Agrobiodiversity management by the Dayak tribe in Labian and Labian Irang villages in Indonesia

A case study of producer organisations in West Kalimantan

riak bumi

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Cover photos: illipe nuts drying in the processing facility of Forestwise (top); traditional productive system of one producer in Labian village (bottom left); river view from Labian Ira'ang village (bottom centre); illipe nut trees in Labian village (bottom right). Credit: Isabela Nunez del Prado/IIED

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Abbreviations

NTFP	Non-timber forest product
NTFP-EP	Non-Timber Forest Products — Exchange Programme
GAPOKTAN	Farmers Group Association (*Gabungan Kelompok Tani*)
BUMDes	Village-owned enterprises (*badan usaha milik desa*)

Summary

As part of the Nature Nurture project, Non-Timber Forest Products — Exchange Programme (NTFP-EP) in partnership with Riak Bumi Foundation conducted research in Labian and Labian Ira'ang villages in Batang Lupar district, Kapuas Hulu Regency, West Kalimantan in Indonesia. The aim was to document local knowledge and its implementation in agrobiodiversity conservation, climate mitigation and prevention of biodiversity loss. The research consisted of interviews with 20 farmers (ten women and ten men) to assess the agrobiodiversity grown in these villages and the strategies used by the farmers to maintain it.

The Dayak peoples have extensive traditional knowledge about the management and use of local biodiversity, practicing holistic and regenerative farming that emphasises harmony with nature and the preservation of biodiversity. Knowledge is inherited orally over generations and forms an essential part of their cultural identity and health security. Both women and men farmers grow a variety of cash and subsistence crops, as well as managing livestock and fishing. In addition, they also harvest non-timber forest products (NTFPs) such as wild fruits and medicinal plants under customary management and community-forest arrangements, helping buffer against crop failures caused by floods or other challenges, and providing economic resilience.

This case study also shows the critical role of forest and farm producer organisations (FFPOs) in building local resilience by sustaining agrobiodiversity, fostering sustainable enterprises, and enabling access to financial resources. These FFPOs promote biodiversity-friendly income generation while strengthening cultural identity and local autonomy. They play an important role in promoting crop production, sharing knowledge and adapting to local environmental conditions. These FFPOs act as vital knowledge hubs, enterprise incubators and vehicles for local resilience and provide a platform for farmers — especially women — to share practices on seed saving, pest management and ecosystem-friendly farming. The FFPOs have enabled the diversification of livelihoods through value-added activities such as illipe nut processing, rubber nursery development, and agroforestry-based cultivation of kratom and illipe nut trees.

Establishing long-term contracts with buyers such as Forestwise demonstrates how external financial partnerships can align with biodiversity conservation and income stability. Meanwhile, partnerships with universities and networks such as the Kalimantan Tengkawang Network help integrate modern insights and improve production outcomes. Knowledge exchange occurs through generational transmission and cultural rituals as well as through community collaboration, peer-to-peer learning and other FFPO activities. Access to finance includes internal mechanisms such as social loan systems and collective savings to help FFPOs finance agricultural inputs, emergencies and business enterprises.

However, capacity-building in financial literacy and group governance remains an essential need. The maintenance of local agrobiodiversity requires FFPOs to focus on sustainable environmental management by utilising local potential. External programmes such as the Forest and Farm Facility (FFF) can be strategic partners by providing mentoring, facilitation and capacity-building support. This collaboration will allow local and external efforts to synergise in conserving biodiversity effectively and sustainably. Other recommendations include:

- **Local marketing facilities:** the government should provide farmers with special storage for agricultural produce and products so that they can be marketed at the village level.
- **Funding support:** funding support is needed through village funds or others allocated to provide production facilities and to enable farmers to market agricultural products outside of the villages at district markets.
- **Licencing and packaging assistance:** support is needed from the government or other stakeholders to license the marketing of agricultural products and NTFPs, and to ensure that product packaging is attractive to buyers.
- **Product-processing training:** there needs to be training in processing local agricultural products. This is necessary to ensure the products can last longer and have better selling value. The process is important to provide motivation to maintain natural biodiversity.
- **Business management:** business management capacity needs to be improved using methods that are easily understood by farmers.

1. Introduction

As part of the Nature Nurture project, NTFP-EP conducted research in two villages in Batang Lupar district, Kapuas Hulu Regency, West Kalimantan in Indonesia. The aim was to document local knowledge and its implementation in agrobiodiversity conservation, climate mitigation and prevention of biodiversity loss. The research consisted of interviews with 20 farmers (ten women and ten men) to assess the agrobiodiversity grown in these villages and the strategies used by the farmers to maintain it.

The two study sites — Labian village and Labian Ira'ang village — are located upstream of the Labian river and the Labian–Leboyan watershed.[1] The river and watershed are important to local people in terms of fishing activities and as a route for river transportation. The river watershed connects two national parks: Lake Sentarum National Park downstream and Betung Kerihun National Park upstream. It also serves as a crossing corridor for wildlife, including Bornean orangutans (*Pongo pygmaeus*).

The land use and land cover in this watershed consists of 65.79% relatively intact forest, 14.75% degraded forest, 14.47% traditional agriculture (fields, former fields, gardens), and 4.99% wetlands. There are three main Indigenous groups: the Iban Dayak tribe at the upper reaches of the river, the Embaloh Dayak tribe in the middle, and the Malay Dayak at the lower reaches. The livelihoods of the Iban and Embaloh are generally cash-crop and subsistence farming, rubber farming, fishing and collecting non-timber forest products (NTFPs) including honey, while the Malays are aquaculture fishers, as well as rubber farmers and forest-honey farmers.

Labian village has three sub-villages: Ngaung Keruh, Ukit-Ukit and Tumbali. The population is approximately 645 people (317 men and 328 women). There are 194 family heads (84 in Ukit-Ukit, 56 in Tumbali, and 54 in Ngaung Keruh). The majority of the people belong to the Embaloh Dayak tribe with dominance in Ukit-Ukit and Tumbali. Ngaung Keruh lies in a customary forest-management area and is mostly dominated by the Iban Dayak tribe. The main livelihood is agriculture, specifically traditional farming, in addition to some other activities such as gardening of vegetables and fruit as well as the harvesting of non-timber products from forests and waters.

Labian Ira'ang village consists of three sub-villages (Bakul, Kereng Lunsa and Sembawang). It has a population of 462 people (247 men and 215 women). The majority of the population belongs to the Embaloh Dayak tribe, primarily residing in Kereng Lunsa and Sembawang. Bakul is predominantly inhabited by the Iban Dayak tribe, many of whom still live in traditional longhouses. The main livelihood of Labian Ira'ang residents is traditional farming, particularly through shifting cultivation, growing vegetables and fruits, as well as harvesting non-timber products from both forests and waters. Tables 1 and 2 list the different forest and farm producer organisations (FFPOs) in Labian village and Labian Ira'ang village.

[1] Labian village is located at coordinates 1°06'27.5" N, 112°17'36.6" E, while Labian Ira'ang village is situated at coordinates 1°07'40.0" N, 112°15'33.8" E. Labian Ira'ang is adjacent to Labian village, and was formed as an expansion of the original Labian village.

