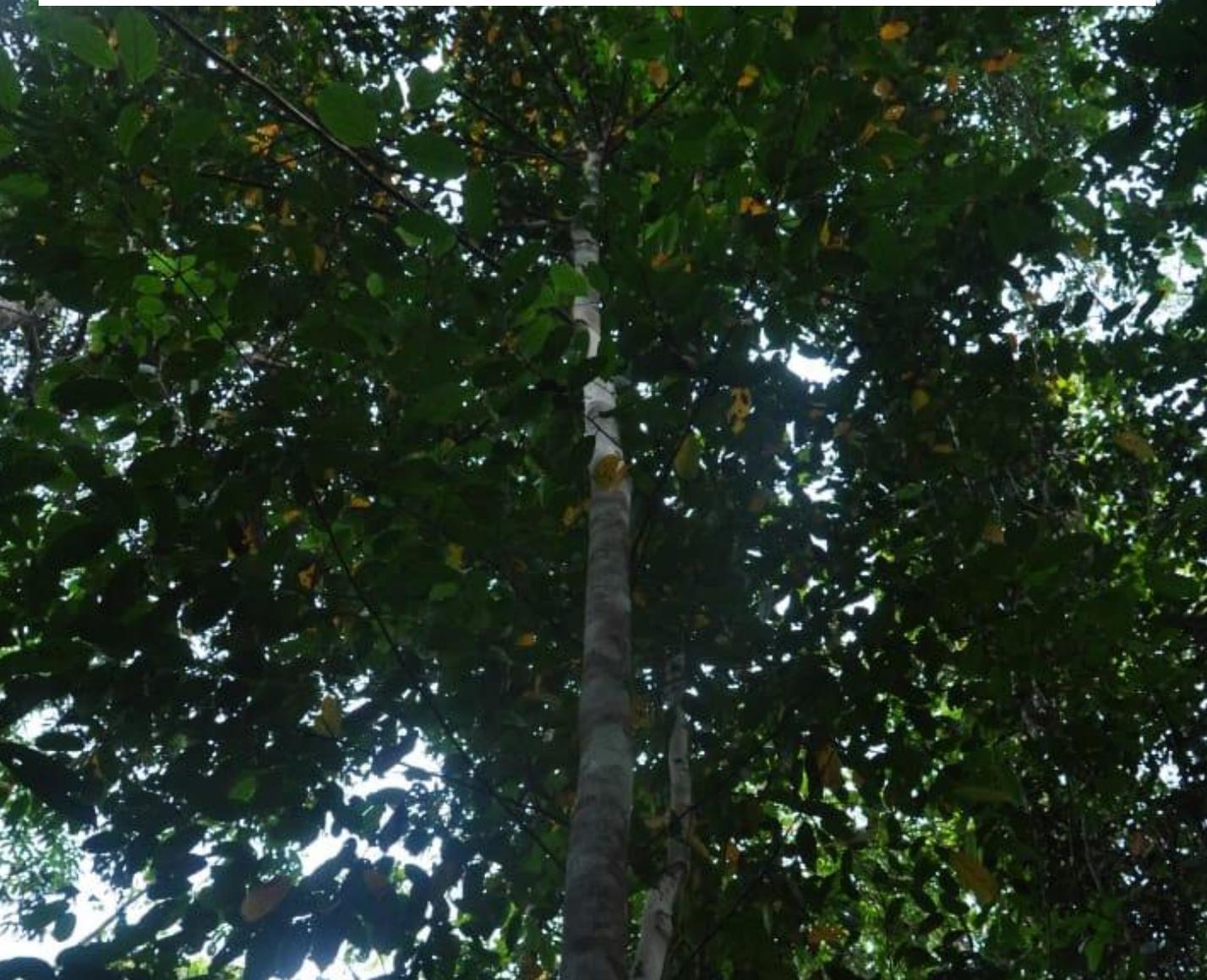




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Overview: Massoi *Cryptocarya Massoia* Kosterm



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OVERVIEW: Massoi
***Cryptocarya Massoia* (Oken) Kosterm)**



Massoi (*Cryptocarya Massoia* (Oken) Kosterm)

1. Description, Ecology, and Distribution

Massoi (*Cryptocarya massoia* (Oken). Kosterm or *Massoia aromatica* (Becc) is classified as Lauraceae family. This tree can reach to a height of 15 – 30 meters, it has no grooves and is not twisted (Figure 1). Generally, the tree has no buttress root and a diameter of 25 – 150 cm, and the bark is smooth without any knots.

Bark. The bark is greenish or light grey in colour with a thickness of 5 – 15 mm. The tree has plank roots 1 – 1.5 m high: 1 – 3 m wide and thickness 5 – 15 mm.

