Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Development Strategy of Potential Non-Timber Forest Product Commodities in the Boti Indigenous Community, Indonesia

Fransiskus Xaverius Dako[1], Retno Setyowati[2], Wieke Herningtyas[3], Eko Pujiono[3*], Imam Budiman[4], Oskar Krisantus Oematan[2], Blasius Paga[1]

[1]Forestry Department, State Agricultural Polytechnic of Kupang, Jl. Prof. Herman Yohannes, Lasiana, Kupang, Indonesia 85228
[2]Environmental and Forestry Instruments and Standard Implementation Agency of Kupang, Ministry of Environment and Forestry, Jl. Alfons Nisnoni No. 7 Airnona, Kota Raja, Kupang, Indonesia 85119
[3]Research Center for Ecology and Ethnobiology, National Research and Innovation Agency, Jl. Raya Jakarta Bogor Km. 46, Komplek CSC Cibinong, Bogor, Indonesia 16911
[4]Agency for Standardization of Environmental and Forestry Instruments, Ministry of Environment and Forestry, Gedung Manggala Wanabakti Blok VII Lantai 10 Jl. Gatot Subroto Jakarta, Indonesia 10270

Received Februari 27, 2024/Accepted June 24, 2024

Abstract

The Boti indigenous community on Timor Island utilizes non-timber forest products for their daily lives, but there is a lack of information about their potential and sustainable use, which requires an empowerment initiative for them. This study aims to investigate the potential and utilization of NTFPs while also formulating an NTFPs development strategy in Boti Village. A combined method, including literature review, plot measurement, socio-economic surveys, and interviews, was used to collect data. NTFPs were evaluated for their potential using the importance value index; their utilization was studied through an ethnobotanical survey; and an NTFP development strategy was formulated utilizing a SWOT-PESTLE analysis. The results show that three types—candlenut, tamarind, and lac tree—dominate among the 13 species of the NTFPs. NTFPs are used for various purposes, such as medicinal, natural dye weaving, and selling to raise household income. The NTFPs development in Boti village needs to be prioritized, with a focus on increasing the added value of NTFPs through funding, facilitation, technological assistance, planting and preserving, collaborating more, and enforcing formal and customary rules. The results can be used as a baseline or reference for sustainable NTFP management and the empowerment of the Boti indigenous community.

Keywords: *NTFPs, development strategy, SWOT-PESTLE analysis, indigenous community empowerment, East Nusa Tenggara*

**Correspondence author, email*: *eko.pujiono@brin.go.id*

Introduction

The three stages of road map research related to indigenous communities include acknowledgment, protection, and empowerment of indigenous communities, as per the Draft Law (RUU) on indigenous communities (DPR, 2018). The first stage, namely research on the recognition of indigenous communities, focused on studies of the identification, verification, validation, and enactment of regarding the recognition of indigenous peoples. The second stage, research on indigenous peoples' recognition, focuses on how to protect their rights. One example of a research topic is the protection or preservation of local wisdom. After creating the desired conditions, namely the establishment and protection of indigenous communities, the third stage of research will focus on community empowerment.

Exploring potential and planning strategies for developing non timber forest products (NTFPs) can be categorized as community empowerment studies (Gusmailina et al., 2020; Harbi et al., 2020). According to Law Number 41/1999, non-timber forest products are biological, non-biological objects and their derivatives, as well as services originating from forests other than wood, which can be plants and their derivatives such as rattan, grass, mushrooms, medicinal plants, rubber, resins, and others, as well as parts of plants or those produced by plants in the forest, and animal forest products and their derivatives such as wild animals and their captive-bred animals, hunting animals, and other animals, as well as their parts or what they produce. Regulation Law Number 41/1999 concerning Forestry and Minister of Environment and Forestry Regulation Number 8/2021 concerning Forest Utilization states that one of the permitted uses is the use of NTFPs in production and protected forest areas. Therefore, the role of NTFPs in providing income for indigenous communities or residents around forests and for conservation needs to be researched (Pasaribu et al., 2021).

In the local scope, the Regional Government of East Nusa Tenggara (NTT) Province has established Regional Regulation Number 6/2017 concerning the management of NTPFs in NTT Province as a legal umbrella for managing

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

and utilizing existing types of NTFP commodities. As a follow-up to this Regional Regulation, Governor's Decree Number 404/KEP/HK/2018 was issued concerning the determination of 14 (fourteen) superior NTFP commodities, namely candlenut (*Aleurites moluccanus*), bamboo (*Bambusa* sp.), honey, cashew (*Anacardium occidentale*), areca nut (*Areca catechu*), *lontar* (*Borrasus flabellifer*), tamarind (*Tamarindus indica*), nutmeg (*Myristica fragrans*), moringa (*Moringa oleifera*), betel (*Piper betle*), avocado (*Persea americana*), cajuput oil (*Melaleuca leucadendra*), lac insects (*Laccifer lacca*), and walnuts (*Juglans regia*) (NTT Provincial Economic Bureau, 2022).

The policy for developing NTFPs, whether originating from inside or outside the forest area, is expected to be able to reduce community dependence on timber forest products, increase the income of communities around the forest from NTFPs, raise public awareness to maintain forest areas, increase foreign exchange from NTFPs, and create jobs from commodities NTFPs (Rahman et al., 2021). Through the development of NTFPs, it is hoped that the utilization of NTFPs will be optimized, which includes the number of types, forms, processing stages, and quality (Muttaqin et al., 2021). Optimizing regional potential in developing NTFPs as an alternative source of food, a source of medicinal ingredients, a fiber producer, and a rubber producer can improve the local and national economies (Wibowo, 2017).

The development of NTFPs in Boti Village is important for improving community welfare byoptimizing potential resource utilization. The Ministry of Villages, Development of Disadvantaged Regions, and Transmigration compiles the Developing Village Index (IDM) and categorizes Boti Village in East Nusa Tenggara as a disadvantaged village (Kemendesa, 2023). Disadvantaged villages are characterized by suboptimal utilization of potential resources (natural and human). Experts believe that Boti Village has not managed its potential NTFP optimally, nor has the strategy for its development been well-structured. Previous studies in Boti Village related to the potential of NTFPs, although within the South-Central Timor district, there is already a grand strategy for the development of NTFPs (CIFOR-ICRAF, 2016), but the strategy at the village level, which has its own unique biophysical and socio-economic conditions, has not yet been developed.

Since each village has different socio-economic and biophysical conditions, it is necessary to plan a strategy for developing NTFPs at the village level. Village level NTFP's development strategies need to be formulated because the community can understand the problems faced, plan the necessary steps, carry out the plans that have been programmed, enjoy the NTFP's products, and preserve the programs that have been formulated and implemented. In the end, it is hoped that the development of NTFPs will be able to encourage village community empowerment in the future.

Boti Village has potential non-timber forest products (NTFPs), which are dominated by candlenuts and tamarind (Sumanto & Takandjandji, 2016; Herningtyas et al., 2023). Candlenut and tamarind are the dominant NTFPs in Boti Village, but there are definitely other potential NTFPs found. Despite a previous study (CIFOR-ICRAF, 2016) that developed a comprehensive strategy for managing NTFPs at the South Central Timor district level, including potential mapping and the formulation of a district-level strategy, the results of field observations in Boti Village indicate that the management of NTFPs in the village is not yet optimal. Initial observations in the field show that NTFPs management starts with collection and then ends with village middlemen (trader collectors at the village level). The community has not made any efforts to increase the added value of NTFP products, which could increase the selling price. It is an opportunity to develop NTFPs in the Boti customary forest to be directed towards economic development and improving the welfare of the Boti community. Apart from that, data and information regarding the potential (supply) and demand (demand) for potential NTFP commodities in Boti Village are also not yet available. This data and information is useful for providing an overview of business feasibility and economic benefits, as well as for developing NTFP development strategies.

