm and 22.6% of rubber plantations, while NGO contributions remain negligible at 2.67% and 0.87%, respectively.

Seasonal factors exacerbate challenges related to rubber yield. Rubber tapping is highly weather-dependent, and during the rainy season, farmers cannot tap rubber, leaving them without income. While the Monsoon Assistance (*Bantuan Musim Tengkujuh*, or BMT) program provides some financial relief (an annual grant of RM600 per household), it is distributed sparingly and cannot offset income losses during non-tapping periods. The eligibility criteria and bureaucratic process remain unclear, leading to inconsistencies in access. Additionally, poor infrastructure hampers the efficiency of harvesting and transporting oil palm fresh fruit bunches, increasing costs and reducing profitability.

Market volatility further impacts farmers, as price fluctuations in rubber and palm oil markets leave them vulnerable to external shocks, reinforcing a cycle of economic dependency. Although government agencies such as JAKOA (Department of Orang Asli Development), MPOB (Malaysian Palm Oil Board), and RISDA (Rubber Industry Smallholders Development Authority) provide some assistance, their support is often limited to one-off programs. For example, JAKOA has distributed rubber seedlings as part of a single initiative rather than an ongoing program in Pasu and Sungai Mai. Given the high cost of rubber seedlings at RM6 each, a majority of Jah Hut farmers from all three villages are unable to afford them without external assistance.

6.6.2. Key Differences Across Systems

The Jah Hut's agricultural systems reveal a dual dynamic of sustainability and vulnerability. Shifting cultivation and home gardens, rooted in cultural traditions and ecological wisdom, prioritize subsistence and biodiversity conservation. By contrast, rubber and oil palm systems, driven by market incentives, expose the community to economic instability and declining productivity. While shifting cultivation faces increasing land pressures and policy restrictions, the cash-crop systems are constrained by systemic inequities in market access, resource distribution, and infrastructure development. These findings set the stage for a detailed sustainability assessment of each system in the subsequent sections.

6.7. Application of the IDEA Method to Jah Hut Agricultural Practices

This section evaluates the sustainability of four Jah Hut agricultural systems using a modified version of the IDEA framework. The assessment covered 58 oil palm plots, 92 rubber smallholdings, 31 shifting cultivation plots, and 68 home gardens, with data collected through household interviews and field observations. The findings examine sustainability across environmental, socio-territorial, and economic dimensions, offering a comprehensive perspective on how these agricultural practices function within both local realities and external constraints.

6.7.1. Acknowledging Overlaps in Agricultural Practices

Many households engage in a combination of agricultural practices, such as maintaining home gardens alongside cultivating rubber or oil palm. For analytical purposes, the assessment categorizes the systems into four distinct types: shifting cultivation, home gardens, rubber plantations, and oil palm cultivation. However, this categorization simplifies the complex, overlapping nature of Jah Hut livelihoods. Respondents frequently participate in multiple systems simultaneously, reflecting the interdependent and multi-dimensional nature of their agricultural strategies. While the data were analyzed as independent observations for methodological consistency, this overlap has been acknowledged and considered in interpreting results.

6.7.2. Shared Challenges and Contextual Considerations

Criteria such as land tenure, transport infrastructure, and access to basic amenities remain largely uniform across farming systems because they reflect broader village-level conditions rather than system-specific factors. For instance, land tenure challenges affect all farmers in the same locality, regardless of whether they practice shifting cultivation, rubber, or oil palm farming. Similarly, access to infrastructure and communal amenities is shaped by shared systemic factors, such as village remoteness or proximity to markets.

While minor variations may occur - for example, differences in infrastructure access depending on proximity to roads or the degree of market engagement - these indicators are best interpreted as reflecting shared systemic constraints rather than fundamental differences between farming systems. As such, results tied to these criteria must be understood within the broader structural challenges faced by the Jah Hut community.

6.7.3. Overall Sustainability Across Cultivation Types

The normalized sustainability scores reveal notable variations across the four agricultural systems assessed – shifting cultivation (traditional farming), home gardens, rubber, and oil palm - as depicted in Figure 6.6 and Figure 6.7. None of the systems achieved high sustainability (≥75%), with scores falling within the moderate sustainability range (50 - 74%). The Kruskal-Wallis test ($p<0.001$) confirms statistically significant differences between the systems, with an eta-squared value ($\eta^2 = 0.48$) indicating that nearly half of the variance in scores is attributable to differences between cultivation types.

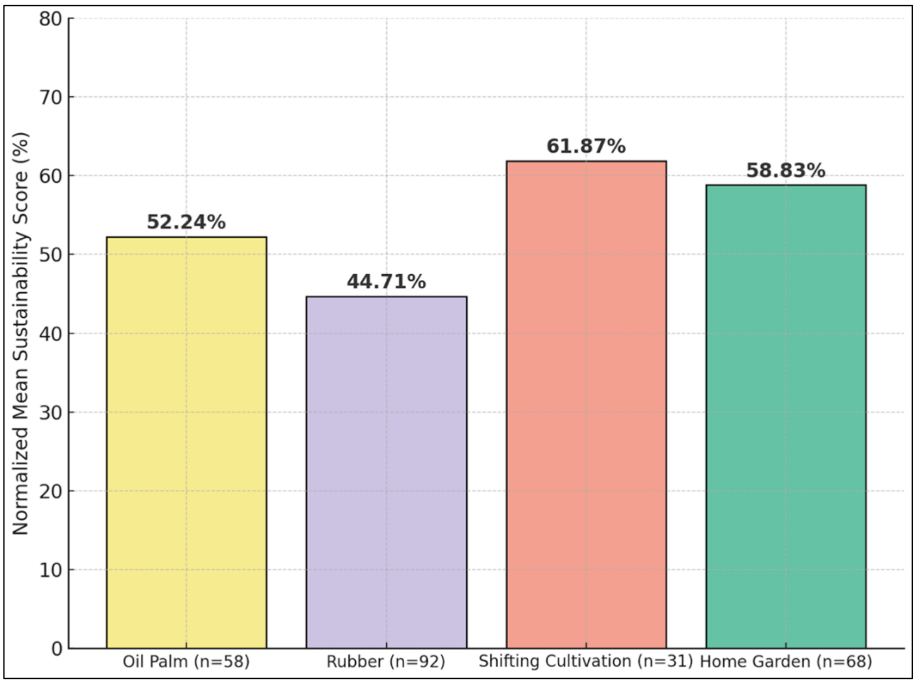

FIGURE 6.6: NORMALIZED MEAN SUSTAINABILITY SCORES BY CULTIVATION TYPE

Shifting cultivation achieved the highest mean sustainability score (61.87 ± 4.53), followed closely by home gardens (58.83 ± 3.43). Both systems fall within the upper range of moderate sustainability, reflecting their continued reliance on diverse, site-specific practices. Oil palm (52.24 ± 3.73) and rubber (44.71 ± 3.27) scored lower, demonstrating consistently poorer sustainability outcomes across criteria. The boxplots (Figure 6.5) highlight limited variability in oil palm and rubber systems, whereas shifting cultivation shows moderate variability, indicating localized adaptations among farmers.

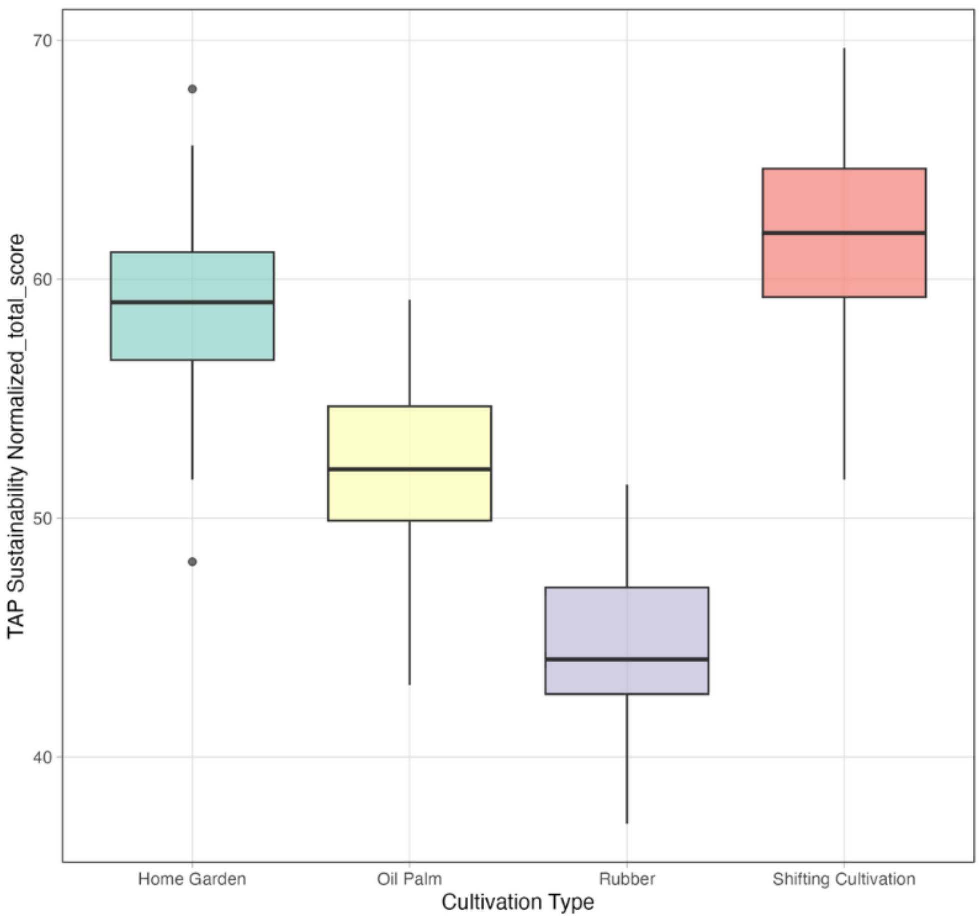

FIGURE 6.7: BOXPLOT OF NORMALIZED SUSTAINABILITY SCORES BY CULTIVATION TYPE

These results provide an overview of sustainability differences between systems and serve as a foundation for more detailed analyses. The subsequent sections will evaluate how these scores vary across the agroecological, socio-territorial, and economic dimensions, as well as the underlying criteria that shape sustainability outcomes.

6.7.4. Agroecological Dimension Analysis

The agroecological dimension reveals significant differences in performance among the four cultivation systems, as confirmed by the Kruskal-Wallis test ($p<0.001$ for all categories). Effect sizes (eta-squared) indicate substantial variability, with values ranging from 26% (perennial crop diversity) to 61% (crop rotation/intercropping). These results highlight the critical role of cultivation practices in shaping agroecological outcomes.

Figure 6.8 highlights these variations, with shifting cultivation as the top performer with the highest median score and consistent outcomes (relatively narrow interquartile range, or IQR).

However, outliers below the lower quartile suggest variability, potentially due to differences in local practices or resource constraints. Home gardens show moderate performance but a wider IQR, reflecting variability in practices and outcomes. Oil palm and rubber have the lowest median scores and the tightest distributions, indicating consistent but poor agroecological outcomes.

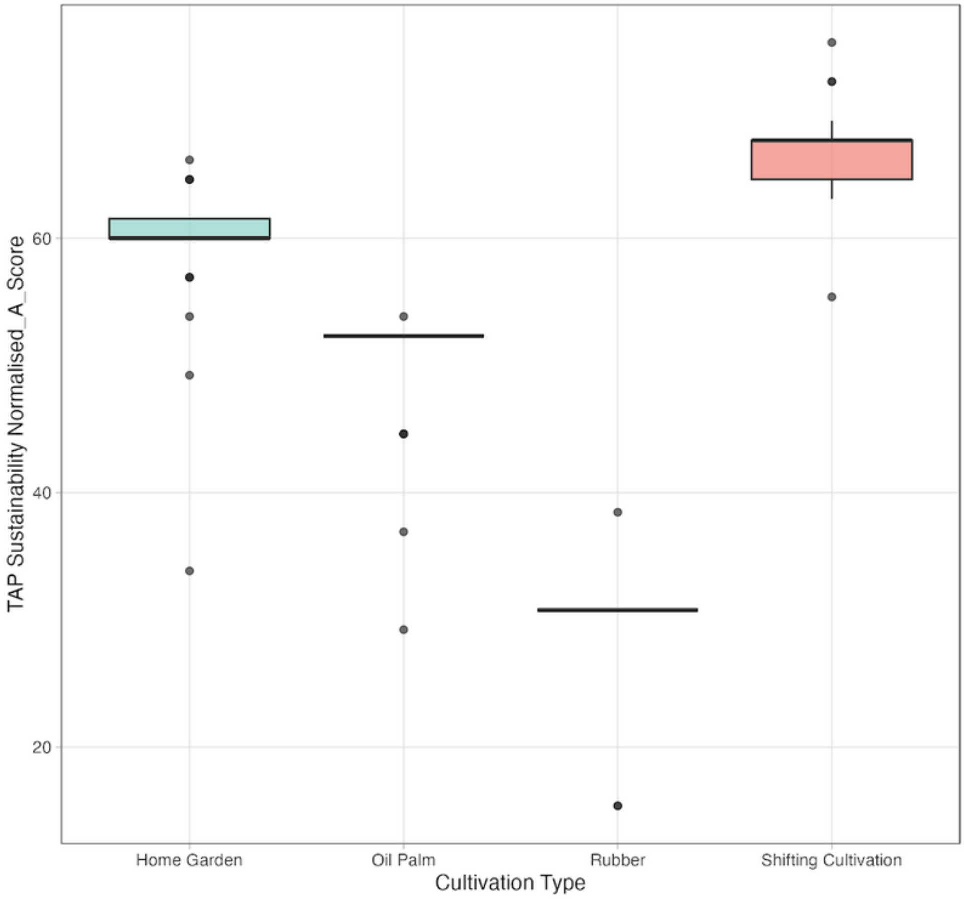

FIGURE 6.8: BOXPLOT OF AGROECOLOGICAL SCORES BY CULTIVATION TYPE

Table 6.6 summarizes the performance of 13 agroecological criteria across cultivation systems. Shifting cultivation consistently excels, particularly in crop diversity, crop rotation, and reduced reliance on chemical inputs, showcasing its ecological advantages. Home gardens perform well in pest management and mechanization efficiency, while oil palm and rubber systems lag across most criteria. These trends highlight the varying capacities of cultivation systems to align with agroecological principles and set the stage for more detailed analysis in subsequent sections.

Criteria	Shifting Cultivation	Home gardens	Oil palm	Rubber	Significance (Kruskal-Wallis test) (p-value)	Eta-squared
Number of annual/ temporary crops by species	41.29	0.59	0	0	S (p<0.001)	0.59
Number of annual/ temporary crops by variety	50.32	0.59	0	0	S (p<0.001)	0.59
Number of perennial crops by species	78.71	57.94	40.34	40.22	S (p=0.04)	0.26
Number of perennial crops by variety	40	40	40	39.57	NS (p=0.9)	-
Crop rotation/intercropping	60	0	0	0		
Plots left to fallow post-harvest	0	0	0	0	-	-
Organic fertilization	96.77	95.59	86.21	94.57	NS (p=0.9)	-
Agroecological pest management	100	98.53	98.28	31.52	S (p<0.001)	0.59
Addition of herbicide	3.23	89.71	0	1.09	S (p<0.001)	0.50
No-tillage farming	100	100	96.55	97.83	NS (p=0.9)	-
Controlled burning	100	100	100	100	NS (p=0.9)	-
Rainfed system/ irrigation not required	100	98.53	100	100	NS (p=0.9)	-
No mechanization requirement	96.77	100	94.83	97.83	NS (p=0.9)	-

TABLE 6.6: MEAN SCORES (%) FOR CRITERIA IN THE AGROECOLOGICAL DIMENSION

(S=Significant; NS= Not Significant)

6.7.4.1. Diversity

Shifting cultivation exhibits the highest diversity across all categories (Table 6.6). For annual crops, it scores 41.29% for species and 50.32% for varieties, significantly outperforming home gardens (0.59%) and monoculture systems (0% for oil palm and rubber). The large eta-squared values (0.59 for both species and variety) indicate substantial differences between systems in annual crop diversity. For perennial crops, shifting cultivation leads with 78.71% species diversity (eta-squared = 0.26), followed by home gardens (57.94%), with oil palm (40.34%) and rubber (40.22%) lagging.

This high species and variety diversity in shifting cultivation is not incidental - it reflects a deliberate ecological strategy by Jah Hut farmers to integrate food security with biodiversity conservation and ecological resilience. Unlike monoculture systems, which optimize economic efficiency at the cost of genetic diversity and habitat complexity, shifting cultivation maintains a heterogeneous landscape that supports in-situ conservation of traditional crop varieties. The intentional maintenance of diverse cropping systems helps safeguard genetic resources, which are crucial for long-term agricultural resilience, pest resistance, and climate adaptation.

Mixed cropping systems, such as intercropping hill rice with perennial species, enhance productivity while preserving ecosystem functions. Field observations in Pasu Village illustrate how farmers interplant hill rice with oil palm seedlings, finding that nutrient competition is minimal. This synergistic approach demonstrates an active strategy to optimize land use without compromising biodiversity. Similarly, in Sungai Mai, where land scarcity is acute, farmers integrate cash crops like oil palm and rubber into shifting cultivation fields or convert small orchards into intercropped systems. These adaptive responses highlight not only the cultural and economic flexibility of shifting cultivation but also its capacity to sustain agrobiodiversity in response to changing land-use pressures.

Home gardens, while less diverse in annual crops, play a critical role in perennial species conservation. These gardens prioritize perennial crops such as fruit trees, ensuring continuous yields with minimal maintenance. This strategy not only strengthens food security but also preserves traditional plant varieties that might otherwise be lost to agricultural intensification. By contrast, monoculture systems such as oil palm and rubber plantations exhibit negligible diversity in annual crops and are structured to maximize cash crop production through uniform planting schemes. The absence of genetic diversity in monocultures leads to increased vulnerability to pests, soil degradation, and loss of associated biodiversity. These findings underscore a fundamental trade-off: while monocultures optimize short-term economic returns, they do so at the cost of long-term biodiversity conservation and ecological sustainability.

Clarification of Diversity Measures

The results presented in Table 6.6 and Figure 6.9 measure diversity from two different but complementary perspectives. Table 6.6 reports the mean diversity scores per cultivated plot, reflecting the relative diversity within each system on a per-unit basis. In contrast, Figure 6.9

displays the total number of species and varieties recorded across all sampled plots within each system, providing an overall measure of species richness at the system level. This distinction explains why shifting cultivation plots exhibit higher diversity scores (percentage of species per plot) than home gardens, even though home gardens contain a greater overall number of species across the landscape. In other words, while home gardens serve as long-term reservoirs of species diversity, shifting cultivation fields maintain higher relative diversity within individual plots, supporting a dynamic mosaic of species that contributes to both food security and biodiversity conservation.

Figure 6.9 Interpretation

Figure 6.9, reveals that home gardens achieve the highest overall diversity (101 species and 165 varieties), followed by shifting cultivation with 53 species and 147 varieties. In stark contrast, oil palm and rubber systems show minimal diversity, with only 13 species and 14 - 15 varieties. These results emphasize the critical role of shifting cultivation and home gardens in sustaining agrobiodiversity. The mosaic landscape created by these systems contributes to broader conservation goals, maintaining habitat heterogeneity, supporting pollinators and wildlife, and sustaining soil microbiota. This stands in direct contrast to the biodiversity loss associated with large-scale monoculture expansion.

Ultimately, shifting cultivation functions as an informal biodiversity conservation mechanism, actively preserving genetic resources and ecological integrity in traditional agricultural landscapes.

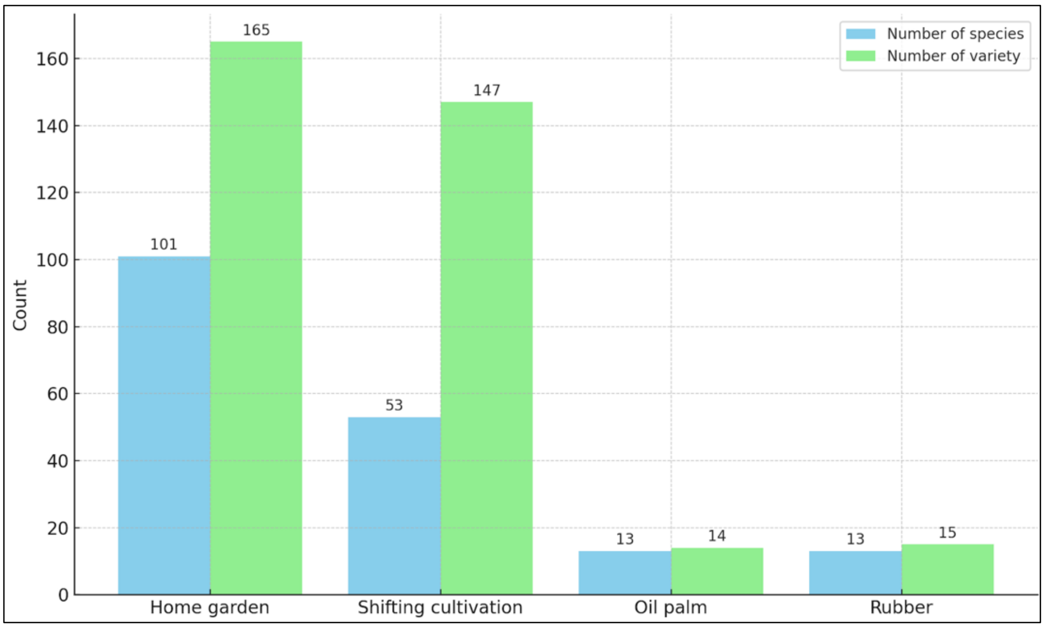

FIGURE 6.9: TOTAL NUMBER OF SPECIES AND VARIETIES SAMPLED ACROSS 4 TYPES OF CULTIVATION

6.7.4.2. Soil Health and Fertility Management

Shifting cultivation achieves the highest score for crop rotation and intercropping (60%), significantly outperforming all other systems, which score zero. The eta-squared value (η^2 = 0.61) indicates that crop rotation and intercropping practices are a defining characteristic of shifting cultivation. These practices are essential for maintaining soil fertility, nutrient cycling, and pest control, reflecting the ecological expertise embedded in Jah Hut farming traditions.

While fallow periods score zero across all systems, qualitative observations suggest that the practice is inherent in shifting cultivation systems, where *belukar lama* (abandoned or regenerating forest) acts as a natural fallow system. This is not merely a necessity; it mirrors traditional land management practices that sustain soil health. These practices, however, are increasingly constrained by land scarcity and labor pressures, underscoring the external limitations shaping Jah Hut farming systems.

Organic fertilization is universally practiced, with shifting cultivation (96.77%) and home gardens (95.59%) slightly outperforming oil palm (86.21%) and rubber (94.57%). Shifting cultivators rely on nutrient recycling methods, such as using ash from controlled burns and decomposed crop residues, reflecting ecological stewardship rooted in Indigenous knowledge systems. By contrast, monoculture systems depend on external fertilizers, but their limited use often stems from financial constraints rather than ecological strategies. For example, a farmer from Sungai Mai explained that his inability to afford fertilizers rendered his oil palm trees unproductive, highlighting the economic vulnerabilities of cash crop systems.

No-tillage farming is practiced almost universally (96.55 - 100%), but the motivations differ. In shifting cultivation, no-tillage is intentional, preserving soil structure and reducing erosion. In oil palm and rubber systems, however, it results from a lack of mechanization, reflecting economic constraints rather than deliberate ecological practices.

6.7.4.3. Weed and Pest Management

Significant differences in the addition of herbicide ($\eta^2 = 0.50$)[49] reveal contrasting approaches among cultivation systems. Home gardens, with the least reliance on herbicides (89.71%), rely on manual weeding and ecological weed management, consistent with their informal, low-input nature. By contrast, all oil palm systems (0% score) exhibit complete dependence on chemical herbicides due to the demands of monoculture production.

In shifting cultivation, reliance on herbicides (3.23%) reflects adaptations to labor demands and land constraints. Although these systems are rooted in ecological traditions, the adoption of chemical inputs highlights how external pressures reshape traditional practices. This trend underscores the challenges of maintaining traditional systems within an economic context that increasingly prioritizes efficiency over sustainability.

Cultural beliefs among the Jah Hut also influence pest management practices, which score uniformly high (98.28 - 100%). Many farmers view pest interference as a natural ecological balance that should not be overly managed, reducing reliance on synthetic pesticides. This perspective reinforces an ecological ethic even within monoculture systems like oil palm and rubber.

---

[49] $\eta 2=0.50$ suggests that 50% of the variance in herbicide use is attributable to differences in cultivation systems. This indicates a strong effect, meaning that the type of cultivation system plays a substantial role in determining herbicide usage.

6.7.4.4. Resource Use Efficiency

Water resource management scores are uniformly high across all systems (98.28 - 100%), reflecting shared reliance on natural rainfall rather than irrigation infrastructure. While this suggests environmental sustainability, it also highlights the lack of investment in irrigation systems that could improve agricultural resilience.

Mechanization dependency is lowest in home gardens (100%) and shifting cultivation (96.77%), reflecting the manual and low-input nature of these systems. In home gardens, this reliance on labor-intensive methods underscores their integration into Jah Hut livelihoods as flexible, multifunctional systems. In shifting cultivation, limited mechanization reflects ecological strategies (e.g., chainsaws to reduce tilling) and constraints related to access to expensive equipment.

By contrast, oil palm (94.83%) and rubber (97.83%) systems also show low mechanization dependency, but this stems from economic barriers rather than ecological intentions. These cash crop systems are labor-intensive not by design but because financial constraints limit mechanization adoption.

6.7.5. Socio-territorial Dimension Analysis

The analysis of socio-territorial dimension scores reveals distinct differences among the four cultivation types, as visualized in the boxplot. Home garden and shifting cultivation scored the highest, with mean scores of 57.41 ± 5.08 and 57.34 ± 8.06, respectively. Rubber scored slightly lower at 54.09 ± 6.29, while Oil Palm had the lowest score of 51.86 ± 6.07. These trends are illustrated in Figure 6.10, where the medians for home garden and shifting cultivation are visibly higher than those for rubber and oil palm.

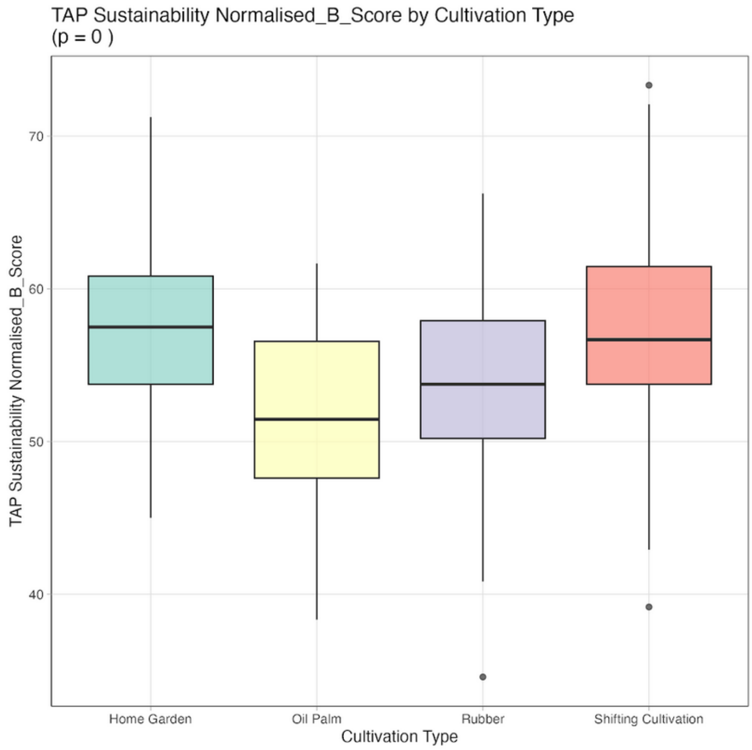

FIGURE 6.103: BOXPLOT OF SOCIO-TERRITORIAL DIMENSION SCORES BY CULTIVATION TYPE

The boxplot provides further insights into the distribution of socio-territorial scores. Shifting cultivation and home gardens exhibit higher medians but differ in variability. Shifting cultivation shows a wider IQR, with some households achieving exceptionally high scores close to 40, while others score closer to the lower quartile. In contrast, home gardens display a narrower IQR, indicating more consistent performance. Oil palm and rubber, while achieving slightly lower median scores, show moderate variability, with a few outliers indicating households that experience lower socio-territorial benefits.

In terms of criteria for the socio-territorial dimension, there are significant differences among cultivation systems across several criteria such as access to resources, livelihood contributions, intergenerational farming continuity, and quality of life indicators. These differences reflect the interplay of cultural practices, community dynamics, and economic constraints within the Jah Hut context, as detailed in Table 6.7.

Criteria	Shifting Cultivation	Home gardens	Oil palm	Rubber	Significance (Kruskal-Wallis test) (p-value)	Eta-squared
Land tenure	19.35	25.98	27.59	23.19	NS (p=0.9)	-
Accessibility of agricultural land by trail or tracks	80.65	100	96.55	100	S (p<0.001)	0.07
Percentage of local food production	66.67	21.57	0.57	0	S (p<0.001)	0.40
Recovery of rainwater	29.03	1.47	56.32	58.33	S (p<0.001)	0.15
Seed production	83.87	100	0	0	S (p<0.001)	0.59
Contribution to livelihood	9.68	10.29	89.66	90.22	S (p<0.001)	0.38
Willingness of the next generation to continue farming	59.35	78.82	72.76	73.26	S (p<0.001)	0.05
Existence of a knowledge transfer system within the community	100	100	100	100	NS (p=1)	-
Perception of farm existence	60	77.65	60	77.61	S (p<0.001)	0.34
Farmers found their job tiring most of the time	30.11	100	2.3	1.45	S (p<0.001)	0.53
Community cooperation in farm work	97.85	0	5.75	10.14	S (p<0.001)	0.35
Provision of basic amenities (water supply, electricity, roads, telecommunication infrastructure)	32.26	37.75	50	41.67	S (p=0.03)	0.01
The state of means of transport (bicycle, motorbike, car, etc)	49.68	47.94	56.21	77.9	S (p<0.001)	0.09
Feelings of isolation (geographical)	35.48	52.45	57.47	48.19	NS (p=0.9)	-
Feelings of isolation (social)	87.1	93.14	93.1	92.75	NS (p=0.9)	-
Feelings of isolation (cultural	76.34	71.57	61.49	70.65	NS (p=0.9)	-

TABLE 6.7: NORMALIZED SCORES (%) FOR CRITERIA IN THE SOCIO-TERRITORIAL DIMENSION

(S=Significant; NS= Not Significant)

6.7.5.1. Access to Farms

Accessibility of agricultural land is generally high across all systems, with home gardens and rubber scoring the highest (100%) and oil palm slightly lower (96.55%). Shifting cultivation scores 80.65%, reflecting the unique challenges faced by farmers accessing plots farther from villages or in difficult terrains. In Pasu, for example, plots across the Krau River are accessible only on foot, with river crossings further complicated by flooding, which disrupts farming routines and intensifies labor demands.

