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Kelekak Agroforestry in Central Bangka, Indonesia: Species Diversity, Challenges, and Conservation Strategies

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ABSTRACT

Forest land conversion has caused global climate change, reducing biodiversity and food security challenges. Climate change's influence on food security must be anticipated promptly by adopting an adaptable agricultural cultivation system, such as agroforestry. The Bangka community is one of many that continue to practice agroforestry. In the Bangka community, agroforestry is known as *kelekak*. This research aims to learn about the history, variety of species, challenges, and conservation strategies of *kelekak.* This study's data was gathered through interviews, field observations, and literature studies. *Kelekak* is a woodland region historically used by the community to produce dryland rice (*ume*), which later became *kelekak* agroforestry land. Several fruit plant species are commonly found on *kelekak* land, including durian (*Durio zibethinus*), mangosteen (*Garcinia mangostana*), cempedak (*Artocarpus integer*), and ketapi (*Sandoricum koetjape*). The community utilizes various plant species in the *kelekak* as food, medicine, building materials, and firewood. *Kelekak*'s survival is threatened by land conversion to monoculture plantations, limiting community resource access. Efforts to revive the *kelekak* can be achieved through the *Tri Stimulus Amar Pro-Konservasi* approach by integrating natural, benefit, and religious willingness stimulus. Efforts to reinvigorate *kelekak* must begin immediately, with mapping activities for the remaining *kelekak* in the Central Bangka area to provide primary data for future *kelekak* development and local government regulations to conserve *kelekak*.

1. Introduction

The conversion of forest areas to oil palm and rubber plantations has altered ecosystem function (Guillaume et al. 2016). Changes in ecosystem function have resulted in a variety of issues, including reduced biodiversity (Wang et al. 2024), water management control (Durmuş et al. 2024), and carbon sequestration (Hardiansyah et al. 2024; Kotowska et al. 2015). In addition, forest land conversion has contributed to global climate change. Global climate change will alter temperature, rainfall, humidity, and CO_2 levels in the atmosphere, reducing water availability and

agricultural production, resulting in a global food catastrophe (Astuti et al. 2024). Over the last few decades, global climate change has undoubtedly caused several unprecedented events, including drought, flooding, ocean acidification, sea level rise, melting glaciers, changes in rainfall patterns, epidemic disease attacks, and threats to food security. Climate change's influence on food security must be anticipated promptly by adopting an adaptable agricultural cultivation system, such as agroforestry.

Agroforestry is one strategy for addressing land conversion and food supply issues while striking a healthy balance between community demands and environmental conservation (Roslinda et al. 2023; van Noordwijk 2021; Wijayanto and Briliawan 2022). In Indonesia, agroforestry is the combination of woody plants (forests) with cultivated plants (typically food crops or fruits) that have been practiced by the community for generations (Prabawani et al. 2024). Agroforestry practices in Indonesia have been carried out by communities traditionally and from generation to generation. Agroforestry has become part of the culture and local wisdom of the community in utilizing natural resources and the environment. Communities in Indonesia have created a variety of traditional agroforestry systems, including *talun* (West Java), *parak* (West Sumatra), *repong* (Lampung), *pelak* (Jambi), and *tembawang* (West Kalimantan). However, the existence of agroforestry land is increasingly threatened by the conversion of land into monoculture plantations. This can lead to a reduction in plant biodiversity and traditional knowledge of the community regarding the use of plant species. One of the conventional agroforestry practices of the community in Indonesia that is increasingly threatened by land conversion is *kelekak*.

Kelekak is a relatively unknown agroforestry system in Indonesian villages. The *kelekak* agroforestry system represents the people of the Bangka Belitung Islands' traditional knowledge of land resource management. *Kelekak* (*kelak kek ikak*), meaning later for you, is a mixed garden with woody and fruit plants. *Kelekak* is dominated by fruit and wood plants, such as durian (*Durio zibethinus*), mangosteen (*Garcinia mangostana*), binjai (*Mangifera caesia*), pulai (*Alstonia scholaris*), and candlenut (*Aleurites moluccanus*), in contrast to the repong agroforestry system identical to damar plants (*Shorea javanica*). However, it is also covered with other plant species, such as durian and langsat (Mulyoutami et al. 2023). Establishing the *kelekak* agroforestry system can help achieve food security based on local commodities. The development of local food commodities needs to be carried out to meet the needs of food commodities, including the development of sago (*Metroxylon sagu*), sugar palm (*Arenga pinnata*), gadung (*Dioscorea hispida*), and other local food commodities (Al Manar et al. 2023a). One of the communities in the Bangka Belitung Islands still developing *kelekak* agroforestry is the community in Central Bangka Regency. Until now, the community in Central Bangka still uses *kelekak* as a source of economy and family food. *Kelekak* also functions as a means of strengthening family ties when the harvest season arrives. This makes *kelekak* a part of the culture and local wisdom of the community in Central Bangka. However, the existence of *kelekak* is increasingly threatened by the conversion of land into monoculture plantations and mining.

The increasing threat to the existence of *kelekak* can cause the loss of local wisdom and community culture in using plants. Based on this, it is essential to conduct research related to the history, diversity of plants, and challenges of *kelekak*. This information is expected to be used as advice and input to the local government to develop a strategy for revitalizing *kelekak* in Central Bangka Regency. Research related to *kelekak* agroforestry has also not been carried out much compared to other agroforestry research, such as *talun* (Hani et al. 2018; Mizuno et al. 2013),

parak (Kardiman and Putri 2023; Santhyami et al. 2018; Santhyami et al. 2020; Santhyami et al. 2023), *repong* (Laura and Darmawan 2020; Santoso et al. 2023; Susanti et al. 2018), and *tembawang* (Aini et al. 2016; Hutagaol 2020; Hutagaol and Sundi 2021; Pitopang 2019). So, this research aims to learn about the history, species variety, challenges, and conservation strategies of *kelekak*.

2. Materials and Methods

2.1. Study Site and Time

This study was conducted from December 2023 to February 2024 in Central Bangka Regency, Bangka Belitung Islands, Indonesia (**Fig. 1**). Central Bangka Regency is located between the coordinates S2°10'–2°50' and E105°45'–106°50'. Regarding geographic position, Central Bangka Regency has boundaries as follows: North–Bangka Regency and Pangkalpinang City; South-South Bangka Regency; West–Bangka Strait; East–Karimata Strait. Central Bangka Regency has tropical and wet seasons with a variation of rainfall average of 3,026.7 mm for the year 2022.