NTFP development strategies can be formulated using several techniques, including the strengths, weaknesses, opportunities, threats (SWOT) and political, economic, social, technological, legal, and environmental (PESTLE) approaches. A strategic assessment method called SWOT analysis is frequently used in companies to evaluate possibilities and threats from the outside as well as internal weaknesses and strengths. Since its inception, SWOT analysis has been used not only for corporate purposes but also frequently in the forestry industry to assist in the formulation of strategies that would help maintain or develop forests. However, PESTLE, an analytical framework, identifies and evaluates externally impacting aspects that stem from socio-cultural, political, economic, technical, legal, and environmental factors. This analytical tool is helpful in giving institutions a better understanding of environmental variables that could affect their operations and necessitate the development of suitable mitigation solutions. Combining SWOT and PESTLE analysis yields a more complete picture, which aids the institution in deciding on its strategic course and prospects for the future. Previous research demonstrates that integrating SWOT and PESTLE has proven capable of designing strategies for promoting smart agriculture in Turkey as well as digital transformation in the agricultural sector in Spain (Parra-Lopez et al., 2021; Uztürk & Büyüközkan, 2023). Motivated by the advantages of combining PESTLE and SWOT analysis, this study attempts to build a strategy for NTFP development in order to empower the indigenous Boti community.

Methods

Study area The Boti tribe lives in Boti Village, which is administratively located in Ki'e District, South Central Timor Regency, NTT Province (Figure 1). Boti Village is located in the Timor Mountains, with steep topography and land prone to landslides. The semi-arid climate conditions cause Boti Village to have limited water sources. The Boti tribe is part of the Amunaban sub-tribe, which is one of the 3 large tribes on the island of Timor (Amanatun, Amanuban, and Mollo). The inner Boti tribe still practices *halaika*, a local tradition and culture Meanwhile, the outer Boti tribe is open to development and has embraced Protestant and Catholic Christianity.

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Data collection Sampling for assessing NTFP potential was carried out using stratified-purposive sampling with observation units at the hamlet level (there are 4 hamlets in Boti Village). In each hamlet a transect will be made (according to information from local residents), and within the transect route, a plot will be made to observe the number and attributes of plants (height and diameter). Data collection plots consist of: plot 20 m × 20 m for tree level (diameter > 20 cm), plot 10 m × 10 m for pole level (diameter 7–20 cm), plot 5 m × 5 m for weaning level (height 150 cm, diameter 2–7cm) as well as a 2 m × 2 m plot for seedling level (height < 15 cm, diameter 2 cm) (Kusmana, 1997).

Ethnobotanical data collection on the use of NTFPs was obtained through interviews, observation and documentation (Cunningham, 2001; Andika, 2016). Informants were selected using the snowball sampling method, where the determination of the next informant was based on the previous informant (key informant). The target informants were 76 indigenous community households, with the primary criterion being that these households engaged in the practice of gathering NTFPs. The ethnobotanical approach is used to study the relationship between human culture and natural surroundings. Ethnobotany is the study of human-plant relationships that include ecological, economic, social, non-economic, and medicinal aspects, in addition to plant use (Mulu et al., 2020). This research focuses on people's knowledge or use of NTFPs. In order to verify the ethnobotanical survey, we consulted with the king and community leaders of the Boti tribe, who understand more about the potential and use of NTFPs.

The strategy for developing NTFPs in Boti Village will be prepared using a SWOT-PESTLE approach. The data collected is related to strengths, weaknesses, opportunities, and threats for NTFP development in Boti Village. Using the six essential aspects of PESTLE, i.e., political, economic, socio-cultural, technology, legal, and environment, each SWOT element was thoroughly examined. Data collection for the SWOT-PESTLE approach was carried out using a mix of a field survey, a literature review, and a socio-economic household survey from parties related to NTFP management. In order to verify and improve the elements of the SWOT-PESTLE study, three NTFP experts (from relevant stakeholders, i.e., the government, NGO, and academic institution) were consulted (Uztürk & Büyüközkan, 2023).

Data analysis The NTFP potential data was analyzed descriptively in tabular form. Vegetation analysis uses the importance value index and the Shannon species diversity index of general diversity (Tamene et al., 2023). The important value index (IVI) is the sum of the percentages of relative quantitative parameters (density, frequency, and dominance) (Muli et al., 2021). A plant community uses the species diversity index to determine the level of diversity of stand types in a plant community (Suchiang et al., 2020). The criteria for determining the level of diversity are H'<1, indicating low species diversity; H = 1–3, indicating a medium level of species diversity; and H'>3, indicating a high level of species diversity (Kusuma et al., 2018).

The ethnobotanical data on the use of NTFPs that has been collected is compiled in table form and analyzed descriptively to obtain information on the existing forms of use and the parts used. The use of NTFPs is divided into two, namely economic value and medicinal plants.

SWOT-PESTLE analysis consists of several steps. The first step is to analyze internal factors (local analysis), which contains a discussion of strengths and weaknesses. The second step is to analyze external factors (global analysis) which contains a discussion of opportunities and threats (Reihanian et al., 2012). This work stands out for its thorough analysis of each SWOT element, utilizing the six core elements of PESTLE methodology. Combining these analytical models guided us understand the NTFP management in Boti better and more comprehensively. The final step was to formulate the NTFP development strategy based on SWOT-PESTLE analysis and expert assessments.

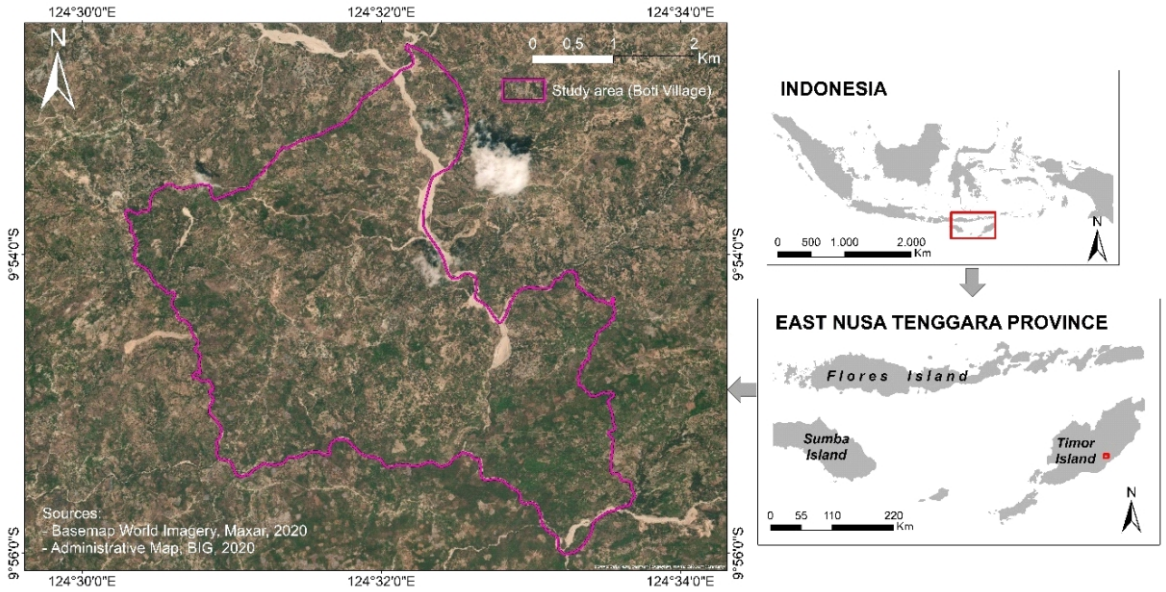

Figure 1 Study area, Boti Village (purple polygon), presented by 2020 Maxar satellite imagery.