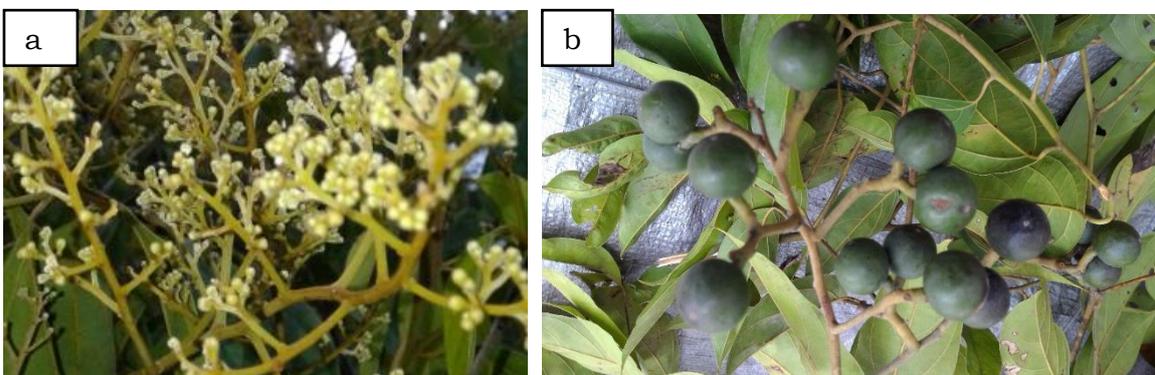
Leaves and flowers. The leaves of the tree are ovate, circular, or opposite with tapered leaf tips. Massoi flowers are compound-shaped, the flowers are greenish-yellow with six elliptical-shaped petals. It has 15 stamens on three stalks, panicle-shaped coming out of the axilla (Figure 2a).



Source: Yeny & Minarningsih, 2018

Figure 1. Massoi tree

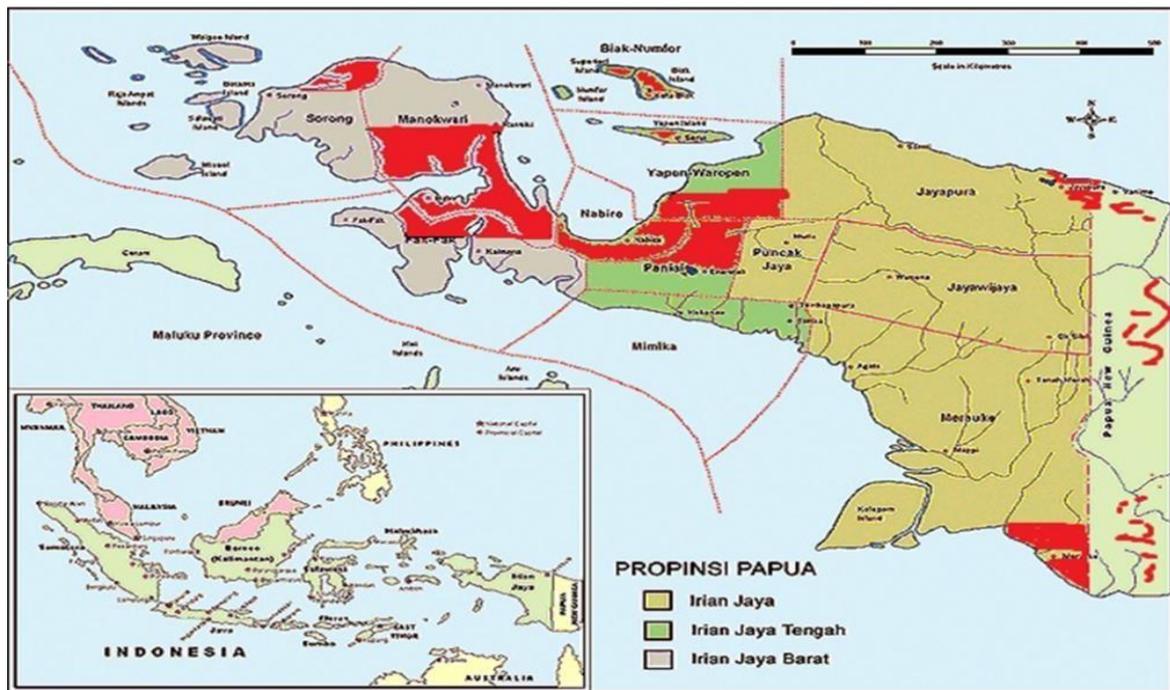
Fruits. The fruits of massoi are round with a slight bulge on one side. The young fruit is green (Figure 2b), while the ripe fruit is black. The massoi fruit is a single fruit, meaning one fruit contains one seed. The fruit consists of two layers, namely *exocarp* (soft outer layer) and *endocarp* (hard layer). The outer layer of the young fruit tends to be tough and softens as it progressively ripens. The season for flowering and fruiting is twice in a year, namely in August and December. A massoi tree can produce at least 2,000 – 3,000 fruits (Yeny, 2019).



Source: Yeny & Minarningsih, 2018

Figure 2. Flowers (a) and fruits (b) of massoi

Massoi is endemic to the Mollucas and Papua. In Papua, the tree is found in Papua Barat (Manokwari, Ransiki, Windesi, Teluk Wondama, Teluk Bintuni, Fak-fak, Kaimana, Sorong Regency, and Teminabuan), and Papua (Nabire, Yapen Waropen, Biak Numfor, Jayapura, and Merauke) (Remetwa, 2000 cited in Yeny & Minarningsih, 2018). Massoi distribution can be seen in Figure 3; whereby, areas in red are the distribution areas.