The forced resettlement of Jah Hut farmers from their ancestral lands to permanent village sites has further strained accessibility, disrupting traditional farming practices that relied on proximity to cultivation areas. Farmers now face long commutes to secondary forest plots, often walking or using motorbikes to reach their farms. While the data indicates good accessibility for most farmers, it does not account for those excluded from farming due to a lack of land or formalized access to ancestral plots. This exclusion highlights a significant barrier, contributing to the gradual abandonment of shifting cultivation practices among some families.

Protected area designations exacerbate these challenges by restricting access to ancestral lands traditionally used for swidden agriculture and foraging. These lands, which were integral to Jah Hut cultural and ecological systems, are now subject to state-imposed conservation policies that prioritize biodiversity protection over Indigenous livelihoods. Without comprehensive policies recognizing Orang Asli land rights, many farmers resort to cultivating crops on ambiguous or contested lands, where they face legal and physical threats. Collaborative land-use practices among families provide some mitigation, but they fail to address broader systemic barriers. The fragmentation of land use fosters high-intensity cultivation and forces some households to migrate to resource-deficient areas, further compromising environmental sustainability and community cohesion.

6.7.5.2. Land Tenure Insecurity and Dispossession

Land tenure insecurity represents one of the most significant barriers to sustainable farming among the Jah Hut. Shifting cultivation scores the lowest (19.35%), reflecting the absence of formalized land rights in secondary forests and communal lands. This insecurity discourages long-term investments, fosters uncertainty, and limits the viability of these systems. Oil palm (27.59%) and rubber (23.19%) also score low, as many Jah Hut farmers operate on land without formal ownership, often within gazetted Orang Asli reserves. Even home gardens, which score slightly higher (25.98%), face tenure challenges despite their proximity to residential areas.

The Jah Hut community's vulnerability stems from systemic neglect of their customary land rights, with overlapping claims, jurisdictional conflicts, and historical dispossession leaving them at constant risk. Maps proving customary ownership are often unavailable, further undermining their land tenure claims. Additionally, the Department of Orang Asli Development (JAKOA) has historically resisted recognizing these rights, forcing communities to rely on NGOs and lengthy legal battles for resolution.

In Berdut, located within the Tengku Hassanal Wildlife Reserve[50], the absence of gazetted Orang Asli land status leaves the community particularly vulnerable to eviction. In Sungai Mai, ancestral lands are encroached upon by settlers and plantations, while in Pasu, forest reserve boundaries restrict agricultural expansion and access to alternative lands. These overlapping conservation and commercial interests prioritize state and corporate goals over Indigenous sovereignty, exacerbating land dispossession and disrupting traditional agricultural practices like crop rotations and fallow cycles.

Land dispossession also threatens cultural preservation, severing ties to sacred spaces and eroding intergenerational knowledge systems critical for sustainable land management. The intersection of protected areas and customary lands creates a structural barrier to sustainable development, reducing agroecological resilience and diminishing biodiversity. Without policy reforms to recognize Orang Asli land rights, these challenges will continue to impede the sustainability of Jah Hut agricultural systems.

6.7.5.3. Livelihood and Local Resources

The contribution to livelihood shows stark differences ($p < 0.001$) across systems. Oil palm (89.66%) and rubber (90.22%) provide significant economic benefits as cash crops, while shifting cultivation (9.68%) and home gardens (10.29%) contribute primarily to subsistence farming. While cash crops are prioritized to meet household needs and market demands,

[50] The Krau Wildlife Reserve was established in June 1923 by the British in Malaya (Yusof & Sorenson, 2000). However, the Jah Hut had lived in the area long before the reserve was gazette, a process that was carried out without consultation or consideration of their presence. This reflects a broader colonial-era practice of disregarding Indigenous land rights - a legacy that continues to cause conflicts over land and conservation policies today.

shifting cultivation and home gardens play critical roles in food security and cultural preservation.

Shifting cultivation scores the highest (66.67%) for local food production, focusing on staple crops like hill rice and vegetables for household consumption. In contrast, oil palm (0.57%) and rubber (0.00%) are entirely cash-oriented, reflecting their dependency on external markets. Home gardens (21.57%) provide supplementary food, but their role in food security is less integral compared to shifting cultivation. These findings highlight the distinctive contributions of traditional agricultural systems to food sovereignty, even as market-oriented systems dominate the economic landscape.

6.7.5.4. Rainwater Harvesting

Rainwater collection varies significantly ($p < 0.05$) across systems, with notable underutilization in most practices. Shifting cultivation scores the lowest (29.03%), reflecting its reliance on natural rainfall without infrastructure to store water for dry periods. This dependency underscores the vulnerability of traditional systems to climate variability.

In cash crop systems like oil palm (56.32%) and rubber (58.33%), rainwater is used primarily to dilute herbicides, tying its application to chemical inputs rather than water conservation. While this supports operational needs, it fails to address broader water resource management challenges. Home gardens score the lowest (1.47%) due to proximity to alternative water sources like wells or piped water, deprioritizing rainwater harvesting. Expanding rainwater harvesting, particularly for shifting cultivation, could improve resilience in the face of environmental challenges.

6.7.5.5. Intergenerational Continuity and Knowledge Transfer

Shifting cultivation scores moderately (59.35%) for intergenerational continuity, as the physical demands and reduced accessibility of ancestral plots discourage younger generations from adopting these practices. However, elder farmers emphasize the cultural importance of preserving hill rice cultivation as a way to maintain heritage and identity. Respondents frequently mention the significance of propagating Indigenous rice varieties, with one elder farmer in Kampung Pasu noting, *“Walaupun sikit-sikit mesti buat. Kerana sayangkan benih”*

(Even if it's just a small amount, it must be done because I love the seeds). She added, *"Tak pernah putus"* (meaning, the propagation of her rice seeds has never been interrupted), highlighting the cultural pride and dedication that drives her efforts despite the challenges.

Resettlement policies and land dispossession further disrupt intergenerational knowledge transfer. Farmers no longer live near their ancestral plots, creating logistical challenges that hinder younger generations' participation in traditional agriculture. Despite these obstacles, the cultural and spiritual value of hill rice remains a driving force, with farmers expressing a strong desire to pass on this legacy.

6.7.5.6. Community Cooperation in Farm Work

Community cooperation in farm work reveals significant differences among systems ($p < 0.001$). Shifting cultivation scores the highest (97.85%), reflecting its reliance on collective labor and traditional farming practices that require shared effort, such as land clearing, planting, and harvesting. In contrast, oil palm (5.75%) and rubber (10.14%) systems score significantly lower, as these cash crop systems are typically managed individually. Home gardens score zero, as they are household-centric and do not involve community labor.

Observations reveal that community cooperation thrives in traditional agriculture, such as shifting cultivation, where tasks like clearing forests and planting hill rice are labor-intensive and culturally rooted in collective effort. Conversely, cooperation is minimal for cash crops (oil palm and rubber), as these are viewed as private enterprises primarily aimed at individual economic benefit. In Sg Mai and Pasu, those who can afford it hire laborers from within the community on a daily wage basis. The cultural and social ties that encourage communal work in traditional systems do not extend to cash crops, where the focus on profitability and market-driven goals reduces the need for shared labor. This highlights the erosion of collective practices under market pressures, as profitability supersedes community-oriented values. Promoting collective practices in cash crop systems could enhance socio-territorial sustainability while preserving cultural integrity.

6.7.5.7. Labor Intensity and Quality of Life

Labor intensity, as measured by whether farmers found their work tiring most of the time, shows marked differences ($p < 0.001$). Home gardens score the highest (100%), indicating the lowest perceived labor demands. Shifting cultivation scores moderately (30.11%), reflecting the significant effort required to clear land and manage crops manually. In contrast, oil palm (2.3%) and rubber (1.45%) score the lowest, as labor demands are concentrated during specific periods like harvesting. However, the low labor intensity scores in cash crop systems do not reflect ease of work but rather the result of systemic financial constraints that limit mechanization, leaving manual tasks arduous and time-consuming.

The provision of basic amenities varies significantly ($p < 0.05$) across cultivation systems, with oil palm scoring the highest (50%) and shifting cultivation the lowest (32.26%). However, these scores obscure the nuanced realities of infrastructure access among the three villages—Berdut, Pasu, and Sungai Mai - where the Jah Hut practice these systems.

In Berdut, the most remote and traditional village, connectivity to basic amenities such as clean water, electricity, roads, and telecommunication infrastructure is severely limited. This remoteness directly impacts the viability of oil palm cultivation, as the challenging terrain and lack of accessible routes for harvest trucks render it impractical. Consequently, Berdut remains more focused on traditional practices like shifting cultivation, which rely on smaller-scale, localized resource use.

By contrast, Sungai Mai and Pasu benefit from relatively better infrastructure, facilitating the proliferation of cash crops like oil palm and rubber. Farmers in these villages use improved roads and transportation networks to bring their produce to markets. For example, oil palm scores higher on basic amenities because of its association with Pasu and Sungai Mai, where infrastructure development aligns with the demands of cash crop systems.

Shifting cultivation, practiced more intensively in Berdut, scores the lowest for basic amenities. The lack of infrastructure in remote areas adds significant labor and logistical challenges, forcing farmers to walk long distances or rely on basic modes of transportation, especially during emergencies or adverse weather conditions. This disparity in resource access underscores how systemic neglect of remote Indigenous villages disproportionately burdens traditional agricultural systems.

6.7.5.8. Structural Disparities in Resource Distribution

These findings highlight the unequal distribution of infrastructure and resources across Jah Hut villages, which disproportionately favors cash crop systems like oil palm and rubber. While oil palm appears to benefit from better infrastructure, this is not reflective of its inherent sustainability but rather the result of state-led development priorities that align with market-driven agricultural models. In contrast, traditional systems like shifting cultivation, which remain vital for food security and cultural preservation, are neglected by policies and investments. Such disparities force Indigenous farmers into a trade-off between culturally significant practices and the economic pressures of cash crop cultivation. Addressing these inequities requires recognizing the historical and structural barriers faced by Indigenous communities, particularly those in remote areas like Berdut.

6.7.6. Economic Dimension Analysis

The economic dimension exhibits remarkable uniformity across all cultivation types, as reflected in both the statistical analysis (Table 6.8) and the boxplot distribution (Figure 6.11). Median scores for shifting cultivation, home gardens, oil palm, and rubber are all 66.67%, suggesting that households experience similar levels of financial viability regardless of their primary cultivation type. The Kruskal-Wallis test reveals that while differences in economic scores among cultivation types are statistically significant ($p < 0.05$), the effect size ($\eta^2 = 0.01$) is small. This indicates that the type of cultivation explains only a minimal portion of the variation in economic outcomes, which are instead likely influenced by broader structural or market-related factors.

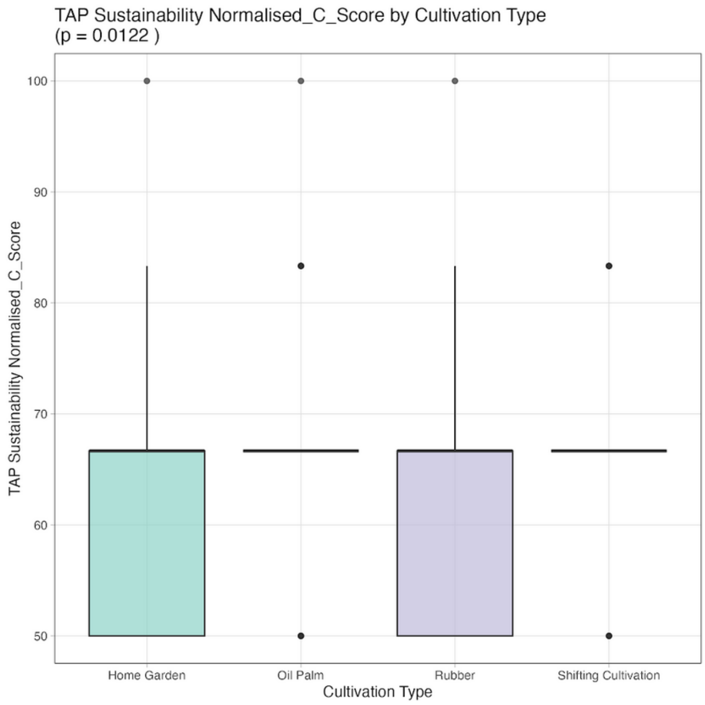

FIGURE 6.41: BOXPLOT OF THE ECONOMIC DIMENSION SCORES BY CULTIVATION TYPE

Figure 6.11 confirms these findings, showing relatively narrow interquartile ranges (IQRs) across all systems. Shifting cultivation and oil palm exhibit the narrowest range of scores, suggesting a more consistent perception of income sufficiency among households engaging in this system. Home gardens and rubber, on the other hand, show slightly wider variability in their economic outcomes, indicating that households practicing these systems may experience a broader range of financial conditions, potentially influenced by factors such as market access, household size, or supplemental income sources.

Criteria	Shifting Cultivation	Home gardens	Oil palm	Rubber	Significance (Kruskal-Wallis test) (p-value)	Eta-squared
Income sufficiency perception	33.33	37.25	37.93	35.14	NS (p=0.9)	-
Independence from Government Aid	100	86.27	93.68	88.77	S (p<0.001)	0.05

TABLE 6.8: NORMALIZED SCORES (%) FOR CRITERIA IN THE ECONOMIC DIMENSION

(S=Significant; NS= Not Significant)

Despite overall uniformity in economic scores across cultivation systems, structural differences emerge when examining financial autonomy and market dependency. Oil palm cultivation scores the highest for income sufficiency perception (C1), with a mean score of 37.93%, compared to 33.33% for shifting cultivation. This suggests that oil palm households perceive their income as slightly more stable, likely due to their integration into commercial markets. However, these differences are not statistically significant (Kruskal-Wallis test), indicating that perceptions of financial sufficiency remain relatively similar across all systems. This finding challenges the assumption that cash-crop integration guarantees economic security, as households engaged in traditional farming report similar financial perceptions despite lower engagement in market-based production.

For independence from government aid (C4), shifting cultivation scores the highest (100%), reflecting complete financial self-reliance among households practicing this system. In contrast, home gardens score 86.27, indicating a moderate level of external dependency. These differences are statistically significant ($p<0.001$), reinforcing the link between shifting cultivation and economic autonomy. The near-total self-sufficiency of shifting cultivators contradicts narratives that frame traditional agriculture as economically vulnerable. Instead, it underscores the resilience of subsistence-based economies that prioritize food sovereignty over external dependencies.

The consistency in economic scores across all systems reflects the widespread adoption of blended agricultural strategies among Jah Hut households. Many households combine shifting cultivation with cash crops like rubber and oil palm, not as a passive transition to market economies, but as a strategy to navigate economic uncertainty. This diversification serves as a buffer against external market shocks, highlighting the agency of Jah Hut farmers in managing economic risks.

While low reliance on government aid across all systems demonstrates economic resilience, it also reflects the historical marginalization of Orang Asli communities from formal financial and agricultural support systems. Shifting cultivation households are almost entirely excluded from government assistance, reinforcing how Indigenous agricultural models operate outside state-defined economic structures.

In summary, while shifting cultivation excels in economic independence, oil palm scores highest for perceived income sufficiency, demonstrating the distinct economic logic of each system. However, the narrow range of scores across all systems highlights shared financial constraints, including limited market access, resource shortages, and structural barriers that hinder long-term resilience. These findings emphasize that improving financial sustainability requires addressing systemic economic inequities rather than merely promoting greater market integration.

6.8. Overall Analysis

6.8.1. Synthesis of Sustainability Trade-Offs

The sustainability assessment of Jah Hut agriculture does not merely reveal trade-offs (Table 6.9) between ecological, socio-territorial, and economic priorities - it exposes structural constraints imposed by colonial land governance, state-led market dependency, and development policies that marginalize Indigenous agricultural models. These challenges are not natural consequences of different farming choices but the result of systemic dispossession that forces Jah Hut farmers to navigate between subsistence and external economic pressures.

Dimension	Home Gardens	Shifting Cultivation	Oil Palm	Rubber
Agroecological	High crop diversity; minimal chemical use	Preserves biodiversity but low soil fertility in fallow cycles	Monoculture reduces biodiversity, high input use	Intermediate crop diversity but moderate input use
Socio-Territorial	High community cooperation; strong cultural ties	Strong connection to ancestral land but insecure tenure	Disrupted community ties; reliance on external markets	Moderate tenure security but dependency on reserves
Economic	Limited income; low market dependency	Minimal cash income; subsistence-focused	High cash income but volatile market prices	Moderate cash income; price sensitivity

Table 6.9: Synthesis of Sustainability Trade-Offs

6.8.1.1. Agroecological Constraints: Sustainability as Dispossession

The biodiversity of shifting cultivation and home gardens is not a weakness - it is a form of ecological resistance against monoculture expansion. However, land dispossession, shortened fallow cycles, and conservation policies criminalizing swidden farming create artificial barriers to sustainability. Shifting cultivation is not ecologically unsustainable - it is made unsustainable by external restrictions on land access (Ioris, 2022). In contrast, cash crop systems are actively incentivized despite environmental degradation, showing how mainstream sustainability frameworks favor profit-driven agriculture over ecological balance (Feintrenie et al., 2010). Thus, while commercial farming increasingly challenges traditional practices, this pressure does not negate their inherent sustainability; rather, it reflects structural constraints that marginalize systems which are otherwise ecologically and culturally resilient.

6.8.1.2. Socio-Territorial Constraints: Land, Settlement, and the Displacement of Jah Hut Agriculture

The relocation of the Jah Hut into permanent villages is not just a shift in settlement patterns - it is a forced restructuring of Indigenous agricultural life (Rotz et al., 2023). Permanent settlements remove farmers from their land, increasing dependency on wage labor and cash-crop farming while weakening the communal labor systems that sustain Indigenous agriculture. Shifting cultivation should not be framed as a system in "decline" - it is actively eroded by conservation policies, land gazettement, and private agribusiness expansion. Taken together, these are political influences and policy limitations that delegitimize TEK-based hill farming, restrict fallow cycles and land access, and weaken intergenerational knowledge transmission. Meanwhile, oil palm and rubber are integrated into state development plans, reinforcing land tenure insecurity by tying Indigenous farmers to volatile global commodity markets (Finnis, 2006).

6.8.1.3. Economic Constraints: Cash-Crop Dependency as a Colonial Legacy

The market dependency imposed on Jah Hut farmers is not a sign of economic development but economic restructuring. Oil palm and rubber deliver higher short-term incomes but leave farmers vulnerable to price crashes, exploitative middlemen, and shifting government policies (Finnis, 2006). Meanwhile, home gardens and shifting cultivation - though economically independent - are not recognized within dominant economic frameworks, reinforcing institutional neglect of non-market agricultural systems. Rather than positioning subsistence farming as economically "limited," sustainability frameworks should acknowledge how cash-crop dependency is a tool of dispossession, forcing Indigenous farmers to engage with exploitative markets at the expense of food sovereignty (Rotz et al., 2023).

6.8.2. Structural Challenges: Cross-Cutting Barriers to Jah Hut Agricultural Sovereignty

The following structural constraints (Table 6.9) must be understood as deliberate systems of exclusion, not just barriers to sustainability.

No.	Structural Challenges	Description	Implications
1.	**Land Dispossession**	Customary land rights remain unrecognized and criminalized through conservation policies and encroachment.	Without land sovereignty, sustainability is impossible. Recognizing customary tenure is not optional - it is foundational.
2.	**Development-Driven Relocation**	Jah Hut farmers were forcibly settled, disrupting agricultural continuity and knowledge transmission.	Permanent settlements remove farmers from their lands, increasing dependency on external markets.
3.	**Institutional Erasure**	Indigenous food systems (shifting cultivation and home gardens) are excluded from agricultural policies.	Policies should not "support" shifting cultivation but recognize it as a legitimate agricultural system.
4.	**Market Dependency**	Cash crops are state promoted but subject farmers to price volatility and external control.	Economic sustainability should prioritize food sovereignty over market expansion.
5.	**Cultural Erosion**	Loss of land and forced cash-crop adoption disrupt intergenerational knowledge transfer.	Agricultural policy should be shaped by Indigenous governance models, not external interventions.

TABLE 6.9: STRUCTURAL BARRIERS TO SUSTAINABILITY

Together, these barriers perpetuate a cycle of ecological vulnerability, economic marginalization, and cultural erosion. Addressing these challenges requires integrated policies that move beyond market-driven solutions to center Indigenous rights and knowledge systems, ensuring equitable development and sustainability for all agricultural systems (Rotz et al., 2023).

6.9. Contributions to Indigenous Sustainability Research

This study contributes to sustainability research on Indigenous agricultural systems by demonstrating how a modified IDEA framework can capture both the ecological complexity and structural challenges shaping Jah Hut agriculture. While mainstream sustainability assessments often struggle to account for shifting cultivation and other non-market subsistence practices, the modifications introduced in this study enhance the framework's ability to engage with key aspects of Jah Hut farming - without erasing its deeper cultural and political dimensions.

6.9.1. Capturing Aspects of Traditional Shifting Cultivation

By refining the IDEA framework, this study was able to quantify and analyze components of shifting cultivation that are often ignored or misrepresented in mainstream assessments. Adjustments such as incorporating variety-level genetic diversity (A1, A2), redefining intercropping and sequential planting (A5), and recognizing controlled burning as an agroecological strategy (A16) allowed for a more accurate representation of Jah Hut land-use strategies. The assessment revealed how biodiversity, regenerative cycles, and localized knowledge contribute to sustainability, countering narratives that portray shifting cultivation as environmentally destructive. However, even with these modifications, quantitative sustainability frameworks remain constrained by Western epistemologies that prioritize fixed land-use models, economic viability, and private property structures. The very need to modify IDEA illustrates the deficiencies of conventional assessment tools in recognizing Indigenous agroecological wisdom.

6.9.2. Using the Modified Framework to Expose Structural Violence

Despite its limitations, the modified IDEA framework proved valuable as a diagnostic tool to expose systemic inequities that shape the sustainability of Jah Hut agriculture. The results - both quantitative and qualitative - demonstrate that sustainability outcomes are not solely the result of internal agricultural practices but are fundamentally shaped by external forces, including state policies, market pressures, and land dispossession. This study highlights the structural injustices embedded in Orang Asli land governance, economic marginalization, and restrictive conservation policies. The quantifiable disparities in land tenure security, access to infrastructure, and economic stability provide concrete evidence that Jah Hut sustainability is deliberately constrained, rather than naturally declining. Thus, while IDEA is a Western framework, its adaptation in this study serves as a critical tool for revealing, rather than reinforcing, colonial dispossession and policy-driven precarity.

6.9.3. Bridging the Cultural and Spiritual Gaps Through Chapter 5

Although this chapter evaluates Jah Hut agriculture through a modified sustainability framework, it does not fully capture the cultural and spiritual dimensions fundamental to Indigenous land stewardship. Chapter 5 fills this critical gap by exploring how ancestral land, ritual practices, and intergenerational knowledge inform Jah Hut farming decisions. Together, these chapters illustrate that sustainability cannot be understood solely through environmental or economic metrics - it is deeply tied to identity, cosmology, and resistance to land alienation.

Yet, even with this combined approach, we are only scratching the surface of what Indigenous sustainability truly means. No Western framework, no matter how modified, can fully encapsulate the complexity of traditional Jah Hut agricultural systems. This is not simply an academic limitation but a structural defect in how Indigenous knowledge is categorized, fragmented, and subordinated within dominant sustainability discourses. Thus, rather than attempting to perfect these frameworks, this study underscores the urgent need to develop Indigenous-led assessments that operate on their own terms, rather than within externally imposed paradigms.

6.10. Future Research Directions: Beyond Western Sustainability Metrics

Future research on Jah Hut agriculture must move beyond conventional sustainability models focusing on how Indigenous farmers can adapt to external constraints. Instead of asking how shifting cultivation can fit within state conservation policies or how Jah Hut farmers can improve cash crop productivity, research should explore what sustainability would look like if Jah Hut land sovereignty and self-determined farming systems were thoroughly restored.

One key area for future study is the long-term impact of land dispossession on agricultural sustainability. As discussed in Chapter 5, Jah Hut farming is deeply tied to ancestral land, spiritual practices, and intergenerational knowledge transfer. However, forced relocation and conservation policies have disrupted access to traditional farming areas, threatening the ability to pass down agricultural knowledge. Longitudinal studies should examine whether cultural resilience can withstand land loss or whether new strategies are needed to reclaim community-led agricultural education outside of state-controlled systems.

Another important direction is the development of community-driven sustainability indicators. Current sustainability frameworks, such as the IDEA model, assess agriculture based on Western agronomic principles, often overlooking Indigenous knowledge, land governance, and food sovereignty. Future research should work directly with Jah Hut farmers to co-create sustainability assessments that recognize shifting cultivation, communal land use, and non-market economies as legitimate measures of agricultural success.

Finally, policy research should reframe how sustainability is modeled. Instead of studying how Jah Hut farmers can improve within the constraints of market-driven policies and conservation laws, research should explore what would happen if these external constraints were removed entirely. What would shifting cultivation look like if it were legally recognized? How would food security change if land tenure was protected? Would home gardens expand if state-imposed cash-crop policies were eliminated? These questions would shift research from an adaptation mindset to one that prioritizes Indigenous sovereignty and agricultural self-determination.

6.11. Conclusion: Reclaiming Sustainability on Indigenous Terms

A truly sustainable agricultural future for the Jah Hut cannot be achieved through incremental improvements to existing farming practices. Sustainability is not just an ecological goal - it is a political struggle (Dhiaulhaq & McCarthy, 2020). Without the recognition of Jah Hut land rights, the dismantling of state-imposed cash-crop dependency, and the restoration of ancestral farming territories, any effort to "enhance" sustainability will remain incomplete. Conventional sustainability assessments often reduce agriculture to measurable ecological and socioeconomic indicators. Still, for the Jah Hut, sustainability is inseparable from land sovereignty, self-determined agricultural governance, and the right to sustain livelihoods without external control (Dhiaulhaq & McCarthy, 2020). Measuring sustainability without addressing historical and structural barriers risks reinforcing inequalities undermining Indigenous food systems. Future discussions on Jah Hut agriculture must move beyond state-driven sustainability frameworks and instead prioritize Indigenous autonomy. True sustainability does not come from external interventions but from recognizing Indigenous land rights, ecological knowledge, and self-determined farming systems. A future where Jah Hut agriculture thrives is not one where it is reformed to fit external expectations - it is one where it is reclaimed on Indigenous terms.

References

Abaniel, J. C. A., Federico, J. D., & Orge, C. A. (2024). Assessing Community Health and Development Needs: A Case Study of Sitio Tagaleb, Iba, Zabales. *American Journal of Humanities and Social Sciences Research*, *8*(12), 39–43. www.ajhssr.com

Abbott, J. A. (2005). *Counting Beans: Agrobiodiversity, Indigeneity, and Agrarian Reform*. *57*(April 2004), 198–212. https://doi.org/https://doi.org/10.1111/j.0033-0124.2005.00472.x

Agossou, G., Gbehounou, G., Zahm, F., & Agbossou, E. K. (2017). Adaptation of the "indicateurs de durabilité des exploitations agricoles (IDEA)" method for assessing sustainability of farms in the lower valley of ouémé river in the Republic of Benin. *Outlook on Agriculture*, *46*(3), 185–194. https://doi.org/10.1177/0030727017726130

Dhiaulhaq, A., & McCarthy, J. F. (2020). Indigenous Rights and Agrarian Justice Framings in Forest Land Conflicts in Indonesia. *Asia Pacific Journal of Anthropology*, *21*(1), 34–54. https://doi.org/10.1080/14442213.2019.1670243

Feintrenie, L., Schwarze, S., & Levang, P. (2010). *Are Local People Conservationists? Analysis of Transition Dynamics from Agroforests to Monoculture Plantations in Indonesia*. https://www.jstor.org/stable/26268223

Finnis, E. (2006). New Answers to Old Questions: Why Grow Cash Crops? Why Grow Cash Crops? Subsistence Farming and Crop Commercialization in the Kolli Hills, South India. *American Anthropologist*, *108*(2), 363–369. http://www.ucpress.edu/journals/rights.htm.

