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Characterization of Smallholders' Forest for Sustainable Wood Supply in West Java

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Abstract
Smallholder forests in West Java, Indonesia, supply domestic and industrial wood needs. However, due to unprofessional forest management and the ease of converting land use, smallholder forests cannot ensure a sustainable wood supply. It is necessary to understand their characteristics to support the implementation of sustainable forest management in smallholder forests. This study aims to assess the sustainability of wood raw material supply by evaluating the characteristics of smallholder forest stands. The research was conducted in the smallholder forest of Sumedang district using a purposive sampling method with a moving plot. The results showed a density of 342.5 trees per hectare, comprising 14 tree species. The diameter of trees in the distribution ranges from 1-49 cm, with a predominant diameter class of 10-15 cm. The potential stands for smallholder forests is 32.68 m3ha-1. The cutting felling cycle occurs at the age of 6.5 years with a selective logging system for diameters larger than 15 cm, which is suboptimal and may not continue. Therefore, it is necessary to extend the cutting cycle to increase sustainability. As a result, there is a risk that community forest areas will be converted into other land uses.

Keywords: cutting rotation; smallholder forest; stand characteristics; sustainable forest management supply

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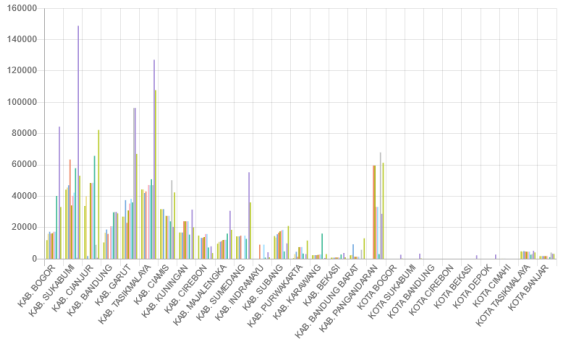
INTRODUCTION

There are four opportunities and challenges for forest resources today, namely facing the increasing demand for wood as a versatile, renewable, and recyclable resource for a low-emission economy, growing a forest-based rural economy to reduce poverty, taking advantage of global interest in investing in trees and solutions forest-based for ecosystem restoration, and taking practical action to mitigate climate change (1). Small-scale forest plantations, owned and managed by small farmers in rural communities, are critical to the sustainability of the forestry and wood products sectors in several countries in Africa, Asia, and South America, as well as in Europe, such as Finland, Sweden, and Portugal, and in the United States. We can overcome the challenges mentioned above by prioritizing sustainable forestry, including community partnerships. One-third of global productive plantations fall under smallholders' ownership, while corporates have ownership of less than one-fifth of the worldwide plantation area. Despite these statistics, a significant share of trees planted by smallholders in woodlots is excluded from official statistics (2). Considering the importance of this, several studies such as (1), suggest several things for the future. We must encourage and strengthen small-scale plantation forests as the primary source of future wood supplies suitable for their intended use without hampering food and commodity production. Then, it is necessary to encourage the production of products that have added value locally and create the needed markets to develop additional jobs (including for farmers), new services, and regional economies. These changes will also support the low-emission circular economy, which many are now pursuing.

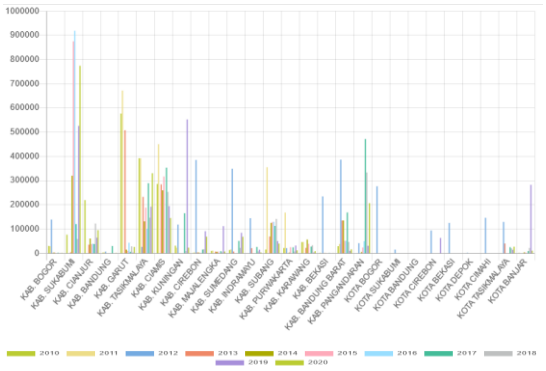
Finland is the most forested country in Europe, with approximately 70% forest cover or 228,000 km2 (3). There are four main categories of forest land ownership in Finland, namely private owners, government, forest industry,