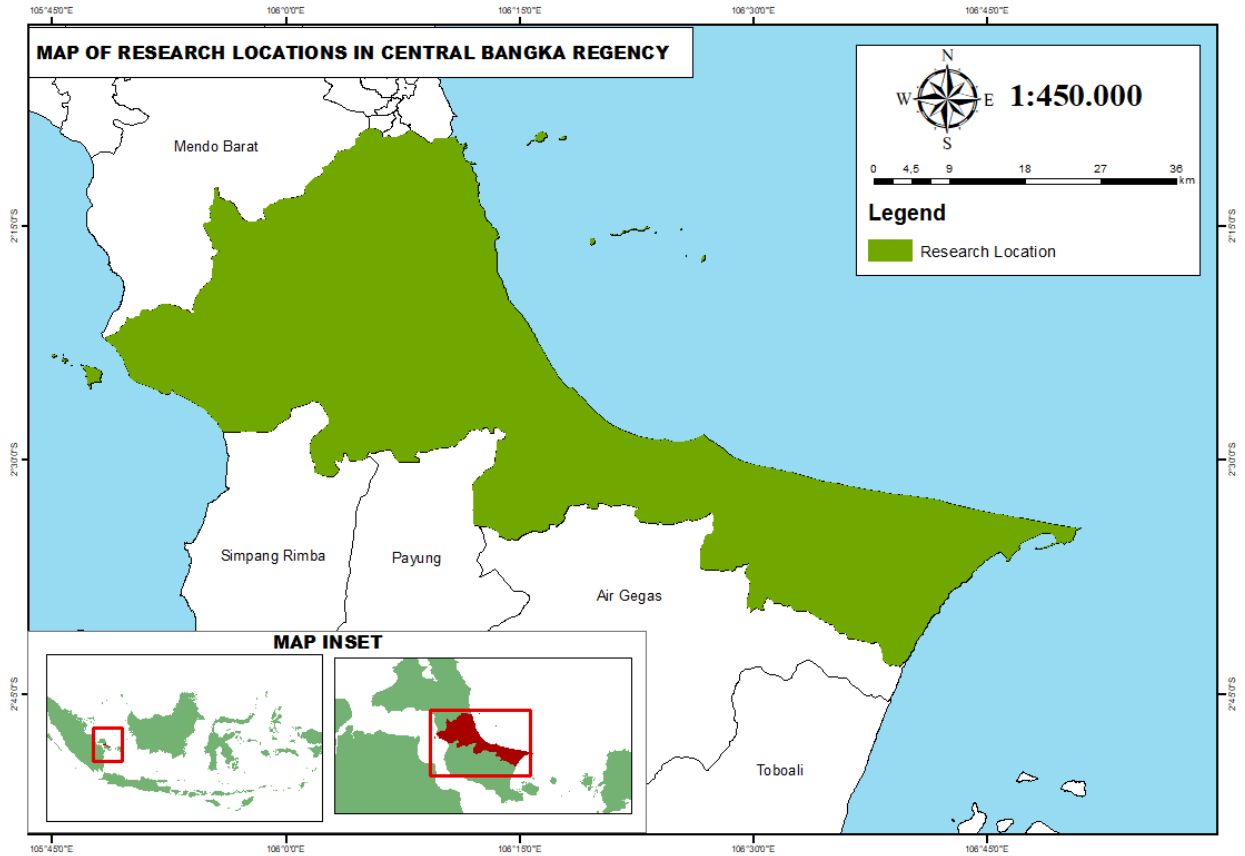

Fig. 1. Research locations in Central Bangka Regency.

2.2 Research Design

This study's data was gathered through interviews, field observations, and literature studies. Interviews were conducted with sources knowledgeable about the history of *kelekak*, including two historians and five community leaders. Interviews were conducted in-depth to explore information related to the history, use, and current problems of *kelekak*. Field observations were

carried out to collect data on the diversity of plant species in *kelekak* and to determine the mode of usage of plant resources in the *kelekak* ecosystem. Data gathered through interviews and field observations will be enhanced through literature studies to complete and enrich the field data. The study's literature included novels, scientific journals, and other papers.

The Tri-Stimulus Amar Pro-Conservation theory proposed by Zuhud (2007) was used to examine the *kelekak* conservation (revitalization) technique. Tri-Stimulus Amar Pro-Conservation includes three stimuli: natural stimulus (*stimulus alamiah*), benefit stimulus (*stimulus manfaat)*, and religious willingness stimulus (*stimulus rela-religius*). Natural stimulus is derived from the truth of nature and the sustainability of natural resources based on their natural qualities. A benefit stimulus is a stimulant derived from the advantages gained from these resources. Religious willingness stimulus refers to a person's commitment to preserving divine values and resources. Establishing attitudes and behaviors that the Tri-Stimulus Amar Pro Conservation strongly drives is required to accomplish successful conservation (Zuhud 2007). Natural stimulation reflects the value of natural truth, requirements, and the sustainability of natural biological resources based on their bioecological characteristics. Benefit stimulation reflects human values, including economic, social, biological, and environmental benefits. Religious stimulus encourages people to engage in conservation activities by providing the highest value in the form of goodness, particularly rewards from nature's creator, spiritual values, universal religious values, rewards, happiness, wisdom, culture/tradition, inner satisfaction, and others.

3. Results and Discussion

3.1. History and Stages in the Creation of the Kelekak

The Bangka Belitung community has traditionally used *kelekak* to feed their families. *Kelekak* is more than just an agricultural technique for the Bangka Belitung community; it is also a part of their culture. *Kelekak* is one of the Bangka Belitung community's traditional agricultural practices, in which the community gradually converts forest areas into agroforestry agricultural land (*kelekak*). *Kelekak* land typically measures 1 to 2 ha. However, some might be more than 5 ha. According to de Groot (1887), entitled "*Herinneringen Aan Blitong, Historisch, Lithologisch, Mineralogisch, Geographical, Geological en Mijnbouwkundig*," the term *kleka, keleka*, or *kelekak* refers to a location in Belitung where remnants of former settlements that used to be a village remain, with only neglected fruit trees to mark the spot. This demonstrates that the *kelekak* has been a source of fruit for the local population from ancient times, and it also indicates that the place was previously a communal hamlet.

The term *kelekak* or *kleka* in the Bangka community is similar to the Dayak community agroforestry system called *kaleka*. The *kaleka* or *awan uluh bihin* system represents an ancient settlement in the Dayak community. This may have started in a hamlet occupied by only a few families by opening up farmed land in the surrounding area and allowing the empty land to regenerate for a year or longer following the planting phase (Silvianingsih et al. 2021). *Kaleka* has many plant trees and is the culmination of the agroforestry system (Rahu et al. 2013).

According to Scheperns' (1860) document "*Aanteekeningen Omtrent de Bevolking van Billiton in the Tijdschrift voor Indische Taal-, Land- en Volkenkunde*," the people in the Bangka Belitung Islands region have practiced a rice field culture, where in some cases the community planted around their houses with several types of fruit trees, where they usually spend time if the

rice fields are not too far away. The indigenous call their permanent residence *kleka* or *kelekak*. This is supported by a Dutch document titled "*De Orang Lom of Belom op Het Eiland Banka*" in the "*Tijdschrift voor Indische Taal-, Land- en Volkenkunde*" (1862), which states that in October 1860, three copper lila (small cannons) made in Palembang were discovered in the Koba area, specifically at the location where the *Kleka Trentang* village was established. According to legend, the Lom people once lived in *Kleka Trentang*. This demonstrates that the term *kleka* or *kelekak* has been known in culture since ancient times.

Kelekak is formed from a forest (*rimbak*) that the community has cleared for agricultural use. The area was previously used as a community field for planting rice or pepper. Before removing the forest area, the community must obtain permission from the shaman who controls it. After getting permission from the forest's shaman, the community must construct a *penimbong* or *sarang punai* (a sign used to request permission from the forest guardian).