Table 1. Forest and farm producer organisations in Labian village

Farmer association name	Est'd	Main objective	Location	No. members	Main activities	Land managed	Land-tenure type
Restorasi Ngaung Keruh Lestari (Sustainable Restoration of Ngaung Keruh)	2013	Sustainable forestry and nature conservation	Ngaung Keruh sub-village, Labian village	50	Cleaning water pipes, patrolling forests and farming	258 ha	Communal
Tengkawang Labian Farmers Group	2021	Sustainable forestry and environmental protection	Ukit-Ukit, Tumbali, and Ngaung Keruh sub-villages, Labian village	30	Planting tengkawang trees (illipe nuts), training related to harvesting and processing illipe nuts, and quality control to improve product quality	50 ha	Private and communal
Dry Rubber Farmers Group	2021	Improving the livelihoods of rubber farmers	Labian village	92	Improving product quality and sales, managing rubber-tree nurseries, providing training on grafting, and establishing coffee nurseries between rubber trees	92 ha	Private land ownership
Sungai Anggali Rice Farmers Group	2006	To realise an independent farming community that promotes environmental sustainability	Ukit-Ukit sub-village, Labian village	25	Planting rice, rubber, kratom and potato yams for sale and personal consumption	50 ha	Private land ownership

Table 2. Forest and farm producer organisations in Labian Ira'ang village

FFPO name	Est'd	Main objective	Group type	No. members	Main activities	Land managed	Land-tenure type
Natural Resources Conservation Efforts (Usaha Pelestarian Sumber Daya Alam — UPSA)	2023	Improving economic welfare while promoting environmental conservation	Cooperative	27	Preserving forest vegetation and continuing intercropping practices (particularly with chives and red ginger), maintaining intercrops, and planting petai, jengkol, durian, tengkawan	10 ha	Private land ownership
Farmers Group Association (Gabungan Kelompok Tani — GAPOKTAN)	2008	Advancing farming practices to create prosperous and sustainable farming communities	Farmer association	69	Agricultural extension, planting, pest control, fertilisation, marketing, and the sustainable use of tengkawang to improve community welfare	69 ha	Private land ownership
Forest and Land Rehabilitation (Rehabilitasi Hutan dan Lahan — RHL)	2023	Creating a positive impact by rehabilitating forests and land to support community preservation efforts	Cooperative	38	Planting, fertilisation, replanting and weeding, specifically managing the production of jengkol, petai and durian for both commercial sale and household consumption	130 ha	Communal

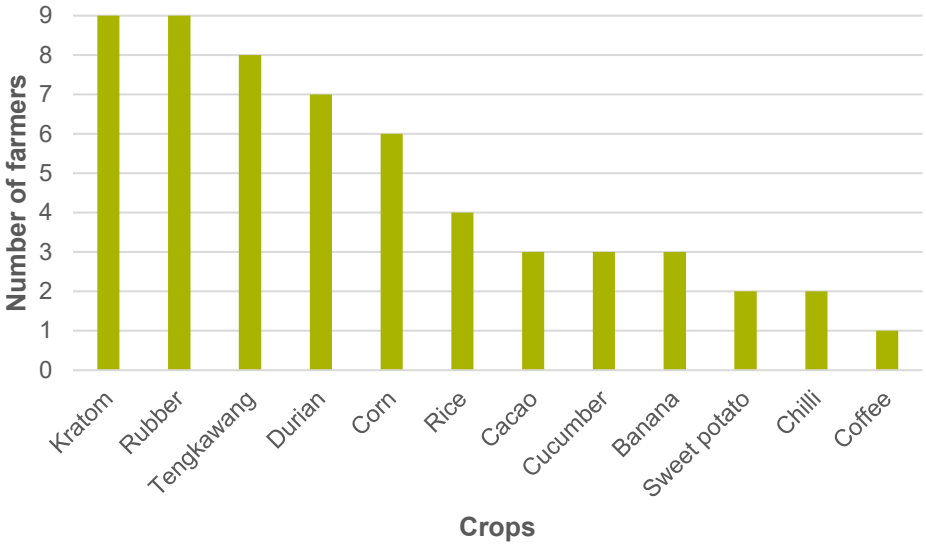
2. Agrobiodiversity in the landscape

The two study sites, Labian and Labian Ira'ang villages, are in Batang Lupar, a district that was planned as a cocoa, coffee and rubber intervention area by the government. In the area planned for cocoa, the reality on the ground is that there are not many cocoa farmers to be found, as most farm food crops or fish in Lake Sentarum. The men in this area can leave the house for days when they go fishing, sometimes being absent for up to a week before returning home. However, when the farming season arrives, the men prioritise farming as they must prepare the land to plant food crops. Marketing products in this area is mainly done by women, which is reflected in the perceptions of men and women surveyed. Agricultural products that are marketed are mostly food crops and horticultural commodities.

2.1 Cash crops grown by men

Commercial cash crops most commonly grown by the ten men farmers surveyed for this research include kratom, rubber, rice, cacao, tengkawang, durian, cucumber, bananas and corn. A few also grow a diversity of additional crops, such as sweet potato and chilli (see Figure 1). Table 3 reveals how diverse the area is in commercial cash crop production.

Figure 1. Main cash crops grown by the ten men farmers surveyed



From the realities encountered in the field, in the agricultural sector there seems to be a general pattern across the regions where women tend to be the main food producers as found in the cacao intervention areas where most crops managed are food crops for sale and subsistence. Meanwhile, men do most of the farming activities for cash crops, including the use of tools and other farm machinery, although not without women's (often unpaid) contributions, although women's participation in commercial farming is less labour intensive. Men are the main decision-makers regarding crop selection, fertiliser use and marketing, which is evident in both cocoa and coffee intervention areas, even though most men from these areas often work outside the farming/plantation sector. Even so, men still retain power in public affairs at the community level. Gender-specific cultural and institutional barriers affect women smallholders, including in the cocoa and rubber commodity sectors, which appear to be 'masculine commodities', as most roles in the farming stages are dominated by men.

Table 3. Cash crops grown by the ten men farmers surveyed

Main cash crops	Vegetables	Fruits	Seasonal cash crops
Kratom, rubber, rice, gaharu, rattan, corn, coffee, cocoa	Sweet potato, lemongrass, turmeric, long beans, ginger, cucumber, mustard greens, chilli, spinach, eggplant, pumpkin, sparrow eggplant, green eggplant, cassava, taro, chives, young bamboo	Banana, durian, keranji, cat's eye (engkuis fruit), langsat, rambutan, jackfruit, mango, cempedak, tekalong/terap fruit, asam pelam, asam pauk, dabai fruit, papaya, pineapple, dogfruit (jengkol), petai	Tengkawang, red rice, edible swallowtail bird's nests[2]

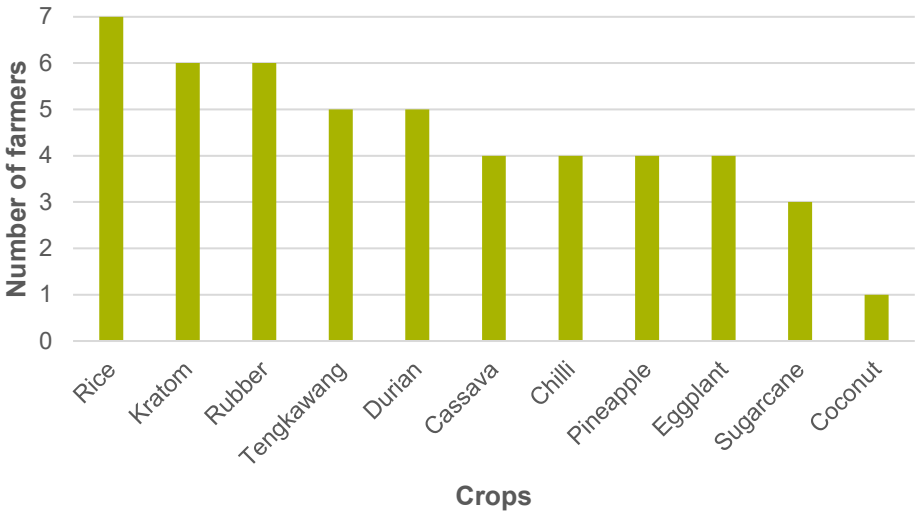
2.2 Commercial livestock

The commercial livestock sector in Labian and Labian Ira'ang is dominated by chickens, cattle and pigs, which the communities raise to sell. Pig and chickens are also slaughtered for household consumption because of their smaller size. In addition, the community also conducts fish farming and fishes in Lake Sentarum. Species include tilapia, catfish, prawns, seluang fish, snakehead fish and tengkuyung (*Sulcospira testudinaria*).