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Results and Discussion

Potential for NTFPs in Boti Village An inventory of potential NTFPs by creating sample plots in people's gardens with a total of 109 plots. The inventory focused on non-timber forest products with potential economic value and medicinal uses. Results show that there are 13 species, consisting of 9 families. The species and number of NTFP individuals found in Boti village are presented in Figure 1.

A. molucannus (candlenut), *Schleichera oleosa* (lac tree), and *T. indica* (tamarind) are NTFPs with economic and ecological potential because they are characterized by natural regeneration conditions with sustainable growth rates, according to Figure 2. The trend shows that the trend of the highest amount of vegetation growth at the seedling level, followed by saplings, poles, and trees with a normal proportion of individuals. These conditions are good for the process towards the formation of complex structures with a diverse collection of species in communities, consisting of trees, poles, saplings, and seedlings that create a multi-layered structure of species composition (Wang et al., 2024). Natural regeneration is a natural biological process that increases forest resources within a dynamic ecosystem so that they can replace themselves and help preserve genetic identity and diversity (Yang et al., 2014). Natural forest regeneration is essential to ensure spatial and temporal consistency in forest ecosystems by replacing old trees with poles, saplings, and saplings. This is critical to advancing forest succession, sustainable development, and preserving forest health (Puhlick et al., 2012; Chen & Cao, 2014).

The IVI is a parameter that describes the role of plant species in the community (Wijana, 2014). The existence of a species shows the level of adaptation to the habitat and high tolerance to environmental conditions (Oktavia et al., 2021). Meanwhile, the species diversity index reflects the stability of a community (Suchiang et al., 2020). The number of species in a community and the proportion of individuals of each type that make up the community determine the high or low value of the species diversity index (Candri et al., 2023). The IVI and species diversity index are displayed in Table 1.

Vegetation growth based on the highest IVI (70.16%) at the seedling level was found in *P. betle*, while the lowest IVI (4.27%) was in *Artocarpus altilis* and *Annona muricata*. Sapling growth rate, the highest IVI (67.04% and 46.21%) were respectively found in *Corypha utan* and *Aleurites molucannus*, while the lowest IVI (0.06%, 0.16, and 0.08%) were respectively found in *A. molucannus*, *Annona squamosa*, and *A. catechu*. Vegetation growth at the pole and tree levels is dominated by *A. molucannus* and *T. indica*.

The high IVI for several potential NTFPs, such as *P. betle*, *C. utan*, *A. molucannus*, and *T. indica*, indicate the ability to adapt to the habitat and wide tolerance to the growing environment in the Boti area. The higher a species' IVI, the greater its community control, or vice versa. This can explain the dominance dominance in its community, indicating that it has succeeded in securing the majority of available resources compared to other species. The potential NTFP species diversity (H') based on the Shannon-Wiener index at all growth levels (seedlings, saplings, poles, and trees) is in the range between 0.37-0.74, so it is categorized as low because it has an H' value <1. This low potential NTFP species diversity index (H') can describe a measure of the community stability of these NTFP plants, which can be vulnerable to disturbances. The lack of diversity of potential NTFP species in Boti Village means that these species will have a high vulnerability to the threat of species disturbance and will maintain their stability and growth.

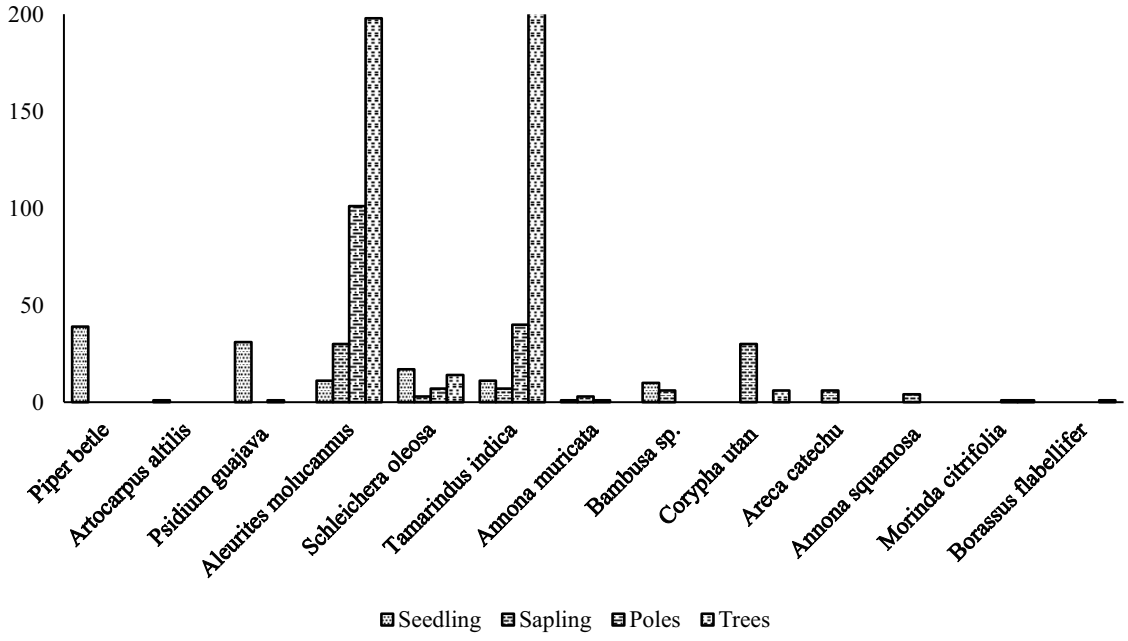

Figure 2 Number of vegetation seedlings, saplings, poles, and trees.

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Table 1 IVI values and species diversity index (H') of potential NTFPs at each level of vegetation growth in the Boti-TTS tribal area

No	Scientific name	Local name	Family	Seedling		Sapling		Pole		Tree	
				IVI	H'	IVI	H'	IVI	H'	IVI	H'
1	*Piper betle*	*Sirih*	Piperaceae	70.16	0.16	-	-	-	-	-	-
2	*Artocarpus altilis*	*Sukun*	Moraceae	4.27	0.02	-	-	-	-	-	-
3	*Psidium guajava*	*Jambu biji*	Myrtaceae	35.96	0.15	-	-	2.68	0.01	-	-
4	*Aleurites molucannus*	*Kemiri*	Euphorbiaceae	15.99	0.09	46.21	0.16	192.68	0.12	132.43	0.15
5	*Schleichera oleosa*	*Kesambi*	Sapindaceae	34.74	0.12	7.54	0.05	13.26	0.06	11.87	0.05
6	*Tamarindus indica*	*Asam*	Fabaceae	22.88	0.09	24.53	0.09	85.44	0.15	148.63	0.15
7	*Annona muricata*	*Sirsak*	Annonaceae	4.27	0.02	15.87	0.05	2.68	0.01	-	-
8	*Bambusa* sp.	*Bambu*	Poaceae	11.71	0.09	19.24	0.08	-	-	-	-
9	*Corypha utan*	*Gewang*	Arecaceae	-	-	67.04	0.16	-	-	4.79	0.03
10	*Areca catechu*	*Pinang*	Arecaceae	-	-	10.91	0.08	-	-	-	-
11	*Annona squamosa*	*Anonak*	Annonaceae	-	-	8.66	0.06	-	-	-	-
12	*Morinda citrifolia*	*Mengkudu*	Rubiaceae	-	-	-	-	3.28	0.01	1.13	0.01
13	*Borassus flabellifer*	*Lontar*	Arecaceae	-	-	-	-	-	-	1.15	0.01
				200	0.74	200	0.72	300	0.37	300	0.40