Source: Remetwa (2000) cited in Yeny and Minarningsih, 2018

Figure 3. Distribution areas of massoia in Papua and Papua Barat

Generally, *Massoi* grows in clusters and is spread unevenly in nature (Hastanti et al., 2018). However, in Teluk Bintuni and Kaimana, *Massoia* was found growing scattered and rarely clustered (Hutapea et al., 2020). Seedlings of *massoi* are not always found growing under the main tree and can be found far away from the main tree. The environmental conditions where *massoi* grows are presented in Table 1.

Table 1. Environmental conditions of a native habitat of *massoi*

Parameters	Native Habitat
Altitude	10 – 1000 masl
Moisture (daytime)	70 – 80%
Rainfall	2.000 – 4.000 mm/year
Soils	Sandy clay without standing water
pH (H ₂ O)	4.6 – 4.8
pH (CaCl ₂)	3.8 – 3.9
Temperature	21.5 – 33.1 °C

Sources: Melawati et al., (n.d); Hutapea et al. (2020); Yeny & Minarningsih (2018)

2. Cultivation and Maintenance

Massoi is considerable susceptible to pests; therefore, its cultivation requires intensive care.

2.1. Vegetative regeneration

Cultivation of Massoi in Papua is done traditionally (Hastanti et al., 2018). Saplings of the Massoi tree are taken from the wild and planted. Saplings are about 15 – 20 cm high with 2 – 4 leaves and can be pulled out by loosening the soils first (Yeny & Minarningsih, 2018). It is suggested this activity is done during rainy season to reduce damage to the soils. The saplings are then transferred into a banana stalk/damp newspaper and are covered with plastic to reduce evaporation. The saplings are then planted into polybags with a suitable growth media, example soils, sandy soils. The best growth media is soil+sandy (2:1, v/v) as this generates 93% shoots and 71.67% roots (Darwo & Yeny, 2018). Using this method, the percentage of survived plants would be high under intensive care. However, finding saplings is challenging as these are scarcely found in the forests (Yeny & Minarningsih, 2018).

Another method is through cuttings, using the KOFCO system (managing temperature and moisture at the ideal state). Its suggested Massoi's cuttings should be taken from a 1-year old tree, with healthy branches and facing the sunlight.

How a branch could be divided for several cuttings as presented in Figure 4. Using this method, genetic and environmental factors must be considered (Darwo & Yeny, 2018). Genetic factors include the content of food reserves in cuttings, water availability, the age of the main/mother tree, and endogen hormone within the tissue of the cuttings. Environmental factors include rooting medium, moisture, temperature, light, and cuttings' technique. After 10 weeks roots will emerge from the cuttings. Another important method that can be used to trigger the growth of the cuttings is a growth regulator (chemical substance) like IBA (*Indole Butyric Acid*) and NAA (*Naphthalene Acetic Acid*) (Darwo & Yeny, 2018; Miriono et al., 2019).

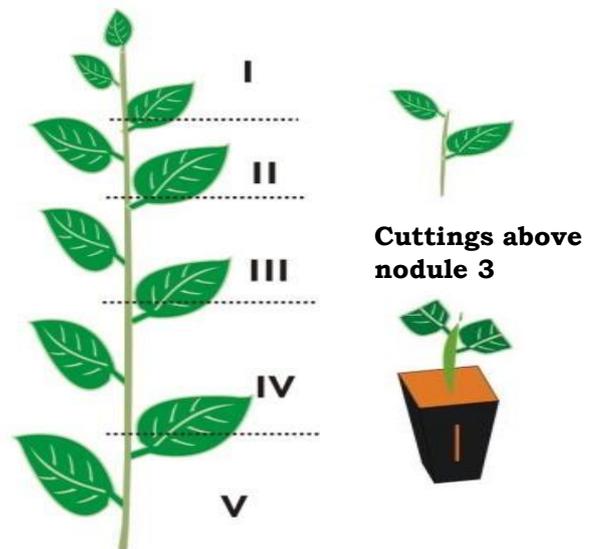


Figure 4. Cuttings' number (I, II, II, IV, V Nodules)
Modified from (Muljana, 2017)

2.2. Generative regeneration

Massoi can be cultivated by employing its seeds. Good seeds should be dark in colour and taken from the tree (not gathered from the forest floor) (Yeny, 2019). Firstly, seeds should be rinsed (Figure 5a), and the flesh of the fruit peeled (Figure 5b), then the seeds are left to germinated. Germination is signalled by the releasing of the radicle then followed by plumula (Figure 5c). Normally the germination process takes about 24 - 32 days with the average seed germination <80% (Table 2) (Yeny & Minarningsih, 2018). During the process of germination, intensive care is required given the high disturbance on the seeds by pests, and the recalcitrant nature of seed. The seeds can also be easily damaged if not germinated immediately.