2.3 Cash crops grown by women

Women are more responsible for household affairs and land maintenance adjacent to residential areas, while men have greater responsibilities as the main income earners and in the public sphere. Men are solely responsible for maintaining land that is away from the housing complex and associated with heavy labour. In terms of land issues, the main problem faced by women is that they remain as unrecognised landholders. Women's roles in land management and farming systems are minor compared to men's roles in villages producing oil palm and rubber. Nonetheless, for aspects where activities are not physically demanding, women play a greater role, for example, in planting, maintenance and post-harvest activities. As for land that is extensively planted with cocoa, where livelihoods are dominated by growing vegetables, food crops and upland rice, women play a significant role in all agricultural activities.

Figure 2. Main cash crops grown by the ten women farmers surveyed



[2] Edible swallowtail bird nests are a highly prized traditional delicacy. Indonesia is the main global producer, accounting for around 80% of global production (IBAI 2021).

Women also earn income from alternative sources. Women in the rubber intervention areas harvest rubber sap from their own plantations, while a small number of them open stalls and sell cooked food. Meanwhile, in the cocoa intervention area, women play an important role in farming food crops both for sale and for household consumption. Women are also involved in raising livestock that can be easily managed, including chicken and farmed-fish species such as tilapia. Table 4 shows the cash crops grown by the ten women farmers surveyed for this case study.

Table 4. Cash crops grown by the ten women farmers surveyed

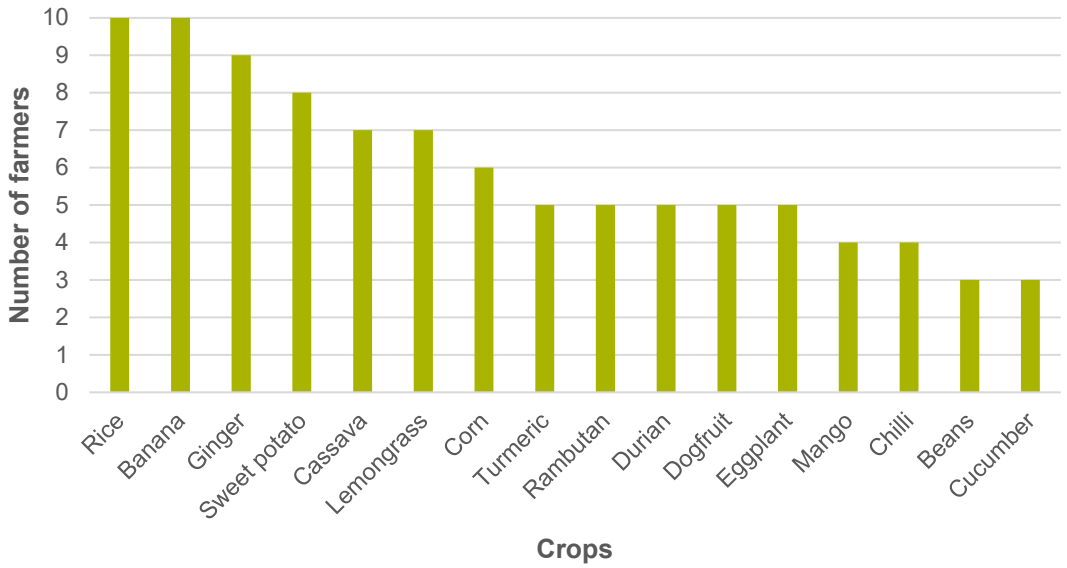
Main cash crops	Vegetables	Fruits	Seasonal cash crops
Rice, kratom, tengkawang, sugarcane, durian, coconut, rubber, pineapple, chilli, cassava	Cucumber, sour eggplant, corn, cassava, potato, yams, turmeric, chives, ginger, mustard greens, spinach, long beans, slime beans, winged beans and lemongrass	Banana, durian, keranji, cat's eye fruit, langsat, rambutan, jackfruit, mango, cempedak, terap fruit, asam pelam, asam pauk, dabai fruit, papaya, pineapple, dogfruit (jengkol), petai	Tengkawang

2.4 Subsistence crops grown by men

Most subsistence crops grown by men are the same crops that are sold at markets, including those which are mostly for household consumption. The main commodity most widely cultivated is field rice in rain-fed rice fields or by using a shifting cultivation system that uses crop rotation and harvest rotation. Rice, apart from being a commercial commodity, is also used grown as a staple food for household consumption. Many of the subsistence crops are also cultivated by women farmers, as this is the role of women in the community. Then men farmers contribute to maintenance and harvesting while planting is done by the women farmers.

Livestock such as cattle and pigs are raised by male farmers, while chickens are raised by female farmers to fulfil their daily household needs. In addition, fishers in Lake Sentarum catch fish for subsistence needs (such as tilapia fish).

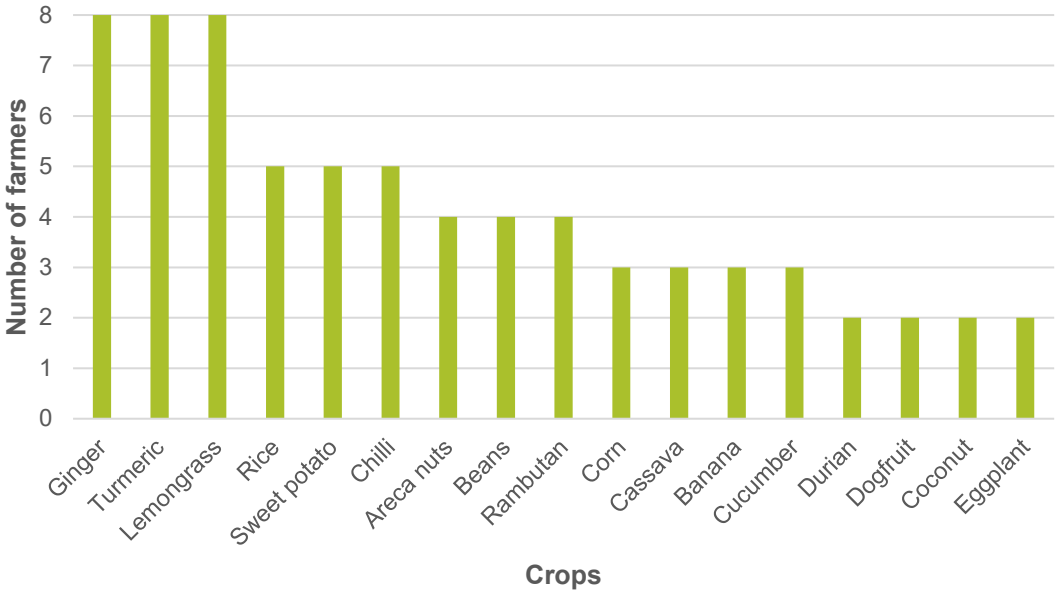
Figure 3. Subsistence crops grown by the ten men farmers surveyed



2.5 Subsistence crops grown by women

Many subsistence crops not grown by men farmers are grown by women. The survey shows that Dayak women farmers have more knowledge about subsistence crops than Dayak men farmers. This is interesting because in Dayak customs, knowledge about plants for food and medicine is passed down from generation to generation by mothers, as the role of women in Dayak customs is to fulfil household consumption needs for food (planting, tending and harvesting crops, cooking) and for traditional medicine.