Utilization of NTFPs in Boti Village The Boti tribe community lives in harmony with nature. They use NTFPs in their surroundings to meet their daily needs, such as medicine, dyeing materials for weaving, handicraft materials, consumption, construction, etc. (Table 2). Income obtained from NTFPs is used by rural communities as additional capital to support their financial security (Harbi et al., 2018; (Kurniasih et al., 2021). The Boti tribe does not sell all NTFPs, except for A. molucannus and T. indica, but other NTFPs are economically valuable in NTT (Chamberlain et al., 2019). For example, in the Boti tribe, *A. catechu* is a must-have in every traditional ceremony.

In terms of medicine, the Boti people have their own methods and ingredients for treating various diseases (Table 3). Similar to other tribes in Indonesia, the Boti tribe continues to practice traditional disease treatment, following ancestor-passed rules and utilizing natural ingredients (Az-Zahra et al., 2021). In traditional medicine, people seek treatment from a Battra (healer) appointed by the king or seek treatment themselves using herbs. The Boti tribe community tends to choose traditional medicine due to beliefs in ancestors, nature, and people who have closer access to Battra. However, if the disease was not cured, the people held the belief that they needed to confess their error before the king. After everything has been done, the disease will heal by itself.

NTFPs production in Boti Village The NTFPs that are often found on community land are *kiu*/*asam* (*T. indica*), fenu/candlenut (*A. moluccanus*), and tarum (*Indigofera tinctoria*). According to data from BPS TTS Regency, in 2021, the production of candlenut kernels will be 18 tons, candlenuts filled with 82 tons, tamarind seeds 390 tons, and sour tamarind 24 tons. Candlenuts and tamarind are often found in Hamlet D, with an average production of 1 ton of tamarind and 600 kg of candlenuts. According to interviews with informants in Hamlet B, the average production of candlenuts was 109 kg, and tamarind was 250 kg. The Boti tribe community cultivates tamarind and candlenuts in their gardens/yards, planted with other commodities such as corn, vegetables, etc. Tamarind and candlenuts are agricultural products that support the family economy of the Boti tribe. The selling prices for tamarind and candlenuts are very volatile. Local traders manipulate the prices of tamarind and candlenuts to generate profits. The selling price for tamarind ranges from IDR5,000–10,000 kg^{-1}, while the price for candlenuts ranges from IDR20,000-30,000 kg^{-1}. When the tamarind fruit harvest season arrives, namely July-August, the community works together to help each other in harvesting. Harvesting is done by collecting tamarind seeds that have fallen to the ground and then selling them to Boti market or collecting traders (middlemen).

NTFPs development prospects East Nusa Tenggara Province has quite a large NTFPs potential, both within forest areas and outside forest areas. According to Regional Regulation Number 06/2017 concerning the management of NTFPs in NTT Province, NTFPs have potential and can provide significant benefits for improving community welfare. Based on the superior NTFPs of South-Central Timor Regency, candlenuts, tamarind, areca nuts, bamboo, betel, and herbs are included as superior commodities that have the potential to be developed. In Boti Village, NTFP sales are limited to tamarind and candlenuts. Meanwhile, bamboo, herbs, areca nuts, and betel are mostly consumed daily. However, several Boti people also sell areca nuts at the Boti market, a weekly Friday event. At present, the village of Boti sells tamarind and candlenuts as raw materials. Marketing is also still carried out individually through the services of collecting traders (middlemen).

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Table 2 NTFPs with economic importance

No	Scientific name	Local name	Family	Part of plant used	Utilization
1	*Tamarindus indica*	*Kiu/asam*	Fabaceae	Fruit	Food material
				Fruit skin	Pig feed
				Stem	Traditional house pillar
2	*Aleurites moluccana*	*Fenu/kemiri*	Euphorbiaceae	Fruit	Cotton thread lubricant, food material
				Stem	House wall
				Seed	Candle replacement
3	*Jatropha curcas*	*Paku/ Jarak pagar*	Euphorbiaceae	Tannin	Treating fungus in baby mouth
				Leaf	Fever
				Fruit	Candle replacement
				Seed	*Bninis* (cotton seed separator tool for making weaving) lubricants
4	*Acacia leuchophloea*	*Kabesak*	Fabaceae	Stem	Traditional house pillar
				Leaf	Animal feed
5	*Pterocarpus indicus*	*Matani/ kayu merah*	Fabaceae	Stem	House pillar, furniture, lopo roof
6	*Sterculia foetida*	*Buah nisa/kepuh*	Malvaceae	Stem	House wall, erosion barrier
				Seed	Lubricate green beans so they don't get eaten by insects, believed to act as a lightning rod by wearing them around the neck
7	*Ficus* sp.	*Nun manu/ beringin*	Moraceae	Stem bark	Woven into rope as material for kalai bags
				Stem	Erosion barrier
8	*Areca catechu*	*Puah/pinang*	Arecaceae	Fruit	Chewed with betel
				Stem	Lopo ceiling, bed base, fence
				Stem	Water storage container
9	*Borassus flabellifer*	*Tua/lontar*	Arecaceae	Fruit	Food material
				Flower	Ingredients for palm wine and sugar
				Young leaf	Woven mats, place for betel nut
				Old leaf	Roof
				Stem	Musical instruments, house rafters, firewood
10	*Corypha utan*	*Tune/gewang*	Arecaceae	Young leaf	Into ropes, woven into kalai bags
				Old leaf	Traditional house roof
				Stem	House wall
				Flower	Palm wine ingredients
				Stem	Food material, tambur instruments
11	*Bambusa vulgaris*	*Oh/bambu*	Poaceae	Stem	Fence, bed base, betel nut holder, whiting container, drinking utensils, water container, ashtray, erosion control plant
12	*Exocarpus latifolia*	*Papi*	Santalaceae	Bark	Chewed with betel and lime as a substitute for areca nut
13	*Indigofera tinctoria*	*Tarum/nila*	Fabaceae	Leaf	Natural dyes for woven fabrics

Developing NTFPs into processed products can provide added value opportunities and increase community income. NTFPs are a commodity that has high economic value and can provide added value so that in the future, the scope of NTFPs exploitation can show industrial development not only moving in the upstream industry (raw materials) but also covering the middle industry (semi-finished products) and downstream (finished products or products that are ready to be used by consumers directly) (Mandang et al., 2018).

Candlenuts are the most economically important plant in Boti Village, but their use is still limited to spices (Variyana et al., 2023). Candlenuts contain a high oil content of around 30-60% (Shaah et al., 2021). This oil mainly consists of unsaturated fatty acids, which are characterized by a greater proportion of polyunsaturated acids (>89%), and also contains small amounts of aromatic oils, such as essential oils (Subroto et al., 2017; Cabral et al., 2016). This means candlenuts have the potential as raw materials for vegetable oil, which can be processed into candlenut oil and a candle substitute, as done by the Boti people.