and others (4); with primary forest ownership being 60.9% private and family forest, company 8.2%, state 25.4%, and others 5.7% (5),(4). Small private forests in Finland currently generate 80% of the supply in a massive forest industry that generates significant economic benefits for the country, so much so that the Finnish people consider forests their "Green Gold" (6). Today, collective ownership has become one of the most prominent forms of forest ownership, apart from direct private ownership, Finland's dominant form (7). Meanwhile, in Indonesia, smallholders produce 80% the teak timber used by small and medium furniture producers (8). According to the Ministry of Environment and Forestry, in 2014, community forests in Indonesia reached 34.8 million. The island of Java covers an area of 2.7 million ha with a timber potential of 78.7 million m^3, while outside Java, the area is 32.1 million ha with a potential of 912 million m^3. For instance, 4.8 million m^3 of timber in 2015 and 6.2 million m3 of wood in 2018 were supplied by private forests as raw materials for forest industries. According to the West Java Province Forest Service, in 2020, the community forests in West Java will have about 0.613 million hectares and produce timber of 1.87 million m^3. The wood production area from community forests in West Java tends to decrease from 2010 to 2020, as seen in the following figure.

Changes in the forest ownership structure in the last three decades in Europe include changes between public and private ownership, changes within public ownership categories, and changes within private forest ownership. Across Europe, the following drivers for ownership changes have been identified in the COST Action, including privatization, or restitution of forestland, Privatization of public forest management, new private forest owners who have bought forests, new forest ownership through afforestation of formerly agricultural or wastelands, and changing lifestyle, motivations, and attitudes of forest owners (9). The general factors causing changes around community forests in Indonesia are policy factors and economic factors.



(a) Graphic of Area Distribution



(b) Graphic of Wood Production Distribution

Figure 1. Area and Production of Wood Products from Community Forests Based on Regency/City in West Java for the Period 2010 - 2020 (West Java Provincial Forestry Service, 2022)

Sources: https://opendata.jabarprov.go.id/id/dataset/luas-hutan-rakyat-berdasarkan-kabupatenkota-di-jawa-barat

Private forests are a valuable natural resource managed by communities to produce timber and associated commodities, to increase community income and welfare (10). Private forests have supported Indonesia's forest industries (11). The term " small-scale forestry has different meanings in several countries and regions. Small-scale forestry generally refers to a wide range of managed land units, ranging from small, isolated patches of native forest to patches of non-native species' timber. They are managed by owners from a variety of rural backgrounds who generally pay attention to community traditions and values (1). Small-scale farmer-owned private forests (PFs), also known as hutan rakyat in Indonesia (12), woodlots (alas or kitren), drylands (tegalan), and home gardens (pekarangan) (8), Talun village, or a mixed farm. Smallholder forests differ from state forests in both ownership and characteristics of the forest. Regardless of forest ownership, characterization of forests is essential for management evaluation.

To sustainably manage forest resources, there is a need to provide information essential to understanding the extent of forest resources, their condition, management, and utilisation through forest status assessments, especially in highly biodiverse tropical forests with high rates of deforestation, degradation, decline, and fragmentation (13). Although most forests in Finland are owned forests, Finland was the first country to conduct a systematic national forest inventory, which was conducted between 1920 and 1923. The results of the last National Forest Inventory (NFI) in Finland provided information on tree growth, total forest area, and total timber volume over the previous century, which has increased (14).

Characterization of forest conditions is essential in forest management, one of which is determining the harvest time, as it mainly uses the mean annual increment (MAI) method. Mean Annual Increment - MAI is a fundamental factor impacting the choice of species (15). The rotation age of the species occurs when the mean annual increment is at maximum (MMAI), the point where the mean annual increment (MAI) and current annual increment (CAI) intersect (16). The forest characteristics used to determine MAI are diameter, tree height, tree volume, and age of the forest stand. The character of this forest is valued from an economic perspective, with several of the standard methods for assessing forest conditions. These methods include Net Present Value, Internal Rate of Return, Benefit Cost Ratio, and Soil Expectation Value. Comparative approaches are used to determine differences in the characteristics and value of smallholder forests in Sumedang District with other districts in West Java. Data on the characteristics of smallholder forests in other districts using the MAI (17). Based on the research conducted so far, this study focuses on the characteristics of community forest stands with pure and even-age stands. This research is expected to introduce a new novelty: the role of smallholders' forests with uneven ages and species diversity in determining the optimal cycle.