Galappaththi, E. K., & Schlingmann, A. (2023). The sustainability assessment of Indigenous and local knowledge-based climate adaptation responses in agricultural and aquatic food systems. In *Current Opinion in Environmental Sustainability* (Vol. 62). Elsevier B.V. https://doi.org/10.1016/j.cosust.2023.101276

Galluzzi, G., Eyzaguirre, P., & Negri, V. (2010). Home gardens: Neglected hotspots of agro-biodiversity and cultural diversity. *Biodiversity and Conservation*, *19*(13), 3635–3654. https://doi.org/10.1007/s10531-010-9919-5

Heredia-R, M., Torres, B., Cayambe, J., Ramos, N., Luna, M., & Diaz-Ambrona, C. G. H. (2020). Sustainability Assessment of Smallholder Agroforestry Indigenous Farming in the Amazon: A Case Study of Ecuadorian Kichwas. *Agronomy*, *10*(12), 1973. https://doi.org/10.3390/agronomy10121973

Heredia-r, M., Torres, B., Vasseur, L., Puhl, L., & Barreto, D. (2022). Sustainability Dimensions Assessment in Four Traditional Agricultural Systems in the Amazon. *Frontiers in Sustainable Food Systems*, *5*(January), 1–22. https://doi.org/10.3389/fsufs.2021.782633

Ioris, A. A. R. (2022). Indigenous Peoples, Land-based Disputes and Strategies of Socio-spatial Resistance at Agricultural Frontiers. *Ethnopolitics*, *21*(3), 278–298. https://doi.org/10.1080/17449057.2020.1770463

Jansen, K. (2015). The debate on food sovereignty theory: agrarian capitalism, dispossession and agroecology. In *Journal of Peasant Studies* (Vol. 42, Issue 1, pp. 213–232). Routledge. https://doi.org/10.1080/03066150.2014.945166

Leyva, D., De la Torre, M., & Coronado, Y. (2021). Sustainability of the agricultural systems of Indigenous people in Hidalgo, Mexico. *Sustainability (Switzerland)*, *13*(14). https://doi.org/10.3390/su13148075

Maezumi, S. Y., Elliott, S., Robinson, M., Betancourt, C. J., Souza, J. G., Alves, D., Grosvenor, M., Hilbert, L., Urrego, D. H., Gosling, W. D., & Iriarte, J. (2022). Legacies of Indigenous land use and cultural burning in the Bolivian Amazon

rainforest ecotone. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1849). https://doi.org/10.1098/rstb.2020.0499
Mgwenya, L. I., Agholor, I. A., Ludidi, N., Morepje, M. T., Sithole, M. Z., Msweli, N. S., & Thabane, V. N. (2025). Unpacking the Multifaceted Benefits of Indigenous Crops for Food Security: A Review of Nutritional, Economic and Environmental Impacts in Southern Africa. *World*, *6*(1), 16. https://doi.org/10.3390/world6010016
Molina Maturano, J., García Serrano, L. A., Carmona García, J. A., García de Alva Magos, M. A., & Hersperger, A. M. (2022). An indicator-based sustainability assessment method for Indigenous communities: a case study from Mexico. *Environment, Development and Sustainability*, *24*(3), 3293–3333. https://doi.org/10.1007/s10668-021-01567-x
Nations, U. (2021). *UN/DESA Policy Brief #101: Challenges and Opportunities for Indigenous Peoples' Sustainability*. https://www.
Ngo, T., Nguyen, H. D., Ho, H., Nguyen, V. K., Dao, T. T. T., & Nguyen, H. T. H. (2021). Assessing the important factors of sustainable agriculture development: An Indicateurs de Durabilité des Exploitations Agricoles-Analytic Hierarchy Process study in the northern region of Vietnam. *Sustainable Development*, *29*(2), 327–338. https://doi.org/10.1002/sd.2148
Phondani, P. C., Maikhuri, R. K., Rawat, L. S., & Negi, V. S. (2020). Assessing farmers' perception on criteria and indicators for sustainable management of Indigenous agroforestry systems in Uttarakhand, India. *Environmental and Sustainability Indicators*, *5*(January), 100018. https://doi.org/10.1016/j.indic.2019.100018
Rotz, S., Xavier, A. L., & Robin, T. (2023). "It wasn't built for us": The possibility of Indigenous food sovereignty in settler colonial food bureaucracies. *Journal of Agriculture, Food Systems, and Community Development*, *12*(3), 93–110. https://doi.org/10.5304/jafscd.2023.123.009
Seligmann, L. J. (2008). Agrarian Reform and Peasant Studies: The Peruvian Case. In *A Companion to Latin American Anthropology* (pp. 337–351). Blackwell Pub.
Soldi, A., Meza, M. J. A., Guareschi, M., Donati, M., & Ortiz, A. I. (2019). Sustainability assessment of agricultural systems in Paraguay: A comparative study using FAO's SAFA framework. *Sustainability (Switzerland)*, *11*(13). https://doi.org/10.3390/su11133745
Vilain, L., Boisset, K., Guillaumin, A., Mouchet, C., Viaux.P, & Zahm.P. (2008). *La méthode IDEA (The IDEA Method: Sustainability Indicators for Agricultural Holdings: User Guide)* (M. Poillot, Ed.; 3rd ed., Issue September 2021). Educagri éditions.
Welch, J. R., Brondízio, E. S., Hetrick, S. S., & Coimbra, C. E. A. (2013). Indigenous burning as conservation practice: Neotropical savanna recovery amid agribusiness deforestation in Central Brazil. *PLoS ONE*, *8*(12). https://doi.org/10.1371/journal.pone.0081226
Yusof, E., & Sorenson, K. W. (2000). Krau Wildlife Reserve - Protected Area Management Experiences. In *Journal of WIldlife and Parks* (Vol. 18, pp. 3–13). https://www.wildlife.gov.my/images/document/penerbitan/jurnal/Jil182000.pdf

Chapter 7 : Assessing the Livelihoods of Jah Hut Communities

7.1. Introduction: Situating the Study within Indigenous Livelihoods Research

As explored in Chapter 6, the Jah Hut community, like many Indigenous groups, faces ongoing challenges due to economic marginalization, land dispossession, and state-led development policies that impose external livelihood models. These challenges have reshaped traditional resource use, limited economic autonomy, and undermined Indigenous governance structure. Over time, these systemic pressures have threatened their material well-being and their cultural and environmental knowledge systems, which are deeply tied to their land and resource practices.

Given these conditions, assessing Jah Hut livelihoods is crucial to understanding how they cope with economic and environmental constraints, the extent to which they maintain or modify traditional practices, and how external interventions shape their survival strategies. Without such an assessment, there is a risk of overlooking the agency of Indigenous communities in shaping their own futures, as well as the long-term implications of policies that do not align with their realities.

Existing livelihood assessments often rely on frameworks developed for non-Indigenous, market-driven economies, prioritizing cash-based income, formal employment, and land privatization (A. G. Kamal & Martens, 2015). Such frameworks frequently fail to capture the full complexity of Indigenous livelihood strategies, overlooking non-monetary exchange systems, communal land stewardship, and subsistence practices that sustain Indigenous resilience (ibid.). Therefore, it is essential to examine how the Jah Hut navigate systemic constraints while maintaining economic and cultural continuity on their own terms.

To systematically assess the Jah Hut's livelihood strategies while acknowledging Indigenous agency, this study employs the Sustainable Livelihoods Framework (SLF), a widely used tool in development research (Scoones, 1999). However, because SLF was initially designed for market-based economies, its application in Indigenous contexts must be critically examined. Many of the Jah Hut's livelihood strategies - including non-monetary exchange, communal land tenure, and ecological stewardship - do not fit neatly into SLF's capital-based model.

Without adaptation, SLF risks overlooking key aspects of Indigenous resilience and autonomy. Thus, this chapter not only applies SLF but also critically evaluates its limitations, ensuring a more accurate representation of Jah Hut livelihoods.

7.2. The Sustainable Livelihoods Framework (SLF) and its Applicability to Indigenous Contexts

7.2.1. Overview of the Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework was developed by the United Kingdom Department for International Development (DFID) in 1999 to assess livelihood sustainability by analyzing access to assets, vulnerabilities, and institutional influences (Scoones, 1998). It builds upon earlier concepts introduced by Chambers & Conway (1991) and has since been widely applied in development studies. A sustainable livelihood, as defined by Scoones (1999), is one that can cope with and recover from stresses and shocks, maintain or enhance capabilities and assets, and provide opportunities for future generations without degrading the natural resource base.

The SLF conceptualizes livelihoods as being influenced by broader contexts, conditions, and trends, which shape access to resources and opportunities. These factors include policy, history, politics, macroeconomic conditions, climate, agroecology, and social differentiation. As shown in Figure 7.1, these contextual elements frame livelihood systems, affecting how people navigate vulnerabilities and build resilience. The framework recognizes that different groups experience these conditions in distinct ways, depending on their social and economic positioning.

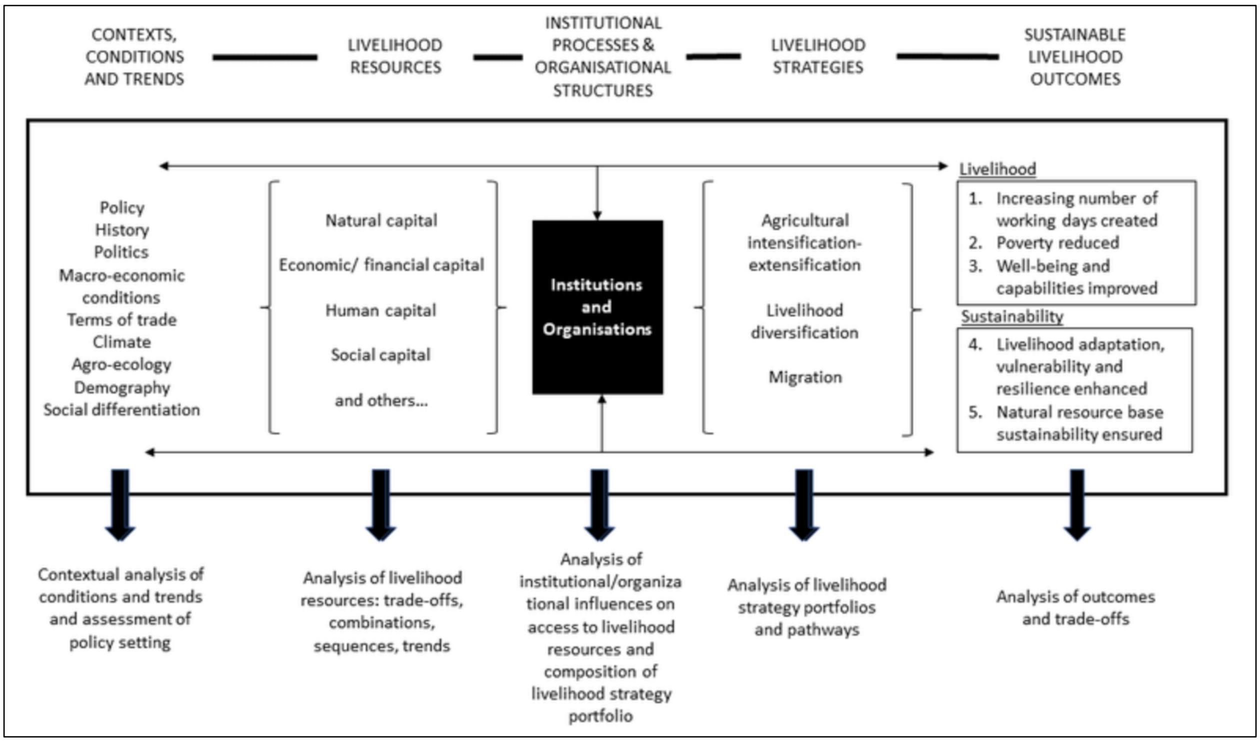

FIGURE 7.1: SUSTAINABLE RURAL LIVELIHOODS: A FRAMEWORK FOR ANALYSIS (SCOONES, 1999)

At the core of the SLF is the five-capital approach, which categorizes livelihood resources into natural, financial, human, social, and physical capital. These resources form the foundation upon which individuals and communities construct their livelihoods. Natural capital includes land, water, forests, and biodiversity, while financial capital consists of savings, credit, remittances, and income-generating opportunities. Human capital encompasses education, health, skills, and labor capacity, whereas social capital refers to networks, relationships, and community support systems. Physical capital includes infrastructure, transportation, housing, and technology access. These assets do not function in isolation but interact in complex ways to enable or constrain different livelihood strategies.

Institutions and organizations play a critical role in shaping how individuals access and use these livelihood resources. Figure 56 highlights the influence of both formal (government policies, markets, legal frameworks) and informal (community norms, kinship networks, customary rights) institutions in mediating livelihoods. As Scoones (1999) notes, institutional arrangements determine the extent to which people can engage with markets, access financial services, adopt new agricultural technologies, or secure land tenure. Understanding these institutional influences is essential for designing effective policies that support sustainable livelihoods.

The SLF identifies three primary livelihood strategies: agricultural intensification/extensification, livelihood diversification, and migration. Agricultural intensification refers to increasing productivity through improved inputs, mechanization, or labor investment, while extensification involves expanding cultivated land. Livelihood diversification includes engaging in multiple income-generating activities beyond farming, such as small businesses or wage labor. Migration, whether temporary or permanent, serves as an adaptive strategy for individuals seeking better economic opportunities elsewhere. Figure 56 illustrates how these strategies emerge from the interaction between available resources and institutional settings, emphasizing that livelihood decisions are often a mix of these approaches rather than a single pathway.

The sustainable livelihood outcomes outlined in the framework emphasize both livelihood security and environmental sustainability. Key indicators include increased working days, poverty reduction, and improvements in well-being and capabilities. Beyond economic gains, the framework also focuses on livelihood adaptation, resilience, and the sustainability of natural resources. As Scoones (1999) argues, true sustainability requires that livelihood strategies not only provide immediate economic benefits but also ensure long-term ecological balance and social stability.

SLF has been widely adopted in policymaking, resource allocation, and resilience-building strategies (Scoones, 1999). However, its application in Indigenous contexts has been met with both support and critique. While some studies highlight its utility in structuring livelihood assessments, others argue that SLF is ill-equipped to capture non-market economies, Indigenous governance, and historical injustices. The following section synthesizes existing research on SLF and Indigenous livelihoods, identifying key areas of strength, adaptation, and critique before applying these insights to the Jah Hut context.

7.2.2. A Synthesis of Insights from Studies on Indigenous Livelihoods and the SLF

The Sustainable Livelihoods Framework (SLF) has been widely used to assess Indigenous livelihoods. Yet, its application varies in the extent to which it is critiqued, adapted, or expanded to address local realities and structural inequalities. Some studies used SLF conventionally, while others expanded or challenged its assumptions. Chowdhury (2021) broadened the framework by introducing two new livelihood capitals - "information" and "freedom" - arguing that SLF lacks adaptability to evolving socio-economic realities. The study highlighted gendered livelihood disparities among Indigenous Bangladeshis, emphasizing the need for a more inclusive and context-specific framework that better informs poverty alleviation policies and well-being indicators (Chowdhury, 2021). Similarly, Delina (2024) integrated Bourdieu's theory of capital with SLF to analyze Indigenous rice farming in Indonesia and the Philippines, revealing cultural and economic vulnerabilities that challenge traditional capital asset classification. The study's findings underscore the importance of safeguarding traditional farming systems, influencing both agricultural policies and heritage conservation efforts (Delina et al., 2024).

A strong critique of SLF's Western-centric approach emerged in Shang et al. (2021) and Lalander et al. (2023). Shang et al. (2021) argued that SLF neglects Indigenous knowledge systems, proposing an expansion of cultural capital to reflect how Indigenous tourism communities sustain their livelihoods through non-material assets like traditions and governance structures. These insights could guide community-led governance models in ethnic tourism development (Shang et al., 2021). Lalander et al. (2023) examined livelihood transformations in the Ecuadorian Amazon, emphasizing Indigenous agency in economic adaptation and critiquing SLF's implicit assumption that capitalist livelihood models are universal. The study advocated for "ethno-development", a concept prioritizing Indigenous self-determination over externally imposed development paradigms. These findings are significant as they challenge mainstream economic integration models, instead promoting community-controlled economic strategies that align with Indigenous values and traditions (Lalander et al., 2023).

In contrast, (Yamarak & Parton, 2023) and Fierros-González & Mora-Rivera (2022) applied SLF without fundamentally questioning its epistemological basis. Fierros-González & Mora-Rivera (2022) used SLF to identify livelihood drivers in Mexico's Indigenous communities. Still, the study did not critically engage with issues of power asymmetry or colonial economic structures. However, its findings on structural barriers, access to resources, and climate vulnerability are helpful in shaping policies that enhance human capital and disaster resilience (Fierros-González & Mora-Rivera, 2022). Yamarak & Parton (2023) examined the impact of mining on Indigenous livelihoods in Papua New Guinea, employing SLF to compare economic outcomes between mining and non-mining villages but neglected structural power imbalances in extractive economies. However, the study provided empirical data on the trade-offs between economic benefits and socio-environmental costs, informing discussions on corporate accountability and resource governance (Yamarak & Parton, 2023). Sujakhu et al. (2019) focused on livelihood vulnerability in Nepalese Indigenous communities, integrating a Livelihood Vulnerability Index (LVI) to assess climate risks and adaptation capacity, findings that can directly influence climate adaptation policies (Sujakhu et al., 2019).

While SLF proved a useful analytical tool, the most critical studies (Lalander, 2023; Shang, 2021) questioned its Western-centric assumptions and called for a reframing of livelihoods research. Others (Delina, 2024; Chowdhury, 2021) extended SLF by adding context-specific indicators to better capture Indigenous realities, shaping policy and community-based interventions. Meanwhile, the remaining studies (Fierros-González, 2022; Yamarak, 2023; Sujakhu, 2019) applied SLF more conventionally but produced relevant findings for policy and community development. Collectively, these studies highlight that SLF remains limited in addressing Indigenous agency, cultural resilience, and political power structures. However, its adaptability - when expanded to include cultural, political, and environmental dimensions - offers valuable insights for strengthening Indigenous livelihoods, resilience, and self-determination.

7.2.3. Strengths and Limitations of SLF in Indigenous Contexts

While SLF has been widely applied in livelihood assessments (Nguyen-Anh et al., 2023; Timire et al., 2023; Wu et al., 2023; Tabares et al., 2022), its assumptions are deeply embedded in market-driven economic models, making it ill-suited for Indigenous contexts. First, SLF prioritizes capital accumulation as a measure of livelihood success, often overlooking non-monetary economies such as subsistence agriculture, reciprocal labor, and communal resource-sharing, which are central to Indigenous livelihoods (Syukron, 2021). By privileging financial capital, SLF risks misrepresenting Indigenous resilience by reducing it to economic transactions rather than cultural, spiritual, and relational systems.

Another key limitation of the SLF is its lack of recognition for Indigenous governance systems. The framework primarily assesses social capital through formal participation in organizations, institutions, or leadership roles, often excluding informal governance mechanisms central to many Indigenous communities. Indigenous governance structures frequently emphasize communal decision-making, customary law, and participatory democracy, operating independently or alongside state legal frameworks (Arceneaux, 2022; Stavenhagen, 2006). While many of these systems are non-hierarchical and consensus-based (Aliye, 2020), others incorporate hierarchical elements, particularly in leadership selection and dispute resolution (Bitew et al., 2021; Zhimo, 2019; Sieder & Barrera, 2017). By not accounting for these diverse and context-specific governance models, SLF-based assessments risk overlooking crucial aspects of Indigenous resilience, social cohesion, and decision-making processes. Given these limitations, it is essential to reframe SLF to ensure that that land, governance, and identity are not merely treated as assets but as fundamental to Indigenous survival and self-determination.

7.2.4. Alternative Indigenous Livelihoods Frameworks

The Sustainable Livelihoods Framework (SLF) has provided a useful lens for understanding how different forms of capital (natural, human, social, physical, and financial) interact to shape livelihood outcomes. However, its limitations - such as its weak engagement with power dynamics, policy structures, and long-term sustainability - have prompted exploration into alternative frameworks rooted in Indigenous knowledge and practices. These alternatives aim to address the gaps in SLF by incorporating ecological, cultural, and social justice dimensions that go beyond economic survival.

Indigenous frameworks such as Buen Vivir (Ecuador) (Calderón Farfán et al., 2021; Mero-Figueroa et al., 2020; Caria & Domínguez, 2016), the Livelihood Vulnerability Framework (Taiwan) (Lin & Polsky, 2016), the Social Justice Ecosystem Framework (Cameroon) (Fonchingong Che & Bang, 2024), and the Māori Sustainable Livelihoods Framework (New Zealand) (Harcourt et al., 2022) provide holistic approaches to well-being, emphasizing harmony with nature, collective governance, and resilience. While these models offer valuable insights, they face significant barriers to implementation. Dominant neoliberal policies, institutional resistance, and the difficulty of translating Indigenous principles into measurable indicators prevent their full integration into mainstream policy and research.

A key challenge is that these frameworks operate in opposition to prevailing development paradigms that prioritize economic growth over sustainability. Governments may adopt Indigenous concepts rhetorically, as seen in Ecuador's constitutional embrace of Buen Vivir, while continuing to pursue resource extraction policies that contradict its principles (Caria &

Domínguez, 2016; Mero-Figueroa et al., 2020). Additionally, many Indigenous communities remain politically and economically marginalized, reducing their influence on decision-making processes.

Bridging SLF with these alternative frameworks requires a more nuanced approach that combines livelihood sustainability with Indigenous governance models. A co-produced policy framework - one that respects Indigenous values while addressing practical policy concerns - can help operationalize these approaches. By integrating social justice, environmental protection, and long-term resilience, policymakers can move beyond short-term economic assessments and create livelihood models that are both sustainable and culturally inclusive.

7.3. Operationalizing SLF for this Study

In the context of this study, SLF was particularly useful for ensuring comparability with existing livelihood research in Malaysia and beyond. Given its extensive application in development studies, using SLF facilitated engagement with prior findings and enabled a structured comparison of livelihood strategies across different contexts. This alignment allowed for a broader understanding of patterns, trends, and gaps in livelihood sustainability, making it a practical choice for structuring the study's initial analytical approach.

However, while SLF effectively assesses material and economic assets, its application in Indigenous contexts required additional considerations. The framework, originally developed for market-based economies, does not fully capture the customary governance systems, non-monetary exchanges, and Indigenous resilience strategies that shape the Jah Hut's livelihoods. Given that Jah Hut livelihood strategies incorporate both subsistence and market-oriented activities, the study adopted a flexible approach to SLF that allowed for the inclusion of customary land use, informal economic practices, and hybrid livelihood strategies. Rather than treating these aspects as external to SLF, the study integrated them into the framework to ensure a contextually relevant application.

This section details how SLF was applied in the study, explaining the indicators used, data collection methods employed, and analytical techniques applied to assess livelihood sustainability. While SLF's core structure remained useful, the study allowed for empirical insights to refine its application, ensuring that Jah Hut-specific dynamics were not excluded.

7.3.1. Defining SLF Capital Assets for the Jah Hut Context

To systematically assess Jah Hut livelihoods, this study collected household survey data and qualitative insights aligned with each of the five SLF capital assets. The survey (Appendix 3.1, Livelihoods) was designed to capture livelihood aspects relevant to SLF while incorporating dimensions that reflect Indigenous resilience strategies, including customary land access, informal governance, and subsistence food security mechanisms.

Natural capital was assessed based on indicators such as land tenure arrangements (private, communal, lease), agricultural land use, reliance on shifting cultivation, home gardens, foraging areas, and access to water and forest resources. Given the Jah Hut's reliance on customary land tenure and shared resource management, the study emphasized land access beyond state-recognized ownership frameworks.

Human capital was examined through education levels (adult and child), knowledge transmission (formal education vs. Indigenous knowledge), access to skill training (agriculture, finance, and trade), health issues, and healthcare access. The study focused on how livelihood-related knowledge is transmitted intergenerationally, recognizing that Indigenous knowledge transfer is critical in sustaining Jah Hut livelihoods.

Economic capital included income sources, engagement in subsistence farming, rubber tapping, oil palm harvesting, informal labor arrangements, government aid dependency, and non-monetary exchanges (barter and self-consumption farming). Given that Jah Hut households often engage in hybrid economic systems that do not rely solely on cash income, the study accounted for monetary and non-monetary contributions to livelihood sustainability.

Social capital was assessed through reciprocal labor arrangements, seed-sharing networks, collective labor-sharing practices, participation in community initiatives, and informal governance structures. Unlike SLF's conventional emphasis on formal institutions, this study highlighted the role of customary governance mechanisms, such as informal village meetings, in decision-making, dispute resolution, and economic cooperation.

Physical capital was examined based on types of housing (concrete, timber, or a combination of both), access to electricity and water, transportation networks, communication infrastructure, and proximity to essential services (markets, schools, and medical centers). Since physical infrastructure significantly influences livelihood opportunities and mobility, these factors were crucial in understanding barriers to economic and social participation.

7.3.2. Data Collection Approach

7.3.2.1. Primary Data Collection Methods

Data was collected from 104 households, further details are in Chapter 3, section 3.4.2, providing a baseline dataset for assessing the distribution of livelihood capitals within the Jah Hut community. In addition to survey data, participatory mapping was employed to document land tenure arrangements, foraging zones, and agricultural areas. Conducted in collaboration with community members, this method allowed for a visual representation of how natural resources were accessed, shared, and governed within customary systems. The mapping exercise provided crucial insights into the overlap between formal and informal land claims, as well as resource use practices that were not reflected in government records.

7.3.2.2. Secondary Data Collection

To complement primary data sources, government reports, NGO publications, and historical records were reviewed to provide contextual background on Indigenous land tenure policies, economic programs, and development interventions affecting the Jah Hut. These sources were crucial in understanding structural constraints - such as land tenure insecurity, resource governance conflicts, and shifts in government assistance programs - that influenced the community's livelihood strategies. By integrating secondary sources with primary data, the study was able to contrast contemporary livelihood conditions with historical trends, highlighting continuities and disruptions in Indigenous economic and social structures.

7.4. Interpreting SLF Findings

The application of the Sustainable Livelihoods Framework (SLF) to the Jah Hut community reveals both its utility in identifying livelihood challenges and its limitations in capturing Indigenous realities. While SLF highlights economic vulnerabilities and access disparities, it fails to account for historical dispossession, informal governance structures, and non-monetary economies that sustain Jah Hut resilience. The following sections critically analyze these gaps, demonstrating how land tenure, social networks, traditional knowledge, and economic adaptations shape livelihood sustainability beyond SLF's conventional categories. This analysis offers a more comprehensive understanding of Jah Hut agency, survival strategies, and structural constraints that influence their livelihoods.

7.4.1. Human Capital

The human capital of the Jah Hut community is shaped by a combination of Indigenous knowledge systems, limited formal education, and expertise in both traditional and commercial agriculture. While frameworks such as the Sustainable Livelihoods Framework (SLF) often equate human capital with formal education, a decolonial reframing perspective acknowledges oral traditions, Indigenous agricultural skills, and medicinal knowledge as valid forms of literacy. The following sections describe the empirical findings for the human capital.

7.4.1.1. Demographics and Household Structures

Most respondents were female (66.3%), though interviews often included couples or extended family members, reflecting communal decision-making within households (Table 7.1). The matrilocal tradition, where men relocate to their wife's village upon marriage, continues to shape settlement patterns. The average household size is 6.6 people, with a range from 1 to 31 individuals. Many families comprise multiple generations living together, supporting one another in both economic and social responsibilities.

Age records are imprecise, especially among older generations, due to historical practices of home births and delayed registration. Some individuals hold official documents listing incorrect birthdates, making formal age statistics less reliable. Household structures also reflect migration and intermarriage. Another household illustrates cultural fluidity: a Chinese father works as an oil palm fruit contractor, his Jah Hut wife cultivates hill rice, and their daughters, who converted to Islam, continue to assist in rice farming while also working as rubber tappers. Similarly, a Jah Hut woman who initially sought city employment eventually returned to village life, prioritizing stability over financial gain.

Indicators	Category		Frequency	Percentage
Gender	Male		35	33.7
	Female		69	66.3
Respondent's education level	No Formal Education		38	36.5
	Primary (completed)		13	12.5
	Primary (incomplete)		28	26.9
	Secondary (incomplete)		12	11.5
	SPM		10	9.6
	Others		3	2.9
Indicators	Mean	Median	**Max**	**Min**
Household size	6.6 ± 3.7	6	31	1

TABLE 7.1: HUMAN CAPITAL INDICATORS OF RESPONDENTS

7.4.1.2. Education and Barriers to Formal Schooling

Education levels in the community remain low. Among respondents, 36.5% have no formal education, while 26.9% did not complete primary school. Only 9.6% completed secondary education (SPM) (Table 7.1). The highest education level among household members follows a similar trend, with 29.8% reaching SPM and 20.18% attaining other forms of secondary education (Table 2). These figures underscore systemic barriers rather than a lack of interest or capability. The primary reasons for school dropout include economic hardship, hidden schooling costs (e.g., pocket money, school supplies, extracurricular fees), and an alienating education model. While JAKOA covers transportation, many families struggle with daily schooling expenses.

Geographic accessibility remains a challenge. Older generations recall how jungle terrain, roaming wildlife, and the absence of proper roads once made attending school unsafe. While infrastructure has improved, long distances and unreliable transport still hinder attendance. Boarding schools, though an option, often result in emotional distress and cultural disconnection, leading some students to return home.

Beyond financial and logistical challenges, Indigenous students frequently experience marginalization in schools. In Sungai Mai, youth reported feeling intensely aware of their lower socioeconomic status compared to their non-Indigenous peers. Differences in clothing, school supplies, and overall living conditions create a sense of exclusion, leading some to withdraw socially. Instances of discrimination further exacerbate this alienation. To avoid these experiences, many children prefer to remain at home.

Technology also plays a role in education. While internet access is limited, children download videos and games to watch offline, often prioritizing entertainment over schoolwork. Parents, seeing this as a way to keep children occupied, do not impose strict screen-time regulation.

Despite these challenges, parents generally encourage education but do not strictly enforce school attendance. They recognize both the benefits and the systemic difficulties their children face. As a result, some students leave school due to economic necessity, others due to social exclusion, and some because the education system does not reflect their lived realities. This pattern underscores how mainstream education systems fail to accommodate Indigenous students. Instead of addressing structural inequalities, current policies impose a rigid, assimilationist model that does not integrate Indigenous knowledge or socio-economic realities.

7.4.1.3. Training and Employment

Agriculture remains central to the Jah Hut economy. The most common occupations include rubber tapping/smallholding (39.4%), traditional farming (20.7%), and oil palm smallholding (20.2%) (Table 7.2). Other employment types, such as wage labor (3.8%) and business ownership (1%), remain marginal due to limited formal job opportunities. Employment preferences reflect a deep-rooted dependence on land-based livelihoods. While agricultural work is physically demanding and financially unpredictable, it provides a level of food security and autonomy that many villagers value. One elder recalled how her parents advised her to always maintain a small farm to ensure she would never go hungry, a sentiment highlighting how subsistence farming remains a critical safety net despite modern economic pressures.

Agricultural training is primarily intergenerational. 60% of respondents learned from spouses, parents, or elders, while 31.3% were self-taught by observing others at work (Table 7.2). Traditional farming, particularly hill rice cultivation, is passed down through hands-on experience rather than formal training. Rubber and oil palm cultivation follow a similar pattern, though a small number of individuals attended external training programs, such as FELCRA's oil palm cultivation course.