After receiving authorization from the forest (*rimbak*) guard, the next step is to pioneer the land (*ngerintis*). Pioneering actions seek to establish land boundaries or develop trails through the forest to facilitate cutting (*nebas*) and felling activities (*nebang*). Pioneering involves clearing little trees and other vegetation that can still be chopped with a machete (*parang*). Following the removal of minor trees, giant trees are hacked down with an axe. Cutting down begins at the edge of the land. It is typically done by *besaoh* (mutual collaboration) with those who are still close family relatives or locals who will also farm the field (*beume*). Each cutter is tasked with cutting one edge so that the cuts meet in the center of the area that will be converted into a field (*ume*). The next step is to cut/lay down (*rebak*) giant trees (**Fig. 2**). The cut wood must face east to speed up the drying process.

Fig. 2. *Rebak*, the process of cutting and lay down trees.

The surrounding region of a burning land is being cleansed to prevent it from spreading (*ngerarat*) to other areas during the process. The land must be cleared of debris, dried leaves (*kerasak*), and twigs to prevent the fire from spreading to the adjacent forest. After the area has been cleared, the next step is to prepare wood or bamboo to be used as a *pelupa* to light a fire or as a burning instrument. Typically, the wood or *bambu pelupa* is long with split or split ends, allowing the fire to ignite quickly.

After the soil has dried sufficiently (approximately three months), the next step is *nunu* or burning the *rebak* (**Fig. 3**). According to astronomical calculations, the period to burn the *rebak* is two dark days after *urang Cin sembahyang rebut* (*chit ngiat pan*). The *nunu* procedure must pay

attention to the direction of the wind in order to keep the fire from spreading. The four corners must be guarded, and the guard must ensure the fire does not escape from the *rebak*.

Fig. 3. *Nunu* activity (burning *rebak*).

The *nunu,* or burning process, is often done in the afternoon. Burning a one-hectare *rebak* (four plots) takes around two hours. The solid black smoke of the fire indicates that a *rebak* is being burned, followed by white smoke visible from a distance. After the *rebak* is burned, the soil will be *mantak* or scorched (*angus*) (**Fig. 4**).

Fig. 4. Land that is already established or burnt (*mantak*).

The next activity performed is *manduk*. *Manduk* is gathering wood that has not been burnt by fire. The wood is sorted into different stacks and burned again (**Fig. 5**). *Cadur* (*Brassica* sp.), *beliwo* (*Cucumis melo* var. *cantalupensis*), and betik (*Cucumis sativus*) can be grown on damp soil. *Ngalang/manteng kerat* is the process of creating plots for rice planting from the arrangement of wood after the *rebak* has been burned and cleaned. During the *ngalang/manteng kerat* activity, plots are assigned to be planted with cerak rice (*padi cerak*), glutinous rice (*padi ketan*), and tubers. Large wood is left alone during this process and will eventually be used up due to weathering or combustion.

After the plot has been completed, the next activity is to make a planting hole filled with rice seeds (*nuja/nugal*). Before the *nuja/nugal* activity is carried out, the rice seeds planted from the previous year's harvest (*ngetam*) must be dried in the sun to repel pests. The *nuja/nugal* activity begins with placing the *penimbong rumahan* on the *nuja/nugal* place, a small building like a stilt

house made of wood measuring around 30 to 50 cm. In the middle of the *penimbong rumahan*, seven holes are made in the ground, and each hole will be filled with seven rice seeds, then a shaman or elder will pray for them. The top of the *penimbong rumahan* is filled with grass and isil-isil wood. After the *penimbong rumahan* process is complete, the *nuja/nugal* activity will be carried out.

Fig. 5. *Manduk* activity, gathering wood that has not been burnt by fire.

The *nuja/nugal* activity is done by making a 5 to 10 cm deep planting hole using wood. After making the planting hole, *mene/menih* will be carried out, namely inserting rice seeds into the planting hole, which women usually do. The rice seeds that are planted are usually local rice seeds, including *mayang angat, mayang besar, padi empat bulan, padi keteb, padi kuning, padi kutu, ampal*, and types of *padi ketan* (*ketan putih, ketan hitam, ketan jawa*, and *ketan pare*). After the rice grows, the following process is *tunggen* (waiting for the rice to grow). During *tunggen*, the owner of the ume land starts building a hut called a *memarung*. The *memarung* is located in the middle of the *ume* land and monitors the land for pests. In the hut, a *pelantar* will be made to separate the rice grains from the stalks during harvest (*mengirik*), dry the rice, and store the *lanting lesung*. In the yard of the hut, a fence (*antang-antang*) is also made to dry cloth. The wood used for *memarung* results from selected felled *rebak* trees, while the roof is made from rumbia leaves (*M. sagu*).

After the rice turns yellow, harvesting (*ngetam*) will occur. After *ngetam* period, the former *ume* land will leave rice stalks that will eventually rot. If farmers still want to work on the land, the land will be planted with secondary crops. Former *ume* land planted with secondary crops is called *kubak*. In *kubak* land, secondary crops such as cassava (*mengalo*), taro, sweet potatoes (*bijur*), beans, corn, and papaya (*katis*) are planted. In addition to being planted with secondary crops, it can also be planted with *sahang* (pepper). Meanwhile, former *ume* land not utilized by the community is usually called *bebak* or *belukar lame*, which will eventually become a secondary forest.

The former *ume darat* land, in the form of *kubak*, is then planted with *sahang* and experiences a phase of around 5–10 years, depending on the duration of the *sahang*. Usually, *longkang sahang*, which has begun to be unproductive, is planted with complex plants such as durian, cempedak, jackfruit, rambutan, and rubber, then over time, the land will become *kelekak* (**Fig. 6**). Ownership of *kelekak* land reaches seven generations: children (*anak*), grandchildren (*cucu*), great-grandchildren (*cicit*), great-great-grandchild (*uning-uning*), great-great-great-

grandchild (*tangkai labu*), great-great-great-great-grandchild (*tali kelambu*), and great-great-great-great-great-grandchild (*papan pengarep*). After seven generations, the *kelekak* land has become communal property for the general public. Therefore, the Bangka community knows several *kelekak* from the past, including *Kelekak Usang, Kelelak Datuk, Kelekak Jirat*, and *Kelekak Ramai*. The naming of the *kelekak* is based on the naming of the ancestors, such as *Kelekak Datuk,* which means that the *kelekak* was planted by the previous grandfather (*datuk*). The same is true for *Kelekak Jirat*, which means that the *kelekak* is still planted by the descendants of the ancestors. In contrast, *Kelekak Usang* means that the *kelekak* has existed since the previous ancestors, and *Kelekak Ramai* means that the fruit of the *kelekak* is for everyone. This hereditary gift unites us in our shared heritage. Along with the development of the times, *kubak* and *kelekak* land, which in their cycle phase become communal property, over time developed into villages.

Fig. 6. Vegetation in *Kelekak* agroforest.