Figure 4. Subsistence crops grown by the ten women farmers surveyed



2.6 Wild products harvested by men

Many men farmers engage in the seasonal collection of NTFPs to supplement incomes, especially when farming yields are low. Harvesting is deeply tied to cultural traditions, including rituals and customary forest-management systems. Fewer plant species are collected from the wild by men than by women. However, a number of plants are known to be harvested by men from the wild, including plants used as herbs, food and timber. Key wild products include:

- Illipe nuts (from the tengkawang tree), which are culturally significant and economically valuable for the Iban communities. Despite price fluctuations, illipe nuts have become an important alternative income source due to increasing demand and prices.
- Forest honey, collected from wild bee colonies, provides both income and nutritional benefits. Honey harvesting is practiced in nearby villages and is part of livelihood diversification.
- Woven crafts from NTFPs, including various species of rattan (such as *Calamus trachycoleus*) and bamboo (such as *Dendrocalamus asper*). These plants are harvested and processed into 18 types of woven products, which are sold to generate income.

Other NTFPs such as wild fruits and medicinal plants are also gathered to support household needs and income. These wild products are harvested sustainably under customary management and community-forest arrangements, helping buffer against crop failures caused by floods or other challenges, and providing economic resilience for men farmers in Labian and Labian Ira'ang village. Table 5 shows 24 wild products harvested by the ten men farmers surveyed for this case study.

Table 5. Uses of wild products harvested by the ten men farmers surveyed

Botanical name	Common/Local name	Food	Medicine	Timber/ Construction
Baccaurea macrocarpa	Tampoi		x	x
Calamus trachycoleus	Rattan			x
Dendrocalamus asper	Bamboo	x		
Dialium indum	Asam keranji		x	
Dipterocarpus gracilis	Keladan			x
Dryobalanops oblongifolia	Kelansau			x
Durio zibethinus	Durian	x		
Ganoderma lucidum	Mushroom	x		
Lansium domesticum	Langsat	x	x	
Mangifera laurina	Asam empelam	x	x	
Mangifera pajang	Asam mawang		x	
Mangifera torquenda	Asam kamantan	x	x	
Metroxylon sagu	Sago palm	x		
Morinda citrifolia	Kemedu		x	
Nephelium cuspidatum	Sibau fruit	x		
Nephelium lappaceum	Rambutan	x		
Nephelium maingayi	Mujau fruit	x		
Pycnarrhena cauliflora	Sengkubak	x	x	
Rasbora argyrotaenia	Seluang fish	x		
Rhynchophorus ferrugineus	Sago worm	x		
Shorea leprosula	Meranti			x
Shorea stenoptera	Tengkawang/illipe nut	x	x	x
Sus scrofa	Wild boar	x		
Syzygium polyanthum	Bungkang	x	x	

2.7 Wild products harvested by women

The role of women in harvesting wild products complements the men's activities, making the overall livelihood system more diversified, resilient and sustainable in the face of environmental and economic challenges (see Table 6).

Women play a crucial role in agricultural livelihoods and community resilience: they actively participate in gathering NTFPs as part of their diversified income strategies, especially when farming yields are low. This participation is driven by several factors:

- **Economic empowerment and income diversification:** women harvest wild products to supplement household incomes, helping to buffer against crop failures or low agricultural productivity. Their involvement in collecting and processing forest products contributes significantly to family welfare and local economies.
- **Traditional knowledge and resource management:** women often possess specialised knowledge of local plants and forest resources, enabling them to sustainably harvest wild products such as medicinal plants, fruits, honey and materials for handicrafts. This knowledge supports sustainable use and conservation of forest resources.
- **Community roles and gender dynamics:** in many Southeast Asian rural communities, including in Labian and Labian Ira'ang, women's roles extend beyond farming to include food gathering, processing and small-scale trade. Programmes supporting women's empowerment

in agriculture have shown that when women have access to resources and training, they enhance productivity and resilience, reshaping agricultural landscapes and livelihoods.

- **Social and cultural factors:** harvesting wild products is often integrated into women's daily activities and social networks, providing them with economic independence and strengthening community cohesion.

Table 6. Uses of wild products harvested by the ten women farmers surveyed

Botanical name	Common/Local name	Food	Medicine	Timber/ Construction
Baccaurea motleyana	Rambai	x		
Calamus trachycoleus	Rattan			x
Clarias Batrachus	Catfish	x		
Dendrocalamus asper	Bamboo	x		
Dialium indum	Asam keranji		x	
Durio zibethinus	Durian	x		
Ganoderma lucidum	Mushroom	x		
Garcinia xanthochymus	Kandis	x		
Lansium domesticum	Langsat	x	x	
Macrobrachium rosenbergii	Shrimp	x		
Mangifera pajang	Asam mawang		x	
Mangifera torquenda	Asam kamantan	x	x	
Metroxylon sagu	Sago palm	x		
Morinda citrifolia	Kemedu		x	
Nephelium cuspidatum	Sibau fruit	x		
Nephelium lappaceum	Rambutan	x		
Nephelium maingayi	Mujau fruit	x		
Oreochromis niloticus	Tilapia fish	x		
Pycnarrhena cauliflora	Sengkubak	x	x	
Rasbora argyrotaenia	Seluang fish	x		
Rhynchophorus ferrugineus	Sago worm	x		
Shorea stenoptera	Tengkawang	x	x	x
Stenochlaena palustris	Fern	x		
Sulcospira testudinaria	Tekuyung (snails)	x		
Syzygium polyanthum	Bungkang	x	x	
Tamarindus indica	Tamarind		x	

2.8 Crop varieties

Dayak farmers actively conserve a wide array of traditional crop varieties that support both household subsistence and market-based income (see Table 7). These varieties are selectively maintained in cultivated fields and forested zones. Other modern plant varieties that the Dayak grow and use include watermelon, apple, orange, snake fruit, grapes, and vegetables such as carrots, cabbage, tempeh tofu, green beans, potatoes, onions and others. There are also some fruits that cannot be propagated in the village. Some tree species are integrated into farming systems and are intentionally preserved during land-clearing processes.