Indicators	Category	Frequency	Percentage
Occupation	Oil palm cultivator	42	20.2
	Rubber tapper/ rubber cultivator	82	39.4
	Offsite employment	20	9.6
	Wage labourer (rubber tapper/ oil palm fruit harvester/ house builder/ forest product harvester)	8	3.8
	Business owner (sundry shop/ oil palm fruit contractor	2	1
	Homemaker	7	3.3
	Traditional agricultural farmer	43	20.7
	Others	3	1.4
Highest education level of household members	Primary (complete)	13	12.5
	Primary (incomplete)	8	7.69
	Secondary (incomplete)	27	26.0
	Secondary (completed SPM)	31	29.8
	Others	21	20.18
Agricultural training received	Rubber/ Oil Palm cultivation techniques	92	48.4
	Traditional Agriculture	90	47.4
	Conventional agriculture	2	1.05
	No training received	6	3.16
Source of instruction/ training	Friends	5	3.33
	Government	3	2
	Self-taught by observing others at work	47	31.3
	Spouse/ parents/ elders	90	60
	Employer (past & present)	5	3.33
Benefit of training	Improves livelihood	96	53.6
	Increased knowledge	83	46.4

TABLE 7.2: TRAINING AND EMPLOYMENT INDICATORS FOR HUMAN CAPITAL

7.4.1.4. Health Practices and Decision-Making

Common illnesses include fevers (32.1%), colds (9.49%), and asthma (5.84%) (Table 7.3). While 41.2% seek treatment at government clinics or hospitals, 43.5% continue to rely on traditional medicine, including herbal remedies and shamanic healing rituals (*berjampi*). Traditional healing remains culturally significant, though the role of shamans (bomohs) is diminishing. In Berdut village, respondents expressed concern that younger generations are not seeking traditional healing knowledge. Some bomohs remain hidden due to fears of spiritual attacks from rivals (due to envy and rivalry), particularly in Sungai Mai. In Pasu, even local guides were unaware of a bomoh's presence, highlighting the secrecy surrounding these practices.

While traditional medicine is valued, many villagers acknowledge its limitations. Bomohs are trusted for treating "village illnesses" (*penyakit kampung*), but modern medicine is sought for infectious diseases (*penyakit luar*, or illnesses originating outside the village) and chronic conditions. Healthcare-seeking behavior often blends traditional and biomedical approaches. Some consult a government clinic first, turning to a bomoh only if conventional treatments fail.

Healthcare decisions are shared within households. 29.8% of decisions are made jointly by spouses, while 26% are led by male heads of households and 25% by female heads. Elders, particularly women, play a significant role in preparing herbal remedies and determining when family members should seek medical treatment. A woman who had not left her village in years converted to Christianity after a personal illness and now follows church practices rather than traditional Jah Hut healing rituals.

Indicators	Category	Frequency	Percentage
Major health issues experienced by the household	Fever	44	32.1
	Cold	13	9.5
	Asthma	8	5.8
	Severe knee problems	7	5.1
	Heart disease	5	3.7
Decision-maker regarding family health	Jointly made by husband & wife	31	30
	Male head of household	27	26
	Female head of household	26	25
	Other members of the family (parents/ siblings/ children)	19	18.3
Method of treatment in case of illness	Shaman & traditional medicine	74	43.5
	Government clinic/ hospital	70	41.2
	Own treatment (medicinal herbs or over-the counter medicine)	17	10
	Private clinic	9	5.3

TABLE 7.3: HEALTH PRACTICES AND DECISION-MAKING INDICATORS

7.4.1.5. Shifting Health Benefits and the Impact of Modernization

As traditional healing knowledge declines, many younger generations turn exclusively to modern medicine. Some respondents lamented that their children no longer believe in *berjampi*, while others noted that traditional herbal knowledge is not being passed down as it once was. However, some younger villagers still retain aspects of this heritage – a respondent from Pasu continues to gather bamboo shoots from the primary forest, using them as a remedy for kidney disease, a practice he learned from his father.

External influences, such as smoking, continue to persist. Betel (areca nut) chewing is a traditional practice widely observed across all ages and genders. Older women often smoke home-grown tobacco, rolling their own cigarettes with tobacco leaves and betel instead of using commercial tobacco products. While this is perceived as a healthier alternative to factory-made cigarettes, its long-term health effects remain uncertain.

While reliance on modern healthcare is growing, the erosion of traditional healing networks is not simply a matter of cultural change but also a result of systemic marginalization. Many villagers expressed frustration that shamans are disappearing, not necessarily because their practices are ineffective, but because state policies, economic pressures, and social stigma have delegitimized their role. The gradual loss of *bomohs* is not just a cultural shift - it represents a broader transformation in Indigenous self-sufficiency, as communities are increasingly pushed toward dependence on external healthcare systems that do not always align with their lived realities.

7.4.2. Social Capital

7.4.2.1. Collective Action Beyond Formal Organizations

Social capital in the Jah Hut community is built on informal networks and collective labor rather than formal organizations. 89.4% of the community engages in collective action, underscoring strong communal ties and cooperation (Table 7.4). Most respondents (82.7%) do not belong to formal organizations. Among the small percentage who do, the most common affiliations include ethnic-based groups (40.9%), village-level organizations (27.3%), political groups (22.7%), and government-affiliated organizations (9.09%). However, institutional membership does not define engagement, as nearly nine out of ten individuals contribute to collective labor efforts. Efficiency and shared workload drive participation, with 72% emphasizing quicker task completion and reduced burden. Additionally, 19% cite cultural obligations and reciprocity, reflecting the significance of traditional mutual aid. Few respondents (8%) are uncertain about the benefits, and only 1% mention stress relief, suggesting that collective work is primarily seen as a functional necessity rather than a social or emotional outlet.

A strong communal support system is acknowledged by 93.3% of respondents, highlighting an informal yet highly effective structure of mutual assistance. The most common forms of support include physical labor (52.3%) and material aid (40.6%), such as food, seedlings, and chemical inputs. Other types of assistance include advice (2.58%), cash aid (2.58%), and training (1.29%), while only 0.65% receive all these forms of support simultaneously. On average, individuals receive help from about 12 community members, with a median of 10. The range varies from zero to 50, indicating that some rely on a small, close-knit support system, while others benefit from broader community engagement.

Despite minimal formal organizational involvement, the Jah Hut community thrives on deeply embedded traditions of mutual aid. The high levels of participation in collective action (89.4%) and communal support (93.3%) challenge conventional governance models that equate engagement with formal membership. Instead, the community sustains itself through a culturally driven and resilient cooperative system that strengthens social bonds and livelihoods.

Indicators	**Categories**	**Frequency**	**Percentage**
Involvement in organizations	Yes	18	17.3
	No	86	82.7
Type of Organization	Ethnic-based	9	40.9
	Government	2	9.09
	Political	5	22.7
	Village-level organisation	6	27.3
Involvement in collective action	Yes	93	89.4
	No	11	10.6
Perceived benefits of collective action	Not sure/none	8	8
	Mind relaxation & stress relieve	1	1
	Culture/ responsibility/ JH tradition/ reciprocity	19	19
	Sense of camaraderie/ reduces burden/ satisfying/ job done quickly	72	72
Perceived existence of a communal support system	No	7	6.73
	Yes	97	93.3
	Advice / input	4	2.58

Indicators	Categories		Frequency	Percentage
Type of communal support received	Material help (food, seedling, chemical inputs)		63	40.6
	Physical help		81	52.3
	Cash help		4	2.58
	Training		2	1.29
	All the above		1	0.65
Indicators	**Mean**	**Median**	**Max**	**Min**
Number of individuals who provide support/assistance from the community	12.21 ± 11.37	10	50	0

TABLE 7.4: INDICATORS FOR COLLECTIVE ACTION AND ORGANIATIONAL INVOLVEMENT

7.4.2.2. Seed Networks for Shifting Cultivation and Home Gardens

Seed networks are essential in maintaining the sustainability of shifting cultivation and home gardening within the Jah Hut community. The data (Table 7.5) highlights a strong reliance on self-sufficiency, with 38.5% of respondents preserving seeds from past harvests. This practice ensures continuity in traditional farming techniques, minimizes dependence on external inputs, and enhances local agricultural resilience. The low rate of commercial seed purchasing - only 12.3% - further underscores the community's preference for autonomy over market-based alternatives. While commercial seeds may offer advantages in terms of yield and disease resistance, their limited use suggests that factors such as cost, adaptability, and trust in traditional varieties shape local seed management strategies.

Beyond self-sufficiency, seed exchange within the community plays a crucial role in sustaining shifting cultivation. A significant proportion (36.9%) of respondents obtain seeds from relatives or neighbors, reinforcing the deep social ties that underpin agricultural practices. In contrast, only 7.26% receive seeds from contacts outside their community, reflecting a predominantly localized seed-sharing system. This reliance on close-knit networks indicates the importance of trust, reciprocity, and shared responsibility in maintaining biodiversity and ensuring seed availability. Additionally, among respondents who have consistently had access to seeds, 53.8% acquired them from within their own community, further demonstrating the centrality of localized seed systems in sustaining farming traditions.

Due to the localized nature of seed management, each village tends to cultivate distinct rice and Indigenous vegetable varieties, with limited awareness of the diversity present in other communities. This knowledge gap became apparent during group discussions when villagers expressed surprise upon learning that certain seed varieties still existed elsewhere, underscoring the extent of knowledge isolation within the Jah Hut community. The lack of inter-village seed exchange not only highlights the central role of internal social networks in preserving agricultural traditions but also reveals the vulnerability of these traditional rice and vegetable varieties to extinction.

Indicators	Categories	Frequency	Percentage
Source of seeds used in shifting cultivation and home gardens	Self-saved and maintained from crops grown in the past	69	38.5
	Bought from the market/commercial seed seller	22	12.3
	Gift/ purchase from a relative or contact from another community	13	7.26
	Gift/purchase from a relative or neighbour in the same community	66	36.9
	Gifted by an extension service or government agency	9	5.03
Initial origin of seeds (if it has always been self-saved)	Always self-saved	37	35.6
	Gift/purchase from a relative or neighbour in the same community	56	53.8
	NGO (gift)	1	0.96
	Gift/ purchase from a relative or contact from another community	6	5.77
	Bought from the market/commercial seed seller	4	3.85

TABLE 7.5: INDICATORS FOR SEED NETWORKS

However, despite the prominence of informal networks, institutional involvement in seed distribution remains minimal. Only 5.03% of respondents report receiving seeds from extension services or government agencies, while an even smaller fraction (0.96%) acquires seeds from NGOs. This suggests that formal institutions play a negligible role in supporting seed access for shifting cultivators, leaving farmers largely dependent on traditional knowledge and social capital. While community-based seed systems have proven effective, their long-term sustainability may be challenged by environmental pressures, climate variability, and the potential loss of seed diversity due to changing agricultural landscapes.

The absence of institutional support raises concerns about the resilience of these informal seed networks in the face of external challenges. A sudden crop failure, pest outbreak, or extreme weather event could disrupt seed availability, particularly for those who rely solely on saved or exchanged seeds. Strengthening community-led initiatives, such as seed banks or farmer-managed conservation programs, could serve as a buffer against these risks. Policies that integrate traditional knowledge with adaptive strategies - such as participatory breeding programs or local seed-saving cooperatives - could enhance seed security while preserving local biodiversity.

7.4.2.3. Fractured Leadership and the Legacy of Colonial Governance

Leadership tensions within the Jah Hut community cannot be directly linked to low organizational participation, as participation in formal institutions does not necessarily reflect trust or cohesion. However, qualitative findings indicate that governance struggles - rooted in colonial disruptions - have affected social dynamics, particularly in decision-making and conflict resolution.

In one village, leadership disputes have divided residents into two factions - one supporting the officially recognized leader and another backing an alternative figure. Conflicts, particularly over land dealings, have eroded trust in formal governance. Some villagers suspect underhanded agreements between leadership and external actors, as one resident reported that her ancestral land had been encroached upon by outsiders due to secret negotiations. These divisions have tangible consequences; for instance, a formerly active participant in communal labor withdrew from collective efforts due to political tensions. Others downplay the issue, with some villagers aligned with the current leader insisting there are no conflicts at all. Interestingly, many respondents avoided commenting on the leadership struggle, reflecting either a reluctance to take sides or a deeper sense of disenfranchisement.

In another village, the absence of formal leadership structures further complicates governance. There is neither a recognized village head nor a functioning community committee, as leadership candidates proposed by residents have been repeatedly rejected by authorities. This lack of official recognition has left villagers uncertain about their administrative status, raising concerns that their community is being sidelined. These fears are further reinforced by the fact that the village has been left out of JUPEM's (Department of Survey and Mapping Malaysia) topographical map, effectively rendering it invisible in official records. Many acknowledge the necessity of a village head (Tok Batin or Batin) for bureaucratic functions - such as endorsing school documents - but without a local leader, they must rely on external figures, including an unresponsive Batin from a neighboring village or a non-Indigenous government-appointed leader unfamiliar with their needs. In a third village, leadership is ineffective, with the current figurehead largely absent from community development efforts.

Historically, the Batin was a powerful and respected figure, deeply connected to the community's spiritual and social well-being. These leaders were well-versed in mystic arts, serving not only as decision-makers but also as cultural and spiritual anchors. However, such personalities are long gone, and no clear replacements have emerged. The modern Batin, now integrated into state governance structures, lacks the traditional authority once held, reducing their role to an administrative function rather than a community leader.

These governance gaps highlight the long-term impact of colonial interference in Indigenous leadership structures. Traditionally, authority was relational and community-driven, yet state-imposed leadership frameworks have fragmented decision-making. In one village, leadership is contested; in another, it is absent altogether; in the third, leadership exists but is ineffective. Rather than strengthening governance, these disruptions have led to a system where leadership is either a source of division, an inaccessible bureaucratic requirement, or an empty title with no real influence. In effect, such fractured leadership structures undermine the transmission of TEK and weaken collective decision-making, directly challenging the sustainability of Jah Hut livelihoods.

Gendered exclusion further reinforces these disruptions. Jah Hut women do not participate in formal political discussions, yet they play a crucial role in sustaining social cohesion. Their exclusion is not an inherent cultural norm but a colonial legacy that prioritized hierarchical male leadership, diminishing Indigenous gender dynamics. While women maintain strong informal networks, these spaces remain unrecognized in governance assessments. The reliance on external authorities and the erosion of traditional leadership models demonstrates how colonial legacies continue to shape Indigenous governance, often to the detriment of community cohesion.

7.4.2.4. Recognizing Informal Networks as Governance Structures

Indigenous governance does not function through bureaucratic models but through flexible, trust-based systems. The *bawah pokok* (under-the-tree) gatherings most evident in Berdut (Figure 7.2) - where elders and villagers discuss communal matters - serve as vital governance spaces, yet they remain invisible in formal assessments. These informal discussions play a crucial role in decision-making, conflict resolution, and the transmission of knowledge. However, the SLF, with its emphasis on institutionalized governance, fails to capture these essential cultural practices, reinforcing critiques of its applicability in Indigenous contexts.

FIGURE 7.2: INFORMAL GATHERINGS (BERDUT; 28 JULY 2022)

The assumption that low organizational participation signals weak governance overlooks these alternative structures. The Jah Hut community's governance is embedded in everyday interactions rather than formalized institutions. Development approaches that push for integration into state-recognized organizations risk undermining Indigenous autonomy and the legitimacy of these traditional systems. Instead, there must be a recognition that these informal governance networks are not signs of disorder but expressions of a deeply rooted, collective decision-making system.

The community's high level of collective action (89.4%) and strong social ties (average of 12 supporters per person) indicate robust social capital that operates outside institutional frameworks. Rather than imposing external governance models, sustainable development efforts should engage with and strengthen these existing networks, ensuring that Indigenous decision-making remains in the hands of the community.

7.4.3. Financial Capital

7.4.3.1. Economic Precarity, Structural Exclusion and Shared Wealth

The Jah Hut community experiences deep financial precarity, with an average monthly income of RM1,933 (USD430) that fluctuates widely between RM0 and RM15,500 (USD3,479/month) (Figure 7.3). This volatility stems from dependence on unstable economic activities such as rubber tapping, oil palm harvesting, and sporadic wage labor in logging and construction. Only 3.96% of households consistently have surplus income, while 67.3% never do. These figures reflect a broader structural exclusion from stable markets, as Indigenous communities lack control over commodity pricing and face barriers to diversified income sources.

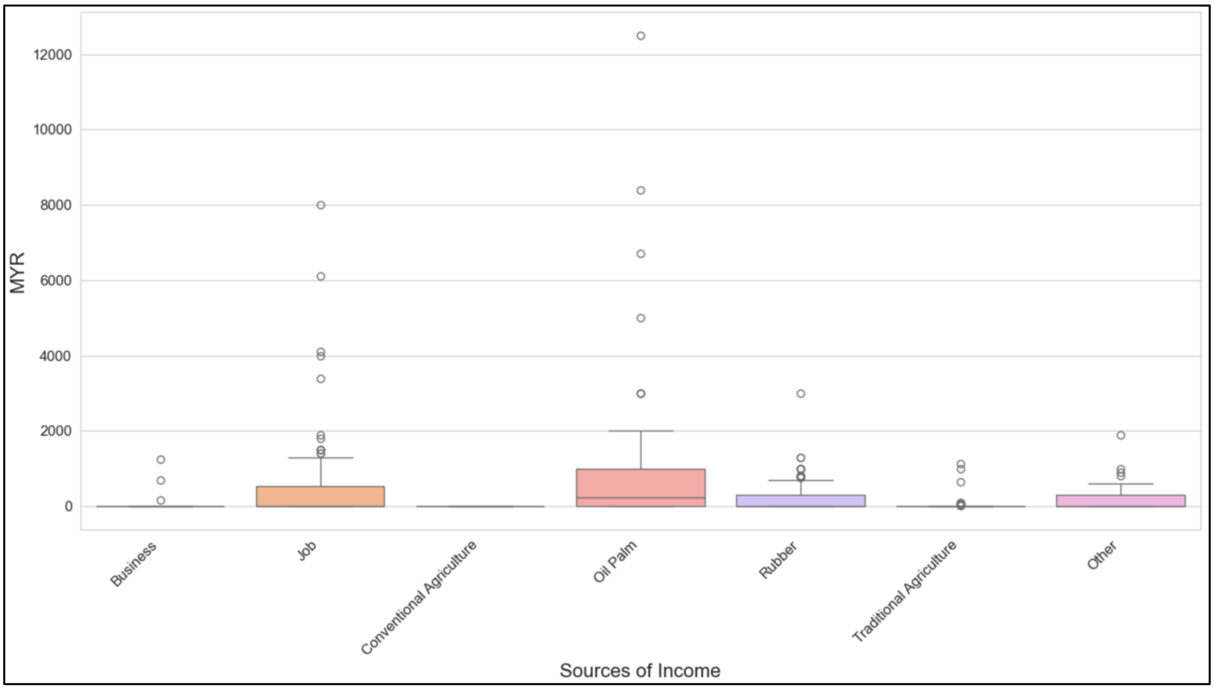

FIGURE 7.3: DISTRIBUTION OF JAH HUT INCOME SOURCES AND VARIABILITY

Despite this economic precarity, many respondents place a high value on economic independence, often avoiding financial assistance even from close relatives. Borrowing money is seen as a last resort, as some feel ashamed to ask, while others hesitate due to uncertainty about repayment. For instance, a woman with 21 family members under one roof never asks for financial help, though her children contribute voluntarily. When assistance is needed, it is typically sought from immediate family members rather than external sources, reinforcing a system of mutual support over external dependency.

At the same time, wealth distribution within the community operates on a deeply communal basis, sometimes at significant personal cost. A couple earning RM9,000 per month (USD2,000) - far above the eligibility threshold for government aid - still faced food shortages for an entire month due to their financial obligations to extended family members. This highlights a fundamental difference between Indigenous and capitalist economic models: financial stability is not an individual achievement but a collective responsibility. This practice disrupts conventional measures of wealth and financial security, as even those with relatively higher incomes may struggle due to social expectations of resource-sharing.

7.4.3.2. Government Aid as Dependency Creation

Government aid is nearly universal (93.3% of respondents receive financial support), with Bantuan Keluarga Malaysia (Malaysian Family Assistance, or BKM) being the primary source (62.7%), followed by Bantuan Musim Tengkujuh (Monsoon Season Assistance or BMT) (34.6%) (Table 7.6). However, this aid is overwhelmingly insufficient - 72.2% of recipients report that it does not meet their needs. The prioritization of financial support for food (59.9%) and school supplies (23.9%) underscores the community's struggle to meet necessities, leaving minimal resources for long-term financial stability or investment in productive assets.

Indicators	Categories	Frequency	Percentage
Existence of financial support system	No	7	6.73
	Yes	97	93.3
Types of financial assistance received	BKM (Bantuan Keluarga Malaysia, Family Assistance)	96	62.7
	BMT (Bantuan Musim Tengkujuh, Monsoon Assistance)	53	34.6
	Others	4	2.6
Utilization of financial assistance	Farm expenses	5	3.52
	Food	85	59.9
	Other household needs	9	6.34
	Saved	5	3.52
	School supplies	34	23.9

Indicators	Categories	Frequency	Percentage
	Others (vehicle repair & maintenance, house renovation, payment of utility bills)	4	2.82
Source of financial assistance	Federal Government	95	99
	State Government	1	1
Perception of assistance sufficiency	Insufficient	70	72.2
	Moderately sufficient	22	22.7
	sufficient	5	5.15
Existence of surplus income	Never	68	67.3
	Sometimes	29	28.7
	Always	4	3.96
Usage of surplus income & excess farm produce	Buy provisions	6	12.5
	Buy school supplies	2	4.17
	Save	32	66.7
	Shared with friends/ neighbours / relatives	3	6.25
	Vehicle maintenance	4	8.33
	Home maintenance	1	2.08

TABLE 7.6: INDICATORS FOR FINANCIAL SUPPORT SYSTEM

The utilization of financial aid highlights the economic precarity of the community, with nearly 60% of recipients prioritizing food purchases, emphasizing the ongoing struggle for subsistence. Similarly, 23.9% allocate funds toward school supplies, reflecting the financial strain of education-related expenses. Investments in future security or productive assets remain minimal, as only 3.52% manage to save their assistance, while an even smaller proportion (3.52%) use it for farm-related expenses. The 2.82% who direct funds toward essential maintenance costs (such as vehicle repairs, house renovations, and utility bills) illustrate how financial assistance is absorbed into immediate survival rather than long-term economic resilience.

From a Sustainable Livelihood Framework (SLF) perspective, this financial aid serves as a short-term stabilizing resource, cushioning seasonal income fluctuations and mitigating extreme poverty. However, the data suggests that these forms of aid act as mechanisms of economic containment rather than empowerment. The overwhelming 99% reliance on federal government support (compared to just 1% from state government) signals not just economic vulnerability but also a structural dependency that restricts Indigenous economic self-determination. Rather than fostering resilience through community-led agricultural initiatives or cooperative enterprises, these policies reinforce an externally controlled economic structure that perpetuates cyclical poverty.

The data on surplus income further underscores this economic precarity. Most respondents (67.3%) never have surplus income, while only 3.96% consistently generate extra financial resources. This suggests that most households operate at the edge of subsistence, with little capacity for savings or reinvestment. Among the minority who do accumulate surplus income, 66.7% prioritize saving, indicating a cautious financial strategy shaped by economic uncertainty. Others allocate surplus funds toward buying provisions (12.5%), vehicle maintenance (8.33%), and assisting friends or relatives (6.25%), reflecting communal solidarity despite financial hardship. The extremely low proportion of respondents (4.17%) who use surplus income for school supplies further highlights the limited flexibility in household budgets.

7.4.3.3. Co-Optation of Indigenous Labor and Economic Contradictions

The paradox of Indigenous labor in logging further illustrates forced economic assimilation. Some Jah Hut individuals in Pasu work as boundary surveyors and laborers for logging companies clearing their customary lands. This work, while providing short-term financial relief (e.g., RM100 (approximately USD20)/day as a logging boundary surveyor), directly undermines long-term land security and ecological stability. Participating in the destruction of one's environment is not a choice but an economic necessity - an outcome of structural exclusion from alternative livelihood opportunities.

Beyond logging, other economic activities reveal additional contradictions. Foraging remains a key subsistence strategy, with some individuals earning more from gathering wild vegetables and bamboo shoots than from rubber tapping. However, these non-monetized forms of labor are unrecognized in conventional economic assessments, reinforcing the invisibility of Indigenous contributions outside capitalist frameworks. Similarly, durian (*Durio spp.*) harvesting and mixed-crop farming (such as lemongrass, *Cymbopogon citratus*, and other local vegetables) generate income but are subject to environmental unpredictability, such as irregular fruiting seasons.

7.4.4. Natural Capital

The Jah Hut community's engagement with land and natural resources reflects a complex interplay between traditional practices, economic adaptation, and structural constraints imposed by state policies and external market forces. While cash crops such as rubber and oil palm have become central to agricultural livelihoods, foraging and shifting cultivation persist as critical strategies for sustenance and sometimes income. The increasing reliance on secondary forests (*belukar*) underscores the community's resilience and resistance against land dispossession. However, structural limitations - including land tenure insecurity, encroachment, and financial barriers - have shaped their patterns of land use, often forcing shifts away from traditional ecological practices. Table 7.7 provides the empirical data that informs the discussions in the following sections.

Indicators	Categories	Frequency	Percentage
Wild areas used	Primary forest	28	21.4
	Secondary growth (*belukar*)	103	78.6
Purpose of wild area usage	Forage in *belukar* / gather forest products	76	25.7
	Fruit orchard	5	1.69
	Mixed cropping	30	10.1
	Oil palm	57	19.3
	Rubber	90	30.4
	Shifting cultivation	37	12.5
Type of landholding	Customary OA land (not recognized by Govt)	28	27.2
	Gazetted OA reserve	75	72.8

TABLE 7.7: INDICATORS FOR NATURAL CAPITAL

7.4.4.1. Landholding and Usage: Negotiating Space and Authority

The Jah Hut's land tenure is divided into gazetted Orang Asli (OA) reserves (72.8%) and customary land (27.2%) that remains unrecognized by the government (Table 7.7). This discrepancy in land classification has significant consequences, as it enables the state to control access while marginalizing Indigenous claims. The lack of legal recognition of customary land leaves communities vulnerable to encroachment, particularly from Chinese businessmen (*taukey* in local parlance) and corporations. In Berdut alone, approximately 2,000–3,000 acres (8 – 12 km^2) of customary land have been occupied by Guthrie Plantation, highlighting the ongoing struggle for land sovereignty. The issue of land tenure has been covered in detail in Chapter 6, Section 6.8.5.1.

Land use within the community reflects both necessity and external pressures. The expansion of commercial crops, particularly rubber (30.4%) and oil palm (19.3%), signifies a shift toward cash crop economies, often at the expense of shifting cultivation, which is now practiced by only 12.5% of respondents. Figure 7.4 highlights this transition, with rubber cultivation averaging 0.03 km^2 per household and oil palm significantly larger at 0.06 km^2 per household. Meanwhile, shifting cultivation persists on a much smaller scale (0.013 km^2 per household), underscoring its gradual marginalization.

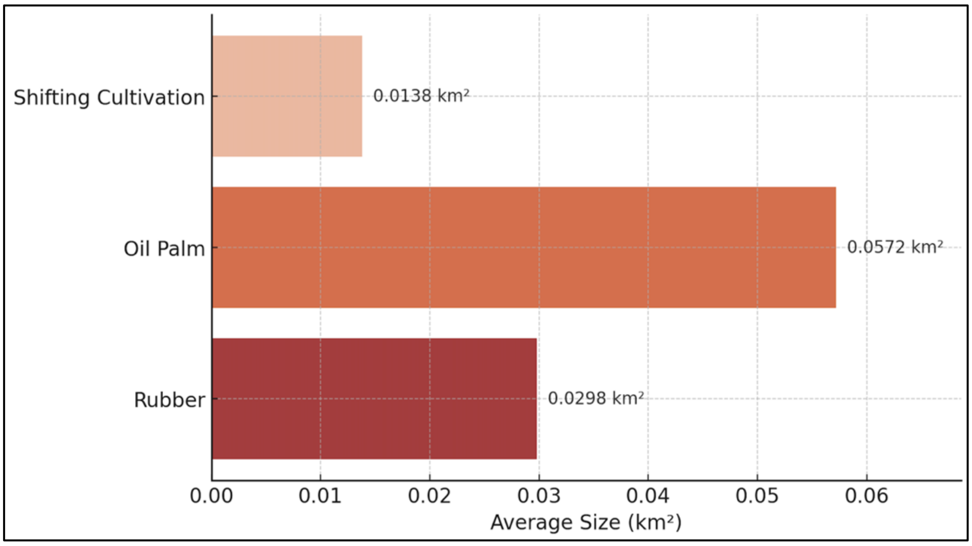

FIGURE 7.4: AVERAGE LAND SIZE BY TYPE OF USAGE

The decline of shifting cultivation is not merely a natural transition but a forced adaptation to land loss and external pressures that favor commercial agriculture. As a result, many villagers have transitioned to rubber and oil palm farming in former secondary forests, although high input costs, a lack of financial support, and reliance on exploitative middlemen limit profitability.

In areas where traditional farming is no longer viable, mixed cropping - integrating oil palm, rubber, fruit trees, and local vegetables - has emerged as an adaptive response to land shortages rather than a deliberate strategy. The data (Table 7.7) shows that 10.1% of respondents engage in mixed cropping, highlighting its growing importance as a coping mechanism. Similarly, some have converted former orchards into oil palm plantations out of necessity rather than preference. However, these economic alternatives are fraught with risks, including price fluctuations, limited direct market access, and the seasonal constraints of rubber tapping, particularly during the monsoon season.

7.4.4.2. Wild Area Usage: Secondary Forests as a Pillar of Livelihoods

The use of wild areas highlights the community's dependence on local resources. Secondary growth forests, or *belukar*, play a critical role, with 78.6% of respondents utilizing these lands, compared to 21.4% who access primary forests (Table 7.7). These areas support foraging and gathering forest products (25.7%), reinforcing their significance for food security and supplementary income. Other uses include mixed cropping (10.1%), oil palm cultivation (19.3%), and rubber plantations (30.4%), illustrating their gradual transformation for commercial activities.

Secondary forests are more readily available for cultivation, foraging, and resource extraction, reflecting historical land-use patterns and accessibility. Despite often being excluded from formal economic assessments, foraging remains a significant livelihood strategy. Some villagers report earning more from gathering forest products - such as bamboo shoots, edible ferns, and traditional medicine - than from cash crops, emphasizing the economic viability of Indigenous ecological knowledge.