In accordance with its use in Boti Village, tamarind can be processed into drinks with medicinal properties. Tamarind is rich in sugar, and the combination of sourness and sweetness makes tamarind an ideal food (Kanfon et al., 2023). Fibri et al. (2022) attribute the sour taste of tamarind to its high vitamin C content. Tamarind has bioactive compounds such as phenolics, alkaloids, saponins, steroids, and terpenoids (Fagbemi et al., 2022). Tamarind is efficacious as a laxative, anti-infective and anti-inflammatory, antitumor, antioxidant, and antidiabetic (Kanfon et al., 2023). Tamarind syrup can be prepared by brewing it and adding sugar. It is processed into a sour turmeric herbal drink by mixing tamarind with Curcuma domestica, brown sugar, and water (Kasih, 2022).

Based on the potential of NTFPs and the use of existing

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Table 3 NTFPs for medicinal properties

No	Scientific name	Local name	Family	Part of plant used	Medicinal properties
1	*Annona squamosa*	*Ata/srikaya*	Annonaceae	Stem bark Leaf	Headache Fever
2	*Indigofera tinctoria*	*Tarum*		Root	Headache
3	*Carica papaya Linn*	*Ukase/pepaya*	Caricaceae	Leaf Stem bark	Fever Headache
4	*Cocos nucifera*	*Noah/kelapa*	Arecaceae	Fruit	Fever
5	*Solanum melongena*	*Kaulili/terong hijau*	Santalaceae	Fruit	Toothache
6	*Tamarindus indica*	*Kiu/asam*	Solanaceae	Leaf Fruit	Smallpox, itchy, wound queasy
7	*Aleurites moluccanus*	*Fenu/kemiri*	Euphorbiaceae	Seed	Hemorrhoids
8	*Punica granatum*	*Inkase/delima*	Lythraceae	Leaf	Fever
9	*Jatropha curcas*	*Paku/jarak*	Euphorbiaceae	Leaf Tannin Stem bark	Fever Anti-fungal Stomachache
10	*Allium sativum*	*Pio muti/ bawang putih*	Amaryllidaceae	Tuber	Fever
11	*Lagenaria siceraria*	*Bakfane/labu air*	Cucurbitaceae	Leaf shoot Young fruit	Hemorrhoids Cancer
12	*Gossypium hirsutum*	*Abas fuaf/kapas*	Malvaceae	Young fruit	Ear pain
13	*Cajanus cajan*	*Tunis/kacang turis*	Fabaceae	Fruit/seed	Vomiting
14	*Psidium guajava*	*Koi/jambu biji*	Myrtaceae	Leaf	Diarrhea
15	*Zingiber officinale*	*Naye/jahe*	Zingiberaceae	Rhizome	Queasy
16	*Piper retrofractum*	*Unono/sirih hutan*	Piperaceae	Fruit	Post natal
17	*Curcuma longa*	*Huki/kunyit*	Zingiberaceae	Rhizome	Post natal
18	*Piper betle*	*Sirih*	Piperaceae	leaf	Headache (mixed anonak)
19	*Areca cathecu*	*Puah/pinang*	Arecaceae	Seed	Headache (mixed betel)
20	*Wrightia pubescens*	*Litsusu/bentawas*	Apocynaceae	Stem bark	Wound, bleeding
21	*Alstonia scholaris*	*Pole/pulai*	Apocynaceae	Stem bark	Anti-malaria
22	*Pterocarpus indicus*	*Matani/angsana*	Fabaceae	Tannin	Anti-fungal
23	*Litsea glutinosa*	*Klone*	Lauraceae	Leaf, stem bark	Headache, stomachache

NTFPs, there are several opportunities for developing other types of NTFPs. Traditional medicine can be developed from concoctions between *P. betle* and *A. squamosa,* which are efficacious for headaches, *Psidium guajava* for diarrhea, and *Morinda citrifolia,* which is efficacious as an antioxidant, anti-cancer, antimicrobial, anti-psychotic, anti-hepatitic, immunomodulator, and stimulant of the central nervous system (Silalahi, 2020). The development of NTFPs for handicrafts can be developed from *Corypha utan* for making ropes and bags (kalai), *A. catechu* for making bedding, and *B. flabellifer* for making woven products.

Plants that are socially, technically, commercially, and ecologically acceptable to the local community can be domesticated to create NTFPs, which might be developed as a small business for the indigenous Boti community and as a means of optimizing land in customary forests. These prospective NTFPs can be a source of sustainable income. Even though the Boti community implements a traditional way of life together with nature, a small business is needed so that the Boti community can get income not only based on harvesting but also add added value through the processing and packaging of NTFPs.

The use of NTFPs by harvesting flowers, sap, leaves, and fruit can minimize tree damage and is a priority for preserving customary forests in Boti. Even though some damaging behaviors, such as prematurely harvesting fruit or flowers, can occur, they may impact the process of natural regeneration (Guariguata et al., 2010). Therefore, to reduce the risk of damage to trees, the use of plant parts such as sap, leaves, fruit, or other tree parts must be done in the correct way (Pasaribu et al., 2021).

SWOT-PESTLE analysis for NTFPs management in Boti Village There are two primary categories in which the SWOT-PESTLE analysis results are examined: internal factors, which are represented by strengths and weaknesses, and external variables, which are represented by opportunities and threats. Each SWOT category is detailly examined using six aspects of the PESTLE framework. SWOT-PESTLE analysis results for NTFPs development in Boti Village are presented in Table 4.

Internal factors: Strengths from a political aspect, its internal strength is its conformity with the government's

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

Table 4 SWOT-PESTLE analysis of NTFPs development in Boti Village

PESTLE	SWOT–Internal factors	
	Strength	**Weaknesses**
Political	One of the visions and missions of the district government is to improve the welfare of the community through the development of NTFPs **(S.P)**	Village government support is not yet optimal **(W.P)**
Economical	The potential for NTFP production is quite promising **(S.Ec)**	• People's income is low and business capital is limited **(W.Ec.1)** • Lack of control of market information so that farmers' bargaining position is low **(W.Ec.2)**
Socio-cultural	Potential of human resources who have a hardworking character and have an awareness for preserving NTFPs **(S.S)**	• Community education level is low **(W.S.1)** • NTFPs management institutions have not yet been developed **(W.S.2)**
Technology	There are simple technology applications in NTFP planting and harvesting activities **(S.T)**	• NTFPs post-harvest processing technology does not yet exist **(W.T.1)** • Minimal facilities and infrastructure for processing NTFPs **(W.T.2)** • There is no data base for potential NTFPs **(W.T.3)**
Legal	There are customary rules governing the management and harvesting of forest products **(S.L)**	There are no formal regulations regarding NTFPs at the village level **(W.L)**
Environmental	There is a diversity of potential NTFP crops (13 commodities), the most commons are tamarind and candlenut **(S.En)**	Low soil fertility conditions and an uncertain climate are several obstacles to the NTFPs growth **(W.En)**
PESTLE	**SWOT–External factors**	
	Opportunities	**Threats**
Political	Boti is one of the target locations in indigenous community-based NTFP development activities **(O.P)**	Local political conditions (regional government) are dynamic and uncertain **(S.P)**
Economical	• High market demand **(O.Ec.1)** • External funding opportunities (government, private sector, NGO) to help facilitate and develop NTFPs **(O.Ec.2)**	• NTFP production is not yet stable and continuous **(S.T.1)** • Demand for high standard quality of NTFP products **(S.T.2)** • The use of village funds in assisting the development of NTFPs has not been optimal **(S.T.3)**
Socio-cultural	Opportunities for cooperation or partnerships from related stakeholders in developing NTFPs **(O.S.)**	• Conflict between stakeholders **(S.S.1)** • NTFP management assistance by related institutions is not yet continuous **(S.S.2)**
Technology	Social media platform that can be used for digital marketing in the NTFPs promotion **(O.T)**	Technology is a threat to the erosion of people's traditional and cultural values **(S.T)**
Legal	Policy support in the form of the NTT Provincial Regulation on NTFP Management in NTT Province **(O.L)**	Current regulations do not yet specifically address NTFP production, processing, or marketing **(S.L)**
Environmental	The development of NTFPs can be integrated with environmentally friendly agricultural practices **(O.En)**	• Threat of overexploitation of NTFPs **(S.En.1)** • The existence of slash and burn and wild grazing practices which can threaten the NTFPs growth **(S.En.2)**