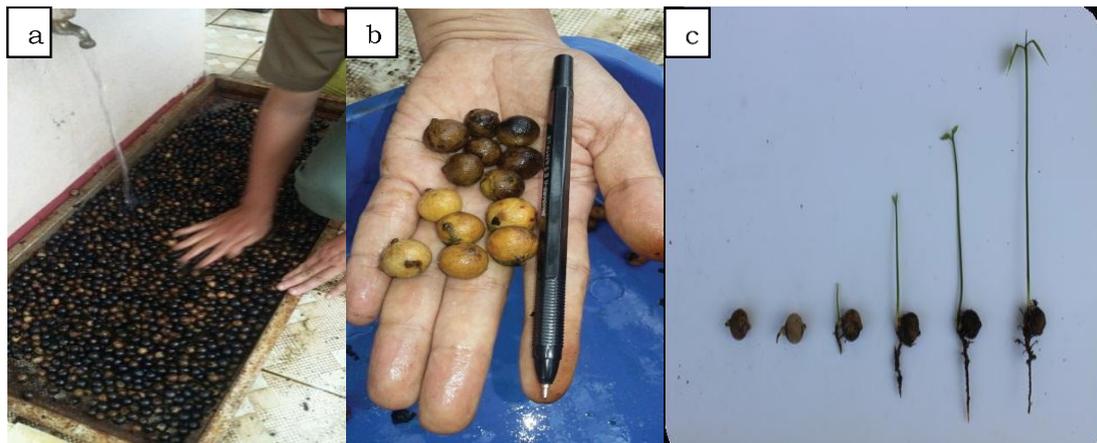


Figure 5. Fruits rinsing (a), flesh removal (b), germination process (C)

Table 2. Germination process

Period	Progress
Day 10	Bulge on the seeds broken
Day 14	Radicle/prospective roots appear
Day 21	Plumula appears and goes up without leaves
Day 31	Leaves appear. 2 leaves mean seedling is ready to be transferred to growth media

Source: (Yeny, 2019)

Seedlings are ready to be planted in the field when they have reached a height of 40 cm and with a diameter of 5 – 6 mm, having at least 6 leaves, and at 4 – 6 months of age (Minarningsih et al., 2018). An optimum light intensity which is required to support seeds growth and development is 50% and they should be shaded (but not a dense shade). Seedlings should not encounter stress due to an alteration of the environmental condition. Besides, the storage and growing medium also affect the percentage of massoi's seedlings surviving. It is reported that the best storage medium for Massoi's seedlings growth (high percentage values) is banana fronds due to its water content in the fronds that manage air temperature and water content. Also, the medium growth is soil+sand (2:1, v/v) (Darwo & Yeny, 2018).

Since massoi is a semi-tolerant species, its plantation requires rare shading (Yeny & Minarningsih, 2018). Two methods for the plantation are using a line system and cemplongan (where the lands are not cleaned entirely, but just making a planting hole and cleaning is conducted around the hole). So that massoi plantation could be suitable for use in an agroforestry system as well. The plantation should be planted during the rainy season to ensure adequate water content in the soil. Planting distance could be adjusted with the density of the stands in the forests (Table 3). Massoi has also been planted outside its native habitat as well, including Bogor-Jawa Barat and Boalemo-Gorontalo. After plantation, intensive care should be carried out. Cleaning is required once in every 2 months; meanwhile, pests can be overcome using chemical pesticide (abamectin 18 EC with dosage 1ml/litre).

Table 3. Suggested planted distance

Planting distance	Stands density
5 x 10 cm / 5 x 20 m	If the existing stands are still quite tight
2 x 10 m / 4 x 10 m	If there are not too many stands

3. Harvesting Method and Utilization

Massoi harvesting has been practised for a long period with its peak occurring in the 1990s along with Gaharu trees harvesting. This tree can be harvested when it reaches 10 – 15 years old with a diameter of about > 15 cm (Yeny & Minarningsih, 2018). In Kaimana, a tree with a diameter of 21 – 58 cm tends to be logged (Luamasar et al. 2010 cited in Nugroho et al., 2019). Nevertheless, there is an indication that trees with small diameter of 2.79 – 16.02 cm also tends to be logged (Nugroho et al., 2019). Data of bark flakes from the Massoi's bark collectors in Nabire indicates that the harvested tree had a diameter of 2.79 – 42.06 cm (Nugroho et al., 2019).

Up to now, harvesting method of massoi's bark still employs a destructive method (personal communication with Irma Yenny – Researcher from FORDA Bogor). The tree will be logged, and a stump at about 80 cm above the ground are left to allow for new regeneration (Hastanti et al., 2018; Nugroho et al., 2019; Yeny & Minarningsih, 2018). The bark is then peeled using a knife (Figure 6a, b, c). Debarking/peeling does not require a special skill or knife. Bark pieces are taken 5 cm wide and 80 – 100 cm long and tied in a bundle Figure 6 (d). The quality of the bark could be tested by scratching hard crosswise with a nail. The scratch will show a dark line and a liquid appears. If these signs do not appear, the tree is considered too old and dry.