Foraging is not limited to forests; villagers also collect edible plants from oil palm plantations, where dispersed seeds allow species like cassava, tubers, water spinach (*kangkong,* or *Ipomea aquatica*), local chilies, and spinach to thrive (Figure 7.5). Women often forage in groups to mitigate risks from wildlife (commonly snakes, and the Malayan sun bear, *Helarctos malayanus*), reinforcing the communal and interdependent nature of this practice. Unlike commercial extraction, Jah Hut foraging is intentionally sustainable, ensuring plant regeneration and reflecting an Indigenous land stewardship model that contrasts with state-driven conservation policies, which often exclude local participation.

FIGURE 7.5: A JAH HUT WOMAN FORAGES FOR WATER SPINACH (KANGKUNG) GROWING IN THE SHALLOW SECTIONS OF THE MAI RIVER (16 AUGUST 2022)

7.4.5. Physical Capital

7.4.5.1. Types of Housing

Housing in these communities reflects a tension between state-imposed infrastructure and Indigenous preferences. Government housing programs, such as the PPRT (*Program Perumahan Rakyat Termiskin* or People's Housing Program for the Poorest) scheme, were introduced to improve living conditions, yet they were designed and built without considering the needs of Indigenous families. These houses follow a rigid, one-size-fits-all model, failing to accommodate the multi-generational living arrangements central to Jah Hut social life. Many of these PPRT homes (Figure 7.6) are small, poorly designed, and constructed with low-quality materials, making them impractical and short-lived. Instead of addressing housing needs, these structures have forced families to either modify them by adding wooden extensions or abandon them in favor of traditional wooden houses that better suit their lifestyles.

FIGURE 7.6: (L) A PPRT (PROGRAM PERUMAHAN RAKYAT TERMISKIN) HOUSE IN SUNGAI MAI, CONSTRUCTED AS PART OF A GOVERNMENT HOUSING ASSISTANCE PROGRAM. (R) THE SIGNBOARD BESIDE THE FRONT DOOR PROVIDES DETAILS OF THE PROJECT. PHOTOGRAPHED ON 6 SEPTEMBER 2022.

The preference for self-built wooden houses (Figure 7.7), which make up 40.4% of all homes, reflects not only a practical response to inadequate government housing but also an assertion of cultural autonomy. In contrast, only 18.3% of respondents live in PPRT houses, and even among them, modifications are common.

FIGURE 7.7: SELF-BUILT WOODEN HOUSES IN PASU (LEFT) AND BERDUT (RIGHT)

Brick houses account for 24%, while hybrid structures (17.3%) - where wooden houses feature brick kitchen extensions or PPRT homes are expanded with additional wooden rooms - illustrate an ongoing adaptation process that reflects the failures of state housing policies to account for real household needs (Figure 7.8).

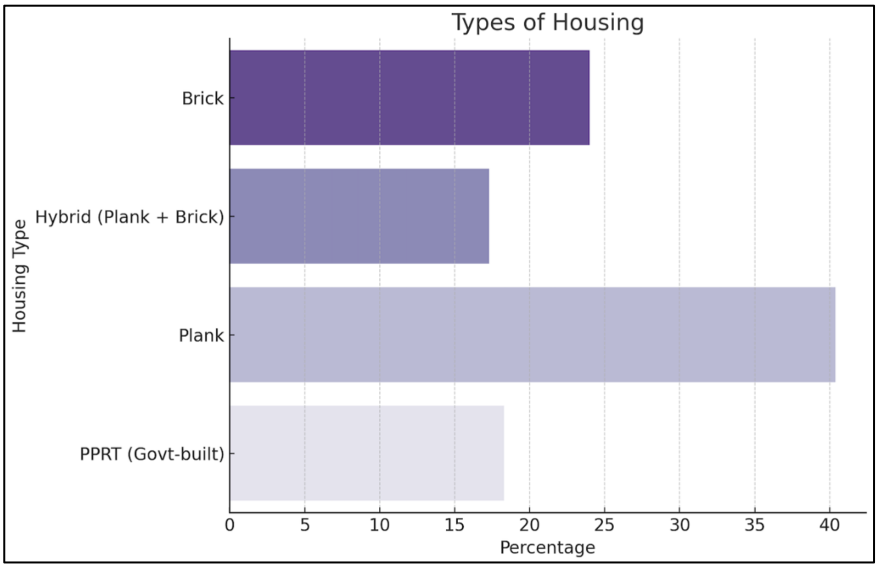

FIGURE 7.8: TYPES OF JAH HUT HOUSING

However, this distribution is not uniform across all areas. In Berdut, there are no PPRT homes at all. Instead, plank houses dominate the landscape, with only a few hybrid structures. This lack of government housing highlights a stark disparity in resource allocation, as some communities receive state support while others rely entirely on self-built solutions. Rather than viewing this reliance on self-constructed homes as a sign of underdevelopment, it as an assertion of autonomy - an act of resilience in the face of development policies that fail to reflect Indigenous needs.

In Sungai Mai, many PPRT homes, initially built as small two-room structures, have been extended using wooden materials to accommodate larger households. Similarly, in Pasu, where PPRT housing is also present but insufficient, many families continue to construct plank houses using timber from the secondary forest. A resident noted that newlywed couples struggle to obtain housing, as there are no state-provided alternatives, leaving them dependent on land and materials sourced within the community.

The presence of hybrid housing solutions - where wooden homes feature brick kitchen extensions or PPRT homes are expanded with additional wooden rooms - illustrates an ongoing negotiation between state-driven infrastructure and Indigenous adaptation strategies. Even among families with brick homes, separate '*pondok*' structures are built for social gatherings, reinforcing the importance of communal space, which is often overlooked in state-imposed housing models.

7.4.5.2. Basic Amenities: Water and Communication Limitations

Access to essential services such as water, electricity, and internet remains highly uneven, with only 18.2% of households enjoying full access (Figure 7.9). The majority - 68.3% - experience incomplete access, while 13.5% have no provision. Water supply remains a significant challenge, particularly in areas where state intervention has been minimal.

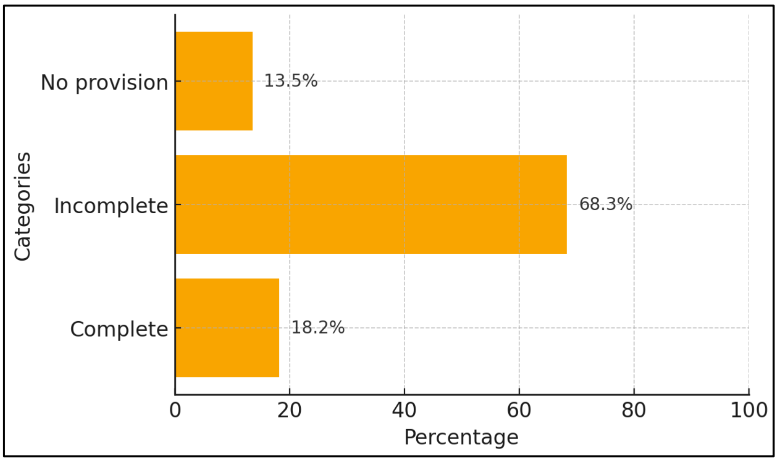

FIGURE 7.9: STATUS OF PROVISION OF BASIC AMENITIES

In Sungai Mai, fresh water is sourced from Hulu Sungai Mai (upstream of the Mai river) via small dam constructions, providing water for drinking, bathing, and cooking. While residents describe the water as generally clean and reliable, heavy rains disrupt its quality, making it murky and difficult to use. The government has made little effort to improve filtration or invest in sustainable water infrastructure, reflecting a continued failure to integrate Indigenous knowledge into water resource management. In Berdut, the situation is even more precarious, with only 14 homes having access to piped water. Even for these households, supply is frequently disrupted, and the water quality is extremely poor, making it unsafe for consumption without additional treatment. Rather than imposing centralized water supply systems that are often unreliable, the state should recognize and support Indigenous water management practices, ensuring that they are enhanced rather than replaced.

Communication networks are equally unreliable, with frequent disruptions in mobile and internet coverage, especially during heavy rains. This technological marginalization further isolates communities, restricting access to online education, healthcare, and emergency services. Like other infrastructure issues, the state's failure to invest in proper communication networks reveals a broader pattern of neglect, where Indigenous areas are left underserved and disconnected from wider economic and social systems.

7.4.6. Household Food Security: Status and Perceptions

The findings reveal that household food security remains a challenge for most respondents. When asked if their farm produce was sufficient for their consumption, an overwhelming 99% (101 respondents) stated that it was not, while only 1% (1 respondent) reported sufficiency (Table 7.8). This highlights a significant dependence on external food sources for meeting household needs.

Indicators	Variables	Frequency	Percentage
Is your farm produce sufficient for your consumption?	No	101	97.1
	Yes	1	0.98
If not sufficient, how do you fulfill your family's needs?	Purchase from the market	97	93.2
	Forage for forest edibles	80	76.9
	Make do	2	1.9
	Ask family/ friends/ community	12	11.5
How do you address food shortage?	Family/friends/community pitch in	10	9.6
	Harvest edibles from forest/belukar lama	40	38.5
	Frugal consumption/ eat simple food/ adjust budget	22	21.1
	Take up extra job in the village/off site	4	3.8
	Pawn rice	4	3.8
	Others (buy provision on credit, collect & sell rubber sap, collect and sell rattan, go without food, pound hill rice from old stock, bills go unpaid)	11	12.6
Ability to maintain food security?	Agree	78	75
	Disagree	7	6.73
	Neutral (we only make do)	13	12.5
	Strongly agree	3	2.88
	Strongly disagree	3	2.88
Have you experienced food shortage for a few months?	Agree	18	17.3
	Disagree	81	77.9
	Strongly disagree	5	4.81

TABLE 7.8: HOUSEHOLD FOOD SECURITY AND PERCEPTIONS

To compensate for this insufficiency, most respondents rely on purchasing food from the market (93.2%), followed closely by foraging for forest edibles (76.9%). A smaller proportion of respondents (11.5%) rely on support from family, friends, or the community, while a negligible 1.9% stated they "make do." These findings indicate that while the market is the primary food source, foraging for forest edibles is crucial in supplementing household diets, reflecting both economic constraints and traditional subsistence practices.

However, the reliance on market purchases and foraging varies between communities. In Sungai Mai, families buy vegetables more frequently (two to three times a week or a few times a month), spending between RM30 to RM60 per month. In contrast, Berdut households depend more on foraged and homegrown food, purchasing market vegetables primarily for variety (RM50 to RM60 per month). Their foraging efforts focus on the *belukar lama* (secondary forest/ old fallow plots), where they gather roots, tubers, local chilies, and perennials. They typically harvest 5kg of vegetables and tubers per trip (1 *ambong*/basket full), about two to three times a week, equating to an estimated market value of RM250 (USD56) per month. Some women harvest smaller quantities (2 - 3kg per trip) twice a week, but without refrigeration, fresh produce must be consumed immediately. Protein sources in Berdut mainly come from fish, anchovies (*ikan bilis*), dried fish, and chicken, purchased separately from vegetable expenses.

In response to food shortages, households employ a variety of coping strategies. The most common method is harvesting edibles from the secondary forests or *belukar lama* (38.5%), demonstrating the continued reliance on natural food sources during difficult times (Figure 7.20). Additionally, 21.1% of respondents consume frugally by eating simpler meals or adjusting their budgets. A smaller proportion takes up extra jobs (3.8%), pawns hill rice (3.8%), or relies on support from family and friends (9.6%). Furthermore, 12.6% of respondents mentioned alternative strategies such as buying provisions on credit, selling rubber sap or rattan, skipping meals, or using old, stockpiled hill rice while leaving bills unpaid. These coping mechanisms reflect the diverse strategies households employ to navigate food insecurity, often blending traditional subsistence practices with economic adaptation.

Food shortages also lead to simple meals. In Sungai Mai, when food is scarce, villagers rely on boiled cassava or sweet potatoes with fern shoots (*pucuk paku*) and water spinach (*kangkung*), and in extreme cases, porridge with *sambal* (a concoction of local chilies pounded with salt) or bananas. Floods exacerbate these shortages, cutting off supply routes and forcing families to survive on boiled cassava with *sambal*. In Berdut, food insecurity results in rice with *sambal* or anchovies, sometimes without vegetables. When rice stocks run low, families rely on cassava, river fish, and foraged greens. During the COVID-19 pandemic, delayed government aid further strained food security in Berdut, with some families struggling to access essential supplies.

Hill rice cultivation plays a crucial role in food security for both communities. In Sungai Mai, paddy planting ensures long-term food stability, reducing the need for external purchases. When not cultivating rice, they must buy vegetables or forage more extensively. In Berdut, hill rice farming offers financial relief, with an estimated 50kg per harvest saving RM50 (USD11) per month. However, cultivating rice demands time and labor, often causing farmers to neglect rubber tapping. When rice is unavailable, households consume cassava, sweet potatoes, and foraged vegetables.

In terms of food expenditure, respondents spend an average of RM136.60 (USD30) per month (±RM97.06) on purchasing market produce, such as vegetables and rice. However, expenditures vary widely, with a median spending of RM112.50 (USD25), a maximum of RM630 (USD145), and some households reporting spending nothing. On the other hand, if all foraged or cultivated produce were to be monetized, the estimated market value of these foods would average RM199.40 (USD200) per month (±RM166.83 or USD38), with a median value of RM150 and a wide range from RM5 to RM1000. This suggests that while market purchases remain a significant part of food consumption, self-sourced food - whether cultivated or foraged - holds substantial value in reducing household food expenses.

Taken together, the evidence shows food security is threatened by supply disruptions (e.g., floods), delays in external aid, exposure to volatile markets, and time trade-offs that reduce subsistence production. Many households remain vulnerable despite multiple strategies. Patterns differ across sites: Sungai Mai households rely more on market purchases and plantation foraging, whereas Berdut households depend more on homegrown foods and foraging from secondary forests. Both communities nevertheless display resilience - adopting frugal consumption, mobilising traditional knowledge, and adjusting planting cycles - yet structural economic constraints, environmental unpredictability, and continued market exposure keep food insecurity risks high.

7.5. Expanding SLF to Reflect Indigenous Realities: Governance, Economy and Food Security

While the Sustainable Livelihoods Framework (SLF) provides a structured tool for analyzing livelihoods, its conventional structure fails to fully capture customary governance, hybrid economic systems, and Indigenous land tenure practices. The Jah Hut's *bawah pokok* (under-the-tree) governance system, where elders mediate land access, labor-sharing, and conflict resolution, remains largely invisible within SLF's institutional framework. Similarly, subsistence-based strategies such as reciprocal labor, barter networks, foraging, and shifting cultivation are essential for Jah Hut economic resilience, yet SLF prioritizes formal employment and cash-based financial capital, often undervaluing these alternative livelihood strategies.

A significant limitation of conventional SLF applications is the incomplete integration of Indigenous agricultural practices into livelihood assessments. Jah Hut livelihoods are directly shaped by land access and food production systems, yet SLF does not adequately account for the dynamic interplay between subsistence farming, cash crop cultivation, and foraging economies. Shifting cultivation, traditionally a key component of food security, has been increasingly constrained by land dispossession and policies discouraging rotational agriculture. As a result, only a small percentage of Jah Hut households continue practicing shifting cultivation, often on fragmented land plots that limit its role in household food security. In response, many Jah Hut have adopted home gardens, small-scale mixed cropping, and reliance on secondary forests (*belukar*) for food and medicinal plant resources.

At the same time, cash crop dependence (rubber and oil palm) has increased economic vulnerability, exposing households to market price fluctuations, land exhaustion, and exploitative middlemen. Rubber tapping, though historically a key income source, remains seasonal and unstable, forcing many Jah Hut to engage in wage labor, small-scale trade, or short-term migration. These shifts reflect a hybrid economic strategy, where subsistence and market-based livelihoods coexist rather than replace one another. However, because non-monetary economies (such as barter and communal labor exchanges) are largely ignored in SLF financial capital assessments, these adaptive strategies remain inadequately represented in mainstream livelihood models.

Another critical gap in SLF is its omission of food security as a core determinant of livelihood sustainability. Unlike market-dependent communities, which rely on wage-based food access, the Jah Hut depend on shifting cultivation, home gardens, and communal food-sharing networks to maintain economic and nutritional stability. However, conventional SLF assessments often prioritize household income and formalized agricultural productivity, failing to recognize subsistence-based food production as a legitimate livelihood strategy.

The findings from this study demonstrate that SLF must be expanded to incorporate Indigenous knowledge systems, non-market economies, and customary governance structures. Table 7.9 summarizes these key adaptations, ensuring that livelihood assessments move beyond market-based assumptions and reflect the complex interplay of governance, economic adaptation, and food security in Indigenous communities.

SLF Capital Asset	Conventional SLF Definition (Scoones, 1999)	Adaptations for Indigenous Livelihoods
Natural Capital	Land, water, biodiversity, and ecological services, often measured through formal land ownership and policy frameworks.	Recognizing customary land tenure and community-based resource management as key elements of land and ecological governance.
Human Capital	Education, formal training, vocational skills, and labor availability.	Expanding to include traditional ecological knowledge (TEK) and intergenerational knowledge transfer as key components of skills and expertise.
Economic Capital	Primarily assessed through income levels, financial assets, and access to credit.	Incorporating non-monetary economies, subsistence farming, barter systems, and reliance on government aid as critical financial strategies.
Social Capital	Measured through institutional participation, governance, and formal networks (NGOs, cooperatives, community organizations).	Recognizing informal governance structures, customary decision-making, labor-sharing reciprocity, and seed-sharing networks as vital aspects of social cohesion.
Food Security (New Dimension)	Food security: Not explicitly measured; typically linked to financial capital and market-based access to food.	Including subsistence farming, foraging, and community-based food-sharing networks as direct indicators of livelihood security.

TABLE 7.9: ADAPTATIONS OF SLF FOR THE INDIGENOUS CONTEXT

7.6. Adapted Sustainable Livelihoods Framework for Hybrid Indigenous Livelihoods: The Case of the Jah Hut

Building upon the findings in Section 7.5, this study introduces a modified Sustainable Livelihoods Framework (SLF) (Figure 7.12) that more accurately captures the hybrid livelihood strategies of the Jah Hut. Unlike conventional SLF applications, which emphasize state institutions, wage-based employment, and formal economic participation, the adapted framework explicitly incorporates customary governance, subsistence economies, and market participation into its analytical structure.

This refined model enhances five key dimensions of SLF. Contexts, Conditions & Trends (External Influences) now incorporate land dispossession, corporate encroachment, policy neglect, and market dependence, all of which shape economic vulnerabilities and require adaptive responses. Capital assets have been expanded to include customary land tenure, Indigenous knowledge systems, and hybrid economic capital, ensuring that informal economies and social governance structures are fully recognized. The role of customary institutions has been explicitly incorporated, acknowledging village councils, local trade networks, and spiritual leadership as governing mechanisms that influence livelihood strategies. Within livelihood strategies, the framework differentiates between market-oriented, subsistence-based, and mixed livelihood strategies, highlighting the flexibility and adaptability of Jah Hut households in navigating economic change. Agricultural practices are central to these strategies, with shifting cultivation and home gardens serving as food security mechanisms, while rubber and oil palm provide fluctuating market-based income sources. Figure … presents this adapted SLF framework, illustrating how these dimensions interact within Jah Hut livelihood strategies.

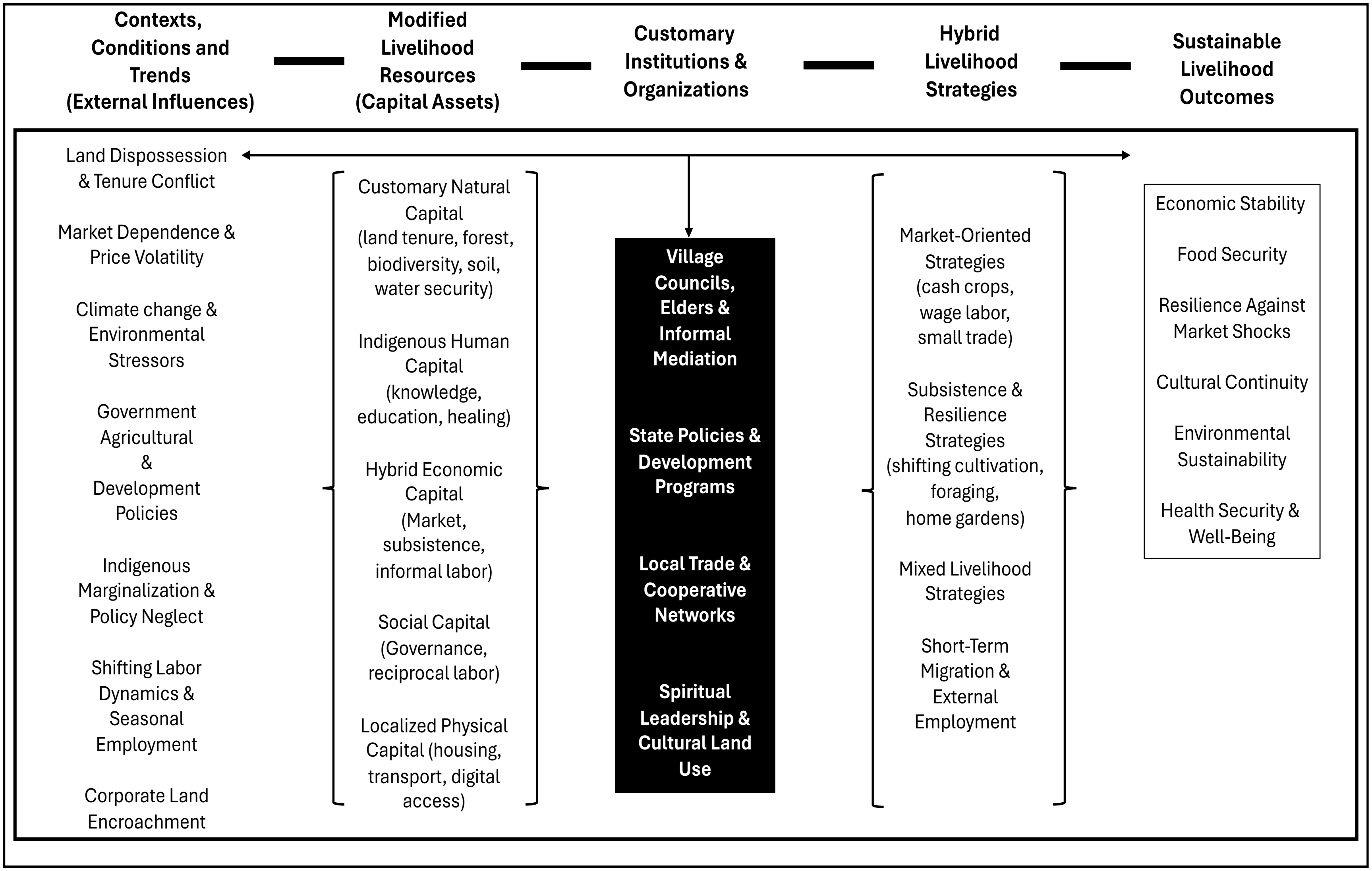

FIGURE 7.10: AN ADAPTED SLF FRAMEWORK FOR ASSESSING INDIGENOUS LIVELIHOODS

Despite these refinements, applying the adapted SLF highlights areas requiring further research. While this study examines climate change impacts on shifting cultivation, it lacks empirical data on soil degradation, biodiversity loss, and long-term environmental changes. Future research should integrate ecological assessments to quantify these environmental shifts. Additionally, while hybrid economic strategies have been explored, further investigation is needed into how informal economies (barter, kin-based labor, cooperative trade) contribute to financial resilience. The role of customary governance in managing land disputes and negotiating with state institutions also requires further study to assess how Indigenous leadership adapts to external governance frameworks.

These findings suggest that future research on Indigenous livelihoods should adopt SLF-based analyses that explicitly incorporate hybrid economic systems and customary governance mechanisms. Indigenous communities do not fit neatly into market-based livelihood models, and their resilience strategies must be recognized as valid, sustainable economic practices. Future research should also integrate ecological indicators such as climate resilience, soil fertility, and biodiversity conservation into SLF assessments, ensuring that environmental sustainability is evaluated alongside economic and social factors. The adapted SLF presented in this section provides a more inclusive and contextually relevant framework for assessing Indigenous livelihoods, bridging subsistence resilience, market participation, and governance structures.

7.6. Policy Implications and Recommendations

The adapted SLF framework presented in this study underscores the need for policy frameworks that recognize hybrid livelihood strategies, secure Indigenous land rights, and integrate customary governance structures. Many of the structural barriers affecting Jah Hut livelihoods - land tenure insecurity, economic marginalization, and governance exclusion - have been extensively analyzed in Chapter 6 within the context of agricultural sustainability. Instead of repeating these discussions, this section focuses on additional policy recommendations that align with the adapted SLF framework, ensuring that land, governance, and economic policies support hybrid livelihood strategies rather than undermine them. Table 7.10 summarizes these policy challenges and recommendations, outlining interventions that extend beyond agricultural sustainability and focus on broader economic and social security measures.

Policy Area	Challenges	Policy Recommendations
Land Tenure and Resource Governance	Land dispossession and lack of legal recognition of customary land tenure undermine Jah Hut livelihoods.	Recognize and secure customary land tenure through legal frameworks, community-led mapping, and protection from external encroachment. Prioritize Indigenous-led models of land stewardship to ensure long-term security for TEK-based economies by recognizing Orang Asli as rights holders, not stakeholders.
Economic Policy	Current economic policies fail to recognize subsistence farming, foraging, and barter systems as viable livelihood strategies.	Support Indigenous-led economic initiatives, including non-monetary economies, cooperative farming, and direct funding for community enterprises. Recognize the role of swiddens and fallow areas for Orang Asli food security.
Education and Knowledge Systems	The state's education system prioritizes Western schooling models, leading to high dropout rates among Jah Hut youth.	Revise education policies to integrate Indigenous knowledge, establish bilingual schooling, and fund community-based education centers. Grant intellectual property rights over their TEK and biological resources. Mandatory community-led FPIC processes.
Healthcare and Indigenous Healing	Indigenous healing practices remain marginalized in state healthcare policies, despite their central role in Jah Hut well-being.	Integrate Indigenous healing into national healthcare, recognize traditional heal medicinal plant resources.
Governance and Decision-Making	State-imposed leadership structures weaken traditional decision-making systems and exclude Indigenous governance.	Ensure recognition of customary governance. Enhance Indigenous political representation. Strengthen women's roles in leadership.
Infrastructure Development	Government housing, water supply, and transportation projects impose unsuitable solutions that disrupt communal living structures.	Develop infrastructure that respects Indigenous needs, supports self-built housing programs, and ensures culturally appropriate development projects.

Policy Area	Challenges	Policy Recommendations
Labor Rights and Social Protection	Many Jah Hut workers in plantations and informal labor sectors lack fair wages and social protections.	Introduce fair labor policies, ensure minimum wage protections, and expand social security coverage for informal laborers.
Digital Inclusion and Economic Mobility	Limited access to digital banking, e-commerce, and internet connectivity restricts market participation.	Develop digital inclusion programs, expand internet access, and provide training for digital financial literacy and entrepreneurship.
Food Security and Climate Resilience	Vulnerability to food shortages and climate change impacts on agriculture are increasing.	Establish community-led seed banks, support agroforestry, and promote food sovereignty policies to ensure long-term food security.

TABLE 7.10: POLICY CHALLENGES AND RECOMMENDATIONS FOR JAH HUT LIVELIHOOD SUSTAINABILITY

7.7. Conclusion: Towards an Inclusive and Decolonized Livelihood Framework

By critically expanding the Sustainable Livelihoods Framework (SLF), this study develops a more contextually relevant and inclusive approach for assessing Indigenous livelihoods. The adapted SLF framework acknowledges that Jah Hut livelihoods are neither purely subsistence-based nor fully market-dependent, but instead represent a fluid, adaptive system that shifts between subsistence farming, home gardens, foraging, wage labor, and cash crop cultivation.

Rather than viewing Indigenous economic struggles as deficiencies, they must be understood as outcomes of historical and structural inequalities. Conventional SLF applications often fail to account for customary governance, non-monetary economies, and Indigenous land tenure systems. The Jah Hut's governance structure, reciprocal labor-sharing, and barter-based subsistence economies demonstrate the continued relevance of Indigenous governance models in shaping livelihood strategies. However, these systems remain invisible in mainstream policy frameworks that prioritize state-recognized land tenure, formal employment, and cash-based financial stability.

A major contribution of this research is the recognition of food security as a central livelihood indicator. Unlike conventional SLF applications, which emphasize income levels and financial assets, this study highlights how shifting cultivation, home gardens, and foraging serve as critical sources of economic and nutritional stability for the Jah Hut. By embedding Indigenous agency, resilience, and self-determination at the center of livelihood research, this study contributes to a broader effort to decolonize development frameworks. The modified SLF presented here is not just an analytical tool but a step toward transforming how Indigenous livelihoods are understood, valued, and supported in both research and policy.

Summary

This chapter critically examines the limitations of the Sustainable Livelihoods Framework (SLF) in assessing Indigenous livelihoods and introduces a modified SLF that better captures the complexities of Jah Hut economic and governance systems. Conventional SLF applications often overlook customary land tenure, informal economies, and Indigenous governance structures, leading to incomplete assessments of livelihood sustainability. Through decolonial reframing, this study highlights how Jah Hut livelihoods are not solely subsistence-based nor fully market-dependent but instead represent a fluid, adaptive system that integrates shifting cultivation, home gardens, rubber and oil palm farming, wage labor, and foraging.

The adapted SLF framework developed in this chapter integrates customary governance, hybrid economic capital, and ecological resilience into livelihood analysis. It acknowledges the role of food security, reciprocal labor, and non-monetary economies, which are often overlooked in conventional livelihood models. Additionally, it recognizes that land tenure insecurity and external market pressures shape economic vulnerability, reinforcing the need for policy frameworks that protect customary land rights and Indigenous economic autonomy.

The chapter concludes by arguing that Indigenous governance, self-determination, and sustainability practices must be recognized as strengths rather than vulnerabilities. It calls for livelihood policies and research methodologies that move beyond Western economic paradigms, ensuring that hybrid economic systems, Indigenous governance, and land-based resilience strategies are fully integrated into future SLF applications. The modified SLF proposed in this study serves as a more inclusive analytical tool, offering a pathway toward reframing livelihood assessments and strengthening Indigenous agency in development research and policymaking.