Note: S = strengths, W = weaknesses, O = opportunities, T = threats, P = political, Ec = economic, S = social, T = technological, L = legal, and En = environmental.

vision and mission for improving community welfare, one of which is through the development of NTFPs. Meanwhile, from an economic aspect, the main strength is the market potential for NTFP products, which is quite promising. This is in line with the biophysical or environmental potential where there are potential NTFP plants in Boti, especially tamarind and candlenut. The potential of human resources with the characteristics of hard work and awareness of preserving nature, as well as the existence of customary rules for managing dynamics, are also strengths in their own right from socio-cultural and legal aspects. The application of simple techniques in harvesting and planting is a separate point in the technological aspect.

Weaknesses One of the political weaknesses the the village government's lack of optimal support. Apart from that, low community income, limited business capital, limited market information, and a low community bargaining position in trade were identified as major weaknesses in the economic aspect. Meanwhile, there is no technology for post-harvest processing of NTFPs, and the lack of facilities for processing NTFPs is one of several weaknesses in the technological

Jurnal Manajemen Hutan Tropika, *30*(2), 246–257, August 2024
EISSN: 2089-2063
DOI: 10.7226/jtfm.30.2.246

Scientific Article
ISSN: 2087-0469

aspect. The social aspect suffers from a low level of community education, while the institutional aspect lacks the formation of community groups responsible for managing NTFPs. The lack of formal regulations at the village level that regulate NTFP management is also a weakness in the legal sector. Meanwhile, environmental weaknesses such as less fertile soil conditions and an uncertain climate hinder the growth of NTFP plants.

External factors: Opportunities The issue of the potential of NTFPs and the uniqueness of the Boti indigenous community is one of the opportunities from a political aspect. Meanwhile, opportunities from the economic aspect are the high demand for NTFP products and their derivatives, there are funding opportunities from various parties, including the government, NGOs, and the private sector. In addition, the identification of institutional social aspects presents opportunities for partnerships and collaboration with diverse stakeholders. The advancement of information technology, particularly social media, presents a potential avenue for promotion and digital marketing. The existence of a legal umbrella in the form of provincial regional regulations regarding NTFPs can be seen as an opportunity in the legal aspect. Meanwhile, in the environmental aspect, opportunities that can be exploited are the integration of the development of NTFPs with environmentally friendly agricultural practices through agroforestry systems.

Threats Local political dynamics and uncertainty, for example, changing regional heads or technical leaders related to NTFPs development, is a form of threat because, in general, changing leaders will change policies. Another threat from the economic aspect is the high demand for high quality NTFP products, while NTFP production is still not stable and sustainable. In the social institutional aspect, one form of threat is the interaction between stakeholders involved in managing NTFPs, which often leads to conflict, sometimes caused by one party feeling disadvantaged by another party, or vice versa. Meanwhile, in the policy aspect, even though there is a policy umbrella in the form of NTFP regulations at the provincial level, what is considered a threat is that there are no regulations at the local level that directly regulate the production, processing, and marketing of NTFPs. Excessive exploitation of NTFPs is also identified as a form of threat from an environmental aspect.

Strategy for NTFPs development The development strategy is prepared based on the results of the SWOT-PESTLE analysis, which has been validated and assessed by experts in the field of NTFP management. A strategic formulation based on aspects is presented in Table 5. Strategies related to economic and technological these aspects are the first priority in developing NTFPs in Boti. Increasing added value by facilitating and assisting farmers in financial, management, and post-harvest matters, as well as digital marketing with social media, are several strategies in the economic aspect. Meanwhile, in the technological aspect, the proposed strategy is the provision of facilities and infrastructure to support the production, processing, and marketing of NTFPs, increasing the technical capabilities of farmers by providing technical training for managing NTFPs, and comparative studies on areas that have success stories in developing NTFPs. In the next priority, the recommended strategy is related to environmental aspects, including

Table 5 Order of NTFP development strategies according to expert evaluation for each aspect

Aspects	Strategies	Related SWOT-PESTLE
Economic	Increasing the added value and diversity of NTFP products by facilitating or assisting with business finance, managing and marketing post-harvest	W.T.1; T.S.2
	Optimizing existing traditional markets and using social media for promotion or marketing initiative	S.Ec; O.T
Technology	Improving facilities and infrastructure for the production, processing, and marketing of NTFPs, such as good accessibility to villages, provision of clean water resources,	W.T.2; O.T
	Increasing human resource capacity in the form of training, technical guidance, as well as comparative studies on post-harvest processing of NTFPs	W.T.1.
Environment	developing NTFPs nurseries and growing planting spaces for excellent NTFPs types, especially on bare land or critical land	S.En
	Identifying plant potential, distribution, and conservation status of existing NTFPs and cultivation efforts	W.T.3; T.En.1
Institutional	Building a business group involving all Boti communities, starting from cultivation, processing and marketing of NTFPs.	T.S.2; W.S.2
	Developing Village-Owned Enterprises (*BUMDes*) institutions with program linkages currently attached to SKPD (*BPMD*) and the Ministry of Village, Development of Disadvantaged Region (*Kemendesa*).	T.Ec.3; W.S.2
Social	Promoting effective collaboration, coordination, and partnership as well as offering stakeholders contributions that will benefit both parties.	T.S.1; W.S.1
	Enhancing community engagement and participation in NTFP management at all levels, from use to conservation initiatives	O.S
Legal	Enforcing formal and customary NTFPs-related regulations and penalizing offenders	S.L: T.L
	Programs related to NTFPs need to be included in the *RPJMDes* because NTFPs can potentially drive the village economy	W.P.

identifying the current conservation status of NTFP types and making efforts to create nurseries and planting that target critical vacant land. Increasing effective collaboration, forming partnerships that benefit both parties, and building village-owned business entities are several strategies related to institutional social aspects that are the next priority. Meanwhile, strategies related to policies in the form of enforcing formal and customary laws, providing sanctions for violators of NTFP management rules, and including NTFP development programs in village government work plans are considered something that can be done later after strategies in the economic, technological, environmental, and socio-institutional aspects.

Conclusion

We classified the utilization of NTFPs in Boti Village into two categories: those with economic value and those with medicinal properties. NTFPs that have the potential to be developed in Boti Village are *A. molucannus*, *T. indica*, *S. oleosa*, *P. betle*, *A. squamosa*, *P. guajava*, *M. citrifolia*, *C. utan*, *A. catechu*, and *B. flabellifer*. NTFPs are used by the Boti community for various purposes, mainly medicine, natural weaving dyes, and increasing household income. The development of NTFPs in Boti Village has yet to be implemented well because the capacity to process NTFPs still needs to be improved. The economic-technological strategy, which aims to increase the added value of NTFP products and provide supporting infrastructure, is the top priority in Boti's NTFP development strategy. These are followed by strategies in the environmental aspect, which focuses on planting and preserving NTFPs; the social-institutional aspect, which seeks to increase collaboration and partnerships; and the legal aspect, which enforces both formal and customary law.