Table 7. Uses of commercial and subsistence plants grown by the Dayak community

Botanical name	Common/ Local name	Food	Cosmetics	Ornamental/ Fibre	Medicine	Timber/ Construction
Mitragyna speciosa	Kratom				x	
Hevea brasiliensis	Rubber					x
Oryza rufipogon	Red rice	x				
Oryza sativa	Rice	x				
Aquilaria malaccensis	Gaharu		x			x
Calamus trachycoleus	Rattan					x
Zea mays	Corn	x				
Coffea canephora	Coffee	x				
Theobroma cacao	Cocoa	x	x			
Solanum tuberosum	Sweet potato	x				
Cymbopogon flexuosus	Lemongrass	x				
Curcuma longa	Turmeric	x				
Vigna unguiculata	Long Beans	x				
Zingiber officinale	Ginger	x			x	
Cucumis sativus	Cucumber	x				
Brassica juncea	Mustard	x				
Artocarpus integer	Cempedak	x				
Nephelium lappaceum	Rambutan	x				
Shorea stenoptera	Tengkawang	x	x		x	x
Ananas comosus	Pineapple	x				
Durio zibethinus	Durian	x				
Dendrocalamus asper	Bamboo	x				x
Manihot esculenta	Cassava	x				
Stenochlaena palustris	Fern	x				
Curcuma xanthorrhiza	Temulawak	x			x	
Dipterocarpus gracilis	Keladan					x
Gluta renghas	Rengas					x
Eusideroxylon zwageri	Ulin					x
Hopea sangal	Tekam					x
Metroxylon sagu	Sago	x				

Rhynchophorus ferrugineus	Sago worm	x				
Carica papaya	Papaya	x				
Shorea leprosula	Meranti					x
Lansium domesticum	Langsat	x				
Parkia speciosa	Petai	x				
Archidendron pauciflorum	Dogfruit (jengkol)	x				
Musa paradisiaca	Banana	x				
Gallus domesticus	Chicken	x				
Canarium odontophyllum	Dabai	x			x	
Mangifera indica	Mango	x				
Capsicum pubescens	Chili	x				
Ipomoea batatas	Yam	x				
Solanum melongena.	Eggplant	x				
Cocos nucifera	Coconut	x				
Alpinia galanga	Galangal	x				
Saccharum officinarum	Sugar cane	x				
Psidium guajava	Guava	x				
Averrhoa bilimbi	Belimbing	x				
Alocasia macrorrhiza	Beranang	x				
Allium sativum	Chives	x			x	
Sus scrofa	Pigs	x				
Sauropus androgynus	Katuk leaves	x				
Cassia alata	Serugan	x			x	
Cucurbita moschata	Perenggi	x			x	
Luffa acutangula	Gambas	x				
Areca catechu	Areca nuts	x				
Amaranthus caudatus	Spinach	x				
Durio Kutejensis	Empakan	x				
Clitoria ternatea	Butterfly pea	x			x	
Marsdenia tinctoria	Rengat			x		
Brassica oleracea	Kale	x				
Aloe vera	Aloe vera	x		x		
Kalanchoe pinnata	Cocor bebek	x		x		
Orthosiphon aristatus	Kumis kucing	x		x		
Euphorbia tirucalli	Patah rodan	x		x		
Premna serratifolia	Bebuas	x		x		
Vatica rassak	Resak					x

3. Knowledge sources for crop and livestock cultivation and management

3.1 Biocultural heritage

The interviews showed that biodiversity is maintained because the varieties of crops planted by farmers are based on certain preferences. This is further explained in the following subsections. Plants used to fulfil nutritional needs include cassava, sweet potatoes, banana, petai, jengkol, rambutan, cempedak, mango, durian, langsat, jackfruit, terap, kepayang, cassava, papaya, bamboo shoots, fern, pineapple, graft, cucumber, simpur (fruit and flower), umbut, meludang, coconut, taro, betel nut, sugar cane, sago fruit, maram fruit, kandis, betel leaves (for offerings), gambir, enau, chives, turmeric, ginger, galangal, cekur, lemongrass, bay leaves, tubok leaves and sabong leaves. Livestock reared for nutritional needs include pigs, fish, chickens (including chicken eggs), sago worms, tilapia fish and pomfret fish.

Local biodiversity is also important culturally to the Dayak peoples. In agricultural areas, glutinous rice is often used to produce palm wine as an offering and can also be cooked in bamboo as part of the tradition. Rattan, banana leaves, betel leaves, areca nuts, gambir leaves (*Uncaria gambir*), kratom leaves *(Mitragyna speciosa*) and aren leaves (*Arenga pinnata*) are used as customary offering materials. In terms of livestock, pigs, chickens and fish (such as seluang) and freshwater snails (such as tengkuyung) are used in different ceremonies. Natural ingredients are also used to produce betel lime, which is required for offerings. Meanwhile, other plants such as temulawak and sugarcane are used in death ceremonies in addition to sawang leaves, isang leaves (*Syzygium polyanthum*) and potato yams considered to have special meanings in traditional rituals for the deceased. Illipe nuts from the tengkawang tree also hold cultural importance for the Dayak and are used in traditional crafts, dyes and rituals, reinforcing community motivation to conserve these trees and their habitats. Customary Dayak rules protect nuts that are germinating, which also aids regrowth.

Sustaining Dayak traditions and their biocultural heritage can be achieved through stories told to children. Information on the characteristics of local foods also needs to be introduced in order to regulate the harvest and utilisation of rare commodities. An example is the usage and introduction of natural spices from the forest such as tubok leaves. The Dayak people have extensive traditional knowledge about forest plants, including leaves like tubok, which they use not only to flavour food but also as traditional remedies. These leaves are often processed by boiling or crushing and are incorporated into cooking or consumed as herbal remedies to treat ailments such as fevers, headaches and other common illnesses. This practice reflects the Dayak's deep understanding of their forest environment and their sustainable use of biodiversity for both culinary and medicinal purposes. The knowledge about the use of tubok leaves and other forest spices is inherited orally over generations and forms an essential part of their cultural identity and health security.

3.2 Generational knowledge transfer in households

Most knowledge related to plant and animal cultivation and management in households is inherited from parents, specifically in families that depend on the fields for their livelihoods. Moreover, the knowledge is generally passed down through the generations through stories and experiences shared. There have also been changes in the sources over time as observed in the efforts to strengthen and expand knowledge through formal education and access to information, in addition to the maintenance and preservation of traditional practices.

Over time, there have been several changes in planting methods. One significant change is the use of chemical fertilisers, which began due to declining soil fertility and unpredictable weather conditions. The use of chemical fertilisers has become more common as farmers devise efficient and reliable ways to support plant growth.

3.3 Knowledge transfer between neighbours

In addition to knowledge passed down through generations, farmers also acquire information from external sources, such as institutions, agricultural services or neighbouring farmers from outside the

area. This knowledge includes improved planting techniques, proper spacing, plant care methods, and more effective fertilisation strategies, all contributing to better crop yields and quality.

Knowledge of crop management has been widely obtained through training or government programmes. However, it is considered insufficient by certain FFPOs, specifically for certain types of crops. For example, there is training in crop cultivation but without providing suitable equipment or facilities considering the local conditions. In addition, the trainings often recommend practices that fail to take into account local conditions and are therefore unsuitable. For example, as reported by the FFPOs in relation to rice cultivation, the available irrigation system is often ineffective because the water channels do not match the conditions of the land, as water is expected to flow from the top of the rice field rather than the bottom. Managing the different conditions of rice fields in different places must be adjusted to ensure suitable treatments.

3.4 Organisational knowledge networks

Knowledge obtained from external parties has significantly improved the insights of farmers in terms of nutrition and the cultivation and management of plants and livestock over time. This has been achieved through training conducted by the government, institutions and agricultural extension workers to provide relevant information on the types of seeds considered suitable for local soil conditions and the management process. Moreover, mass media such as television and radio are important sources of information for the people in the two villages. The knowledge obtained has led to the adjustment of planting patterns to land conditions and seasons to ensure an effective and efficient cultivation process.