3.2 Species Diversity and Plant Utilization in the Kelekak

The people of Bangka Belitung Islands utilize *kelekak* as their primary or additional source of income by selling their fruit harvest. The fruit plant species that are usually found in *kelekak* habitats include durian (*D. zibethinus*), mangosteen (*G. mangostana*), cempedak (*A. integer*), kabung (*A. pinnata*), binjai (*M. caesia*), ketapi (*Sandoricum koetjape*), langsat (*Lansium domesticum*), jackfruit (*A. heterophyllus*), rambai (*Baccaurea motleyana*), and petai (*Parkia speciosa*) (**Fig. 7**), and several species of woody plants such as rubber (*Hevea brasiliensis*), pulai (*A. scholaris*), and seruk (*Schima wallichii*). Based on the beliefs of some communities, durian and mangosteen are plant species that must be present in *kelekak*. This is because durian and mangosteen are symbols of natural balance; durian is a symbol of heat, and mangosteen is a symbol of cold.

Plant species found in the *kelekak* habitat are utilized by the community for personal consumption or sold to collectors. The utilization of fruit plant species in the *kelekak* habitat is primarily seasonal, such as durian, mangosteen, cempedak, binjai, rambai, and raman (*Bouea macrophylla*). Meanwhile, the utilization of plant species in the *kelekak* habitat, which is daily or monthly, is sugar palm and jackfruit. The community uses durian to be eaten directly or processed into durian porridge combined with palm sugar. The community also sells durian fruit in simple huts on the side of the road (**Fig. 8**). Some types of durian sold by the community include local durian, montong, musang king, and cumasi. Based on the type of durian, durian cumasi is the most

expensive type of durian sold by the community at a price between USD 15.30 to USD 30.60 per kg.

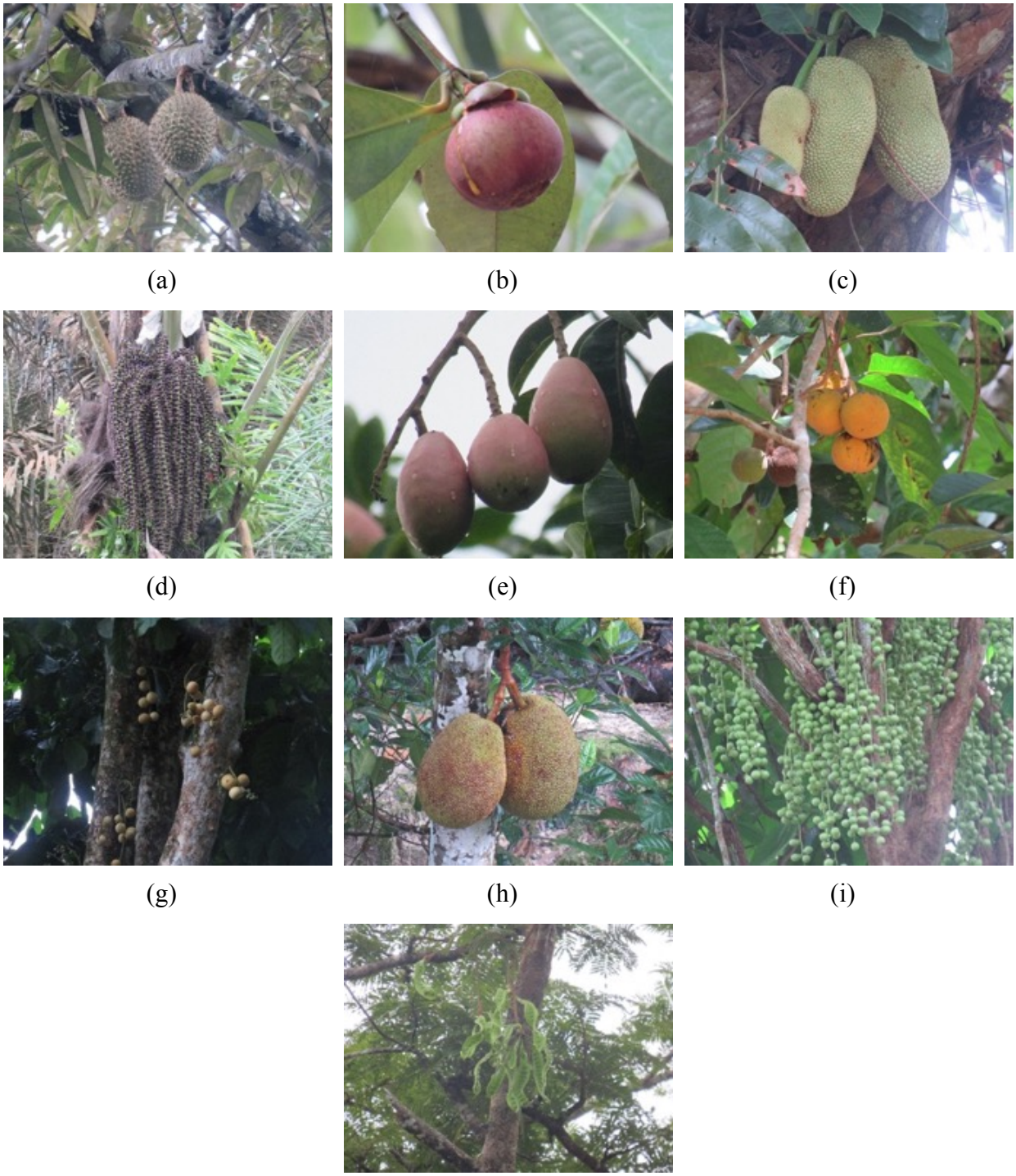

Fig. 7. Plant species in *kelekak*: (a) durian (*D. zibethinus*); (b) mangosteen (*G. mangostana*); (c) cempedak (*A. integer*); (d) kabung (*A. pinnata*); (e) binjai (*M. caesia*); (f) ketapi (*S. koetjape*); (g) langsat (*L. domesticum*); (h) jackfruit (*A. heterophyllus*); (i) rambai (*B. motleyana*); (j) petai (*P. speciosa*).

In addition to utilizing durian, people also utilize *kabung* (sugar palm) for daily needs. The community uses sugar palm (*A. pinnata*) to be processed into palm sap drinks or palm sugar. The

part of the sugar palm tree that produces palm sap is the male flower bunch. People usually collect palm sap in the morning and evening. In addition to palm sap, people utilize female flowers (*beluluk*) to be processed into *kolang-kaling* during Ramadan. The sugar palm fruit that is taken is not too old or young. A sugar palm fruit that is too old will produce a hard fruit texture. At the same time, if the fruit is too young, its texture will be too soft during processing, making it challenging to process further, resulting in low product quality (Zuhud et al. 2020).

Fig. 8. A stall selling durian from *kelekak* in Air Mesu Village.

In addition to utilizing plant species as food, people also utilize plant species as medicine, one of which is pasak bumi (*Eurycoma longifolia*). Pasak bumi found in the *kelekak* habitat, is a plant species that grows naturally (**Fig. 9**). Pasak bumi is a semi-tolerant plant that requires shade when young and sufficient sunlight to grow into adulthood (Hidayati et al. 2021). Pasak bumi is usually used by people as a solid medicine to increase body stamina. This follows research conducted by Kamsani et al. (2020), which states that pasak bumi is used as a stamina boost (aphrodisiac).

Fig. 9. Pasak bumi (*E. longifolia*).