This article will identify and evaluate the characteristics of smallholder forests that can be used to determine the condition of smallholder forests. This study aimed to identify the features of smallholder forests that can regulate yields and ensure timber supply sustainability. The research location is a smallholder forest in the Sumedang district. The data collection method is a purposive sampling method with a moving plot. The plot form is a circle with 0.1 ha per plot of 20 sampling plots.

MATERIALS AND METHODS

Study area

We study this problem in the smallholder forest of Nagarawangi Village located in West Java Province of Indonesia (Fig. 1). Based on data sources from BPS Sumedang Regency (2013), Nagarawangi Village has an area of 333.3 hectares. The area has several uses, such as agriculture, settlement, and forestry. The total area used as agricultural land is 70.39 percent or around 234.61 hectares. Agricultural land in the form of rice fields covering an area of 95.56 hectares and an area of 139.05 hectares in the form of dry agricultural land, namely plantations, fields, and land. The area of forestry is 14.92 percent or around 49.73 hectares. Settlement and yard area of 13.05 percent or around 43.49 hectares. The remaining 1.63 percent, or around 5.43 hectares, is used for other land such as public facilities, cemeteries, etc.

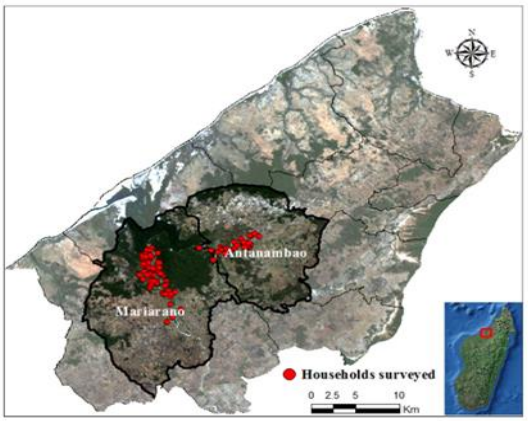


Figure 1 Map shows the study area's location within Nagarawangi Village, Subdistrict Rancakalong, Sumedang District, West Java Province, Indonesia.

Data collection

Data were collected from Nagarawangi Village, a dry agricultural land with 139.05 hectares of community forest. The sampling intensity used was 1.5% with a sample size of 0.1 ha in a circle. Thus, as many as 20 sample plots are needed. Characteristics of stands measured included tree species, tree age, trees per unit area, diameter, tree height, and tree volume. The size and age of trees cut down were recorded in each plot. Then a confirmation is made to the landowner farmers regarding the selling price of standing trees, the sales system, and the intended use of wood.

Data analysis

Trees per Unit Area

Trees per unit area is number of stems or trees per unit area is referred to in terms of trees per hectare (TPH). Analisis data dengan membuat table sederhana dari setiap sample plot, kemudian dikelompokkan jumlah pohon per ha oleh diameter.

Average Diameter of Trees

Breast height is 4.5 feet (1.37 meters) above ground level. The average DBH of a stand provides the relative size of the samples obtained through field measurements. This, in conjunction with other structure measures, can help you visualize the quality of the forest. The average diameter is a requirement for habitat suitability models as well.

Diameter Distribution of Trees

We would group the trees into diameter classes of 2 cm or more. A graph constructed to illustrate the number of trees per unit area by diameter breast height (DBH) class. For an even-aged stand, distribution is normal. Uneven-aged stands have more than one distinct age class and usually consist of small trees filling in the gaps in the canopy. Therefore, when developing a diameter distribution for uneven-aged stands, the distribution should approximate an inverted J-shaped distribution.