Photos: Yeny & Minarningsih (2018), Julanda Noya (2015)

Figure 6. Bark harvesting (a, b), bark (c), ready bark bundle (d)

Another method that can be used is known as “open window system (*sistem buka jendela*)” (personal communication with Irma Yenny – Researcher from FORDA Bogor). Using this method, the massoi’s bark is not entirely peeled, however, the bark is peeled in certain locations only, leaving the rest of the bark unpeeled (Figure 7 as an illustration). Bark peeling is done on the trunk and branches of tree. Nevertheless, this proposed method has not yet been applied in practice. This is a good opportunity for conducting further research.

Massoi barks processing can be done using four methods (Yeny, 2019):

- (1) Water distillation
- (2) Maceration
- (3) Vapor distillation
- (4) Steaming

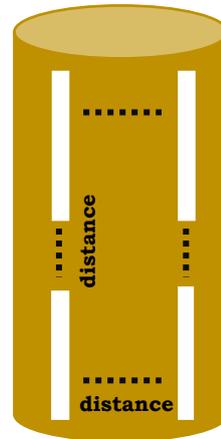


Figure 7. Illustration of open window system harvesting on the trunk

Massoi tree products have various uses, including:

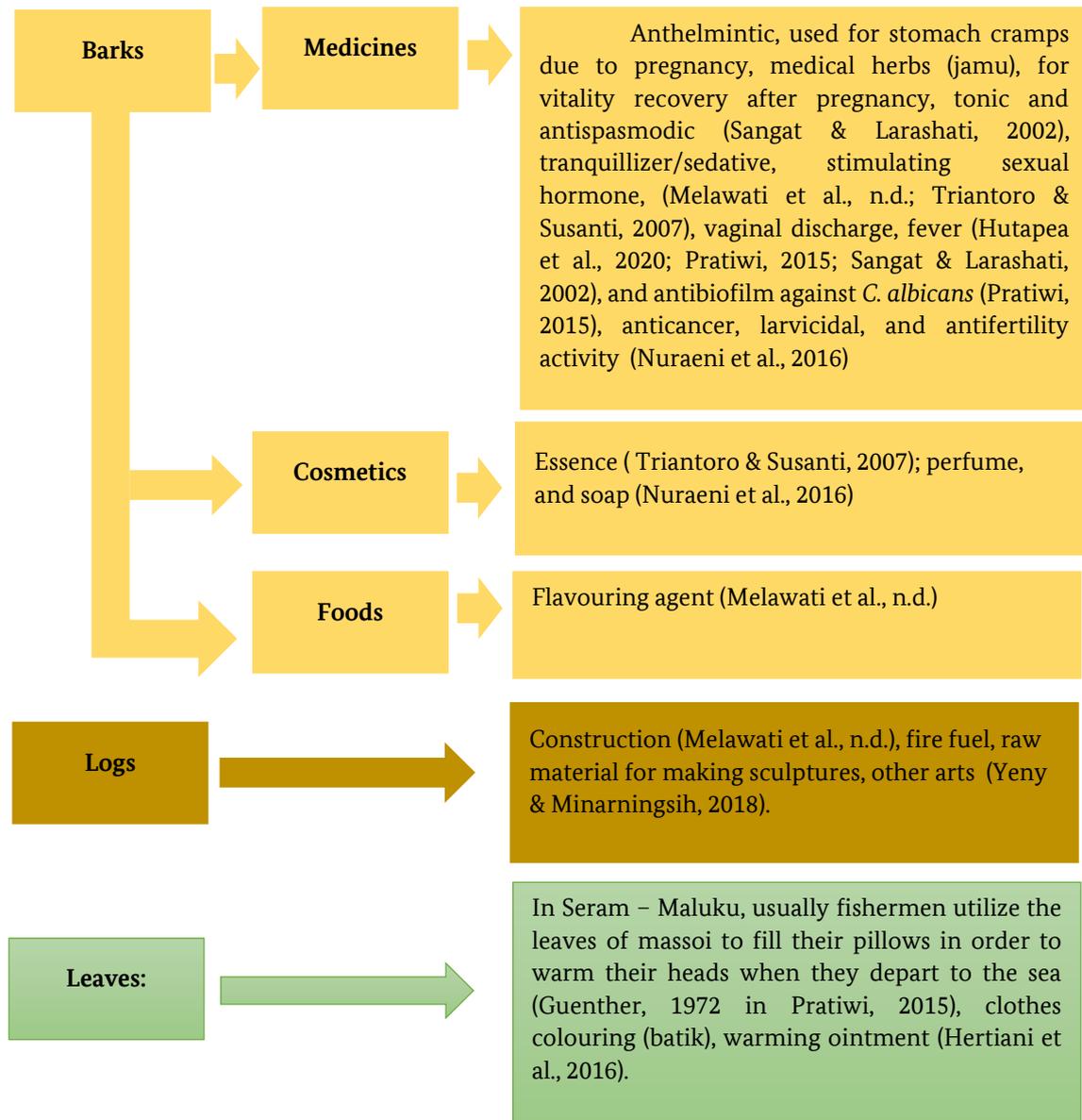


Figure. 8 Massoi's utilization

4. Production and Potential Market

Trees with a diameter >15 cm can produce more than 20 kg of bark/tree (Heyne, 1987 cited in Yeny & Minarningsih, 2018). Research in Manokwari shows that a tree with a diameter of 10 cm produces 9 kg of wet bark, 11 kg of leaves, and 7 kg of branches (Yeny & Minarningsih, 2018). In Nabire, massoi's bark can be obtained at around 300 kg wet bark/"seeking" period (Nugroho et al., 2019). Seeking period is about 2 weeks to 1 month, as the seekers should go into the wilderness (Hastanti et al., 2018). According to Yeny (2019), a massoi tree can produce 10 kg dry bark. For producing massoi oil, 600 ton/year of dry bark is supplied from Papua (Yeny, 2019).

The Massoi has been collected since the 14th century in Papua, and commercially used since the 1980's. Papua has become the largest supplier of Massoi's oil from Indonesia aside from Papua New Guinea (Hastanti & Noya, 2018; Hutapea et al., 2020). The price of massoi is influenced by the quality of massoilactone, whereby, its quality is determined by the concentration of massoilactone 10C, namely 45-52%, 60-65%, and 70-75% (Yeny & Minarningsih, 2018). The higher its concentration, the higher its quality will be, and the more expensive the product (Hutapea et al., 2020). The market price of massoi's barks and oils is presented in Table 4.

Table 4. Massoi's traders' price in domestic and international markets.

Market Price	
Domestic (IDR)	International (\$)
Oil (per litre)	
Level of a local trader	
2.000.000	
Domestic	
3.500.000	
2.000.000	
3.250.000	
Bark (per kg)	
	250 – 350
Level of farmers	
75.000	
15.000 – 27.000	
50.000 – 75.000	
45.000	
Online shopping (2017), Level of local trader, Domestic	
120.000 – 250.000	
Exporter (in 5 years)	
2.500.000 – 5.000.000	

Source: Hastanti et al., 2018; Hastanti & Noya, 2018; Rostiwati and Effendi, 2013; Yeny et al., 2018; Litbang, 2014; Yeny & Minarningsih, 2018

Market analysis