In addition, specifically for illipe nuts (tengkawang), the West Kalimantan region has a tengkawang network, which includes farmers, community-based organisations (CSOs), government, private-sector actors and academics. The Kalimantan Tengkawang Network is a multistakeholder network concerned with the development of tengkawang, especially the processing of tengkawang into more valuable alternatives to improve community incomes and environmental protection. The network is a medium for sharing experiences and working together to achieve the goals of tengkawang conservation, farmer empowerment and market access. The roles of the network are to:

- Encourage recognition of the Kalimantan Tengkawang Network and policy support tied to the development and conservation of Kalimantan Tengkawang NTFPs
- Investigate the potential of tengkawang in Kalimantan and make the necessary preparations for the annual tengkawang harvest
- Conduct studies and undertake efforts to increase tengkawang production, to provide positive social, economic and environmental impacts for the community
- Promote tengkawang products and tengkawang development (product development, quality standardisation, marketing)
- Make a joint action plan and regularly report on the progress of activities from each member region
- Share information and knowledge related to tengkawang development, and
- Encourage geographical indication for tengkawang.

Figure 5. Tengkawang Network annual meeting

Credit: Kalimantan Tengkawang Network

Figure 6. Illipe nut oil extraction training

Credit: Kalimantan Tengkawang Network

Figure 7. Social forestry facilitation

Credit: Riak Bumi Foundation

4. Sources of seeds and livestock

Local seeds have better resistance to pests and diseases than crossbred or introduced seeds. Therefore, agricultural practices are based on using local seeds, specifically in terms of rice cultivation. The selection of the best seeds is a key step in ensuring a successful harvest, leading to the recommendation of high-quality seeds to ensure products are maximised and resistant to pests or adverse environmental conditions. Based on local wisdom, ancestors taught that part of the harvest from rice should be provided for wild animals or pests. This philosophy reflects an attitude of sharing with nature, maintaining the balance of the ecosystem, and respecting other creatures that depend on produce from the fields. There is also the need to maintain the balance of the natural environment by avoiding the use of poisons that damage the ecosystem. In the fields, different types of plants should be planted to meet the needs of the harvest while controlling pests naturally. An example is the cultivation of other types of productive plants capable of repelling pests in addition to rice. Potato yams can become food for caterpillars to avoid pest attacks on rice. Moreover, local knowledge prevents the felling of trees that would harm the sustainability of the forests.

4.1 Self-provisioning or multiplication of seeds

4.1.1 Rice

There are more than ten types of local rice grown by individual households, including rice bali, ase uwe, barok, manjin, bungkang, dolok, paya' nyamok, tasik, mogret, bario, salon, seluang, salima, siam, rabek, selab, kemujuk and pulut. Each household retains two to six *koelaks* of rice seeds depending on the size of the field (1 *koelak* = 10 *canting* = 2 kg). One person often stores four to five types of seeds. It is also observed that rice seeds can only be stored for one year, leading to the need for continuous rejuvenation. For example, seeds suitable for farming in lower lands are prepared and planted for a specific year and then the reserved seed is subsequently exchanged with friends who will be farming the same type of land the following year.

4.1.2 Illipe nuts (tengkawang)

Tengkawang is a plant native to Borneo, Indonesia. Oil is extracted from the tengkawang tree nuts (illipe nuts), which are a valuable non-timber forest product (NTFP). Dayak communities traditionally use illipe nuts to produce "green butter", a product similar to shea or cocoa butter. It is used in cooking and traditional medicine, and has the potential to be used instead of cocoa butter in commercial cosmetics. The types of tengkawang available include tumpeng, cerindak, majao, and biasa. Planting is often conducted by selecting the best seedlings during the harvest season. Tengkawang trees can also grow independently on the banks of small rivers or planted on private land.

However, the species is at risk, due to factors such as climate change and deforestation (Slow Food Foundation for Biodiversity). Local tengkawang seedlings are available from the group nursery, but the number of available trees is fewer than 1,000. In addition, although each group member's household has approximately 100 seedlings, not all are planted due to members' concerns about the fluctuating market price of illipe nuts. The risk to tengkawang trees has been exacerbated by the indiscriminate felling of trees, which are then replaced by palm oil because of its much higher selling value. However, the village is expected to stop felling the trees because prices are improving and farmers are being encouraged to plant and maintain the trees by the Tengkawang Labian Farmers Group and the Kalimantan Tengkawang Network. The government needs to continue supporting the effort by setting a selling price or encouraging markets for tengkawang products to avoid extinction.

4.1.3 Rubber

Each family has an average of 500–600 rubber trees within an approximate area of 1 hectare. Rubber seedlings are obtained from a superior rubber seedling nursery owned by the rubber FFPO. The nursery and plantation-management training have been facilitated by the village government. The price of rubber was low in the 2000s which led to the felling of several trees and the land was cleared to be used as fields for crops. Most current rubber trees are the result of new plantings and efforts are currently being made to plant more due to the increase in the price of rubber.

4.1.4 Purik leaves (kratom)

Purik leaves are the leaves of the native kratom plant that grows in West Kalimantan. Purik leaves can be brewed or steeped to make a tea and have long been used as a traditional medicine, especially by local communities in Indonesia (Budiarti et al. 2025). Kratom grows effectively in Ukit-Ukit and Tumbali sub-villages and each household has approximately 100 trees, leading to a total of more than 5,000 trees. Kratom seedlings are obtained from a nursery run by a kratom FFPO. The Farmers Group Association (*Gabungan Kelompok Tani* or GAPOKTAN) has a nursery for kratom seedlings and sells kratom seedlings to farmers from other areas. However, there is a need for care such as fertilisation and pest control to ensure the sustainability of kratom plant production.

4.1.5 Vegetables

Each household grows vegetables such as bananas, chillis and pineapples. The seeding process is adjusted to the needs of farmer households and the availability of land. Many farmers in Labian and Labian Ira'ang villages lack the knowledge on how to preserve seed from cucumbers, mustard greens or beans, so most seeds for these types of vegetables are obtained from the market. The average cost of seeds to plant on approximately 30m² of land is 200,000–300,000 Indonesian rupiahs. Some preserved local seeds such as mustard greens, spinach and sour eggplant and are sometimes obtained from neighbours or friends and not purchased from external sources. The seeds are maintained by leaving the fruit to ripen on the tree as observed in sour eggplant or cucumber followed by replantation. The seed of local corn stored in the racks can be planted, prepared as animal feed, and consumed.

4.2 Bartering or purchasing from neighbours

Seeds are exchanged through barter and this is observed in the process of adjusting the type of rice available in each season to the characteristics of the suitable soil. The maintenance of diversity for different types of rice is important for sustainability. This allows the farmers to obtain types they do not possess during a certain planting season from neighbours or friends. The bartering process is effective in maintaining the diversity of rice types in the farming community.