Basal Area

The basal area of a stand of trees is the sum of the cross-sectional surface areas of each tree, measured at DBH, and reported on a per-unit area basis. Basal area is a measure of tree density and is widely used in forestry, wildlife, and other natural resource management professions. To calculate basal area, assume a tree is cut off 1.3 meters above ground (DBH). Since the area of a circle is πr2, and since we commonly measure the diameter of a tree rather than the radius, we can substitute (DBH/2) into the equation, which then becomes:

$$Basal\ Area(m^2) = \pi \left(\frac{DBH}{2}\right)^2$$

Timber Volume

Timber Volume is calculated using the formula:

Timber Volume (m^3) = BA (m^2) x H (m^2)

Mean Annual Increment, Periodic Annual Increments

The mean annual increment (MAI) is the average yearly growth computed for volume, weight, or other measures, up to the time of measurement or projection. MAI can be calculated for a tree or a stand of trees, and if for the latter, it represents the growth rate per unit area per year.

$$MAI = \left(\frac{Volume\ per\ ha}{age}\right)$$

The periodic annual increment (PAI) is the growth rate of a tree or stand of trees over some time, whether one year, 5 years, a decade, or longer. Dalam penelitian ini menggunakan satu tahun atau menggunakan CAI (current annual increament) dengan perhitungan tahunan. The CAI computation in equation form can be expressed as:

CAI = (volume at the end of a year - volume at the beginning of the year)

The quality of tree wood

In calculating the quality of tree wood that still stands, using the Down Wood Class from Thomas. Unlike the original use, the Down Wood Class table is used for former standing trees, whereas in this study, it is used on trees that are still alive and standing (18) In. Damage rate is the percentage of damage to the total stand population. Assessment of each tree uses the wood damage class from Thomas in Table 1.

Table 1. Down Wood Class from Thomas, J.W. (18)

	Decay class				
	I	II	III	IV	V
Bark	intact	Mostly intact	Mostly intact	Absent	Absent
Integrity	sound	Sapwood rotting	Heartwood sound	Heartwood rotten	None
Branches	All present	Larger twigs present	Larger branches present	Branch stubs present	Absent

RESULTS AND DISCUSSION

Silviculture system and characteristics of the stand

Based on stand composition, small-scale forests in our study area consisted of 89% mixed forests and 11% monoculture forests. Meanwhile, based on stand age, the forest in our study area consisted of 60% uneven-aged forest and 40% even-aged forest. Mixed forests comprised 67% uneven-aged forests and 33% even-aged forests, whereas monoculture forests are all of an even-aged forest. According to (8)Compared to monoculture systems, mixed forest systems have a lower risk, higher diversity, greater product and farmer income, and a better environmental impact.

Small-scale forest silvicultural systems determine their sustainability. Based on the results of observations in the field, small farmers use a regeneration system of around 82% local seedlings and 18% coppice system. Small farmers apply the coppice system to *P. falcataria* and *T. sureni species*, while other types use local seedlings. This differs from small farmers with small-scale teak forests in different areas in Indonesia. According to (8) That small teak forests used 72% wildlings, 30% local seedlings, and 12% improved germination.

Most smallholders of forests do not undertake stand maintenance activities such as pruning and thinning. Fertilization is carried out only at the beginning of tree planting using organic fertilizers, and at a later age, relies on fertilizers from fertilizing agroforestry plants. This situation differs from that of small teak forest farmers, where farmers have carried out pruning and thinning activities. According to (8), smallholder teak forests in Indonesia that had cut 65% of farmers, where 55% of the pruned branches were used for firewood; while farmers who have carried out teak thinning are as much as 57% of farms, but those that are left are larger trees that can already be sold. These silvicultural systems are poor practices that have caused overstocks, slow growth, low wood quality, and low productivity. Using the classification of stem quality classes using Down Wood Decay Classes from Thomas (18), the results showed that the quality of tree stems was 0.88% class 1, 80.88% class 2, 13.72% class 3, and 4.53% class 4. Results of assessment of community forest management activities in Lampung by (19) showed that planning, organizing, maintenance (including thinning), monitoring, and evaluation activities were rated as moderate, planting and harvesting were rated as good, and marketing as poor.