Both in the international and national market, massoia is in high demand (Hastanti et al., 2018; Hutapea et al., 2020; Melawati et al., n.d.). It is reported that while global demand for massoia is approximately 500.000 ton/year (Hutapea et al., 2020), up to now Indonesia could only provide 2% of the demand (Hutapea et al., 2020), or about 10.000 ton/year. Another report mentions that domestic production is only 8.000 – 12.000 ton/year (Yeny & Minarningsih, 2018). According to Dewan Atsiri Indonesia (2018) as cited in (Yeny, 2019), massoi is the 8th biggest production of essential oil. Production of massoi oil increases since 2014 to 2017 at about 15 – 20 ton. Generally, Massoi's oil is exported to Europe, America, Japan, Brazil, and China (Yeny, 2019; Yeny et al., 2018). Massoi bark has a quality standard from Badan Standar Nasional (BSN), also its Standar Nasional Indonesia (SNI) is 7941: 2013, meanwhile, SNI for massoi oil is in process.

In order to meet market demand, there should be an attempt or strategy to increase massoi's bark production. If 1 ha with 5 x 5 m planting distance would contain 400 trees, whereby, a tree may generate 10 kg of dry bark (Yeny, 2019). This means that 1 ha of land may produce 4,000 kg of dry bark per harvesting period (after 10 years of planting). Hence, for meeting 500,000 ton or 500,000,000 kg of market's demand, a 1,250,000-ha land should be prepared. Furthermore, if 1 kg of the bark costs Rp. 60,000, therefore, 1 ha (4,000 kg) would earn Rp. 240,000,000/harvesting period. In addition, the result of feasibility analysis/ study of massoi cultivation with a 10-year harvesting cycle is presented in Table 5.

Table 5. Result of feasibility analysis of massoi cultivation

Investation criteria	Value/ha	
	Planting distance 2 x 10 m	Planting distance 5 x 5 m
Net Present Value (NPV)	Rp. 31,507,517	Rp. 41,573,815
Benefit Cost Ratio (BCR)	1.64	1.82
Internal Rate of Return (IRR)	18.39%	19,98%
Break Even Point	Year 10	Year 10

Source: Irma Yeny (2019)

Table 5 shows that positive NPV providing net benefit for massoi development, and area with 5 x 5 m planting distance gives higher NPV value. Furthermore, BCR value informs that one-unit cost incurred in this business provide benefit of 1.64 and 1.82, 2x10 m and 5x5 m planting distance, respectively. IRR value is higher 10% meaning the return rate of the capital is greater than the rate of loan interest. So that, in year 10 (first harvesting), the capital could be covered. All these investment criteria suggest that financially, massoi development for business is feasible/and worth being established.

5. Development Strategic

In general, massoi development might boost public welfare and foreign exchange as well as maintaining biodiversity. This development requires integrated comprehension regarding strength, opportunity, threat, and weakness that could be analysed. Based on several research, SWOT analysis of massoi development is displayed in Figure 10.