Acknowledgment

This publication was funded by the BPDLH and the Ford Foundation through the Fund for *Program Dana untuk Kesejahteraan dan Ekonomi Berkelanjutan Masyarakat Adat dan Komunitas Lokal–Dana Terra*. We would like to express our gratitude to *Usif* Namah Benu, for his kindness and assistance in data collection. We also thank to the local government of Timor Tengah Selatan District for its cooperation in providing supporting data. Special thanks go to Ape Didex Nino, Fransiskus Boy Manek and the Boti's people for their invaluable assistance in data collection.

References

Andika, R. R. (2016). *Ekologi dan etnobotani pohon penghasil damar pada suku Anak Dalam di Taman Nasional Bukit Duabelas*. Bogor: Institut Pertanian Bogor.

Az-Zahra, F. R., Sari, N. L. W., Saputry, R., Nugroho, G. D., Pribadi, T., Sunarto, S., & Setyawan, A. D. (2021). Review: Traditional knowledge of the Dayak Tribes (Borneo) in the use of medicinal plants. *Biodiversitas Journal of Biological Diversity*, *22*(10), 57. https://doi.org/10.13057/biodiv/d221057

Cabral, M. R. P., dos Santos, S. A. L., Stropa, J. M., da Silva, R. C. de L., Cardoso, C. A. L., de Oliveira, L. C. S., Scharf, D. R., Simionatto, E. L., Santiago, E. F., & Simionatto, E. (2016). Chemical composition and thermal properties of methyl and ethyl esters prepared from *Aleurites moluccanus* (L.) Willd (Euphorbiaceae) nut oil. *Industrial Crops and Products*, *85*, 109–116. https://doi.org/10.1016/j.indcrop.2016.02.058

Candri, D. A., Hakimi, B., Ahyadi, H., Suana, I. W., Prasedya, E. S., Ambarwati, K., & Mardiati, A. U. (2023). Condition of coral diversity in Kuta Mandalika Coastal, Central Lombok Regency. *Jurnal Biologi Tropis*, *23*(2), 15–26. https://doi.org/10.29303/jbt.v23i2.5627

Chamberlain, J., Small, C., & Baumflek, M. (2019). Sustainable forest management for nontimber products. *Sustainability*, *11*(9), 2670. https://doi.org/10.3390/su11092670

Chen, Y., & Cao, Y. (2014). Response of tree regeneration and understory plant species diversity to stand density in mature *Pinus tabulaeformis* plantations in the hilly area of the Loess Plateau, China. *Ecological Engineering*, *73*, 238–245. https://doi.org/10.1016/j.ecoleng.2014.09.055

CIFOR-ICRAF. (2016). *Grand strategy pengelolaan HHBK unggulan yang terintegrasi berbasis bentang alam di Kab. TTS*. Retrived from https://www.cifor.org/knowledge/slide/7861

Cunningham, A. B. (Ed.) (2001). *Applied ethnobotany: People, wild plant use and conservation*. London: Routledge. https://doi.org/10.4324/9781849776073

[DPR] Dewan Perwakilan Rakyat. (2018). *Rancangan undang undang tentang masyarakat hukum adat*. Retrieved from https://berkas.dpr.go.id/akd/dokumen/RJ2-20171106-094054-7086.pdf

Fagbemi, K. O., Aina, D. A., Adeoye-Isijola, M. O., Naidoo, K. K., Coopoosamy, R. M., & Olajuyigbe, O. O. (2022). Bioactive compounds, antibacterial and antioxidant activities of methanol extract of *Tamarindus indica* Linn. *Scientific Reports*, *12*(1), 9432. https://doi.org/10.1038/s41598-022-13716-x

Fibri, D. L. N., Anjani, D. M., Maymunah, Putro, A. W., & Muhammad, D. R. A. (2022). Spice mapping profile in Indonesian traditional side dishes and beverages. *Research Square*. https://doi.org/10.21203/rs.3.rs-2048305/v1

Guariguata, M. R., García-Fernández, C., Sheil, D., Nasi, R., Herrero-Jáuregui, C., Cronkleton, P., & Ingram, V. (2010). Compatibility of timber and non-timber forest product management in natural tropical forests: Perspectives, challenges, and opportunities. *Forest Ecology and Management*, *259*(3), 237–245. https://doi.org/10.1016/j.foreco.2009.11.013

Gusmailina, Saputra, N. A., & Sumadiwangsa, S. (2020). Management prospects through development of non-timber forest products. *IOP Conference Series: Earth and Environmental Science*, *591*(1), 012042. https://doi.org/10.1088/1755-1315/591/1/012042

Harbi, J., Erbaugh, J. T., Sidiq, M., Haasler, B., & Nurrochmat, D. R. (2018). Making a bridge between livelihoods and forest conservation: Lessons from non timber forest products' utilization in South Sumatera, Indonesia. *Forest Policy and Economics*, *94*, 1–10. https://doi.org/10.1016/j.forpol.2018.05.011

Harbi, J., Erbaugh, J. T., Widagdo, F. R. A., Mauri, J., Supriyanto, S., & Milantara, N. (2020). Three generations of forest peoples' empowerment in Indonesia: process towards sustainable and equitable forest management. *Jurnal Manajemen Hutan Tropika*, *26*(2), 91–104. https://doi.org/10.7226/jtfm.26.2.91

Herningtyas, W., Pujiono, E., Kurniadi, R., & Setyowati, R. (2023). Disaster risk reduction through local knowledge and practices-A case study of the indigenous Boti Tribe, Timor Island, Indonesia. In G. K. Panda, U. Chatterjee, N. Bandyopadhyay, M. D. Setiawati, & D. Banerjee, D. (Eds.), *Indigenous knowledge and disaster risk reduction. Disaster risk reduction* (pp. 441–463). Springer, Cham. https://doi.org/10.1007/978-3-031-26143-5_19

Kanfon, R. E., Fandohan, A. B., Agbangnan, P. D. C., & Chadare, F. J. (2023). Ethnobotanical and nutritional value of pulps, leaves, seeds, and kernels of *Tamarindus indica* L.: A review. *Agronomie Africaine*, *35*, 297–322.

Kasih, N. P. M. (2022). Pemanfaatan kunyit asam sebagai bahan dasar sorbet. *Jurnal Ilmiah Pariwisata dan Bisnis*, *1*(7), 1848–1864. https://doi.org/10.22334/paris.v1i7.126

Kemendesa. (2023). *Hasil rekomendasi IDM*. Retrived from https://idm.kemendesa.go.id/rekomendasi

Kurniasih, H., Ford, R. M., Keenan, R. J., & King, B. (2021). The evolution of community forestry through the growth of interlinked community institutions in Java, Indonesia. *World Development*, *139*, 105319. https://doi.org/10.1016/j.worlddev.2020.105319

Kusmana, C. (1997). *Metoda survey vegetasi*. Bogor: IPB Press.