Different silvicultural systems from small-scale forests in Finland. Planting and thinning remain the mainstays of Finnish forest management. Most forests in Finland today are of plantation origin and are thinned several times over the average stand rotation of 70-100 years. For example, 73 percent of the 612,000 hectares of forest land harvested in Finland in 2015 were merchantable thinnings (6). The following table presents a typical forest management treatment regime in Finland currently.

Table 2. Typical Forest Management Treatment Regime in Finland

No	Age (years)	Treatment
1	0	Regeneration — Following harvest, all sites are regenerated through planting (~65%) or direct seeding (~35%). All cutovers are site-prepared with machines through mounding (rich sites) or scarification (poor sites).
2	5	Early competition control — All stands are manually or mechanically weeded of early competition to favour planted or seeded regeneration.
3	10-15	Second stage competition control — Depending on the site, a second early weeding is scheduled to reduce competition and allow 'free to grow' selected trees.
4	25-30.	First merchantable thinning — First thinning is when the landowner receives some stumpage revenues and begins to see a return on their investment; primarily, pulp and/or bio-energy wood (lowest grade) is removed.
5	45 – 65	Second merchantable thinning — As with the earlier thinning, the poorest quality trees are cut at roughly one-third removal, leaving the best quality trees growing for the final cut. While some logs are produced, most of the product is pulp and bio-energy wood. There may be a third thinning on the best sites, but this does not appear to be the norm.
6	80 – 100	Final harvest – Clear cut. Most of the wood harvested is logs optimized for the highest end value. This stage offers the full economic return to the landowner with funds set aside for the forest rotation to begin anew by planting or seeding.

Source: (6)

In general, there are three community forest planting patterns in Indonesia: pure community forest (monoculture), mixed community forest (polyculture), and agroforestry. In agroforestry systems, there are three basic sets of elements or components that are managed by the land user, namely, the tree or woody perennial, the herb (crops including pasture species), and the animal (20). In Sukamaju Village, Ciamis and Kiarajangkung Village, Tasikmalaya, West Java, the types of plants that make up community forests consist

of woody plants, namely sengon, mahogany, suren, tissuek, afrika, manglid in Sukamaju Village and sengon, puspa, manglid in Kiarajangkung Village; multipurpose plants (MPTS), namely coconut, sugar palm, petai, durian, jengkol, avocado, mangosteen, nutmeg in Sukamaju Village and sugar palm in Kiarajangkung Village; as well as crops, namely cardamom, bananas, papaya in Sukamaju Village and cardamom in Kiarajangkung Village (21). In Central Lombok, we have found that pure community forest (monoculture) planting patterns with three agroforestry patterns as the combination of: *Falcataria moluccana* with vanilla and small taro; *F. moluccana* with vanilla and ginger; and *F. moluccana* with vanilla, ginger, and small taro. The community has developed this pattern to increase the productivity of *F. moluccana* private forests (22).

Trees per Unit Area

Most of the smallholder forests have a small number of trees. This condition is due to the smallholder forests model, which is an agroforestry model that combines tree stands with perennial crops and cropland. The inventory results show that the number of species is 13. The average number of trees per hectare (TPH) in smallholder forests in Sumedang district is 335 trees. The characteristics distinguished between smallholder forest stands, age stands, and uneven-age stands. TPH for even–age stands is 274 trees per ha, and TPH for uneven is 411 trees per ha. This is under the provisions of the Ministry of Environment and Forestry where community forests are forests owned by the community that have a minimum area of 0.25 ha, greater than 50% canopy cover of wood species or other plants, or a minimum of 500 stems per hectare in the first planting year (Decree of the Minister of Forestry No. 49 of 1997). According to (22), this condition of stand density creates competition for sunlight and optimal space, including intercropping between trees.