Figure 10. SWOT analysis of massoi development in general

6. Massoi State in Papua

Though Papua is recognised as a native habitat and the main supplier of massoi, the population density of massoi trees in the forest is in decline. From the original population of massoi trees in the wild, only 20% remains (Nuraeni et al., 2016). In Nature, massoi is found in the steep areas, whereas, in the flat areas this tree can hardly be found due to easy access for the tree to be logged (Nugroho et al., 2019; Yeny & Minarningsih, 2018).

Less is known regarding the population density per ha of Massoi in Papua due to the lack of data. In Teluk Bintuni, the population density of Massoia was 1.593 individual tree /ha, meanwhile in Kaimana it was just around 871 individuals/ha (Hutapea et al., 2020). However, the information in both regions is around the timber industry. Furthermore, a study conducted in Nabire (harvesting sites) found that there are no mature trees and poles found (Nugroho et al., 2019). It is estimated that in this area only 16 individuals of stakes level per ha and 20 individual of saplings level per ha which are usually found on slopes and scattered around the stumps of felled trees.

A reduction in population density of massoi results in a decline in production. In Nabire regency, massoi's bark production has reported a decrease every year (Nugroho et al., 2019). Of three industries, only one remains concurrent with reduction in the production. Annually, about 66,000 kg of bark are exported out of Nabire in 2012: However, along with a period, the production decreases to 20,950kg/year (Figure 11).

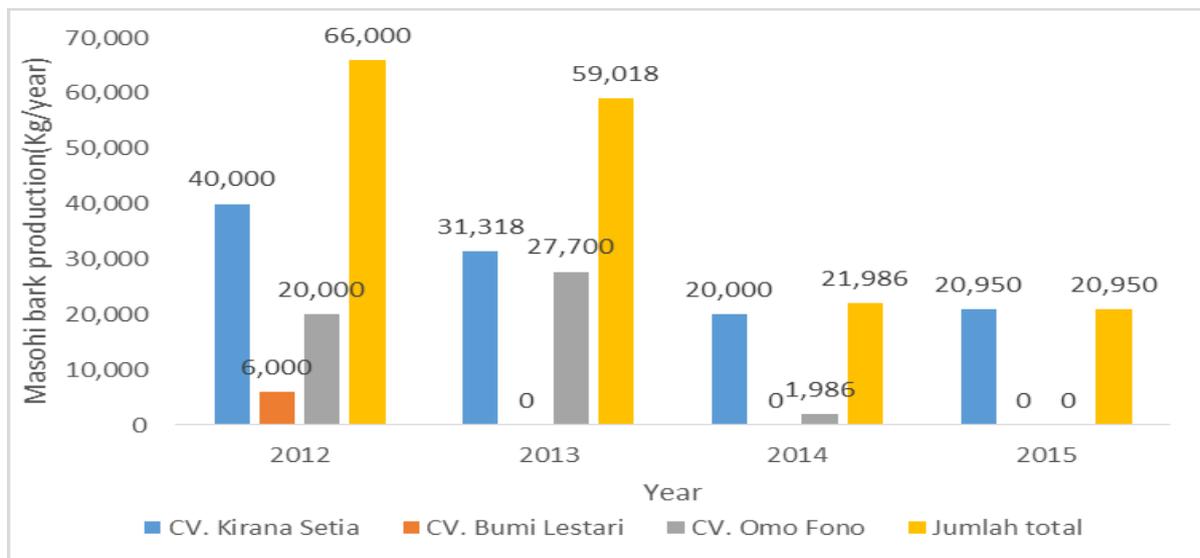


Figure 11. Production trend in massoi's industries from 2012 – 2015 in Nabire

In relation to the supply chain, there is a massoi's refinery industry in Kabupaten Nabire and Bintuni. The supply chain in Bintuni and Kaimana is presented in Figure 12. While in Bintuni the bark is obtained directly from the local people, in Kaimana, local people are visited by the collectors (personal communication with a researcher of FORDA's Manokwari). Marketing information in Papua is not informed explicitly. The information regarding the market's price is also not available. Therefore, the suppliers (local people) never know the real market price of massoi. People do this activity due to economic pressure/for additional income.