4.3 Formal systems: community storage or purchasing

The Dayak communities in Labian and Labian Ira'ang villages do not have a seed bank. This has led to the implementation of a personal storage system by each household. The process ensures the village maintains a diversity of seed types. Agricultural activities, specifically traditional farming, are sustained to 'keep the seeds alive'. This is observed from the annual cultivation of crops despite the limited agricultural land available which is conducted to ensure seeds are available, maintained and sustained. Farmers who are not capable of planting during a season provide seeds to others and later request new seeds in exchange. Some of the FFPOs, such as GAPOKTAN in Labian Ira'ang, have seed nurseries and provide their members with seeds. However, there is presently no special programme or active role implemented by FFPOs to improve the quality and availability of seeds. This shows the need for collaborative efforts to improve seed management in addition to the development of existing traditional knowledge in order to ensure more effective maintenance of the culture in the village.

5. Enterprise strategies and agrobiodiversity

5.1 Commercial crops

The production of cash crops can increase agrobiodiversity on agricultural land, if done under an agroforestry system. In this case it is possible, because a variety of crops at the shade and intercrop levels are planted in one landscape. Agrobiodiversity enhancement with cash crops in Labian and Labian Ira'ang villages relies heavily on Dayak traditional knowledge, which integrates their proven agricultural practices with sustainable commercial objectives. This approach is based on the Dayak tribes' holistic and regenerative farming system that emphasises harmony with nature and the preservation of biodiversity.

The Dayak cultivate a diverse array of crops — rice, vegetables, medicinal plants, fruits and timber species — interspersed with native trees that form forest canopies. This diversity mimics natural ecosystems, promoting nutrient cycling, pest control and habitat for wildlife, which benefits commercial crop productivity and ecological balance. The Dayak practice a rotational farming system where land is cultivated for a period and then left fallow for up to 15 years, allowing natural forest regeneration to restore soil fertility and biodiversity. This cyclical process ensures that commercial crops are grown without permanently degrading the land, maintaining a mosaic of forest and farmland that supports diverse plants (Murhaini and Achmadi 2021). Rather than destructive, the Dayak's small-scale rotating method enriches soil nutrients from ash produced by controlled burning and stimulates germination of native tree species such as ironwood. This creates a resilient young forest alongside agricultural plots, enhancing biodiversity while supporting crop growth.

Figure 8. A traditional Dayak agroforestry system for growing cash crops

Credit: Riak Bumi Foundation

5.2 Changes in patterns of commercial crop sales

Farmers often adjust to grow types of plants with market potential to increase income. The information obtained from the village showed that there used to be a high demand for pepper plants which led to an increase in sales price. Most pepper is sold in Sarawak, Malaysia because the village is close to the border between the countries. However, a reduction in the price of pepper led to the abandonment and replacement of the plantations with rubber plants, which became an important source of cash income. The situation later changed when the price of rubber fell and some farmers cut down and

replaced their trees with kratom plants. Currently, the attention is on kratom and tengkawang trees due to the increasing demand for kratom leaves as well as illipe nuts from tengkawang trees. The groups are also adapting to this change by forming new FFPOs such as the Tengkawang Labian Farmers Group to support the production of plants demanded in the market. Income from illipe nuts provides a safety net during poor crop years for other commodities such as rubber and vegetables, reducing pressure to convert forests for agriculture. Supporting nurseries and agroforestry diversification further stabilises livelihoods while maintaining forest cover.

The process has led to more diversity in the types of plants cultivated as observed in the continuous increase in the number of kratom and tengkawang trees. This is also driven by other parties such as community-based nongovernmental organisations (NGOs) that assist in producing certain plants to maintain sufficient availability for commercial purposes.

Dayak communities collect illipe nuts only once every two-to-three years during mast seasons (a season when the trees produce a large quantity of nuts). Usually, they only gather nuts fallen naturally upon the forest floor as they deliberately leave some nuts on trees to ensure regeneration. This non-destructive harvesting avoids deforestation and chemical use, and preserves forest biodiversity. Additionally, people do cultivate illipe trees within the traditional *tembawang* land-management system practiced by the Dayak. *Tembawang* combines conserving biodiversity with maintaining livelihoods as a customary forest-garden system managed individually or collectively.

5.3 The role of forest FFPOs in shaping what is sold

In Labian and Labian Ira'ang villages, various FFPOs play an important role in promoting crop production, sharing knowledge and adapting to local environmental conditions. These FFPOs foster cooperation among farmers to manage shifting cultivation and permanent crops such as rice, rubber and durian (commercial crops). They facilitate the sharing of traditional knowledge, labour and resources, enabling more efficient and sustainable crop production adapted to local land and water conditions. FFPOs support the development of production systems suited to the local environment, such as shifting cultivation on dry upper river levees, as well as innovative floating gardens and rubber nurseries on rafts in flood-prone lower areas. This flexibility in production patterns allows communities to optimise land use despite environmental constraints. Traditional knowledge holders, including men and women farmers, contribute ethnobotanical knowledge that guides the selection and management of crops, such as durian and medicinal plants, ensuring sustainable use and cultural continuity.

Figure 9. Developing products from illipe nuts

Credit: Kalimantan Tengkawang Network

FFPOs such as GAPOKTAN in Labian Ira'ang and the Tengkawang Labian Farmers Group are also collaborating with universities and other organisations that conduct studies on plants. One collaborative plant study on the use of tengkawang (illipe nut) in medicinal raw materials was conducted by Tanjungpura University, West Kalimantan (Riska and Manurung 2018). In addition, other studies have shown that the illipe nut produces high-quality edible oil and has high economic value. Tanjungpura University also trains community farmers and FFPO members to process the illipe nut into derivative products for food, chocolate, lubricants, medicine, candles and cosmetics. This usefulness makes the Dayak tribe in West Kalimantan consider the tengkawang as the 'tree of life'. The Faculty of Forestry of Tanjungpura University has also provided press equipment to extract illipe nut oil to produce several derivative products.

Product quality along with workers' health have improved after switching from customary smoking methods to sun-drying and semi-automated mini mills. Local social enterprises produce value-added products such as lip balms and moisturisers and also candles, and this production can increase income and empower women within the community. The economic viability of sustainable illipe nut harvesting is strengthened by all of these innovations.

Figure 10. Promoting locally produced illipe nut-oil products

Credit: Kalimantan Tengkawang Network

Another example of how FFPOs shape what is sold is their cooperation with village-owned enterprises (*badan usaha milik desa* or BUMDes, a local government enterprise programme for farmers) to negotiate with illipe nut-processing centres. While specific negotiations with processing units were not detailed by the farmers surveyed, the presence of active FFPOs working with BUMDes to manage inputs, production and marketing suggests ongoing collaboration that would include joint negotiation efforts to secure favourable prices and contracts for local products. In addition, due to difficult access and transportation challenges, farmers in these villages often rely on collective arrangements facilitated by village institutions, including BUMDes, to consolidate agricultural and fishery products for market delivery. For example, farmers coordinate to wait for shared transport vehicles to bring products such as vegetables, durian and fish to market, sometimes bartering goods collectively. This cooperation enhances their ability to negotiate better terms with buyers or factories by presenting larger, more consistent volumes.

5.4 Future plans

The Dayak farmers continue to practice and adapt their traditional shifting cultivation and agroforestry systems, which have sustained biodiversity for centuries. These systems involve rotational farming with long fallow periods (up to 20–25 years), allowing forest regeneration and maintaining a mosaic

landscape rich in species diversity. They use controlled burning to restore soil nutrients naturally, supporting crops such as upland rice, maize and cassava, while preserving forest ecosystems. Their agroforestry gardens (using the *tembawang* land-management system and the *lembo* agroforestry system) integrate rubber, fruit trees, rattan and medicinal plants, reflecting deep Indigenous ecological knowledge and spiritual respect for the forest as ancestral home. Strong customary institutions and conservation ethics guide sustainable resource use and protect biodiversity from overexploitation and external threats such as forest fires and land conversion.