Kusuma, Y. W. C., Rembold, K., Tjitrosoedirdjo, S. S., & Kreft, H. (2018). Tropical rainforest conversion and land use intensification reduce understorey plant phylogenetic diversity. *Journal of Applied Ecology*, *55*(5), 2216–2226. https://doi.org/10.1111/1365-2664.13201

Mandang, I. C., Polii, B. J. V., & Walangitan, H. (2018). Strategi pengembangan hasil hutan bukan kayu di kawasan hutan lindung Gunung Soputan KPHP Unit V Provinsi Sulawesi Utara. *AGRI-SOSIOEKONOMI*, *14*(3), 1. https://doi.org/10.35791/agrsosek.14.3.2018.21530

Muli, E., Sulistyorini, I. S., Poedjirahajoe, E., Faida, L. R. W., Purwanto, R. H., & Imanuddin, I. (2021). Structure and dominance of species in mangrove forest on Kutai National Park, East Kalimantan, Indonesia. *Jurnal Manajemen Hutan Tropika*, *27*(1), 59–68. https://doi.org/10.7226/jtfm.27.1.59

Mulu, M., Ntelok, Z. R. E., Petrus S. I. I., & Mulu, H. (2020). Ethnobotanical knowledge and conservation practices of indigenous people of Mbeliling forest area, Indonesia. *Biodiversitas Journal of Biological Diversity*, *21*(5), 12. https://doi.org/10.13057/biodiv/d210512

Muttaqin, M. Z., Ilham, I., & Idris, U. (2021). Sosialisasi pengelolaan hhbk bagi masyarakat di perbatasan Papua Indonesia-Papua New Guinea. *Jurnal PkM Pengabdian Kepada Masyarakat*, *4*(3), 240. https://doi.org/10.30998/jurnalpkm.v4i3.6462

NTT Provincial Economic Bureau. (2022). *Konsultasi publik fasilitasi pengembangan sentra HHBK unggulan jambu mete dalam rangka penyusunan Peraturan Gubernur tentang sentra pengembangan jambu mete di Kabupaten Flores Timur*. https://biro-perekonomian-provntt.com/

Oktavia, D., Pratiwi, S. D., Munawaroh, S., Hikmat, A., & Hilwan, I. (2021). Floristic composition and species diversity in three habitat types of heath forest in Belitung Island, Indonesia. *Biodiversitas Journal of Biological Diversity*, *22*(12), 40. https://doi.org/10.13057/biodiv/d221240

Parra-Lopez, C., Reina-Usuga L, C. C.-T., Sayadi, S., & Klerkx, L. (2021). Digital transformation of the agrifood system: Quantifying the conditioning factors to inform policy planning in the olive sector. *Land Use Policy*, *108*. https://doi.org/10.1016/j.landusepol.2021.105537

Pasaribu, G., Winarni, I., Gusti, R. E. P., Maharani, R., Fernandes, A., Harianja, A. H., Saragih, G. S., Turjaman, M., Tampubolon, A. P., Kuspradini, H., Lukmandaru, G., Njurumana, G. N., Sukito, A., Aswandi, A., & Kholibrina, C. R. (2021). Current challenges and prospects of Indonesian non-timber forest products (NTFPs): A review. *Forests*, *12*(12), 1743. https://doi.org/10.3390/f12121743

Puhlick, J. J., Laughlin, D. C., & Moore, M. M. (2012). Factors influencing ponderosa pine regeneration in the southwestern USA. *Forest Ecology and Management*, *264*, 10–19. https://doi.org/10.1016/j.foreco.2011.10.002

Rahman, M. H., Roy, B., & Islam, M. S. (2021). Contribution

of non-timber forest products to the livelihoods of the forest-dependent communities around the Khadimnagar National Park in northeastern Bangladesh. *Regional Sustainability*, *2*(3), 280–295. https://doi.org/10.1016/j.regsus.2021.11.001

Reihanian, A., Mahmood, N. Z. B., Kahrom, E., & Hin, T. W. (2012). Sustainable tourism development strategy by SWOT analysis: Boujagh National Park, Iran. *Tourism Management Perspectives*, *4*, 223–228. https://doi.org/10.1016/j.tmp.2012.08.005

Shaah, M. A., Allafi, F., Hossain, M. S., Alsaedi, A., Ismail, N., Kadir, M. O. A., & Ahmad, M. I. (2021). Candlenut oil: Review on oil properties and future liquid biofuel prospects. *International Journal of Energy Research*, *45*(12), 17057–17079. https://doi.org/10.1002/er.6446

Silalahi, M. (2020). Morinda citrifolia: Bioactivity and utilization as traditional medicine and food for the community. *International Journal of Business, Economics, and Social Development*, *1*(2), 81–89. https://doi.org/10.46336/ijbesd.v1i2.40

Subroto, E., Widjojokusumo, E., Veriansyah, B., & Tjandrawinata, R. R. (2017). Supercritical CO_2 extraction of candlenut oil: process optimization using Taguchi orthogonal array and physicochemical properties of the oil. *Journal of Food Science and Technology*, *54*(5), 1286–1292. https://doi.org/10.1007/s13197-017-2542-7

Suchiang, B. R., Nonghuloo, I. M., Kharbhih, S., Singh, P. P., Tiwary, R., Adhikari, D., Upadhaya, K., Ramanujam, P., & Barik, S. K. (2020). Tree diversity and community composition in sacred forests are superior than the other community forests in a human-dominated landscape of Meghalaya. *Tropical Ecology*, *61*(1), 84–105. https://doi.org/10.1007/s42965-020-00066-w

Sumanto, S. E., & Takandjandji, M. (2016). Identifikasi pemanfaatan hasil hutan oleh masyarakat: Upaya konservasi sumber daya genetik dan sosial budaya. *Buletin Plasma Nutfah*, *20*(1), 27. https://doi.org/10.21082/blpn.v20n1.2014.p27-40

Tamene, S., Negash, M., Makonda, F. B., Chiwona-Karltun, L., & Kibret, K. S. (2023). Ethnobotanical study on medicinal plant knowledge among three ethnic groups in peri-urban areas of south-central Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, *19*(1), 55. https://doi.org/10.1186/s13002-023-00629-w

Uztürk, D., & Büyüközkan, G. (2023). Strategic analysis for advancing smart agriculture with the analytic SWOT/PESTLE framework: A case for Turkey. *Agriculture*, *13*(12), 2275. https://doi.org/10.3390/agriculture13122275

Variyana, Y., Ermayaa, D., Shintawati, Cendekiaa, D., & Mahfud, M. (2023). Response surface methodology-based parameter optimization of candlenut seeds (*Aleurites moluccana* Willd) extraction. *Equilibrium Journal of Chemical Engineering*, *7*(1), 69–77. https://doi.org/https://dx.doi.org/10.20961/equilibrium.v7i1.72842

Wang, R., Hu, R., Wu, Y., Shaaban, M., Zhang, T., Pan, G., Lu, J., & Jiang, Y. (2024). Elevation-dependent natural regeneration of *Abies georgei* var. smithii forest in Southeastern Tibet. *Forests*, *15*(1), 142. https://doi.org/10.3390/f15010142

Wibowo, G. D. H. (2017). Analisis kebijakan pengelolaan hasil hutan bukan kayu (HHBK) di NTB dan NTT. *Jurnal Hukum & Pembangunan*, *43*(2), 180. https://doi.org/10.21143/jhp.vol43.no2.1484

Wijana, N. (2014). Analisis komposisi dan keanekaragaman spesies tumbuhan di hutan Desa Bali Aga Tigawasa, Buleleng, Bali. *Jurnal Sains dan Teknologi*, *3*(1). https://doi.org/10.23887/jst-undiksha.v3i1.2907

Yang, X., Yan, D., & Liu, C. (2014). Natural regeneration of trees in three types of afforested stands in the Taihang Mountains, China. *PLoS ONE*, *9*(9), e108744. https://doi.org/10.1371/journal.pone.0108744