References

Aliye, A. A. (2020). African Indigenous Leadership Philosophy and Democratic Governance System: Gada's Intersectionality with Ubuntu. *Journal of Black Studies*, *51*(7), 727–759. https://doi.org/10.1177/0021934720938053

Arceneaux, C. L. (2022). The Struggle for Identity: Autonomy and the Indigenous. In *Political Struggle in Latin America* (pp. 45–81). https://doi.org/10.1007/978-3-031-07904-7_2

Bitew, B., Sewenet, A., & Fentahun, G. (2021). Indigenous Governance Systems and Democracy in Ethiopia: Yejoka Qicha System of the Gurage People. *International Indigenous Policy Journal*, *12*(3), 1–20. https://doi.org/10.18584/IIPJ.2021.12.3.10969

Calderón Farfán, J. C., Dussán Chaux, J. D., & Arias Torres, D. (2021). Food autonomy: decolonial perspectives for Indigenous health and buen vivir. *Global Health Promotion*, *28*(3), 50–58. https://doi.org/10.1177/1757975920984206

Caria, S., & Domínguez, R. (2016). Ecuador's buen vivir. *Latin American Perspectives*, *43*(1), 18–33. https://doi.org/10.1177/0094582X15611126

Chambers, R., & Conway, G. R. (1991). *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*.

https://opendocs.ids.ac.uk/articles/report/Sustainable_rural_livelihoods_practical_concepts_for_the_21st_century/26473510?file=48232906

Chowdhury, T. A. (2021). Applying and extending the sustainable livelihoods approach: Identifying the livelihood capitals and well-being achievements of Indigenous people in Bangladesh. *Journal of Social and Economic Development*, *23*(2), 302–320. https://doi.org/10.1007/s40847-021-00163-z

Delina, L. L., Fuerzas, I., Dharmiasih, W., Dulay, M. J., & Salamanca, A. (2024). Are capital assets under pressure? The state of and challenges to Indigenous rice farming in the cultural ricescapes of Indonesia and the Philippines. *Journal of Rural Studies*, *106*. https://doi.org/10.1016/j.jrurstud.2024.103235

Fierros-González, I., & Mora-Rivera, J. (2022). Drivers of Livelihood Strategies: Evidence from Mexico's Indigenous Rural Households. *Sustainability (Switzerland)*, *14*(13). https://doi.org/10.3390/su14137994

Fonchingong Che, C., & Bang, H. N. (2024). Towards a "Social Justice Ecosystem Framework" for Enhancing Livelihoods and Sustainability in Pastoralist Communities. *Societies*, *14*(11). https://doi.org/10.3390/soc14110239

Harcourt, N., Awatere, S., Hyslop, J., Taura, Y., Wilcox, M., Taylor, L., Rau, J., & Timoti, P. (2022). Kia Manawaroa Kia Puawai: enduring Māori livelihoods. *Sustainability Science*, *17*(2), 391–402. https://doi.org/10.1007/s11625-021-01051-5

Kamal, A. G., & Martens, T. (2015). Rethinking the Sustainable Livelihoods Framework: An Indigenous Perspective. *The Journal of Aboriginal Economic Development*, *9*(2), 52–66.

Lalander, R., Lembke, M., & Porsani, J. (2023). Livelihood Alterations and Indigenous Innovators in the Ecuadorian Amazon. *Alternautas*, *10*(1), 94–125. https://orcid.org/0000-0002-7088-971X

Lin, K. H. E., & Polsky, C. (2016). Indexing livelihood vulnerability to the effects of typhoons in Indigenous communities in Taiwan. *Geographical Journal*, *182*(2), 135–152. https://doi.org/10.1111/geoj.12141

Mero-Figueroa, M., Galdeano-Gómez, E., Piedra-Muñoz, L., & Obaco, M. (2020). Measuring Well-Being: A Buen Vivir (Living Well) Indicator for Ecuador. *Social Indicators Research*, *152*(1), 265–287. https://doi.org/10.1007/s11205-020-02434-4

Nguyen-Anh, T., Leu, S., Nguyen-Thi-Phuong, A., Ngo-Dang, T., & To-The, N. (2023). Adapting to the new normal: A sustainable livelihood framework for the informal sectors during COVID-19. *Review of Development Economics*, *27*(2), 1092–1112. https://doi.org/10.1111/rode.12974

Scoones, I. (1999). Sustainable Rural Livelihoods: A Framework for Analysis. In *IDS* (Vol. 72, Issue 2). https://doi.org/10.1057/palgrave.development.1110037

Shang, Q., Li, M., & Wang, H. (2021). Environment Governance, Sustainable Livelihood and Indigenous Knowledge in Ethnic Tourism Villages of China. *E3S Web of Conferences*, *272*. https://doi.org/10.1051/e3sconf/202127201027

Sieder, R., & Barrera, A. (2017). Women and Legal Pluralism: Lessons from Indigenous Governance Systems in the Andes. In *Journal of Latin American Studies* (Vol. 49, Issue 3, pp. 633–658). Cambridge University Press. https://doi.org/10.1017/S0022216X16002273

Stavenhagen, R. (2006). Indigenous Peoples: Land, Territory, Autonomy, and Self-Determination. In P. Rosset, R. Patel, & M. Courville (Eds.), *Promised Land: Competing Visions of Agrarian Reform* (pp. 208–217). First Food Books.

Syukron, M. (2021). *Sustainable Livelihoods of Indigenous Community: A Bibliometric Study*.

Tabares, A., Londoño-Pineda, A., Cano, J. A., & Gómez-Montoya, R. (2022). Rural Entrepreneurship: An Analysis of Current and Emerging Issues from the Sustainable

Livelihood Framework. In *Economies* (Vol. 10, Issue 6). MDPI. https://doi.org/10.3390/economies10060142

Timire, C., Pedrazzoli, D., Boccia, D., Houben, R. M. G. J., Ferrand, R. A., Bond, V., & Kranzer, K. (2023). Use of a Sustainable Livelihood Framework-Based Measure to Estimate Socioeconomic Impact of Tuberculosis on Households. In *Clinical Infectious Diseases* (Vol. 77, Issue 5, pp. 761–767). Oxford University Press. https://doi.org/10.1093/cid/ciad273

Wu, X., Nie, X., Chen, Z., Wang, H., Kang, Q., & Lei, W. (2023). How to improve the adaptive capacity of coastal zone farm households?-explanation based on complementary and alternative relationships of livelihood capital in a sustainable livelihood framework. *Ocean and Coastal Management*, *245*. https://doi.org/10.1016/j.ocecoaman.2023.106853

Yamarak, L., & Parton, K. A. (2023). Impacts of mining projects in Papua New Guinea on livelihoods and poverty in Indigenous mining communities. *Mineral Economics*, *36*(1), 13–27. https://doi.org/10.1007/s13563-021-00284-1

Zhimo, A. G. (2019). Indian Anthropological Association Indigenous System of Governance and its Implication. *Indian Anthropological Association*, *49*(2), 41–56. https://doi.org/10.2307/26954858

Chapter 8 : Integrated Findings, General Discussion, and Policy Recommendations

8.1. Introduction

This chapter synthesizes key findings from the research on Jah Hut agricultural practices, their sustainability, and associated livelihood strategies. It integrates the interconnection of the ecological, cultural, and economic dimensions within the Jah Hut's shifting cultivation systems. This chapter also presents policy recommendations that are grounded in the realities of Jah Hut farming.

8.2. Integrated Findings and Discussion

The findings Chapters 4 to 7 of this study demonstrate that Jah Hut agricultural systems represent a resilient, knowledge-rich, and ecologically attuned form of Indigenous land use. Rather than viewing these practices as static or primitive, the evidence shows that they have evolved through dynamic interaction with ecological change, policy pressure, and market shifts - without losing their cultural core.

Chapter 4 traced the deep historical roots of shifting cultivation in Southeast Asia and among the Orang Asli, showing that these systems are neither chaotic nor transient, but grounded in environmental cycles and cultural governance. Chapter 5 provided a detailed ethnographic picture of current Jah Hut farming practices, highlighting their adaptability, gendered knowledge systems, and spatial logic. Chapter 6 assessed these practices using a sustainability index (modified IDEA framework) and found that Jah Hut agriculture performs well in ecological viability, cultural relevance, and social continuity, though economic stability remains fragile. Chapter 7 further explored how households combine traditional subsistence methods with market-oriented strategies to support their livelihoods, revealing hybrid systems shaped by necessity and agency.

Across all chapters, a consistent theme emerges: Jah Hut agriculture is not in decline because it is unsustainable or irrelevant, but because it is constrained by a combination of insecure land tenure, conservation restrictions, development schemes promoting monoculture, and limited policy recognition of Indigenous governance. These constraints inhibit the full expression of a farming system that is otherwise ecologically sound, socially cohesive, and culturally meaningful.

This section draws together these findings, structured around the key chapters, to provide a final synthesis and discussion.

8.2.1. Agricultural Transitions and Continuity

Jah Hut agriculture represents a dynamic and enduring system that has evolved through centuries of ecological attunement, cultural coherence, and strategic adaptation. Far from being a primitive relic, shifting cultivation emerged historically as one of the most ecologically appropriate responses to the challenges of tropical forest environments - balancing productivity with biodiversity, and guided by spiritual and social norms that safeguarded land integrity.

This system was never static. Historical records and ethnographic sources show that Jah Hut farming has always responded flexibly to ecological and socio-political change. Ritual calendars, spiritual governance, and taboos around land use were not symbolic abstractions - they were sophisticated regulatory mechanisms that sustained ecological balance. The source of disruption of these systems is from internal failure, but from external impositions: colonial displacement, post-independence conservation restrictions, and state-led development policies that fractured traditional land tenure and governance.

Contemporary practices continue to reflect this capacity for innovation. Faced with declining access to ancestral lands and shrinking fallow cycles, Jah Hut farmers have actively recalibrated their systems - integrating agroforestry, home gardens, and selected market crops. These are not passive adaptations but deliberate strategies to uphold agricultural autonomy under constraint.

When examined through Olofson's framework of harmonic and disharmonic swidden systems, current Jah Hut practices reveal both resilience and strain. The spiritual and ecological logics of shifting cultivation persist but are increasingly challenged by structural pressures. Yet, even within these constraints, the fundamental ethos of the Jah Hut farming system - its reciprocity with land, its emphasis on diversity, and its cultural embeddedness - remains intact. This evolution does not weaken the system; it reaffirms its relevance in resisting homogenizing models of agricultural development and in advancing Indigenous-led sustainability.

8.2.2. The Socio-Spiritual Dimension of Jah Hut Agriculture

Jah Hut agriculture is not merely an economic activity; it is deeply embedded within a cultural and spiritual worldview that frames land as a living entity and farming as a sacred responsibility. As detailed in Chapter 5, rice cultivation is accompanied by rituals, offerings to ancestral spirits and land guardians, and the guidance of agricultural shamans known as *pawang padi*. These spiritual and ritual practices form a system of cultural governance, ensuring ecological balance, moral order, and intergenerational continuity.

However, this governance system is under increasing strain. The decline of the *pawang padi* institution, largely due to religious conversion, reduced ritual observance, and the disintegration of customary authority, has resulted in a fractured leadership structure within TEK systems. This fracture weakens community cohesion and undermines the enforcement of land-use norms that once ensured sustainability. In this sense, TEK itself becomes vulnerable when its custodial leadership is compromised, presenting a significant challenge to the long-term viability of Jah Hut agricultural systems.

As shown in Chapter 7, the erosion of cultural authority is compounded by external structural pressures, such as conservation policies, land dispossession, and shifting economic priorities. While elders continue to uphold traditional values, the transfer of agricultural knowledge to younger generations is weakening. The loss of ritual leadership directly affects knowledge retention, as spiritual dimensions of farming are not easily documented or transmitted outside of lived cultural contexts.

This study argues that the sustainability of Jah Hut agriculture cannot be preserved through technical interventions alone. Instead, cultural revitalization - including the restoration of spiritual institutions, leadership roles, and culturally grounded agricultural education - is essential. Policies must move beyond the technocratic to embrace Indigenous ontologies, where land is not just a productive resource but a sacred, relational space.

8.2.3. Sustainability of Jah Hut Agriculture

The sustainability assessment conducted in Chapter 6 applied a modified version of the IDEA framework to examine Jah Hut agriculture through ecological, economic, and socio-cultural lenses. The results reveal a system under multidimensional pressure yet still displaying core elements of resilience.

Ecologically, Jah Hut farming practices remain strong. The use of rotational fallows, native crop varieties, and minimal chemical inputs supports long-term soil fertility and biodiversity preservation. These practices reflect generations of accumulated ecological knowledge and a continued commitment to land stewardship, despite declining access to traditional farming territories. Economically, however, the system is vulnerable. Limited access to secure markets, absence of institutional support, and land tenure insecurity have collectively pushed many households toward unstable forms of cash cropping. This economic precarity undermines both food sovereignty and intergenerational interest in farming, as younger Jah Hut face reduced incentives to remain engaged in agricultural livelihoods.

Socio-culturally, the assessment reveals fragmentation. Although cultural rituals and oral traditions still guide farming cycles, these are increasingly weakened by migration, educational disconnection from land-based knowledge, and the erosion of community-based governance. The weakening of institutions such as *gotong-royong* (reciprocal labor) and ritual authority diminishes the cultural cohesion that once sustained agricultural resilience. Importantly, this study demonstrates that standard sustainability metrics, even when adapted, are insufficient for capturing the embeddedness of Indigenous agriculture within broader systems of value, meaning, and governance. The modified IDEA framework, while useful, risks undervaluing the Jah Hut's informal economic networks, sacred land relations, and internal mechanisms of accountability.

Therefore, sustainability assessments in Indigenous contexts must be expanded to include indicators defined by the communities themselves - such as the transmission of cultural knowledge, autonomy over land use, spiritual agricultural roles, and collective governance. Without these, policy and development frameworks will continue to misread the health of Indigenous food systems through incomplete and externally imposed criteria.

8.2.4. Sustainability of Jah Hut Livelihoods

This study employed the Sustainable Livelihoods Framework (SLF) to evaluate the broader livelihood strategies of the Jah Hut community, particularly how they navigate food security, economic adaptation, and land tenure insecurity. Findings reveal that Jah Hut households adopt hybrid livelihood strategies, combining traditional subsistence farming with market-oriented practices such as cash cropping and participation in informal labor networks.

This growing involvement in commercial farming reflects both economic necessity and shifting aspirations. However, it introduces a significant tension between the sustainability principles rooted in TEK and the demands of market-based agriculture. While commercial farming offers short-term income opportunities, it often undermines long-term ecological and cultural resilience by encouraging monocropping, chemical inputs, and reduced fallow cycles. These shifts challenge the core tenets of Jah Hut agroecology, which emphasize biodiversity, land stewardship, and spiritual governance.

Moreover, while traditional knowledge systems, communal labor, and diversified income sources still contribute meaningfully to resilience, their influence is being gradually eroded. Land insecurity, economic marginalization, weakened traditional governance, and the lack of institutional recognition for TEK further exacerbate this erosion.

Crucially, the SLF itself does not adequately capture non-monetary dimensions of Indigenous livelihoods, such as spiritual value of land, ritual governance, and collective reciprocity. To enable more inclusive assessments, future adaptations of the SLF must incorporate Indigenous-defined indicators, including customary land tenure, cultural transmission, and ecological ethics.

When viewed alongside the sustainability assessment (IDEA), it becomes evident that subsistence farming remains a vital pillar of livelihood sustainability in the Jah Hut context. Ecologically, it supports biodiversity and soil regeneration; economically, it buffers against market volatility and reduces household expenses; socially and culturally, it reinforces seed-sharing, ritual life, and land-based identity.

Although the study did not formally adopt an ecosystem services (ES) framework, the Jah Hut system clearly aligns with key ES domains. It provides provisioning services (subsistence food, medicinal plants), regulating services (fallow-based soil restoration, pest control), supporting services (biodiversity and seed conservation), and cultural services (ritual, kinship, and place-based identity). Recognizing these contributions reinforces the need to protect Jah Hut agroecology - not only as cultural heritage but as a living system of environmental governance and rural sustainability.

8.3. Policy Recommendations

Despite the abundance of studies proposing reforms for Orang Asli land and agriculture, these recommendations have often gone unheeded. This study affirms that simply outlining policy solutions is insufficient. What is needed is political will, institutional accountability, and structural reform to ensure that Indigenous agricultural systems are not only recognized, but actively protected and supported. The following policy recommendations are grounded in Jah Hut-specific realities and structured around actionable strategies that bridge Indigenous knowledge with inclusive governance, environmental sustainability, and livelihood resilience.

8.3.1. Recognizing and Integrating Jah Hut Community Needs

A fundamental policy shift is required to recognize shifting cultivation not as a backward or destructive practice, but as a viable, adaptive agroecological system deeply aligned with tropical forest dynamics and Indigenous knowledge systems (Mertz & Bech Bruun, 2017). National agricultural, forestry, and conservation frameworks must formally classify shifting cultivation as a legitimate farming system and integrate it into land-use planning, agricultural extension programs, and incentive schemes for sustainable agriculture. This reclassification must be accompanied by a revision of environmental laws and planning language that currently frame swidden systems as environmentally harmful. Such legislative reform should explicitly acknowledge the ecological value of rotational farming and its contributions to biodiversity, carbon storage, and food security.

Policy formulation must move beyond symbolic consultation. Jah Hut representatives must be embedded in formal decision-making bodies, such as district land planning committees, to ensure that policy reflects lived agricultural realities. Community participation must be structural, not tokenistic. Critically, all external interventions must be designed to safeguard Jah Hut autonomy, not erode it. While development programs and incentives may provide transitional support, they must not foster long-term dependency on state control or external funding. Instead, they should enhance Indigenous self-governance through training in Indigenous-led agroforestry, locally managed seed preservation networks, and community-controlled planning platforms.

Research has shown that autonomy regimes often fail when imposed from above or left unsupported in practice (Springerová & Vališková, 2016). True autonomy requires functional decision-making power over land, resources, and agricultural models (Binder & Binder, 2016; Rayo et al., 2024). Policies must therefore empower Jah Hut communities to maintain full control over their agroecological systems, ensuring that their land-based practices evolve through Indigenous governance—not state or market dictates.

8.3.2. Inclusive and Data-Driven Land-Use Planning

Securing land tenure for the Jah Hut requires more than legal acknowledgment - it demands a transformation of how land-use data is produced, interpreted, and acted upon. Current land-use policies, shaped by conservation agendas and commercial pressures, have marginalized Indigenous farming systems by criminalizing shifting cultivation and ignoring communal land claims. To rectify this, the government must integrate shifting cultivation into national land-use strategies, with accurate, participatory, and context-specific data as the foundation. This includes establishing legal frameworks that recognize and protect customary land tenure, encompassing both cultivated plots and fallow lands as essential components of rotational agroecology (Rayo et al., 2024; Springerová & Vališková, 2016).

Participatory land mapping must become mandatory, not optional. Tools such as remote sensing and GIS should be deployed collaboratively - with community researchers, local knowledge holders, and independent experts - to document Indigenous farming territories and protect them from displacement and encroachment (Kilawe et al., 2018). These tools must support, not override, oral histories and customary boundaries.

Furthermore, district and state-level land authorities must institutionalize Jah Hut representation in spatial planning bodies. This includes giving them decision-making power in zoning regulations, conservation area designations, and rural development programs that affect their territories. Policies must reflect that land planning is not merely technical - it is deeply political, and its exclusionary nature has been a root cause of dispossession.

Finally, political and institutional will - not just technical solutions - is essential. Policy recommendations alone will not suffice unless there is clear commitment from government bodies to uphold Indigenous land rights and dismantle structural biases that prioritize plantation agriculture, infrastructure projects, and top-down conservation over community land governance.

8.3.3. Developing Sustainable Agricultural Alternatives Without Banning Shifting Cultivation

Shifting cultivation must remain legally protected and actively supported as a core Jah Hut farming system - not treated as a stopgap to be replaced. However, policy must also provide voluntary, culturally appropriate pathways for economic diversification that strengthen resilience without undermining Indigenous autonomy. Agroforestry policies should build on existing Jah Hut practices, offering targeted incentives for integrating traditional crops with high-value native species such as medicinal plants, forest fruits, and spices. This approach aligns economic adaptation with ecological knowledge systems and avoids the productivity-at-all-costs logic of industrial agriculture (Mertz & Bech Bruun, 2017).

To prevent the erosion of self-sufficiency, government incentives must be structured as transitional mechanisms - not as permanent aid schemes. Subsidies, grants, or agricultural extension programs must empower community-led initiatives, rather than embedding dependence on state control (Rayo et al., 2024). Policy design must shift from extraction to empowerment: interventions should enhance local capacities to manage agricultural transitions, not impose external development trajectories.

Community-driven agricultural cooperatives should be prioritized as a viable alternative to state-managed models. These cooperatives would allow Jah Hut farmers to collectively manage production, access local markets, and pool resources for small-scale processing or storage facilities - without ceding control to external actors. Cooperative models have proven successful in improving Indigenous economic outcomes while protecting communal values.

Seed sovereignty must also be safeguarded. The expansion of community-managed seed banks and local resource-sharing systems (Porcuna-Ferrer et al., 2020; Vernooy et al., 2020) will reduce reliance on state-distributed hybrid seeds, preserve genetic diversity, and reinforce cultural knowledge tied to cultivation practices.

Above all, alternative farming models must remain optional - not a condition for support. Respecting the right to farm traditionally is a matter of justice. Economic development strategies must not force assimilation into market-centric systems but instead open flexible pathways that reinforce both livelihood security and cultural continuity.

8.3.4. Recognizing the Environmental Benefits of Shifting Cultivation

In the Krau Wildlife and Forest Reserve (now known as Tengku Hassanal Wildlife Reserve), where a considerable tract of Jah Hut agriculture is located, conservation policies have significantly limited Indigenous access to ancestral farmlands. These restrictions are often justified by outdated assumptions that portray shifting cultivation as ecologically harmful. However, empirical research across Southeast Asia has shown that rotational agroforestry systems - such as those practiced by the Jah Hut - support biodiversity, improve soil regeneration, and prevent large-scale deforestation (Mertz & Bech Bruun, 2017; Falvey, 2017).

To correct these misrepresentations, conservation frameworks must formally recognize shifting cultivation as a sustainable land management practice. Redefining it as sustainable land stewardship highlights its contributions to ecological stability, including soil nutrient cycling, biodiversity maintenance, and carbon sequestration (Heinimann et al., 2017). Conservation planning should be revised to integrate Indigenous land-use systems, ensuring that shifting cultivation is not criminalized but supported as a viable climate adaptation and forest management strategy (Burchfield, 2022).

Government and conservation agencies should also invest in interdisciplinary research to document the ecosystem services generated by shifting cultivation. Doing so will provide an evidence base to inform land-use decisions and disprove simplistic conservation narratives. Collaborative forest governance models offer a promising way forward. For example, FSC-certified community-based forest management in Tanzania has been shown to reduce deforestation effectively when supported by strong local governance networks (Henriksen et al., 2023). In contrast, Argentina's forest governance reforms reveal that poor implementation and power imbalances can undermine otherwise sound policies (Inguaggiato et al., 2021).

These cases underscore the need for genuine Indigenous participation in conservation policy. Rather than imposing top-down restrictions, forest governance in areas like Krau should adopt co-management models that legitimize and strengthen Indigenous stewardship. Supporting Jah Hut agroecology not only protects cultural heritage but also offers scalable solutions for ecological sustainability in tropical forest regions.

8.3.5. Ensuring Land Tenure Security and Farmer Incentives

Secure land tenure remains the cornerstone of Jah Hut agricultural sustainability. However, existing land laws in Malaysia prioritize statutory definitions of land ownership, leaving Indigenous customary claims unrecognized or inconsistently enforced. Without legal recognition of customary territories, Jah Hut farmers are vulnerable to eviction, encroachment, and exclusion from decision-making processes that directly affect their land-based livelihoods (Wook, 2015).

A robust policy response must begin by reconciling the dual legal system - statutory and customary - through legal pluralism. Customary law must be formally acknowledged as a legitimate basis for land rights rather than subordinated to state-centric frameworks. This requires legislative amendments that recognize Indigenous territoriality not as informal claims, but as legally binding entitlements rooted in long-standing tenure systems (Wook, 2015).

Participatory mapping must be legally integrated into national land-use governance. Community-led mapping efforts, often initiated by Indigenous organizations, provide critical evidence of traditional land boundaries and land use. Policies should support these efforts by recognizing Indigenous maps as admissible in court proceedings and official land records (Subramaniam & Nicholas, 2018; Wook, 2015). This requires the creation of collaborative mapping frameworks involving Indigenous communities, land officers, and geospatial specialists.

To prevent land dispossession during lengthy legal disputes, a moratorium on development activities should be imposed on all areas under customary claim until Free, Prior and Informed Consent (FPIC) is verified and due process is followed. As Subramaniam and Nicholas (2018) note, irreversible harm often occurs before courts can intervene, making such preventive action urgent and essential.

The land registration process must also be decentralized, accessible, and culturally sensitive. Current procedures are too bureaucratic and urban-centric, alienating Orang Asli communities (including the Jah Hut) claimants who rely on oral histories and lived landscapes. Policy reform should therefore enable local land offices to accept non-written evidence - such as witness testimony, land use histories, and traditional markers - as valid in land documentation and adjudication (Wook, 2015).

In addition to legal reforms, targeted financial support is essential. Incentive programs should include flexible agroforestry grants, access to traditional seed systems, and localized technical training that builds on Indigenous ecological knowledge rather than imposing external agricultural models. These supports should be time-bound and designed to enhance autonomy, not create dependency (McElwee, 2022).

Finally, it is important to acknowledge that the marginalization of Jah Hut land rights is not a technical failure - it is the result of systemic power asymmetries over resource-rich territories. Policies that treat Indigenous tenure security as a mere administrative task risk reproducing ecological imperialism under a new guise (Balce, 2022). Land reform must therefore be pursued not only as a matter of conservation or food security, but as a broader project of territorial justice.

8.3.6. Strengthening Local Knowledge Systems and Participatory Governance

Traditional governance structures, including reciprocal labor systems, community decision-making, and land consecration rituals, play a central role in maintaining sustainable Jah Hut agriculture. However, state-led interventions have excluded these governance structures and replaced them with external institutions that do not reflect Indigenous realities. Policies should recognize and incorporate Indigenous governance systems into land-use planning, ensuring that cultural continuity is maintained and enabling collective land management and local economic resilience (Falvey, 2017).

Additionally, formal documentation and preservation of Jah Hut agricultural knowledge should be prioritized, particularly regarding spiritual land-use practices often overlooked in mainstream policies. Rather than imposing top-down agricultural frameworks, policymakers must engage directly with Jah Hut leaders, farmers, and women's groups to develop culturally sensitive agricultural policies that reflect Indigenous knowledge and priorities.

8.3.7. Summary of Key Policy Recommendations

The key policy recommendations outlined in Table 8.1 provide a structured approach to addressing the challenges faced by the Jah Hut in sustaining their agricultural traditions while ensuring economic and ecological resilience. By addressing these policy gaps collaboratively and inclusively, governments, conservation agencies, and development organizations can create an enabling environment that balances Indigenous rights, environmental conservation, and economic empowerment, ultimately fostering a more sustainable future for the Jah Hut and similar Indigenous communities.

Policy Area	Key Recommendation
Land Use & Tenure	Recognize Jah Hut customary land rights and fallow systems; embed these in national land-use plans through participatory, accessible registration mechanisms.
Agroecological Support	Promote Indigenous-led agroforestry; provide transitional incentives for mixed cropping of traditional and marketable species without replacing swidden systems.
Market Inclusion	Develop independent farmer cooperatives and support access to informal and semi-formal markets; reduce reliance on state-controlled schemes.
Legal & Policy Reform	Reform conservation laws that criminalize shifting cultivation; integrate TEK into environmental planning frameworks.
Institutional Recognition	Include Jah Hut leaders in district planning committees; strengthen Indigenous governance mechanisms in land and farming policies.
Education & Knowledge	Fund culturally grounded agricultural extension services; support documentation of oral/spiritual land-use knowledge.
Economic Resilience	Provide microfinance, agroforestry grants, and seed support; ensure they promote autonomy rather than dependence.
Gender & Youth Inclusion	Actively include women and youth in decision-making and farming programs; recognize them as key knowledge holders and future stewards.

TABLE 8.1: KEY POLICY RECOMMENDATI

8.4. Limitations of the Study

This study provides an in-depth analysis of Jah Hut agricultural practices, their sustainability, and their socio-economic and cultural significance. However, several limitations were encountered in the research process, affecting the scope, methodology, and generalizability of the findings. These limitations stem from data constraints, theoretical frameworks, and external socio-political factors influencing Jah Hut livelihoods.

8.4.1. Data Constraints and Accessibility Issues

One of the primary limitations of this study was limited access to long-term historical data on Jah Hut agriculture. While archival research provided insights into broader agricultural transitions in Southeast Asia (Chapter 4), specific data on historical changes in Jah Hut land use was scarce. Additionally, due to land tenure insecurity and ongoing encroachment, some areas traditionally used for shifting cultivation were no longer accessible, restricting on-site field observations and limiting direct engagement with older agricultural plots. Similar constraints have been noted in research on Sahelian landscapes, where missing historical data, tenure insecurity, and encroachment have complicated efforts to document long-term land use changes. In the absence of direct access, alternative methods - such as historical imagery analysis and model-based extrapolations - are often required to reconstruct past agricultural landscapes (Sinare et al., 2022).

Another constraint was the reliability of quantitative sustainability assessments. The IDEA framework used to assess the sustainability of Jah Hut agriculture (Chapter 6) was developed for formal agricultural systems and required adaptation. Certain indicators - such as economic viability - did not fully capture subsistence-based and barter-dependent economies, leading to potential misrepresentations of economic sustainability. Similar critiques have been raised in studies on rural agricultural assessments, where standard sustainability models have struggled to account for informal economies, localized trade, and self-sufficiency strategies in smallholder communities (Prändl-Zika, 2008). This necessitated a qualitative adaptation of sustainability indicators to better reflect community-based resource management and barter-driven agricultural systems. As sustainability assessments continue to evolve, there is a need for frameworks that incorporate non-market economic activities, customary land-use patterns, and informal trade networks to provide a more accurate representation of sustainability in Indigenous and subsistence farming contexts (Prändl-Zika, 2005).

8.4.2. Methodological Limitations

This study employed semi-structured interviews, focus groups, and participant observation, providing rich ethnographic insights into Jah Hut agricultural practices. These methods allowed for firsthand narratives and a deep understanding of cultural knowledge, land-use traditions, and adaptive strategies. However, as with all qualitative research, certain limitations must be acknowledged.