Apart from food and medicine needs, people still use plant species in *kelekak* for building materials. People generally use wood from *kelekak* to make houses and huts for farmers. A farmer's hut is a building that many people or farmers own as a place to shelter or rest when the farmer has finished gardening. Some examples of species that people prefer for building materials are cempedak (*A. integer*) and durian (*D. zibethinus*). Cempedak wood is often used as raw material

for industry, crafts, home furniture, ships, and house boards because it has strong and durable properties (Lempang 2012). Durian wood has a high potential to be used as a building raw material (Tibarrang 2022).

In addition to being used as a building material, the trunk is also used as a source of firewood. Some people still use firewood to process food. Almost all species of tree-habitat plants in the *kelekak* can be used as firewood (**Fig. 10**). Two species cannot be used as firewood: langsat (*L. domesticum*) and binjai (*M. caesia*). The smoke produced from burning duku wood can cause headaches. Meanwhile, the smoke produced by binjai wood is very disturbing. Usually, food that is processed with firewood has a long cooking time. One of the uses of firewood by the community is as fuel in processing sap into palm sugar. One of the species used to make palm sugar is cempedak wood (*A. integer*). The use of firewood in making palm sugar is done to make costs more efficient because firewood is easy to find and widely found in the *kelekak*. Firewood for making palm sugar usually comes from their gardens (Prasmatiwi et al. 2022).

Fig. 10. Firewood from *kelekak*.

3.3 Threats to the Sustainability of the Kelekak

The existence of *kelekak* is currently threatened by the development of oil palm plantations on Bangka Island. The degraded land area in Bangka Belitung Province covers 4,508.8 km² (27.24% of the total area), consisting of *kelekak* land (Fahrudin et al. 2023). Field observations show that most of the *kelekak* land has been converted into oil palm plantations (**Fig. 11**) due to several factors, such as economic and family problems. Some *kelekak* that their descendants inherited were sold to other people to avoid conflicts over ownership and distribution of the *kelekak* harvest, so most of the *kelekak* sold to other people have been converted into oil palm plantations because they are considered more profitable. This is different from the *kaleka* system in the Dayak community, where selling *kaleka* land is taboo and prohibited because the local community protects the land because the fruits can be enjoyed by all villagers (Rahu et al. 2013; Silvianingsih et al. 2021). In the Dayak community, selling *kaleka* land will lower the family's social status in the village community, and psychologically, it is believed to trigger harmful impacts on the family (Rahu et al. 2013).

Fig. 11. Conversion of *kelekak* into oil palm plantations.

As happened in *Kelekak Kedemangan*, Namang Village, Central Bangka Regency, which has been converted into an oil palm plantation, only a few large trees remain, such as the binjai tree (*M. caesia*) (**Fig. 12**). *Kelekak Kedemangan* is a *kelekak* that the community has used for tens or even hundreds of years. The condition has resulted in several species of native *kelekak* plants being difficult to find, such as raman (*B. macrophylla*), randik (*Bouea oppositifolia*), and tampoi (*Baccaurea macrocarpa*).

Fig. 12. Conditions around the *Kelekak Kedemangan* area have been converted into an oil palm plantation.

Oil palm is an important food crop and commodity cultivated in many tropical regions, including Indonesia (Al Manar et al. 2023b; Byerlee et al. 2017). In Indonesia, smallholders use oil palm production to increase their income and livelihoods and drive rural growth and development (Euler et al. 2017). Oil palm farmers in Indonesia usually supply fresh fruit bunches to large industries at prices determined by the industry (Kühling et al. 2022). This condition causes the farming community to have no sovereignty over their harvest.

For farming communities, the land is not only a place to plant crops or work but also an area of historical and emotional value (Quinn et al. 2014). *Kelekak* also has historical and emotional value for its owner because it is one way to connect ties between extended families. Land conversion will cause loss and sadness, reducing farmers' interests (Maladi 2013).

3.4 Attempts to Revitalize the Kelekak

Several conservation/revitalization actions of *kelekak* have emerged independently from the community and village government, such as those carried out by the Kerantai Village Government, Sungai Selan District, and Central Bangka Regency. The Kerantai Village Government has revitalized *kelekak* on 7 ha of village-owned land by planting various plants, such as durian, mangosteen, binjai, cempedak, and jackfruit. Kerantai Village *kelekak* is the first village-owned *kelekak* in Central Bangka Regency, named *Kelekak Ujang* (*kelak kek ikak la jang*), which means later for you (**Fig. 13**).

Fig. 13. *Kelekak Ujang* in Kerantai Village, Central Bangka Regency.

The ideal conditions expected from the *kelekak* revitalization activities are that the function of the *kelekak* can be maintained as a wildlife habitat and food provider for the community, the availability of processed products from *kelekak* resources, *kelekak* as a means of education and tourism, the existence of a *kelekak* farmer cooperative, assistance and incentives provided by the local government for *kelekak* owner communities, the existence of a one village one *kelekak* village program, and the existence of a *kelekak* plant nursery center. It is necessary to carry out *kelekak* conservation. The prerequisite for the realization of successful conservation is the creation of attitudes and behaviors that are strongly driven by the Tri-Stimulus Amar Pro Konservasi: crystallization or unity of natural stimulus (*stimulus alami*), benefit stimulus (*stimulus manfaat*), and religious willingness stimulus (*stimulus rela-religius*) (Zuhud 2007).

Natural stimuli are related to the ecological role of the *kelekak* so that the community can feel it. Natural stimuli in *kelekak* conservation efforts include the ecological function of *kelekak* for water management and microclimate, *kelekak* as a habitat for wildlife, and many *kelekak* that have been converted into monoculture plantations. Agroforestry systems are naturally more adaptive to climate change and provide better microclimate conditions than monoculture planting (Lin 2007; Nguyen et al. 2013; Willmott et al. 2023). Agroforestry also provides a habitat for wildlife, including arthropods (Boinot et al. 2019; Pardon et al. 2019), birds (Edo et al. 2024), and mammals (Gonçalves et al. 2012). Changing the *kelekak* land to monoculture plantations is also a natural stimulus that can spur conservation action.

The natural stimulus also includes a conservation action, where the community utilizes *kelekak* resources for economic needs and socializes with family and other communities. The agroforestry system can benefit nature, the economy, and society through interactions between system elements (Atangana et al. 2014; Hemel et al. 2024). Using *kelekak* can increase farmers'

access to food, animal feed, and firewood, significantly increasing farmers' livelihoods (Akter et al. 2022). In addition to providing consistent income and other benefits for human welfare, agroforestry can stop environmental damage, increase agricultural production, encourage carbon sequestration, and promote soil and ecosystem health compared to monoculture (Castle et al. 2022).

In addition to this, religious willingness stimuli are also one of the driving factors for conservation actions. Religious willingness stimuli in *kelekak* conservation efforts include not all fruits in the *kelekak* being sold to collectors but being distributed to others, the community planting plant species in the *kelekak*, the community starting to cultivate *kelekak* plants, and the village government starting to develop village *kelekak*. Religious willingness stimuli occur because of encouragement from the farming community related to the values of willingness and divinity, so this stimulus becomes the main factor in conservation actions. The willingness of the community, especially farmers whose livelihoods depend on agroforestry as their primary source of income, greatly influences achieving conservation goals (Jones et al. 2023).