In the other district of the West Java Province, for example, Garut District, the range of TPH is 140 trees per hectare for age 1 year to about 140 at harvest age. (17). In each district in succession in Pandeglang, while in Sukabumi, for the other districts in Java island, the pole and tree levels were found as many as 39 species and 28 species; for the sapling level, 28 species and 20 species were found. While for the seedling level, there are 21 species and 16 species (23). Hutan rakyat di Desa Rumoong Atas, Kecamatan Tareran, Provinsi Sulawesi Utara berjumlah 249 pohon per ha, terdiri dari 8 jenis pohon pertukangan (24). The difference between smallholders' forests in Sumedang District and other districts is that the smallholder forest species in Sumedang District are fast-growing tree species with a 5-year harvest age. In contrast, in different districts, the harvested species are longer-lived. In addition, most Silviculture systems in Sumedang planting systems do not use natural seedlings.

Table 3. Composition species of Smallholder Forest in Sumedang District

Species	The average number of trees. (per ha)	%
Persea Americana	2	0,60
Syzygium aromaticum	3	0,90
Durio zibethinus	2	0,45
Anthocephalus cadamba	20	5,97
Elaeocarpus ganitrus	34	10,00
Gmelina arborea	20	5,82
Archidendron pauciflorum	1	0,30
Mangifera foetida	1	0,15
Swietenia mahagoni	8	2,39
Albizia falcataria	145	43,13
Maesopsi eminii	39	11,64
Toona sinensis	59	17,46
Hibiscus macrophyllus	4	1,19
Grand Total	335	100,00

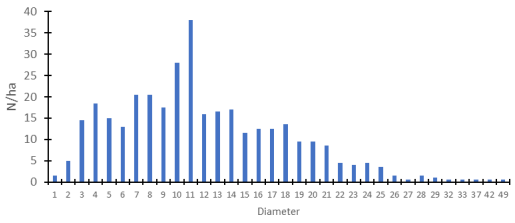
Diameter Distribution of Trees

The results of the tree diameter classification and its distribution for all areas of smallholder forest in Sumedang show the characteristics of an even-aged forest. For an even-aged stand, the distribution should be approximately normal (Figure 1.a). Still, in other districts, it is indicated that a forest is

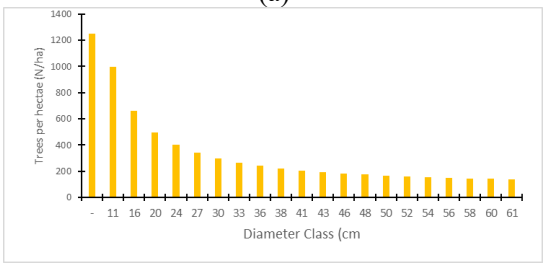
described as an uneven-aged forest in one smallholder forest block. Diameter distribution for uneven-aged stands should approximate a reverse J-shaped distribution (Figure 1.b).

Both characters of the diameter distribution of the two smallholder forests show the different characteristics of the smallholder forest stands between the two districts. The character of smallholder forests in Sumedang District reflects the use of land unsuitable for planting trees for timber production, and the remaining space is used for planting trees other than wood. Most smallholder forests in Sumedang District use agroforestry models where the area is planted with trees mixed with fruit trees and plantation commodities (see Table 4).

In other districts, as a comparison, planted tree species are dominated by Jabon (*Anthocephalus cadamba*), and some are mixed with different tree species such as cloves, coconut, durian, suren, gmelina, acacia, mahogany, mindi, Africa, tisuk, ganitri, jackfruit, teak, acacia mangium, lame, rasamala, and for fruits, coconut, sugar palm, melinjo, durian, petai, jackfruit, harp, candlenut, jengkol, rambutan, mango, and manglid, where these species are wood forest species (17). In other areas, examples of wood species that are generally planted on community forest land in Central Lombok are *Swietenia mahagoni*, *Paraserianthes falcataria*, and *Tectona grandis* (25), using mixed patterns with other types of wood and multi-purpose trees (MPTS), such as fruit trees, and intercropped with food and livestock crops (22), as a type of wood that is known for its high wood quality, high selling price, and grows quickly compared to other types of wood (26).