One challenge was the subjective nature of self-reported data, as participants' responses were influenced by personal experiences, perceptions, and contemporary socio-political dynamics. One challenge was the subjective nature of self-reported data, as participants' responses were influenced by personal experiences, perceptions, and external factors. In some cases, sensitive topics such as land rights and conservation policies may have led to cautious responses, given governmental restrictions on shifting cultivation. Additionally, as shifting cultivation knowledge is largely transmitted orally, some variations were observed in historical accounts and technical details, particularly when comparing different generations' recollections.

While research suggests that logs and diaries offer more reliable self-reports than questionnaires (Bakker et al., 2020), this method was not feasible in this study due to literacy barriers. Many respondents were unable to read and write, making written self-reporting impractical, and even among those who were literate, there was little motivation to maintain consistent logs. As a result, reliance on oral recall further introduced challenges related to memory bias and inaccuracies.

A related challenge was the changing knowledge base among younger Jah Hut farmers. As highlighted in Chapter 5, modernization, policy restrictions, and economic shifts have impacted the transmission of agricultural knowledge, with some younger farmers being less familiar with specific rituals, land-use customs, and rotational cropping systems. This indicates a potential shift in knowledge continuity, requiring further research into intergenerational learning strategies and cultural preservation initiatives. Similar challenges have been documented in studies on Indigenous knowledge transmission, where younger generations show reduced engagement with traditional ecological practices due to external socio-economic pressures (Ross, 2016). The shift away from intergenerational knowledge transfer is driven by modernization, restrictive policies, and the loss of customary land access, reinforcing the need for structured cultural preservation programs and community-led knowledge-sharing initiatives (Ross, 2016).

Despite these considerations, triangulation of multiple data sources - including archival research, field observations, and diverse participant perspectives - helped ensure a balanced and well-contextualized analysis. Future studies may benefit from longitudinal research, participatory action methodologies, and expanded historical documentation, which can further validate and strengthen these findings.

8.5. Directions for Future Research

A critical area for future study is the longitudinal tracking of land-use patterns among the Jah Hut. A long-term approach would provide a more comprehensive view of agricultural transformations, particularly in response to external pressures such as land dispossession, climate change, and policy shifts. Additionally, conducting comparative studies with other Orang Asli groups in Malaysia would help contextualize Jah Hut farming within broader Indigenous agricultural trends, identifying common challenges and opportunities across different communities. Such research would strengthen advocacy for inclusive land-use policies that recognize Indigenous land management systems.

Another essential direction is the development of Indigenous Sustainability Assessment Models. While this study adapted the IDEA framework to assess sustainability, custom indicators that better reflect subsistence economies, land tenure security, and cultural resilience should be developed. A potential approach is creating an Indigenous Sustainability Index, co-designed with Jah Hut farmers, to ensure that assessments are based on locally defined values and priorities rather than externally imposed standards. This would contribute to more accurate and culturally relevant sustainability evaluations.

Policy-oriented research on land tenure and governance is also necessary, particularly in exploring alternative land tenure systems that offer pathways for the legal recognition of shifting cultivation. Investigating customary land registries and community-led conservation initiatives could provide valuable insights into Indigenous land governance models that balance ecological sustainability with land rights protection. Furthermore, analyzing how state conservation policies can integrate Indigenous land-use knowledge would help promote co-managed environmental governance frameworks, ensuring that Indigenous expertise informs policy decisions rather than being excluded from formal conservation efforts.

A crucial issue that requires further research is the transmission of agricultural knowledge to younger generations. As highlighted in this study, modernization and external pressures have disrupted the intergenerational transfer of Indigenous agricultural knowledge, raising concerns about cultural continuity. Future studies should explore effective knowledge-sharing mechanisms, such as community-driven agricultural education programs, digital storytelling projects documenting traditional practices, and intergenerational farming workshops that connect elders with youth. By fostering youth engagement in Indigenous farming, these initiatives could revitalize interest in sustainable, culturally rooted agricultural practices, ensuring their long-term survival and adaptation.

Lastly, future research should investigate the role of agroecology in climate adaptation, particularly how Jah Hut farmers respond to climate variability and shifting environmental conditions. Studies could examine the contributions of shifting cultivation to climate resilience, the role of traditional crop diversification in mitigating climate risks, and Indigenous water management techniques that support drought resistance and soil conservation. By integrating traditional ecological knowledge with contemporary agroecological research, future studies can develop locally relevant adaptation strategies that ensure both environmental and cultural sustainability.

By addressing these research gaps, future studies can contribute to more inclusive land policies, sustainable agricultural practices, and strengthened Indigenous governance, ultimately supporting Jah Hut self-determination and environmental stewardship.

8.6. Conclusion

This study highlights the ecological, cultural, and economic resilience of Jah Hut shifting cultivation while challenging narratives that frame it as an unsustainable relic. Policy interventions should move beyond top-down regulation and instead embrace participatory, evidence-based approaches that respect Indigenous knowledge and sovereignty. The future of shifting cultivation depends on policies that recognize land rights, traditional ecological knowledge, and livelihood diversity. Recognizing shifting cultivation as a dynamic, knowledge-intensive system rather than an obstacle to development is crucial to ensuring equitable and sustainable agricultural futures for the Jah Hut and other Indigenous communities.

Yet it must also be acknowledged that technical recommendations alone are insufficient. The core obstacle lies not in the feasibility of these proposals, but in the political economy of land control. Implementing meaningful reforms would require the state to cede authority over resource-rich territories and recognize Indigenous autonomy in ways that directly challenge entrenched interests. If the structures of power prioritize monopoly over genuine equity, shifting cultivation will continue to be sidelined in policy discourse - not because it is unviable, but because it is inconvenient. Without political and institutional will to rebalance these power dynamics, even the most compelling evidence risks being ignored.

References

Balce, E. D. (2022). Ecological imperialism: A Georgist alternative. American Journal of Economics and Sociology, 81(1), 189–209. https://doi.org/10.1111/ajes.12381

Bakker, E. A., Bakker, E. A., Hartman, Y. A. W., Hopman, M. T. E., Hopkins, N. D., Graves, L. E. F., Dunstan, D. W., Dunstan, D. W., Healy, G. N., Eijsvogels, T. M. H., Thijssen, D. H. J., & Thijssen, D. H. J. (2020). Validity and reliability of subjective methods to assess sedentary behaviour in adults: A systematic review and meta-analysis. In *International Journal of Behavioral Nutrition and Physical Activity* (Vol. 17, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s12966-020-00972-1

Binder, C., & Binder, C. (2016). A capability perspective on Indigenous autonomy. *Oxford Development Studies*, *44*(3), 297–314. https://doi.org/10.1080/13600818.2016.1167178

Burchfield, E. K. (2022). Shifting cultivation geographies in the Central and Eastern US. *Environmental Research Letters*, *17*(5). https://doi.org/10.1088/1748-9326/ac6c3d

Falvey, J. L. (2017). Policies Impacting Shifting Cultivation: Getting them right. In *Shifting cultivation policies: balancing environmental and social sustainability* (pp. 43–63). https://doi.org/10.1079/9781786391797.0043

Heinimann, A., Mertz, O., Frolking, S., Christensen, A. E., Hurni, K., Sedano, F., Chini, L. P., Sahajpal, R., Hansen, M., & Hurtt, G. (2017). A global view of shifting cultivation: Recent, current, and future extent. *PLoS ONE*, *12*(9). https://doi.org/10.1371/journal.pone.0184479

Henriksen, L. F., Kamnde, K., Silvano, P., Olwig, M. F., Mwamfupe, A., & Gallemore, C. (2023). Strong collaborative governance networks support effective Forest Stewardship Council-certified community-based forest management: Evidence from Southeast Tanzania. *Global Environmental Change*, *82*. https://doi.org/10.1016/j.gloenvcha.2023.102734

Inguaggiato, C., Ceddia, M. G., Tschopp, M., & Christopoulos, D. (2021). Collaborative governance networks: A case study of argentina's forest law. *Sustainability (Switzerland)*, *13*(18). https://doi.org/10.3390/su131810000

Kilawe, C. J., Mertz, O., Silayo, D. S. A., Birch-Thomsen, T., & Maliondo, S. M. (2018). Transformation of shifting cultivation: Extent, driving forces and impacts on livelihoods in Tanzania. *Applied Geography*, *94*, 84–94. https://doi.org/10.1016/j.apgeog.2018.03.002

McElwee, P. (2022). Shifting policies for shifting cultivation: A history of anti-swidden interventions in Vietnam. *Journal of Southeast Asian Studies*, *53*(1–2), 153–182. https://doi.org/10.1017/S0022463422000194

Mertz, O., & Bech Bruun, T. (2017). Shifting Cultivation Policies in Southeast Asia: A need to work with, rather than against, smallholder farmers. In *Shifting cultivation policies: balancing environmental and social sustainability* (pp. 27–42). https://www.cabidigitallibrary.org/doi/abs/10.1079/9781786391797.0027

Porcuna-Ferrer, A., Fiala, V., Freyer, B., van Etten, J., Vernooy, R., & Probst, L. (2020). Do community seed banks contribute to the social-ecological resilience of communities? A case-study from western Guatemala. *International Journal of Agricultural Sustainability*, *18*(3), 232–249. https://doi.org/10.1080/14735903.2020.1747199

Prändl-Zika, V. (2008). From subsistence farming towards a multifunctional agriculture: Sustainability in the Chinese rural reality. *Journal of Environmental Management*, *87*(2), 236–248. https://doi.org/10.1016/j.jenvman.2006.10.028

Rayo, G. A., Mosinger, E. S., & Thaler, K. M. (2024). State building and Indigenous rights implementation: Political incentives, social movement pressure, and autonomy policy in Central America. *World Development*, *175*. https://doi.org/10.1016/j.worlddev.2023.106468

Ross, J. B. (2016). Indigenous Intergenerational Teachings: The Transfer of Culture, Language, and Knowledge in an Intergenerational Summer Camp. *American Indian Quarterly*, *40*(3), 216–250. https://doi.org/10.5250/amerindiquar.40.3.0216

Sinare, H., Peterson, G. D., Börjeson, L., & Gordon, L. J. (2022). Ecosystem services in Sahelian village landscapes 1952-2016: estimating change in a data scarce region. *Ecology and Society*, *27*(3). https://doi.org/10.5751/ES-13292-270301

Springerová, P., & Vališková, B. (2016). *Canadian Association of Latin American and Caribbean Studies Territoriality in the development policy of Evo Morales' government and its impacts on the rights of Indigenous people*. *41*(2), 147–172. https://doi.org/10.2307/26588191

Subramaniam, Y., & Nicholas, C. (2018). The Courts and the Restitution of Indigenous Territories in Malaysia. Erasmus Law Review, 11(1), 67–79. https://doi.org/10.5553/elr.000096

Vernooy, R., Mulesa, T. H., Gupta, A., Jony, J. A., Koffi, K. E., Mbozi, H., Singh, P. B., Shrestha, P., Tjikana, T. T., & Wakkumbure, C. L. K. (2020). The role of community seed banks in achieving farmers' rights. *Development in Practice*, *30*(5), 561–574. https://doi.org/10.1080/09614524.2020.1727415

Wook, S. (2015). Land rights of the Orang Asli in Peninsular Malaysia: From the perspective of National and International Law [Master's thesis, University of Malaya]

Appendix 3.1

Identification and Validation Information

Site name:
Survey date:

Basic information of the village being studied (to be obtained from the Village Head)

Profile of the Settlement

Name of village: Location Coordinates:
District:
State:
Ethnic composition (main group and sub-group):
Land uses in the village (previous and current):
Topography:
Altitude:
Vehicle accessibility:
General livelihoods of villagers:
Distance from (ask villagers) i) main road………., ii) nearest market………..iii) town……….
Distance to i) nearest primary school …………..ii) high school………., iii) medical centre
Electricity supply:
Water supply:
Telecommunications connectivity:
Internet availability:
Cooking energy supply (gas or firewood or others):

Questionnaire for Household Interviews

Socio-Demographic Background

Respondent's Profile

1. Date:
2. Respondent's number:
3. Gender: Male/Female
4. Community group and sub-group:
5. How long have you been living in this village?
6. Respondent's Age:
7. Respondent's education: None, SPM, STPM, A levels, Diploma, Degree, Others:_______.
8. Respondent's occupation:
9. Marital status:
10. Number of family members (living in your house):
11. Highest education of family members:
12. Education levels of children:
13. Mean monthly household income
14. House Material: Concrete house, timber house with tin roof, Mud house with tin roof/grass thatched

15. Land Use Type

Homegarden (Yes/No)	Fruit Orchard	Irrigated fields	Non-irrigated fields	Are the fields in different parts of the landscape?	Which wild areas are used (forest, wetland, meadows) and for which purposes?

Land Security

16. Agricultural land:
17. Land ownership: Own (personal)   Communal   Lease   Others
18. Total land holding:

Objective 1: Identify prevailing agricultural practices

Agricultural Practices

Household Agricultural Survey

1. Traditional agriculture practices (shifting cultivation, para-cultivation, agroforestry, home garden, mixed cropping, gathering forest products, oil palm mixed cropping):
2. Oil Palm (Yes/No):
3. Rubber (Yes/No):
4. Others:
5. Main sources of income:
   Source **% of total income**
   Business (types) –
   Job (types) –
   Conventional agriculture –
   Oil Palm -
   Rubber -
   Traditional Agriculture (type)-
   Others (specify) –
6. What is your main method of cultivation?
7. Do you sell your farm produce? Yes/No
8. If yes, what is the reason? [e. g. extra income for family expenses, child education, etc.]
9. What are the products you usually sell?
10. What is the proportion of farm produce sold?
11. How do you sell your products? [e. g. direct to consumers, to retailers, to whole sellers, etc.]
12. If you consume all produce, what might be the estimated market price of these?

Crop Diversity Information

What are the root/tuber, vegetables, fruits, oilseed crops do you grow?

Species	Variety name	Local or commercial names	Source of seed*	Uses

**Source of seed: Maintained by yourself; obtained from a relative or neighbour in the same community; obtained from a relative or contact from another community; obtained from market/commercial seed seller; obtained from extension service or government agency; obtained from NCO or from a seed fair*

*** Reasons: High yield (Y), adapted to local soil (S), medicinal properties (M), cooking properties (C), drought tolerance (D)*

Objective 2: Assess the sustainability of Jah Hut agricultural practices

Assessment Scale			Evaluation
Criteria	**Scale**	**Points**	
Number of annual/ temporary crops by species	None	0	
	1 - 3 species	2	
	3 - 5 species	3	
	More than 5 species	5	
Number of annual/ temporary crops by variety	None	0	
	1 - 3 variety per species	2	
	More than 3 variety per species	5	
Number of perennial crop by species	None	0	
	1 - 5 species	2	
	6 - 10 species	3	
	10 or more species	5	
Number of perennial crops by variety (new addition)	None	0	
	1 - 3 variety per species	2	
	4 or more variety per species	5	
Crop rotation / intercropping	Monoculture or replanting with cash crops	0	
	Intercropping	3	
	Crop rotation	5	
Plots left to fallow post-harvest	No	0	
	Yes	3	
Organic fertilization	Use of chemical fertilisers	0	

Assessment Scale			Evaluation
Criteria	**Scale**	**Points**	
	Use of organic fertilisers or no fertilisers used	3	
Agroecological pest management	Inorganic/chemical pesticides used	0	
	Use of organic/ natural pesticides / integrated pest management or no pesticides used	3	
Herbicide use	Inorganic / synthetic herbicides	0	
	Organic/ natural herbicides	3	
No-tillage farming	Tillage farming	0	
	Conservation tillage / no-tillage farming	5	
Controlled burning	Uncontrolled burning	0	
	Controlled burning	2	
Rainfed system/ No irrigation required	Yes	0	
	No (Rainfed system / no irrigation required)	3	
Mechanization requirement	Yes	0	
	No (minimal to none)	3	
Land tenure	Contested land / unrecognized reserved land, etc	0	
	Gazetted Orang Asli Reserve	1	
	Own / Communal	3	
	Not accessible	0	

Assessment Scale			Evaluation
Criteria	Scale	Points	
Accessibility of agricultural land by trail or tracks	Access available	3	
Percentage of local food production	Less than 20% is self-produced	0	
	20 - 50% is self-produced	1	
	More than 50% is self produced	3	
Recovery of rain water	No	0	
	Yes	3	
Seed production	No	0	
	Yes	3	
Contribution to livelihood	No	0	
	Yes	3	
Willingness of the next generation to continue traditional farming	Definitely not willing	0	
	Unlikely to continue	1	
	Unsure but open	3	
	Likely to continue	4	
	Committed to continuing	5	
Existence of a knowledge transfer system within the community	No	0	
	Yes	3	
Belief that the farm will exist over the next 10 years	Extremely unlikely	0	
	Unlikely	1	
	Not sure	3	
	Likely	4	
	Extremely likely	5	
Farmers found their job tiring most of the time	Always	0	
	Occasionally	1	
	Never	3	

Assessment Scale			Evaluation
Criteria	**Scale**	**Points**	
The community works together to help each other in farm work	Always	0	
	Occasionally	1	
	Never	3	
Provision of basic amenities (water supply, electricity, roads, telecommunication infrastructure)	No provision	0	
	Incomplete	1	
	Complete	3	
The state of means of transport (bicycle, motorbike, car, etc.)	No means of own transport	0	
	Poor	1	
	Fair	2	
	Good	3	
	Very good	4	
	Excellent	5	
Geographic Isolation	Most isolated	0	
	Fairly isolated	1	
	Least isolated	3	
Social Isolation	Most isolated	0	
	Fairly isolated	1	
	Least isolated	3	
Cultural Isolation	Most isolated	0	
	Fairly isolated	1	
	Least isolated	3	
Farmer's perception on the sufficiency of their income	Extremely insufficient	0	
	Insufficient	1	
	Moderately sufficient	2	
	Sufficient	3	
Independence from government aid	Completely dependent	0	
	Largely dependent	1	
	Occasionally dependent	2	
	Independent	3	

<u>Objective 3: Assessing Jah Hut Livelihoods</u>

Social capital

1. Name of organisations/groups/NGOs you're involved in
2. Types of organisations
3. Composition of these organisations (eg. Members are from the same village, kin group, occupation, economic status, religion, gender, age, level of education, political association, ethnic group…)
4. What are the benefits from joining the group?
5. Do you involve in collective actions in your village? Yes/No
6. If yes, what are the collective actions that you involved in 12 months?
7. What are the benefits of collective actions?
8. Do you get any support from your neighbours/friends/relatives/organisations related to farming activities?
9. If yes, who are they?
10.

Supporter	Number of supporters	Type of support provided (e.g. input, advice, etc.)
Neighbour		
Friend		
Relative		
Organisations (NGOs/Govt..)		

<u>Seed Sources and Seed Networks</u>

1. What is the source of the seed you have planted?
   - Maintained by yourself from a crop you have grown from the past (self)
   - Relative or neighbour in the same community (gift, exchange, purchase)
   - Relative or contact from another community (gift, exchange, purchase)
   - Market/commercial seed seller
   - Extension service or government agency (gift, purchase)
   - NGO (gift, purchase)
   - Seed fair

2. If maintained by yourself, what was the original source of the seed you are using?
   - Always yourself
   - Relative or neighbour in the same community (gift, exchange, purchase)
   - Relative or contact from another community (gift, exchange, purchase)
   - Market/commercial seed seller
   - Extension service or government agency (gift, purchase)
   - NGO (gift, purchase)
   - Seed fair

Financial Capital

1. Do you get any financial support such as loans from NGOs or any organisations? Yes/No
2. If yes, what are the financial supports you received in last 2-3 years?
3. What were the purposes of these?
4. Who provided this support and what were the conditions?
5. How does this support benefit your livelihood?

Human Capital

Training

1. What training related to farming and livelihoods have you received so far in the last few years, and from whom?
2. What are the benefits of this training?

Health conditions

1. What are the major health problems that members of your family have faced during the past year? (ranked by 10 marks for the most important problem and one mark for the least important problem)
2. How are decisions being made in the household with regard to health or responding to health problems? Who makes specific decisions? How are household resources allocated in case of ill health and malnutrition?

Food Security

1. Please provide your opinion on followings considering all income sources and farming produces:
2. Able to maintain household food security
3. Have some surplus
4. Shortage of food for a few months
5. What do you do with surplus income/farm produces?
6. How do you address the shortage of food?

Appendix 3.2

Questionnaire for Group Discussions / Key Informant or Elder Interviews

1. Name of village:
2. Number of participants attended:
3. Gender of the respondents: Male …. /Female ……
4. Average age:

Objective 1: The Evolution of Jah Hut Agricultural Practices

Farming Practices

1. How did your community grow/gather/acquire food for subsistence when you were young?
2. If you grew food, what were the cropping systems (crops, crop sequences and management techniques) like when you were a child?
3. What is the difference between the agricultural practices of your childhood and the agricultural practices of today in terms of:
   i. farming techniques
   ii. food availability and security
   iii. contribution to livelihood
   iv. cultures surrounding food production
   v. the roles of men and women
2. What are the landraces (local cultivars that have been improved by traditional agricultural methods) cultivated in the past and at present?
3. Are there shifts in the landrace diversity of crops or cropping patterns? If yes, what has shifted and why?
4. What do you practice before and now for the following:
   i. Soil fertility assessment and management
   ii. Plant health (diseases, insects, fungi, etc)
   iii. Increasing crop-productivity
   iv. Marketing the produce
   v. Storage of seeds and food grains and other food items

Why are you still practising tradtional agriculture (shifting cultivation)? What are the factors? (health, consumption, market demand, incentives, eg)
If not, what has changed? Why?
How have these changes impacted the community (in terms of food security, socio-economy, identity, etc….)
How is traditional knowledge related to farming relayed/passed on to the next generation?
What is the future of these types of farming systems in your village? Why?
How do you ensure the long-term productivity of your farm?
What are the challenges you face to ensure that your farm continues to exist and flourish?
How did you learn the current methods of cultivation/soil management/pest control?
Is the food grown in your farm sufficient for your family's consumption?
If not, how do you supplement your family's requirement**?**
What kind of assistance have you received so far, and from whom? (subsidy, technical, training)(Gov, NGO, etc)
What are the major problems in present day agriculture?

Gender Relationships

1. What are roles of men and women in making decisions on farming activities? [e. g. choice of crops]
2. Who carries out the following activities in the village?

Farm activities	Elders	Men	Women	Children	
				Boys	Girls
Ritual accompanied by land clearing					
Land preparation					
Ritual for thanksgiving for planting					
Planting (prepare the seeds, plant the seeds and dig the holes)					
Weeding and tending					
Pest management					
Ritual for harvest					
Harvesting for seeds and grains					
Storage					

Objective 3: **Assess the socio-economic, ecological and institutional (political ecology) factors that impact the continuity of traditional agricultural practices and livelihoods**

<u>Socio-Political Institutions</u>

1. What are the different leadership roles of these institutions:
   i. Headman/ Batin;
   ii. JKKK (appointed by JAKOA);
   iii. Council of elders;
   iv. Shaman;
   v. Others
2. What are the community values (eg. rituals on land use, rules and practices in relation to natural resource use)
3. What is the mechanism used by the community in managing natural resources and land use?

<u>Health and Nutrition</u>

1. What are the major health problems that members of the community have faced during the past year? (ranked by 10 marks for the most important problem and one mark for the least important problem)
2. In your view, what are the reasons for these problems and what is commonly done to resolve these problems?

<u>Household food security</u>

1. During the last year, what have been the problems in the community, households and individuals to obtain an adequate diet *(to be food secure)*?
2. In your view, what were the reasons for these problems? What did the community and households do to resolve these problems?
3. What resources are needed by the community, households and individuals to become more successful at preventing food security problems from recurring?

Appendix 5.1

List of Extinct Jah Hut Rice Varieties

Jah Hut Indigenous rice varieties, locally known as *bak* (for non-glutinous rice) and *pulut* (for glutinous rice), exhibit diverse morphological traits influenced by traditional cultivation practices and environmental adaptation. The characteristics of these varieties are primarily identified by the hull color, grain shape, grain texture, and plant stature, as traditionally recognized by Jah Hut women, the primary custodians of rice knowledge. The edible rice grain, known as the *caryopsis*, consists of the bran layer, endosperm, and germ.

Jah Hut *pulut* is an Indigenous glutinous rice with a unique flavor profile distinct from commercially available varieties. When cooked, it has a mild, subtly sweet, and slightly nutty taste, accompanied by a chewy and sticky texture. Unlike regular rice, it has a denser and creamier mouthfeel, making it particularly satisfying to eat.

No.	Variety	Growth Duration	Hull Color & Features	Caryopsis (Grain) Traits	Plant Characteristics / Notes
1	**Pulut Teng**	6 months	Not specified	Yellow caryopsis	-
2	**Pulut Manis**	6 months	Not specified	Not specified	Uncertainty regarding extinction status.
3	**Pulut Pinang**	Not available	Not available	Not available	Possibly known by other names in different communities.
4	**Pulut Bakok**	6 months	Black, red, and yellow hull	Red-hued, oblong caryopsis	-
5	**Pulut Petai**	6 months	Yellow hull	Large, round, white caryopsis; also noted with red-hued, oblong caryopsis	-
6	**Pulut Pret**	6 months	Not specified	Black, short, round caryopsis	-
7	**Pulut Kajang**	6 months	Not specified	Red caryopsis	Similar to *Bak Satang* (existing strain), but fragrant.
8	**Pulut Sanding**	6 months	Yellow hull	Short, oblong, white caryopsis	Shorter-than-usual stalks.
9	**Pulut Plong**	6 months	Not specified	White caryopsis	Stalks spread widely, resembling a blooming flower (*"macam bunga"*).
10	**Pulut Siam**	6 months	Black hull	Round, black caryopsis	-

No.	Variety	Growth Duration	Hull Color & Features	Caryopsis (Grain) Traits	Plant Characteristics / Notes
11	**Pulut Galah**	6 months	White hull	White caryopsis	Morphologically similar to *Bak Libar* (a non-extinct variety).
12	**Pulut Manis**	6 months	Yellow pubescent hull with black hairs	White caryopsis, sharp awn at the apical end (*resembling an eyelash*)	Similar to *Bak Geli*.
13	**Pulut Semangkuk**	6 months	Not specified	Red caryopsis	-
14	**Pulut Bakok**	6 months	Not specified	Long, white caryopsis	Morphologically similar to *Pulut Semangkuk*, but differs in hull characteristics.
15	**Sekoi (Indigenous millet)**	6 months	Yellow hull	Small, round, yellow caryopsis	Fine grains make cultivation challenging; rich, creamy flavor.
16	**Mehilai (uncertain classification)**	6 months	Black-and-white hull	Large, round, white caryopsis	Difficult to cultivate; creamy, rich taste.
17	**Bak Bendang Ciko**	6 months	White hull	Short, round, white caryopsis	Fast-growing; ordinary rice flavor. Known as *Bak Bendang Tiku* in Sg Mai.
18	**Bak Bendang Kuning**	6 months	Yellow hull	Short, round, white caryopsis	Quick-growing; ordinary rice flavor.
19	**Bak Gelung**	6 months	Black hull	Short, round, white caryopsis	Ordinary rice flavor.
20	**Bak Tanom**	6 months	Black-and-white hull	Not specified	Ordinary rice flavor.
21	**Bak Empis**	6 months	Yellow hull	Fine, round, short, white caryopsis	Short stalks (*knee-length*); ordinary rice flavor.
22	**Bak Jaamai**	6 months	Yellow-grey hull	Large, round, white caryopsis	Swamp rice (*padi paya/sawah*); short stalks (knee-length); soft texture when cooked.
23	**Bak Lampai**	6 months	Not specified	Not specified	Taller-than-usual stalks; morphologically similar to *Bak Julai*, but with a different grain shape.

No.	Variety	Growth Duration	Hull Color & Features	Caryopsis (Grain) Traits	Plant Characteristics / Notes
24	**Bak Bumban**	3 months	White hull	Short, round, white caryopsis	Fast-growing (*only 3 months*); ordinary rice flavor.
25	**Bak Libar Papan / Bak Buman**	6 months	Not specified	Not specified	Similar to *Bak Libar Pasir* (a non-extinct variety) but larger; produces superior flattened rice (*emping*).
26	**Bak Julai**	6 months	White hull	Long, white caryopsis	Ordinary rice flavor.
27	**Bak Geli**	6 months	Not specified	White caryopsis; apical end has an awn (*eyelash-like*)	Ordinary rice flavor.
28	**Bak Melik**	6 months	Red hull	Round, short, white caryopsis	Ordinary rice flavor.

(This information was recorded from Berdut Jah Hut elders on October 17, 2022)

Appendix 6.1

Omitted IDEA Indicators

Dimensions of the IDEA Framework	Components of the IDEA Framework	IDEA Indicators Utilized	Justification
Agroecological	**Diversity**	A3: Animal Diversity	Livestock is not a significant component of Jah Hut farming practices, which are more plant-focused or involve other cultural practices incompatible with livestock diversity as a priority.
		A4: Enhancement and conservation of genetic heritage	Difficult to assesss in Jah Hut agriculture because their practices are naturally biodiverse, small-scale, and rooted in traditional knowledge that is not easily aligned with formal evaluation methods. This indicator is irrelevant or redundant in their context, as genetic conservation happens organically and does not require active enhancement or external measurement.
	Organization of space	A6: Dimension of fields	Jah Hut farming practices does not align with standard field dimension assessments, as their approach to space utilization is different, prioritizing traditional or ecological layouts.
		A7: Management of Organic Matter	Organic matter is a naturally integrated practice without explicit management structures, making this indicator redundant.

Dimensions of the IDEA Framework	Components of the IDEA Framework	IDEA Indicators Utilized	Justification
		A9: Contribution to territorial environmental challenges	Allows the study to maintain its focus on the practical, rapid evaluation of Jah Hut farming sustainability. This reflects the localized, small-scale nature of their practices and avoids the complexity and resource demands of assessing broader territorial impacts, which are beyond the scope of this study.
		A10: Improvement of the space	This omission reflects the practical limitations of assessing this indicator in the Jah Hut context without clear baselines or tailored definitions of "improvement." While their practices may be culturally meaningful and potentially harmonious with nature, further data collection would be required to conclusively determine their sustainability. Instead, the study focuses on other indicators that provide more immediate evidence of ecological, social, and economic sustainability.
		A11: Management of fodder area	Similar to A3, the absence of significant livestock diminishes the importance of this indicator for their community.