Conservation actions that can be taken to achieve ideal conditions based on current conditions referring to the Tri-Stimulus Amar Pro Konservasi include the existence of regional government policies to maintain the function and status of *kelekak*, assistance to the community in increasing the added value of *kelekak* resource products, assistance to the community in providing quality seeds, and forming *kelekak* farmer institutions (**Fig. 14**).

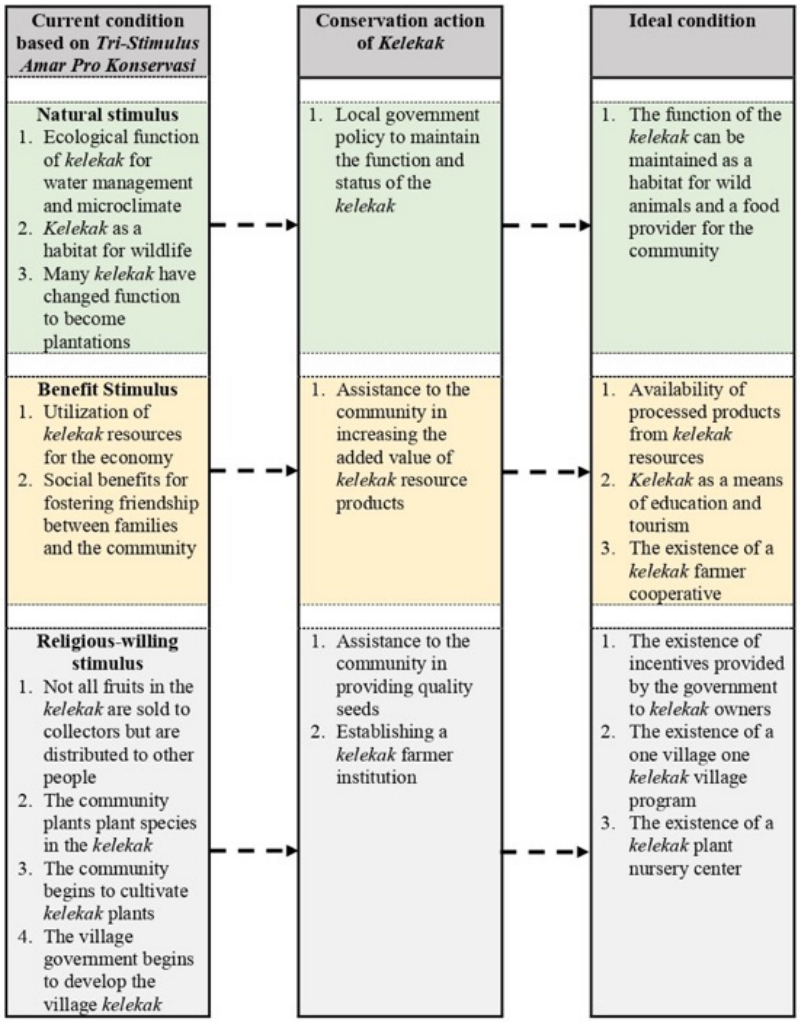

Fig. 14. Conservation (revitalization) strategy for *kelekak*.

4. Conclusions

Kelekak is a traditional agroforestry of the Bangka community that has been practiced since ancient times to meet food needs and environmental conservation. *Kelekak* is not only used for economic interests but also has social benefits as a bond of brotherhood between families and communities. The conversion of *kelekak* into oil palm plantations has made it difficult to find several species of native *kelekak* plants. *Kelekak* revitalization efforts must be carried out immediately through the *Tri Stimulus Amar Pro-Konservasi* approach because the threat of changing the function of kelekak into settlements or plantations is increasingly widespread. The *kelekak* revitalization efforts can be optimized by implementing natural, benefit, and religious willingness stimuli. Strategies that need to be carried out include mapping activities for the remaining *kelekak* in the Central Bangka Regency area as primary data for future *kelekak* development and the creation of local government policies related to *kelekak* protection.

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References

Aini, Y. S., Santoso, N., Soekmadi, R. 2016. Management of Tembawang Dayak Iban Ethnic at Sungai Mawang, Puring Kencana, Kapuas Hulu, West Kalimantan. *Media Konservasi* 21(2): 99–107. DOI: 10.29244/medkon.21.2.99-107

Akter, R., Hasan, M. K., Kabir, K. H., Darr, D., and Roshni, N. A. 2022. Agroforestry Systems and Their Impact on Livelihood Improvement of Tribal Farmers in A Tropical Moist Deciduous Forest in Bangladesh. *Trees, Forests and People* 9: 100315. DOI: 10.1016/j.tfp.2022.100315

Al Manar, P., Zuhud, E. A. M., Andarwulan, N., and Bintoro, M. H. 2023a. Morphological Characteristics and Potential of Sago (*Metroxylon* spp.) in Lingga Regency, Riau Islands, Indonesia. *Jurnal Manajemen Hutan Tropika* 29(1): 11–21. DOI: 10.7226/jtfm.29.1.11

Al Manar, P., Hikmat, A., and Zuhud, E. A. M. 2023b. The Role of Leguminosae Plants for Soil Fertility in Oil Palm Plantations. In *IOP Conference Series: Earth and Environmental Science* IOP Publishing. DOI: 10.1088/1755-1315/1243/1/012016

Astuti, P. K., Ayoob, A., Strausz, P., Vakayil, B., Kumar, S. H., and Kusza, S. 2024. Climate Change and Dairy Farming Sustainability; A Causal Loop Paradox and Its Mitigation Scenario. *Heliyon* 10: e25200. DOI: 10.1016/j.heliyon.2024.e25200

Atangana, A., Khasa, D., Chang, S., and Degrande, A. 2014. Tropical Biomes: Their Classification, Description and Importance. In: *Tropical Agroforestry*. Springer, Dordrecht. DOI: 10.1007/978-94-007-7723-1_1

Boinot, S., Poulmarc'h, J., M´ezi`ere, D., Lauri, P. E´., and Sarthou, J. P. 2019. Distribution of Overwintering Invertebrates in Temperate Agroforestry Systems: Implications for Biodiversity Conservation and Biological Control of Crop Pests. *Agriculture, Ecosystems and Environment* 285: 106630. DOI: 10.1016/j.agree.2019.106630

Byerlee, D., Falcon, W. P., and Naylor, R. 2017. *The Tropical Oil Crop Revolution: Food, Feed, Fuel, and Forests*. Oxford University Press, New York. DOI: 10.1007/s12571-017-0698-7

Castle, S. E., Miller, D. C., Merten, N., Ordonez, P. J., and Baylis, K. 2022. Evidence for The Impacts of Agroforestry on Ecosystem Services and Human Well-Being in High-Income Countries: A Systematic Map. *Environmental Evidence* 11: 10. DOI: 10.1186/s13750- 022-00260-4

De Groot, C. 1887. *Herinneringen Aan Blitong, Historisch, Lithologisch, Mineralogisch, Geographisch, Geologisch en Mijnbouwkundig*. H.L. Smits, 's-Gravenhage.