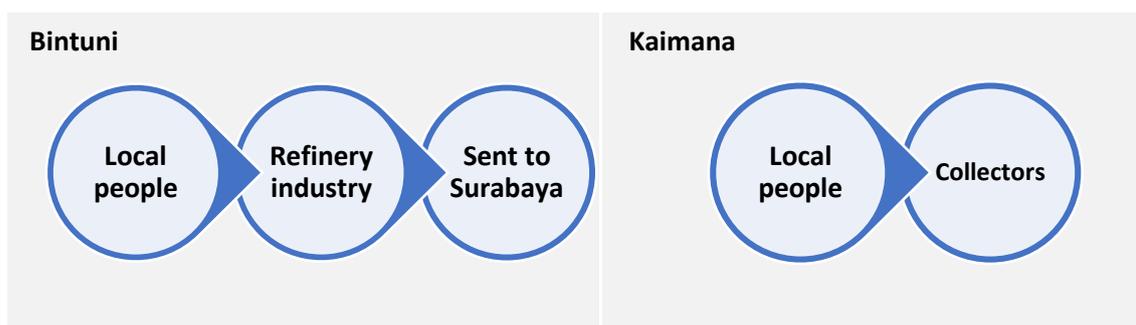


Figure 12. Supply chain of massoi in Bintuni and Kaimana

Several efforts have made to support massoi development in Papua. Several regional governments of Papua have initiated massoi forest plantation development as a superior plant of Papua (Yeny, 2019). Furthermore, Ministry of Environment and Forestry through Research, Development and Innovation Agency – Manokwari, massoi development has been conducted in several places like Teluk Wondama and Ransiki (Yeny, 2019; personal communication with a researcher of FORDA’s Manokwari). This program in collaboration with local people, private sectors, and forest exploitation permit holders. As mentioned before massoi development requires a comprehensive understanding, SWOT analysis in Bintuni is presented in Table 6.

Table 6. SWOT Analysis

Internal	
Strengths (S)	Weaknesses (W)
<ol style="list-style-type: none"> 1. The research location is suitable to be planted with massoi. 2. There are many saplings found in the research location. 3. Massoi associated with other plants. 4. Vast areas 5. The land belongs to indigenous people 6. There are many workers 7. Massoi is an alternative source of income 8. Community interest in massoi cultivation 	<ol style="list-style-type: none"> 1. Destructive method for harvesting 2. Lack of knowledge about massoi cultivation 3. Shifting cultivation method by the local people 4. The high failure rate of plant growth 5. Seeds are difficult to be found 6. Intensive cultivation is lack of capital to support. 7. Unclear boundaries of community land Multiple owners – claiming on land by other tribes.
External	
Opportunities (O)	Threats (T)
<ol style="list-style-type: none"> 1. PP No. 6/2007 allows a certainty in utilizing NTFPs in natural and plantation forests. 2. High market value. 3. High demand in NTFPs’ market. 4. There is a refinery factory of massoi in Teluk Bintuni for barks gathering. 	<ol style="list-style-type: none"> 1. Stable price, there is no information regarding massoi’s price. 2. There is no guarantee of business from the local government 3. There are no regional regulations for regulating the distribution and trade of massoi. 4. There is a bonded bond system (Ijon system).

Source: Hastanti et al.(2018)

Table 6 demonstrates that there are several actions which could be considered as followed:

- (1) Establishing a multi-stakeholder communication forum for massoi development
- (2) Establishing group of indigenous/tribe farmers
- (3) Multi-stakeholder participation in establishing a massoi demonstration plot (demplot) for the community in Teluk Bintuni
- (4) Socialization about massoi cultivation
- (5) Legal counselling
- (6) Exposing market price information
- (7) Providing business assurance for farmer's groups
- (8) Forming/drafting a regulation regarding circulation/utilization of NTFPs from the related SKPD
- (9) Support on technology and innovation for massoi cultivation and harvesting from the related agency.
- (10) Provide capital assistance and subsidies for massoi planting
- (11) Provide legal guarantee (law) for customary land according to state and custom

7. Challenges and Recommendation

Challenges	Recommendations
<p>The demand for the supply of massoi has not met yet due to limited stocks in the forests. This limitation occurs due to over exploitation in response to high demand (Hutapea et al., 2020).</p> <p>Regarding cultivation, massoi's seedlings are hard to find even in the natural forests (Hastanti et al., 2018). High failure rates of the seedlings to survive. According to local people in Teluk Wondama, since Massoia has a heat, seedlings should be planted in certain distance. Otherwise, trees will die.</p>	<p>Supply escalation:</p> <ul style="list-style-type: none"> • Cultivation/plantation development program could be established since we cannot rely on natural stocks indefinitely. • Recommended cultivation method is cutting practice since this method allows high population (Darwo & Yeny, 2018). • Massoia plantation and development have been done in several places outside its native place in Bogor – Jawa Barat and Boalemo – Gorontalo (Yeny & Minarningsih, 2018). This could be a lesson learned.
<p>Lack of information on economic valuation, potency, and harvesting method.</p>	<p>An integrated and comprehensive research could be conducted by involving Educational Institutions (Universities), Government and Non-Governmental Institutions.</p> <p>This research might provide information regarding the income, costs, socio-economic background, harvesting location, etc that would be essential for estimating profit, establishing regulation, mapping its distribution, etc. Harvesting method (<i>open system method</i>) would be another opportunity to provide novel method that more environmentally and sustainably friendly.</p>
<p>Until now the massoi industry still obtains raw materials from the natural forests.</p>	<p>If every industry is given utilization permit in an area, plantation program has to be established in each industry for their continuous supply.</p>
<p>Stakeholders integration and land/territorial claiming conflict in Papua</p>	<p>Multi-stakeholder cooperation between Governmental and Non-Governmental Organisations, Customary Organizations, Education and Research Institutions, etc.</p> <p>Community engagement through intensive socialization. This approach is intended to reduce overexploitation.</p>

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