(a)



(b)

Figure 1. Even-aged stand diameter distributions in smallholder forests in Sumedang District (a) and other districts in West Java are used (17) (b).

Table 4. Characteristics of Smallholder Forests in Agroforestry Systems in Nagarawangi Rancakalong Village, Sumedang District

No.	Characteristics of species	Species (Indonesian Name)
1.	Trees species	1) *Albizia falcataria* (Ind. Sengon) 2) *Toona sinensis* (Ind. Surian) 3) *Swietenia mahagoni* (Ind. Mahoni) 4) *Maesopsis eminii* (Ind. Kayu afrika 5) *Hibiscus macrophyllus* (Ind. Tisuk) 6) *Anthocephalus cadamba* (Ind. Jabon) 7) *Gmelina arborea* (Ind. Jati putih) 8) *Elaeocarpus ganitrus* (Ind. Jenitri)
2.	Fruit Plant species	1) *Syzygium aromaticum* (Ind. Cengkeh; Eng. Clove) 2) *Persea Americana* (Ind. Alpukat; Eng. Avocado) 3) *Durio zibethinus* (Ind. Durian) 4) *Artocarpus heterophyllus* (Ind. Nangka; Eng. Jackfruit) 5) *Archidendron pauciflorum* (Ind. Jengkol) 6) *Mangifera foetida* (Ind. Limus)
3.	Agricultural commodities species	1) Coffee 2) Banana 3) Pepper 4) Tea 5) Taro 6) Chili

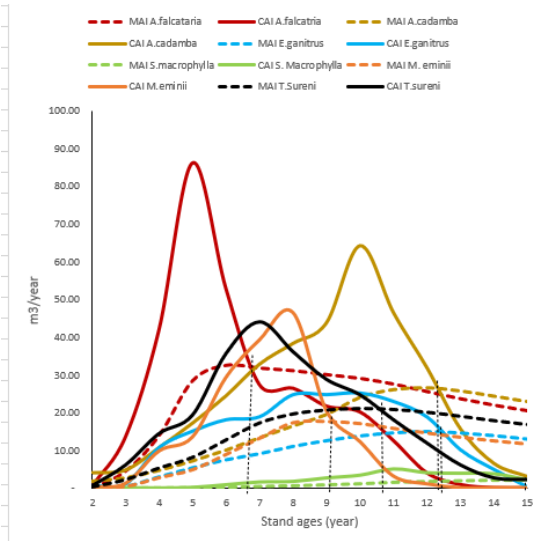
The characteristics of small-scale forest stands in Indonesia differ significantly from those in Finland. According to (6) In Finland, the commercial forestry focus is on the three

dominant species: Norway spruce (Picea abies), Scots Pine (Pinus sylvestris), and Silver Birch (*Betula spp.*). An area of concern in community forest management is deadwood. It is widely acknowledged that deadwood plays a crucial role in ecosystem dynamics (27).