Durmuş, Y., Arslansoy, G., Gürbüz, T. K. 2024. Impact of Smart Irrigation Systems and Water Management on Climate Change. *BIO Web of Conferences* 85: 01057. DOI: 10.1051/bioconf/20248501057

Edo, M., Entling, M. H., and Rosch, V. 2024. Agroforestry Supports High Bird Diversity in European Farmland. *Agronomy for Sustainable Development* 44(1): 1–12. DOI: 10.1007/s13593-023-00936-2

Euler, M., Krishna, V., Schwarze, S., Siregar, H., and Qaim, M. 2017. Oil Palm Adoption, Household Welfare, and Nutrition Among Smallholder Farmers in Indonesia. *World Development* 93: 219–235. DOI: 10.1016/j.worlddev.2016.12.01

Fahrudin, Hati, T., Herlina, E., Wikantika, K., Anna, Z., and Anjar, D. S. 2023. Modeling Degraded Land Area in Province of Bangka Belitung Islands Based on Remote Sensing and Ecosystem Service to Support Sustainable Tourism. *Proceedings of the International Conference on Sustainable Environment, Agriculture and Tourism (ICOSEAT 2022)* Atlantis Press. DOI: 10.2991/978-94-6463-086-2_103

Gonçalves, P., Alcobia, S., Simoes, L., and Santos-Reis, M. 2012. Effects of Management Options on Mammal Richness in A Mediterranean Agro-silvo-pastoral System. *Agroforestry Systems* 85: 383–395. DOI: 10.1007/s10457-011-9439-7

Guillaume, T., Maranguit, D., Murtilaksono, K., and Kuzyakov, Y. 2016. Sensitivity and Resistance of Soil Fertility Indicators to Land-Usechanges: New Concept and Examples from Conversion of Indonesian Rain Forest to Plantations. *Ecological Indicators* 67: 49–57. DOI: 10.1016/j.ecolind.2016.02.039

Hani, A., Fauziyah, E., Widyaningsih, T. S., and Kuswantoro, D. P. 2018. Potency and Agroforestry Patterns that Support Bamboo Sustainability in Sukaharja Village, Ciamis District. *Jurnal Wasian* 5(2): 115–125. DOI: 10.62142/sn6y5674

Hardiansyah, G., Indrianingrum, D. R., Anwari, M. S., Haryono, Z., Diba, F., Ekamawanti, H. A., and Yani, A. 2024. Carbon Sequestration in the Green Open Spaces along Primary Road of Pontianak City, West Kalimantan, Indonesia. *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan* 14(1): 190–200. DOI: 10.29244/jpsl.14.1.190

Hemel, S. A. K., Hasan, M. K., Akter, R., Roshni, N. A., Sayem, A., Rasul, S., and Islam, M. T. 2024. Delving Into *Piper chaba*- Based Agroforestry System in Northern Bangladesh: Ecosystem Services, Environmental Benefits, and Potential Conservation Initiatives. *Trees, Forests and People* 16:100523. DOI: 10.1016/j.tfp.2024.100523

Hidayati, S., Zuhud, E. A. M., Adiyaksa, I. K., and Al Manar, P. 2021. Review: Etnotaksonomi dan Bioekologi Tumbuhan Pasak Bumi (*Eurycoma longifolia* Jack.). *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan* 11(2): 177–188. DOI: 10.29244/jpsl.11.2.177-188

Hutagaol, R. 2020. Potensi Tumbuhan Lokal di Areal Tembawang Desa Suka Jaya Kabupaten Sintang. *Jurnal Piper* 16(30): 61–76. DOI: 10.51826/piper.v16i30.378

Hutagaol, R., and Sundi. 2021. Keanekaragaman Jenis Tumbuhan Buah Edibel pada Areal Agroforestri Tembawang Desa Bedayan Kabupaten Sintang. *Jurnal Piper* 17(2): 132–136. DOI: 10.51826/piper.v17i2.542

Jones, R. F., Kam, H., and Potter, C. 2023. Are Landholders Willing to Collaborate Under Elms? Promoting Collaborative Conservation on A Landscape Scale in The UK. *Journal of Rural Studies* 103: 103109. DOI: 10.1016/j.jrurstud.2023.103109

Kamsani, K., Franco, F. M., and Slik, F. 2020. A Comparative Account of The Traditional Healing Practices of Healers and Non-Healers in The Kiudang Area of Brunei Darussalam. *Journal of Ethnopharmacology* 256: 112788. DOI: 10.1016/j.jep.2020.112788

Kardiman, R., and Putri, I. L. E. 2023. Structure of Tree Community on Agroforestry Parak in Peri-Urban Areas District of Lubuk Alung Padang Pariaman. *Bioscience* 7(1): 14–22. DOI: 10.24036/0202371122621-0-00

Kotowska, M. M., Leuschner, C., Tridariati, T., Meriem, S., and Hertel, D. 2015. Quantifying Above- and Belowground Biomass Carbon Loss with Forest Conversion in Tropical Lowlands of Sumatra (Indonesia). *Global Change Biology* 21: 3620–3634. DOI: 10.1111/gcb.12979

Kühling, M., Alamsyah, Z., and Sibhatu, K. T. 2022. Agrarian Change, Livelihood Dynamics and Welfare Outcomes: Evidence from Plantation Crop Farmers in Indonesia. *Journal of Environmental Management* 311: 114864. DOI: 10.1016/j.jenvman.2022.114864

Laura, C. T., and Darmawan, A. 2020. Monitoring Agroforestry for REDD+ Implementation Using Remote Sensing Data and Geographic Information System: A Case Study of Repong Damar, Pesisir Barat Lampung. *IOP Conf. Series: Earth and Environmental Science* IOP Publishing. DOI: 10.1088/1755-1315/538/1/012015

Lempang, M., and Suhartati. 2013. Potensi Pengembangan Cempedak (*Artocarpus integer* Merrr.) pada Hutan Tanaman Rakyat Ditinjau dari Sifat Kayu dan Kegunaannya. *Jurnal Info Teknis Eboni* 10(2): 69–83. DOI: 10.20886/buleboni.5012

Lin, B. B. 2007. Agroforestry Management as An Adaptive Strategy Against Potential Microclimate Extremes in Coffee Agriculture. *Agricultural and Forest Meteorology* 144: 85–94. DOI: 10.1016/j.agrformet.2006.12.009

Maladi, Y. 2013. Kajian Hukum Kritis Alih Fungsi Lahan Hutan Berorientasi Kapitalis. *Jurnal Dinamika Hukum* 13(1): 109–-123. DOI: 10.20884/1.jdh.2013.13.1.160

Mizuno, K., Mugniesyah, S. S., Herianto, A. S., and Tsujii, H. 2013. Talun-Huma, Swidden Agriculture, and Rural Economy in West Java, Indonesia. *Southeast Asian Studies* 2(2): 351–381.