However, the government also needs to ensure food security in the rice-farming sector by ensuring decent intensive fields with higher production such as the cultivation of 8 tonnes per hectare in Java. The government should also provide irrigation to rice fields for the purpose of ensuring the needs of the villages are met efficiently.

Figure 11. Tubok leaves used for both food and medicine by the Dayak tribe

Credit: Riak Bumi Foundation

6. Finance strategies for diversified production

6.1 Internal financial mechanisms

The communities in Labian and Labian Ira'ang villages currently have no access to formal financial services. In terms of internal finance mechanisms, usually FFPOs rely on assistance and self-help from other group members. However, there are savings and loans opportunities from Keling Kumang Credit Union. The credit union collaborates with local FFPOs and community organisations to extend financial services and support sustainable livelihoods.

Keling Kumang also links financial services with social and environmental programmes, such as partnerships with Lingkar Temu Kabupaten Lestari (LTKL), a district government association that promotes sustainable agriculture and forest conservation, aligning with Dayak farmers' needs for biodiversity-friendly practices. The logistical needs of members during the planting process are covered while the rest is saved as group savings. The FFPO Restorasi of Ngaung Keruh Lestari (Sustainable Restoration of Ngaung Keruh) also has a social loan system where members can borrow funds and loans above 5 million Indonesian rupiahs, although they are required to provide collateral. Financial assistance is also provided to each group of farmers by the village government through BUMDes (a local government enterprise programme for farmers).

6.2 Financial services that support biodiversity

Employment insurance is currently being implemented for Restorasi Ngaung Keruh Lestari group members in addition to providing work-safety equipment. The employment insurance helps members apply to the government's Employment Social Security Agency as well as to access some support from the Worldwide Fund for Nature (WWF), which covers medical expenses due accidents.

Other financial services include interest-free loans from Keling Kumang Credit Union to support local tourism enterprises. Both Labian and Labian Ira'ang villages are located in Kapuas Hulu, a popular tourist destination due to the famous Lake Sentarum. Many local groups now offer homestay accommodation for tourists. As group businesses, the income goes towards the internal fund of group. Group savings are stored externally in Keling Kumang Credit Union. Loans of less than 5 million Indonesian rupiahs do not require collateral but loan exceeding this amount must be supported by documents such as a SKT (*sertifikat tanah* or land certificate) or other securities. Although the loan is interest-free, there is an agreed repayment deadline.

Non-financial services are also currently not necessary as the costs of running local nurseries are fully borne by the village government.

6.3 The role of FFPOs role in external financing partnerships

Restorasi Ngaung Keruh Lestari group members receive financial support for planting, maintenance and fertilising activities from external institutions, such as NGOs, in addition to funding from the FFPO. Group funds are stored Keling Kumang Credit Union without being used for other activities. The funds are subsequently reported to members every month and any excess from the group's budget is added to the savings after being agreed with members. Some of the funds can be withdrawn for urgent social needs in the village. It was observed that only group members had requested loans up to the period of conducting this study. The group also has an efficient clean water programme that has been running since 2017, supported by monthly contributions of 2,000 Indonesian rupiahs per household head.

Additionally, a memorandum of understanding has been signed for a partnership between the Forestwise company and farmers from Labian and Labian Ira'ang villages, agreeing to training, farmer registration and purchasing contracts for illipe nuts that are sourced from standing forests.[3] This is a promising external investment for the farmers. For companies such as Forestwise, they work with Dayak communities using three-year commercial contracts. The contracts provide a stable market

[3] Forestwise creates high-value wild-harvested ingredients for the cosmetic and food industry. The company is dedicated to halting deforestation and promoting rainforest conservation in Indonesia. See www.forestwise.earth/about-us

and also income. Forest protection is incentivised via this long-term perspective, as income depends on nut availability and forest health. The nuts are processed into illipe butter, which is sold to cosmetics brands internationally, so this creates some value-added opportunities.

6.4 Future finance strategies

The implementation of a membership fee system for the FFPOs needs to be discussed as a method to support financial development. In addition, local group tourism enterprises are recommended to form dedicated tourism management teams. Groups can be formed based on needs such as the determination of tourism rates or other related activities. A major challenge identified was limited human resources and capacity in financial management. Therefore, efforts are needed to increase local capacity to ensure better financial management, especially among the younger generation.

7. Conclusion and recommendations

7.1 How FFPOs are advancing agrobiodiversity, livelihoods and resilience

This case study shows the critical role of FFPOs in sustaining agrobiodiversity, fostering sustainable enterprises, and enabling access to financial resources in the Dayak communities of Labian and Labian Ira'ang villages. Rooted in traditional ecological knowledge and enriched by external partnerships, these groups act as vital knowledge hubs, enterprise incubators and vehicles for local resilience.

Knowledge exchange occurs not only through generational transmission and cultural rituals such as *gawai* (harvest parties), but also through community collaboration, peer-to-peer learning and FFPO activities. FFPOs provide a platform for farmers — especially women — to share practices on seed saving, pest management and ecosystem-friendly farming, while partnerships with universities and networks such as the Kalimantan Tengkawang Network help integrate modern insights and improve production outcomes.

In terms of enterprise development, FFPOs enable diversification of livelihoods through value-added activities such as illipe nut processing, rubber nursery development, and agroforestry-based cultivation of kratom and illipe nut trees. FFPOs also enable external partnerships with companies such as Forestwise. These groups promote biodiversity-friendly income generation while strengthening cultural identity and local autonomy.

Regarding financial access, internal mechanisms such as social loan systems and collective savings — often supported by village-owned enterprises (BUMDes) and cooperatives such as Keling Kumang Credit Union — help FFPOs finance agricultural inputs, emergencies and business enterprises. Long-term contracts with buyers such as Forestwise demonstrate how external financial partnerships can align with biodiversity conservation and income stability. However, capacity-building in financial literacy and group governance remains an essential need.

7.2 Recommendations for external partners

The maintenance of both planned and natural biodiversity requires FFPOs to focus on sustainable environmental management by utilising local potential. External programmes such as the Forest and Farm Facility (FFF) can be strategic partners by providing mentoring, facilitation and capacity-building support.[4] This collaboration allows local and external efforts to synergise in conserving biodiversity effectively and sustainably. Some steps that can be implemented include:

- **Local marketing facilities:** the government should provide farmers with special storage for agricultural produce and products so that they can be marketed at the village level.
- **Funding support:** funding support is needed through village funds or others allocated to provide production facilities and to enable farmers to market agricultural products outside of the villages at district markets.
- **Licencing and packaging assistance:** support is needed from the government or other stakeholders to license the marketing of agricultural products and NTFPs, and to ensure that product packaging is attractive to buyers.
- **Product-processing training:** there needs to be training in processing local agricultural products. This is necessary to ensure the products can last longer and have better selling value. The process is important to provide motivation to maintain natural biodiversity.
- **Business management:** business management capacity needs to be improved using methods that are easily understood by farmers.

[4] The Forest and Farm Facility (FFF) is a partnership between the Food and Agriculture Organization of the United Nations (FAO), the International Union for Conservation of Nature (IUCN), the International Institute for Environment and Development (IIED) and AgriCord. See www.fao.org/forest-farm-facility/en

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