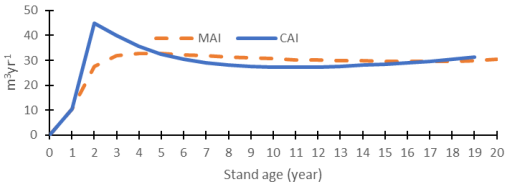
Mean Annual Increment

Other forest characteristics measured in smallholder forests are the mean annual increments of a tree. The mean annual increment (MAI) is the average yearly growth computed for volume up to the time of measurement or projection. With the characteristics of smallholder forests in Sumedang District as mixed forests, the MAI character is shown in Figure 2. a. The MAI chart illustrates that the condition of smallholder forests in Sumedang Regency has both short- and long-cycle growth. The species of tree in the smallholder forest in Sumedang district has six main tree species based on the growth cycle, namely the short stand cycle, which is the A. falcataria species, and the medium stand cycle, which is the species of M. eminii and A.cadamba. The long-standing cycle is S. macrophylla. In comparison, districts with one species only have one growth cycle, while the medium stands in the cycle with *A. cadamba*. Therefore, for smallholder forests in Sumedang Regency, there is a harvesting cycle of at least two times, namely at the age of 6 years for *A. falcataria* species, at the age of 10 years for species of *M. eminii* and *A. cadamba*, and at the age of over 15 years for the *S. macrophylla*. The research results by (28) in community teak forests in Gunung Kidul, Yogyakarta, show that if we look at the field's logging, the community's need cycle is still below the optimal volume cycle. However, if we look at the average diameter cut down, it is at least 20 cm; based on predictions of diameter growth, this figure is reached at the age of 17 years. Meanwhile, teak stands should be harvested when teak growth does not increase rapidly, namely when it is over 14 years old. So, the demand cycle is still acceptable, even though it has not reached the optimal volume cycle, but has gone through a period of rapid growth. Meanwhile, according to (29) reported that the habit of harvesting community forests in the provinces of Banten, West Java and DKI Jakarta is carried out based on needs called harvesting-need (HN), which causes the pattern of wood supply from community forest to be irregular, so that on a broad scale, wood production will experience fluctuations. Therefore, the HN practices should receive special attention because they can help meet the need for wood from state forests.

Nationally, the type of community forest wood used as industrial raw material is sengon, which is used as raw material for the plywood industry and mainly produced in Java. In international trade, this product is known as light wood. According to environmental and forestry statistics, the contribution of log production from community forests to national products from 2014 to 2018 reached an average of 12.86% (30). Meanwhile, according to statistics on forestry production, most of Indonesia's sengon / albazia log production in 2015 was produced in Java, which amounted to 2.51 million m³ (97.16 percent). The second largest production is made in Sumatra, which is 0.04 million m³ (1.61 percent), followed by Kalimantan, Bali, Nusa Tenggara, and Sulawesi, with each producing sengon / albazia around 0.03 million m³ (1,00 percent), 4,71 thousand m³ (31).



(a)



(b)

Figure 2. Mean annual increment (MAI) and current annual increment (CAI) for an even-aged smallholder forest (a) in Sumedang District (b) in Garut District (b)

Certification is necessary to ensure sustainable community forest management in Indonesia. Certified community forests must prepare a comprehensive management plan, which includes an annual harvesting plan. A forest inventory is conducted for all member farmers to identify potential harvested trees based on minimum tree circumference or diameter. The annual allowable cut is then used as a reference to achieve sustainability goals in production. However, research results from three forest farmer groups in East Java indicate that community forests are still struggling to achieve their annual harvest targets due to a lack of implementation of the agreed-upon management plan, including farmer motivation. As a last resort, farmers only cut timber for urgent needs, such as celebrations (hajatan) or school fees. This situation can cause delays or even premature tree cutting, leading to missed harvest targets (32). However, community forests have contributed to increasing timber supply, restoring land, reducing poverty, and mitigating climate change (1).

In Finland, forest management is based on long rotation periods. According to the National Forest Inventory (NFI), the growing stock volume has increased by more than 40% since 1971, now 2,356 million m^3. In Europe, over the last 25 years, the total growing forest stock has risen by an average of 403 million m^3 each year. The most common tree species in Finland are Scots pine (50% of growing stock volume forest land), Norway spruce (30%), and birches (17 %) (5). However, according to NFI 2019, stands >150 years old account for 5.9% and stands >160 years old account for 5% of the total stands across Finland. This is because the current forest management regime favours fast-growing trees (14).

Conclusion

Stands of uneven age and various tree species characterize most smallholders' forests in Sumedang District. This presents potential for the sustainability of community forests as wood suppliers for industries in West Java. To ensure this sustainability, it is important to support the age of the stand harvest cycle, with short, medium, and long-lived harvest cycles. Regulating the harvesting cycle of these stands is expected to promote a sustainable timber supply.

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