Dimensions of the IDEA Framework	Components of the IDEA Framework	IDEA Indicators Utilized	Justification
	Farming Practices	A13: Organic waste (manure) management	Omitted because it is irrelevant in the Jah Hut context, where livestock is minimal, waste is naturally recycled, and the small-scale farming system generates negligible environmental risks from organic waste. This ensures the evaluation remains focused on indicators that directly reflect the sustainability of Jah Hut agriculture.
		A15: Veterinary treatments	Veterinary care is unnecessary and culturally irrelevant due to minimal reliance on livestock.
Socio-territorial	**Quality of Products and the Land**	B1: Quality process	Standardized quality processes does not apply to traditional or subsistence farming.
		B2: Valorization of built heritage and landscape	Jah Hut practices prioritizes the natural landscape over built heritage, making this indicator less relevant.
		B3: Management of non-organic waste	Non-organic waste might not be a significant issue in a low-input traditional farming system.
		B5: Social involvement	Covered by indicator B15, avoiding redundancy.
	Employment and Services	B6: Short trade value chains	Jah Hut farming operates in subsistence or bartering systems rather than formalized trade chains.
		B8: Services and diversification	Omitted as Jah Hut oil palm and rubber cultivation is being evaluated separately using the same modified IDEA framework. Including B8 in the broader analysis would introduce redundancy.
		B10: Collective work	Covered by indicator B15.

Dimensions of the IDEA Framework	Components of the IDEA Framework	IDEA Indicators Utilized	Justification
	Ethics and Human Development	B12: Dependence on commercial concentrates	Excluded from this assessment as the only input used in the Jah Hut agricultural system is herbicide, which is evaluated under indicator A14 rendering B12 redundant in this context."
		B13: Animal welfare	Minimal or no animal husbandry reduces the importance of this indicator.
		B14: Training	Addressed in the Sustainable Livelihoods Assessment, Chapter 7, ensuring no duplication.
		B18: Quality of buildings	Ethical concerns over evaluating traditional or culturally significant structures as per external standards.
Economic	**Viability**	C2: Rate of economic specialization	Jah Hut farming is more generalized and less dependent on specialization.
	Independence	C3: Financial autonomy	Financial autonomy is less relevant in a largely subsistence-based system.
	Transferability	C5: Economic transferability	Transferability may not apply as their farming practices are rooted in unique cultural and environmental contexts.
	Efficiency	C6: Efficiency of the production processes	Efficiency as defined by modern standards may not reflect the values or goals of Jah Hut farming systems.

Appendix 6.2

Modified IDEA Indicators Used in this Study

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
AGROECOLOGICAL DIMENSION (Total Score: 50)					
Component 1: Diversity					
A1: Diversity of annual and temporary crops	Diversity of annual/temporary crops by species and variety	Number of annual/ temporary crops by species	None	0	Reflects the importance of genetic diversity for resilience, particularly relevant in the context of swidden agriculture practices.
			1 - 3 species	2	
			3 - 5 species	3	
			More than 5 species	5	
		Number of annual/ temporary crops by variety (new addition)	None	0	
			1 - 3 variety per species	2	
			More than 3 variety per species	5	
A2: Diversity of perennial crops	Diversity of perennial crops by species and variety	Number of perennial crop by species	None	0	Emphasizes genetic diversity as an adaptive strategy for cultural and environmental sustainability .
			1 - 5 species	2	
			6 - 10 species	3	
			10 or more species	5	
		Number of perennial crop by variety (new addition)	None	0	
			1 - 3 variety per species	2	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
			4 or more variety per species	5	
Component 2: Organization of Space					
A5: Crop Rotation	Crop rotation / intercropping	Crop rotation / intercropping	Monoculture or replanting with cash crops	0	Recognizes traditional crop rotation or intercropping systems used by Indigenous farmers, which enhance biodiversity and reduce reliance on monocultures.
			Intercropping	3	
			Crop rotation	5	
A8: Ecological Buffer Zones			No	0	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
	Plots left to fallow post-harvest	**Plots left to fallow post-harvest (new addition)**	Yes	3	The concept of ecological buffer zones in the original framework primarily refers to protected areas adjacent to farming plots for biodiversity conservation. However, leaving plots fallow post-harvest serves a similar ecological function by enabling natural regeneration and supporting biodiversity. Reflecting the fallow periods typical of traditional swidden systems, this revised indicator is more specific, directly observable, and easier to measure in the Jah Hut context.
Component 3: Farming Practices					
A12: Fertilization	Organic fertilization	Organic fertilization	Use of chemical fertilisers	0	Acknowledges the importance of organic fertilization for maintaining

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	**Scale**	**Points**	
			Use of organic fertilisers or no fertilisers used	3	soil health, as emphasized in sustainable farming practices.
A14: Pesticides	Agroecological pest management	Agroecological pest management	Inorganic/chemical pesticides used	0	
			Use of organic/ natural pesticides / integrated pest management or no pesticides used	3	
	Weed control (new addition)	**Herbicide use (new addition)**	Inorganic / synthetic herbicides	0	Relevant to the Jah Hut context because traditional farming systems often rely on manual or natural methods for managing weeds rather than synthetic herbicides.
			Organic/ natural herbicides	3	
A16: Soil protection	Retained	No-tillage farming	Tillage farming	0	
			Conservation tillage / no-tillage farming	5	
		Controlled burning (new addition)	Uncontrolled burning	0	Controlled burning is a key practice in swidden

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
			Controlled burning	2	agriculture, where burning is used to clear land and return nutrients to the soil. The focus on distinguishing between controlled and uncontrolled burning allows the framework to address potential environmental risks while acknowledging the ecological benefits of controlled burning as practiced by the Jah Hut and other Indigenous swidden communities.
A17: Water resource management	Retained	Rainfed system/ No irrigation required	Yes	0	Reflects the reliance on rainfed systems in Jah Hut agriculture.
			No (Rainfed system / no irrigation required)	3	
A18: Energy dependency	Retained	Mechanization requirement	Yes	0	Mechanization is less relevant in Jah Hut

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
			No (minimal to none)	3	traditional farming, but this indicator highlights energy efficiency in broader sustainability.
SOCIO-TERRITORIAL DIMENSION (Total Score: 54)					
Component 4: Quality of the Products and the Land					
B4: Access to the farm	Retained	**Land tenure (new addition)**	Contested land / unrecognized reserved land, etc	0	The socio-political significance of land ownership is not captured in the original framework. Land tenure plays a critical role in Indigenous contexts, where contested rights, communal ownership, and cultural ties to land are key to sustainability.
			Gazetted Orang Asli Reserve	1	
			Own / Communal	3	
		Accessibility of agricultural land by trail or tracks	Not accessible	0	
			Access available	3	
Component 5: Employment and Services					
B7: Autonomy and enhancement of local resources	Retained	Percentage of local food production	Less than 20% is self-produced	0	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
			20 - 50% is self-produced	1	
			More than 50% is self-produced	3	
		Recovery of rainwater	No	0	
			Yes	3	
		Seed production	No	0	
			Yes	3	
B9: Contribution to employment	Contribution to livelihood	Contribution to livelihood	No	0	To better reflect the realities of subsistence-based Indigenous farming systems. Unlike formal employment, the Jah Hut rely on farming as a primary source of food and basic needs rather than as a source of wages or jobs. This revision emphasizes the role of farming in securing household livelihood, making it more contextually relevant.
			Yes	3	
B11: Probable farm sustainability	Retained	Willingness of the next generation to continue traditional farming	Definitely not willing	0	
			Unlikely to continue	1	
			Unsure but open	3	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	**Scale**	**Points**	
			Likely to continue	4	
			Committed to continuing	5	
		Existence of a knowledge transfer system within the community	No	0	
			Yes	3	
		Belief that the farm will exist over the next 10 years	Extremely unlikely	0	
			Unlikely	1	
			Not sure	3	
			Likely	4	
			Extremely likely	5	
Component 6: Ethics and Human Development					
B15: Labour intensity	Retained	Farmers found their job tiring most of the time	Always	0	
			Occasionally	1	
			Never	3	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
		The community works together to help each other in farm work	Always	0	
			Occasionally	1	
			Never	3	
B16: Quality of life	Retained	Provision of basic amenities (water supply, electricity, roads, telecommunication infrastructure)	No provision	0	
			Incomplete	1	
			Complete	3	
		The state of means of transport (bicycle, motorbike, car, etc.)	No means of own transport	0	
			Poor	1	
			Fair	2	
			Good	3	
			Very good	4	
			Excellent	5	
B17: Isolation	Self-assessment on feelings of isolation based on:	Geographic Isolation	Most isolated	0	
			Fairly isolated	1	
			Least isolated	3	
		Social Isolation	Most isolated	0	
			Fairly isolated	1	
			Least isolated	3	

IDEA Indicators Utilized in this Study	Reformulation / Addition of IDEA Indicators	Assessment Scale			Justification for Reformulation / Addition of new IDEA Indicators and Criteria
		Criteria	Scale	Points	
		Cultural Isolation	Most isolated	0	
			Fairly isolated	1	
			Least isolated	3	
ECONOMIC DIMENSION (Total Score: 6)					
Component 7: Viability					
C1: Economic viability	Retained	Farmer's perception on the sufficiency of their income	Extremely insufficient	0	
			Insufficient	1	
			Moderately sufficient	2	
			Sufficient	3	
Component 8: Independence					
C4: Sensitivity to subsidies	Retained	Independence from government aid	Completely dependent	0	
			Largely dependent	1	
			Occasionally dependent	2	
			Independent	3	

This table was developed based on the principles and methodologies outlined in Méthode IDEA: *Indicateurs de durabilité des exploitations agricoles* by Vilain et al. (2008), and Baccar's (2016) work, as cited in Biret (2016).

Appendix 6.3

Description of Scales for Modified IDEA Indicators

Reformulated IDEA Indicators	Criteria	Scale	Description
A1: Diversity of annual/temporary crops by species and variety	Number of annual/ temporary crops by species	None	The agricultural system lacks diversity in annual or temporary crops, relying entirely on other types of crops or production systems. This approach often indicates a highly specialized or monoculture-based farming model, limiting ecological resilience and reducing biodiversity benefits.
		1 - 3 species	The farm includes a minimal diversity of annual or temporary crop species. While some level of biodiversity exists, it remains limited, offering restricted environmental advantages such as pest control, soil fertility improvement, or resilience against climate fluctuations.
		3 - 5 species	Moderate diversity in annual or temporary crops, providing a balance between ecological benefits and manageability. This level supports better soil health, promotes ecosystem functions like pollination and pest regulation, and reduces risks associated with crop failure, though it may not fully exploit the resilience potential of higher diversity.

Reformulated IDEA Indicators	Criteria	Scale	Description
		More than 5 species	High diversity of annual or temporary crop species, representing a farming model emphasizing ecological balance and sustainability. This level encourages soil health, reduces dependency on chemical inputs, and enhances ecosystem services by maintaining habitat heterogeneity.
	Number of annual/ temporary crops by variety	None	A lack of varietal diversity within crop species. Such homogeneity can expose the farm to risks from pests, diseases, and climatic stress due to the uniform genetic profile of crops.
		1 - 3 variety per species	Moderate varietal diversity, which provides limited genetic variation. This degree of diversification can partially mitigate risks from environmental stressors while maintaining simplicity in crop management.
		More than 3 variety per species	Significant varietal diversity within crop species, fostering resilience against biotic and abiotic pressures. This approach aligns with agroecological practices, promoting adaptation to environmental changes and improving overall farm sustainability.
A2: Diversity of perennial crops by species and variety	Diversity of perennial crop by species	None	The absence of perennial crops indicates a high reliance on other farming systems, often leading to a lack of perennial root systems that are essential for improving soil stability, reducing erosion, and enhancing carbon sequestration. This approach limits the farm's contribution to long-term sustainability.

Reformulated IDEA Indicators	Criteria	Scale	Description
		1 - 5 species	A low level of diversity in perennial crops provides some ecological benefits, such as moderate erosion control and habitat creation. However, this level limits the full potential of ecosystem services, such as pest regulation and soil health improvements.
		6 - 10 species	A moderate diversity of perennial crops supports a balanced ecosystem by providing multiple services, such as enhanced water retention, improved soil biodiversity, and increased resilience to pests and diseases. This diversity also allows for improved economic stability through diversified production.
		10 or more species	High diversity of perennial crops ensures a robust agroecosystem with maximum ecosystem benefits, including long-term soil enrichment, habitat provision for beneficial organisms, and climate resilience. This level reflects a commitment to sustainability by enhancing biodiversity and reducing dependency on external inputs.
	Diversity of perennial crop by variety	None	A lack of varietal diversity within perennial crops results in uniformity, which increases vulnerability to diseases, pests, and environmental stresses. This homogeneity reduces the system's overall adaptability to changing climatic and ecological conditions.

Reformulated IDEA Indicators	Criteria	Scale	Description
		1 - 3 variety per species	A moderate level of varietal diversity provides some genetic variation, offering limited protection against specific pests and diseases. This level of diversity can serve as a stepping stone toward greater resilience and sustainability.
		4 or more variety per species	High varietal diversity within perennial crops promotes significant genetic resilience, enabling adaptation to various environmental conditions and reducing risks associated with pests and diseases. This diversity aligns with sustainable farming practices, improving productivity and long-term viability.
A5: Crop rotation / intercropping	Crop rotation / intercropping	Monoculture or replanting with cash crops	Monoculture or repetitive replanting of cash crops without rotation signifies a high dependency on external inputs, such as fertilizers and pesticides, and can lead to soil degradation, pest buildup, and nutrient depletion. This approach lacks ecological resilience and sustainability.
		Intercropping	Intercropping provides short-term benefits by optimizing nutrient use and preventing soil degradation within the same season. Crop rotation has a stronger long-term impact on soil fertility by addressing nutrient balance, pest cycles, and organic matter accumulation over time. Both practices reflect sustainable soil management practices, by helping to maintain soil fertility, reduce pests and diseases, and enhance biodiversity. It also promotes efficient resource use by diversifying plant root systems and nutrient uptake.
		Crop rotation	

Reformulated IDEA Indicators	Criteria	Scale	Description
A8: Plots left to fallow post-harvest	Plots left to fallow post-harvest	No	Not leaving plots fallow post-harvest signifies continuous land use, which can lead to soil exhaustion and loss of fertility over time.
		Yes	Leaving plots fallow post-harvest is a regenerative practice that allows the soil to recover and replenish its organic matter. It minimizes the risk of erosion, improves soil structure, and enhances its long-term productivity. Fallow periods also support biodiversity by creating temporary habitats for wildlife.
A12: Organic fertilization	Organic fertilization	Use of chemical fertilisers	The reliance on chemical fertilizers focuses on immediate yield improvements but often contributes to environmental degradation, such as soil acidification, water pollution, and greenhouse gas emissions. Over time, it may compromise soil health and sustainability.
		Use of organic fertilisers or no fertilisers used	Using organic fertilizers or refraining from fertilizers entirely aligns with sustainable farming practices. Organic fertilizers enhance soil structure, increase microbial activity, and support long-term nutrient cycling. Avoiding fertilizers altogether may signify reliance on natural processes for maintaining soil fertility.

Reformulated IDEA Indicators	Criteria	Scale	Description
A14: Agroecological pest management	Agroecological pest management	Inorganic/chemical pesticides used	Reliance on synthetic pesticides focuses on immediate pest control but often disrupts natural pest-predator relationships and leads to environmental issues such as soil contamination, water pollution, and reduced biodiversity. Prolonged use can also cause pest resistance, requiring higher doses over time.
		Use of organic/ natural pesticides / integrated pest management or no pesticides used	This approach integrates environmentally friendly pest control methods, including natural pesticides, biological control, and pest-resistant crops. It promotes ecosystem balance, reduces chemical dependency, and minimizes environmental damage, aligning with sustainable agroecological practices.
Herbicide use (new)	Herbicide use	Inorganic / synthetic herbicides	The use of synthetic herbicides offers effective weed control but often harms non-target plants and contributes to soil degradation, water contamination, and biodiversity loss. Overuse can also result in herbicide-resistant weeds, creating long-term management challenges.
		Organic/ natural herbicides	Using organic or natural herbicides is a more sustainable option, as these products are less harmful to the environment and degrade more quickly in the soil. This practice supports biodiversity and soil health while ensuring effective weed management within an ecological framework.

Reformulated IDEA Indicators	Criteria	Scale	Description
A16: Soil protection	No-tillage farming	Tillage farming	Conventional tillage disrupts soil structure, accelerates erosion, and reduces organic matter, contributing to long-term soil degradation. While it may offer short-term productivity gains, it increases reliance on fertilizers and other inputs to maintain soil fertility.
		Conservation tillage / no-tillage farming	Conservation tillage or no-tillage farming maintains soil structure, reduces erosion, and enhances water retention. It supports biodiversity in the soil and promotes long-term sustainability by reducing energy and labor inputs.
	Controlled burning	Uncontrolled burning	Uncontrolled burning damages the soil ecosystem by destroying organic matter, beneficial organisms, and nutrients. It can lead to severe erosion and loss of fertility, causing long-term damage to the land.
		Controlled burning	Controlled burning, when used judiciously, helps manage vegetation and return nutrients to the soil while minimizing environmental harm. This practice requires careful planning and monitoring to prevent negative impacts and maintain ecological balance.
A17: Water resource management	Irrigation requirement	Yes	The reliance on irrigation indicates a farming system dependent on external water sources, which may increase costs, energy use, and environmental pressures, such as water depletion and competition for resources. Efficient irrigation systems or water-saving technologies can mitigate these challenges.

Reformulated IDEA Indicators	Criteria	Scale	Description
		No (Rainfed system / no irrigation required)	A rainfed or no-irrigation system relies entirely on natural precipitation, reflecting low water dependency and a more sustainable approach in regions with adequate rainfall. This reduces resource consumption and environmental impact while aligning with climate-adaptive practices.
A18: Energy dependency	Mechanization requirement	Yes	Mechanized systems require significant energy inputs, often from fossil fuels, contributing to greenhouse gas emissions and increasing dependency on non-renewable resources. While mechanization improves labor efficiency, it may undermine sustainability goals without energy-efficient technologies.
		No (minimal to none)	Mechanized systems require significant energy inputs, often from fossil fuels, contributing to greenhouse gas emissions and increasing dependency on non-renewable resources. While mechanization improves labor efficiency, it may undermine sustainability goals without energy-efficient technologies.
B4: Access to the farm	Land tenure	Contested land / unrecognized reserved land, etc	Farming on contested or unrecognized land presents risks related to land security, limited rights for development, and potential disputes. Such situations often inhibit long-term investments in sustainable agricultural practices.

Reformulated IDEA Indicators	Criteria	Scale	Description
		Gazetted Orang Asli reserve	Land within gazetted reserves offers certain protections and access rights but may come with regulatory constraints that limit agricultural expansion or activities.
		Own / Communal	Ownership or communal access to land provides long-term security and the ability to invest in sustainable practices. This stability encourages better resource management and land stewardship.
	Accessibility of agricultural land by trail or tracks	Not accessible	Limited access to agricultural land hinders transportation of inputs and outputs, reducing economic viability and operational efficiency. Poor accessibility may also limit opportunities for mechanization or infrastructure development.
		Access available	Accessible agricultural land facilitates efficient farming operations, allowing for easier transport of goods and services. Improved accessibility supports market integration, reduces operational challenges, and encourages adoption of modern farming practices.
B7: Autonomy and enhancement of local resources	Percentage of local food production	Less than 20% is self-produced	Reliance on external sources for more than 80% of food production reflects limited autonomy and resource utilization within the local system. This dependency increases vulnerability to market fluctuations and reduces the potential for self-reliance.

Reformulated IDEA Indicators	Criteria	Scale	Description
		20 - 50% is self-produced	A moderate level of local food production indicates partial self-sufficiency. While some external dependencies remain, the system shows progress toward utilizing local resources and reducing environmental impacts associated with long supply chains.
		More than 50% is self produced	High levels of local food production demonstrate strong autonomy, reducing reliance on external inputs and supporting sustainability. This approach promotes local resource use, enhances food security, and minimizes the carbon footprint of the agricultural system.
	Recovery of rain water	No	Absence of rainwater recovery represents missed opportunities to enhance water sustainability. This can increase dependency on external water sources and elevate costs or environmental pressures during periods of water scarcity.
		Yes	Incorporating rainwater recovery systems demonstrates a commitment to sustainable water management. This practice reduces dependence on external water resources, mitigates water scarcity risks, and supports long-term environmental resilience.

Reformulated IDEA Indicators	Criteria	Scale	Description
	Seed production	No	A lack of seed production indicates dependence on external seed suppliers, which may limit adaptability and resilience to local environmental conditions. It also reflects higher operational costs and reduced self-sufficiency.
		Yes	Local seed production enhances self-reliance and supports the conservation of genetic diversity. It enables adaptation to local conditions, reduces costs, and promotes long-term sustainability by fostering agroecological resilience.
B9: Contribution to livelihood	Contribution to livelihood	No	A system with no measurable contribution to livelihood fails to generate sufficient income or support community well-being. This indicates a lack of alignment with socio-economic sustainability goals and may threaten the viability of the farming system.
		Yes	A positive contribution to livelihood highlights the role of agriculture in generating income, supporting local economies, and improving the quality of life for farmers and their communities. This criterion emphasizes socio-economic sustainability by promoting employment and economic stability.

Reformulated IDEA Indicators	Criteria	Scale	Description
B11: Probable farm sustainability	Willingness of the next generation to continue traditional farming	Definitely not willing	The next generation expresses no interest or intention to engage in traditional farming. This suggests significant disconnection from agriculture, often driven by urban migration, unfavorable economic conditions, or lack of appeal in the farming profession.
		Unlikely to continue	Limited interest in farming is present, with significant obstacles such as economic constraints, unfavorable working conditions, or external opportunities that discourage engagement. This indicates a weak succession plan.
		Unsure but open	Mixed feelings exist within the next generation. They may be open to continuing but are hesitant due to uncertain economic viability, external opportunities, or lack of experience. This reflects a critical juncture where interventions like mentorship or support could sway decisions positively.
B11: Probable farm sustainability		Likely to continue	Positive inclination toward continuing traditional farming exists, though the decision is not absolute. The next generation may consider pursuing farming if specific conditions, such as training, infrastructure, or economic incentives, are met.

Reformulated IDEA Indicators	Criteria	Scale	Description
		Committed to continuing	The next generation demonstrates a strong intent and is actively planning to take up farming. This reflects not only a willingness but also an active investment in skills, knowledge, or resources needed to sustain traditional farming practices. It suggests a solid pathway for continuity and long-term sustainability.
	Existence of a knowledge transfer system within the community	No	The absence of knowledge transfer systems signifies a gap in the dissemination of traditional farming practices and techniques. This could result in a loss of valuable expertise and hinder the farm's sustainability, as newer generations may lack the skills or understanding to manage farming operations effectively.
		Yes	The presence of a knowledge transfer system ensures the intergenerational transmission of skills, experience, and local agricultural practices. This enhances sustainability by preserving traditional methods, improving efficiency, and fostering community engagement in agriculture.
B11: Probable farm sustainability	Belief that the farm will exist over the next 10 years	Extremely likely	There is no confidence in the farm's future due to significant challenges such as economic pressures, resource depletion, or lack of succession planning. This perception signals a high risk to long-term sustainability and viability.

Reformulated IDEA Indicators	Criteria	Scale	Description
		Unlikely	Confidence in the farm's continuity is low, indicating concerns about profitability, resource availability, or external uncertainties that threaten sustainability efforts.
		Not sure	Farmers are uncertain about the farm's future, reflecting a mix of optimism and doubt. This indicates moderate resilience but highlights the need for improved resource management, economic stability, and long-term planning.
		Likely	There is strong confidence in the farm's resilience and its ability to continue over the next decade. This reflects effective management, adaptability, and economic viability.
B11: Probable farm sustainability	Belief that the farm will exist over the next 10 years	Extremely unlikely	The farm's future is seen as secure and sustainable, supported by robust planning, profitability, resource management, and strong intergenerational continuity.

Reformulated IDEA Indicators	Criteria	Scale	Description
B15: Labour intensity	Farmers found their job tiring most of the time	Always	Farmers consistently find their work physically or mentally exhausting, indicating high labor intensity. This suggests a lack of mechanization, excessive workload, or challenging working conditions, which may affect productivity, health, and overall quality of life.
		Occasionally	Farmers experience tiring work sporadically, often during peak periods such as planting or harvest seasons. This reflects a moderate level of labor intensity, with some relief provided by mechanization, hired labor, or other support systems.
		Never	Farmers rarely or never feel that their work is overly tiring, reflecting a well-balanced workload. This is often indicative of efficient resource allocation, adequate mechanization, and effective labor management practices.
	The community works together to help each other in farm work	Always	Community members consistently support one another in farm work, indicating strong social cohesion and collective resilience. This collaboration often results in improved efficiency, shared resources, and enhanced socio-economic sustainability.
		Occasionally	Occasional collaboration within the community reflects moderate levels of social interaction and support. While not constant, this assistance still provides benefits during critical periods, such as harvesting or emergencies.

Reformulated IDEA Indicators	Criteria	Scale	Description
		Never	Lack of community collaboration suggests a more isolated approach to farming, which may lead to increased labor demands on individual farmers and reduced access to shared knowledge, resources, or support networks.
B16: Quality of life	Provision of basic amenities (water supply, electricity, roads, telecommunnication infrastructure)	No provision	Basic amenities, such as water, electricity, roads, and telecommunications, are completely absent. This severely impacts the quality of life and operational efficiency of farmers, leading to significant barriers to economic and social sustainability.
		Incomplete	Partial availability of basic amenities indicates some improvement in living conditions, though gaps remain. Challenges like inconsistent access to clean water, unreliable electricity, or inadequate roads can still hinder productivity and quality of life.
		Complete	Full provision of basic amenities ensures a high quality of life, supporting the socio-economic well-being of farmers. This level of infrastructure promotes productivity, connectivity to markets, and access to essential services, enabling long-term sustainability.

Reformulated IDEA Indicators	Criteria	Scale	Description
	The state of means of transport (bicycle, motorbike, car)	No means of own transport	The individual or household has no access to personal transportation (bicycle, motorbike, or car). This lack of mobility creates significant barriers to accessing markets, healthcare, education, and other essential services, increasing dependency on external support.
		Poor	Ownership of transport exists, but it is either minimally usable or non-functional due to frequent breakdowns or lack of maintenance. This limits mobility and reduces reliability in critical times.
		Fair	Transport is available but comes with significant limitations, such as frequent repairs or reliability issues. This level provides basic mobility but remains inefficient and costly over time.
		Good	Transportation is reliable and functional but may not be optimal for long-term use or demanding conditions. The mobility provided is sufficient for essential activities, though room for improvement exists.
		Very good	Reliable, functional, and generally in good condition with only minor flaws. The system supports regular mobility without significant inconvenience or cost.
		Excellent	Fully functional, reliable, and in optimal condition. Transport enables seamless access to essential services, enhancing connectivity and operational efficiency.

Reformulated IDEA Indicators	Criteria	Scale	Description
B17: Isolation	Geographic Isolation	Most isolated	Residing in a remote area with very limited access to transportation, infrastructure, or essential services. This isolation hinders connectivity, market access, and opportunities for social and economic engagement.
		Fairly isolated	Living in a somewhat remote area where access to transportation and services exists but remains limited or inconsistent. Noticeable challenges in mobility and access persist, affecting economic and social opportunities.
		Least isolated	Living in a well-connected area with easy access to transportation, infrastructure, and services. This minimizes the impact of geographic isolation, enabling efficient engagement with markets and communities.
	Social Isolation	Most isolated	Rare or no interactions with friends, family, or the community, resulting in a feeling of complete disconnection. This can impact mental well-being and reduce opportunities for mutual support or collaboration.
		Fairly isolated	Occasional social interactions occur, but they are limited in frequency or depth. A sense of partial disconnection from social circles persists, though not entirely isolating.
		Least isolated	Frequent and meaningful interactions with friends, family, and the community foster a strong sense of connection and social engagement. This reduces social

Reformulated IDEA Indicators	Criteria	Scale	Description
			isolation and enhances mental and emotional well-being.
	Cultural Isolation	Most isolated	Little to no exposure to or engagement with cultural traditions or community practices. This isolation leads to a loss of cultural identity and a sense of detachment from the community's values and heritage.
		Fairly isolated	Limited engagement with cultural traditions, which may occur infrequently or superficially. While some connection exists, it is not deeply rooted or regularly maintained.
		Least isolated	Strong and frequent engagement with cultural traditions and community practices. This fosters a deep sense of belonging and connection to the community's heritage and values.
C1: Economic viability	Farmer's perception on the sufficiency of their income	Extremely insufficient	Income is far below what is required to cover basic needs such as food, shelter, and clothing. Farmers experience constant financial hardship, often relying heavily on external aid or informal support networks to survive.
		Insufficient	Income occasionally covers basic needs but often falls short, requiring farmers to seek additional support or make significant sacrifices. This reflects a precarious financial situation where minor disruptions can lead to crises.
		Moderately sufficient	Income consistently meets basic needs but leaves little to no margin for savings, investment, or unexpected expenses. Farmers remain financially stable but vulnerable to external shocks or economic changes.

Reformulated IDEA Indicators	Criteria	Scale	Description
		Sufficient	Income comfortably meets basic needs and allows for some level of savings or investment. This reflects a stable financial situation with potential for growth and resilience against unforeseen challenges.
C4: Sensitivity to subsidies	Independence from government aid	Completely dependent	Farmers rely entirely on government aid for their financial survival, covering most or all expenses. Without this support, they would be unable to sustain their livelihood, reflecting extreme economic vulnerability.
		Largely dependent	Farmers depend on government aid for a significant portion of their income, but they are able to manage some expenses independently. This indicates partial self-reliance but ongoing reliance on external financial support.
		Occasionally dependent	Farmers use government aid only occasionally, typically for specific needs such as emergencies, seasonal challenges, or infrastructure investments. This suggests moderate financial independence with occasional external assistance.
		Independent	Farmers do not rely on government aid for financial support, though they may access non-financial government resources, such as training or advisory services. This indicates strong economic independence and the capacity to manage financial challenges without external aid.

This document was developed based on the principles and methodologies outlined in Méthode IDEA: Indicateurs de durabilité des exploitations agricoles by Vilain et al. (2008).