Mulyoutami, E., Tata, H. L., Silvianingsih, Y. A., and van Noordwijk, M. 2023. Agroforests as The Intersection of Instrumental and Relational Values of Nature: Gendered, Culture-Dependent Perspectives?. *Current Opinion in Environmental Sustainability* 62: 101293. DOI: 10.1016/j.cosust.2023.101293

Nguyen, Q., Hoang, M. H., Oborn, I., and van Noordwijk, M. 2013. Multipurpose Agroforestry as A Climate Change Resiliency Option For Farmers: An Example of Local Adaptation in Vietnam. *Climatic Change* 117: 241–257. DOI: 10.1007/s10584-012-0550-1

Pardon, P., Reheul, D., Mertens, J., Reubens, B., De Frenne, P., De Smedt, P., Proesmans, W., Van Vooren, L., and Verheyen, K. 2019. Gradients in Abundance and Diversity of Ground Dwelling Arthropods as A Function of Distance To Tree Rows in Temperate Arable

Agroforestry Systems. *Agriculture, Ecosystems and Environment* 270–271: 114–128. DOI: 10.1016/j.agee.2018.10.017

Prabawani, B., Hadi, S. P., Fisher, M. R., Warsono, H., Dewi, R. S., and Ainuddin, I. 2024. Socioeconomic Perspective of Agroforestry Development in Central Java. *Environmental and Sustainability Indicators* 22: 100354. DOI: 10.1016/j.indic.2024.100354

Prasmatiwi, F. E., Evizal, R., and Zahra, A. R. 2022. Pengadaan Bahan Baku Nira dan Nilai Tambah Pengolahan Gula Aren di Desa Air Kubang, Air Naningan Kabupaten Tanggamus. *Mimbar Agribisnis Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis* 8(2): 1188–1201. DOI: 10.25157/ma.v8i2.7863

Quinn, J. E., Johnson, R. J., and Brandle, J. R. 2014. Identifying Opportunities for Conservation Embedded in Cropland Anthromes. *Landscape Ecology* 29: 1811–1819. DOI: 10.1007/s10980-014-0098-8

Pitopang, R. 2018. The Phytososiological of Agroforestry Tembawang at Secundary Forest Sekadau Hulu in West Kalimantan Indonesia. *IOP Conf. Series: Journal of Physics: Conf. Series* 1242: 012041. DOI: 10.1088/1742-6596/1242/1/012041

Rahu, A. A., Hidayat, K., Ariyadi, M., and Hakim, L. 2013. Ethnoecology of Kaleka: Dayak's Agroforestry in Kapuas, Central Kalimantan Indonesia. *Research Journal of Agriculture and Forestry Sciences* 1(8): 5–12.

Ratnakaran, A. P., Sejian, V., Jose, V. S., Vaswani, S., Bagath, M., Krishnan, G., Beena V., Devi P. I., Varma G., and Bhatta, R. 2017. Behavioral Responses to Livestock Adaptation to Heat Stress Challenges. *Asian Journal of Animal Sciences* 11(1): 1–13. DOI: 10.3923/ajas.2017.1.13

Roslinda, E., Prosola, F. W., and Mariani, Y. 2023. The Patterns of Agroforestry and Its Contribution to the Community Income. *Jurnal Sylva Lestari* 11(3): 543–557. DOI: 10.23960/jsl.v11i3.749

Santhyami, Basukriadi, A., Patria, M. P., and Abdulhadi, R. 2018. The Comparison of Aboveground C-Stock Between Cacao-Based Agroforestry System and Cacao Monoculture Practice in West Sumatra, Indonesia. *Biodiversitas* 19(2): 472–479. DOI: 10.13057/biodiv/d190214

Santhyami, Basukriadi, A., Patria, M. P., and Abdulhadi, R. 2020. Tree Community Composition and Structure of Cacao (*Theobroma cacao* L.) Based Agroforestry in West Sumatera, Indonesia. *Journal Bioeksperimen* 6(1): 52–59. DOI: 10.23917/bioeksperimen.v6i1.2795

Santhyami, Roziaty, E., and Suparti. 2023. Trade-Off Between Carbon Offset and Economic Benefit: Potential of Cocoa-Based Agroforestry Systems in The Voluntary Carbon Market. *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 124(2): 101–114. DOI: 10.17170/kobra-202311028937

Santoso, T., Paridduar, R., and Bintoro, A. 2023. Plant Diversity Under Traditional Agroforestry System of Repong Damar in Pesisir Barat District, Lampung Province, Indonesia. *Biodiversitas* 24(8): 4675–4684. DOI: 10.13057/biodiv/d240849

Schepern, L. 1860. Aanteekeningen omtrent de bevolking van Billiton. In: Munich, J., and Netscher, E. (Eds.), *Tijdschrift voor Indische Taal-, Land- en Volkenkunde*. Lange & Co, Batavia.

Silvianingsih, Y. A., Hairiah, K., Suprayogo, D., and van Noordwijk, M. 2021. Kaleka Agroforest in Central Kalimantan (Indonesia): Soil Quality, Hydrological Protection of Adjacent Peatlands, and Sustainability. *Land* 10: 856. DOI: 10.3390/land10080856

Susanti, A. D., Wijayanto, N., and Hikmat, A. 2018. The Diversity of Medicine Plant in Repong Damar Agroforestry of Krui, Lampung Province. *Media Konservasi* 23(2): 162–168. DOI: 10.29244/medkon.23.2.162-168

Tibarrang, N., Saroinsong, F. B., and Walangitan, H. D. 2022. Analisis Potensi Kayu Pertukangan pada Hutan Rakyat di Desa Rumoong Atas Kecamatan Tareran. *Silvarum* 1(1): 15–21. DOI: 10.35791/sil.v1i1.41303

Van Noordwijk, M. 2021. Agroforestry-Based Ecosystem Services: Reconciling Values of Humans and Nature in Sustainable Development. *Land* 10(7): 699. DOI: 10.3390/land10070699

Wang, Z., Wang, T., Zhang, X., Wang, J., Yang, Y., Sun, Y., Guo, X., Wu, Q., Nepovimova, E., Watson, A. E., and Kuca, K. 2024. Biodiversity Conservation in The Context of Climate Change: Facing Challenges and Management Strategies. *Science of The Total Environment* 937: 173377. DOI: 10.1016/j.scitotenv.2024.173377

Wijayanto, N., and Briliawan, B. G. 2022. Study on the Growth of Falcataria moluccana at 14-Month-Old and the Productivity of Rice Plant (*Oryza sativa*) IPB 3S in Agroforestry System. *Jurnal Sylva Lestari* 10(3): 372–388. DOI: 10.23960/jsl.v10i3.573

Willmott, A., Willmott, M., Grass, I., Lusiana, B., and Cotter, M. 2023. Harnessing The Socio-Ecological Benefits of Agroforestry Diversification in Social Forestry with Functional and Phylogenetic Tools. *Environmental Development* 47: 100881. DOI: 10.1016/j.envdev.2023.100881

Zuhud, E. A. M. 2007. *Sikap Masyarakat dan Konservasi, Suatu Analisis Kedawung (Parkia timoriana (DC) Merr.) sebagai Stimulus Tumbuhan Obat bagi Masyarakat, Kasus di Taman Nasional Meru Betiri*. [Dissertation]. IPB University. Bogor, Indonesia.

Zuhud, E. A. M., Al Manar, P., Zuraida, and Hidayati, S. 2020. Potency and Conservation of Aren (*Arenga pinnata* (Wurmb) Merr.) in Meru Betiri National Park, East Java-Indonesia. *Jurnal Manajemen Hutan Tropika* 26(3): 212-221. DOI: 10.7226/jtfm.26.3.212