Assessing the potential of Gunung Dahu Research Forest as Source-Identified Seed Stand of Shorea leprosula Miq

A T D A Pratiwi1, P Pamoengkas1, H H Rachmat2*

1 Department of Silviculture, Faculty of Forestry, IPB University (Bogor Agricultural University), Bogor, Indonesia
2 Forest Research and Development Center, Bogor, Indonesia

*Corresponding email: hendalastut@gmail.co.uk

Abstract. Shorea leprosula Miq is a species from Dipterocarp family with high economic value but has complex problems in seeds availability and storage. S. leprosula stand in Gunung Dahu Research Forest (GDRF), Bogor-West Java has been flowering for several times that makes these stand to have potential to be developed as seed stand. This research was aimed to assess the potential of Gunung Dahu Research Forest as source-identified seed stand for S. leprosula. Assessment was carried out in plot number 1, 2, 5, 7 and 21A by developing a scoring technique to several criteria, those were: total amount of seed trees, stand’s quality, flowering and fruits quality, stand’s health, trees parentage, accessibility, and stand’s security. Only those of plots having 94 points or above would be accepted as seed stand and that designated plot number 2, 5, and 21A with total score 131; 131.5; and 96.5 points accepted as seed stands while plot number 1 and 7 were failed to fulfil the criteria. Among those of accepted plots, plot number 5 has higher potential as seed stand because it has fewer disturbances than plot number 2.

1. Introduction

Shorea leprosula Miq is a species from Dipterocarp family with high economic value. It has a lightweight wood with density of 0.30 g - 0.55 g which is a valuable and excellent timber for joinery furniture, panelling, flooring, ceilings and also plywood [1]. Continuous supply of good quality with sufficient number of seed is needed to develop S. leprosula stand to fulfill the market demand of its timber both domestically and internationally. Currently, establishing community forest in form of mix species between fast growing and Dipterocarps has also started to gain its popularity. Good seeds can be obtained from mother trees at good-managed seed sources. Seed source can be obtained in two ways, those are: developed existing stands as a seed sources and establishing new seed sources with planting [2].

Source-identified seed stand is seed sources with average stand quality, appointed from natural or plantations forests and it originality is correctly identified. Source-identified seed stand need to established considering there will be lagging time for 3-20 years before a seed source that has been built to begin producing seeds and can be harvested [3].

According to data from Directorate General of Watershed Management and Protection Forest [4], currently in total there were only six source-identified and source-selected seed stands class of S. leprosula spanning all over Indonesia, those were located in Riau, Kepulauan Riau, Bengkulu, West...
Kalimantan and East Kalimantan. A limited number of seed sources can cause deficiencies to both seeds to supply and its quality of *S. leprosula* species [5].

GDRF is a man-made dipterocarp forest located in Bogor-West Java and have potential to be developed as seed source of *S. leprosula* due to their flowering for several times, especially at plot number 1, 2, 5, 7 and 21A. This research was aimed to assess the potential of GDRF as source-identified seed stand for *S. leprosula* species.

2. Method

2.1. Research site and materials

The study was conducted at Gunung Dahu Research Forest, an area in the Leuwiliang village, Bogor-West Java. Five plots were chosen thus were plot number 1, 2, 5, 7 and 21A. The location of the five plots can be seen in Figure 1.

![Figure 1 Map of observation plots](image)

2.2. Procedure

Data was collected from plots that have been flowering for several times. The criteria for assessment are described as follows.

2.2.1 Total number of mother tree

Trees that have been recorded for their flowering and showed good phenotype were observed and determined as mother trees at each of the plot.

2.2.2 Stands Quality (Fenotype) Mensuration

Stand quality were determined by evaluating the growth performance of the trees in each plot, including diameter, tree height and tree health. Tree diameter were measured at 1.30 m on the ground using phi-band, total height using haga hypsometer and stem straightness based on criteria develop by Department of Forestry, 2006.

2.2.3 Stands Flowering and Fruiting

Data of flowering and fruiting for each mother tree at selected plots were generated from interviews with managers. Total amount of seedlings under mother trees were also collected as secondary data.
2.2.4 Stands Health Observation
Stands health were obtained by direct observation and assessment on the level of pest attack to mother trees at selected plots.

2.2.5 Trees Parentage
The information of trees parentages obtained by interviews with managers and based on written record of trees parentage of the planted trees.

2.2.6 Area, Accessibility and Security
Accessibility of stands was assessed based on total distance from basecamp (measured using GPS), total time needed (measured using stopwatch) and slope (quantified using clinometer). While information on the security level of plots from various disturbances were obtained by direct observation in the area and by interviews with forest managers.

2.3. Analysis
Data of stem straightness, health and total amount of seedlings per mother tree were analysed based on the scoring assessment in Table 1. Selected mother tree determined as a tree with total scoring 17.5 points or more. Matrix of source-identified seed stand scoring can be seen in Table 2. Total number of mother trees have the highest score due to the condition there is compulsory criteria for minimum numbers of mother tree to be fulfilled for determination of source-identified seed stand. The total number of minimum 25 trees for mother trees is important to keep genetic variation high [3]. Accepted source-identified seed stand required a minimum total scoring of 94 points or above.

| Table 1 Scoring assessment matrix for mother tree |
|-----------------------------------------------|
| Criteria                                      | Class | Score |
| Stem straightness *                          | 1     | 0     |
|                                              | 2     | 6     |
|                                              | 3     | 10    |
|                                              | 4     | 14    |
|                                              | 5     | 18    |
|                                              | 6     | 20    |
| Mother tree health**                         | Healthy | 5  |
|                                              | Not healthy | 0  |
| Total amount of seedlings ***                | >= 30  | 10   |
|                                              | 15-29  | 7.5  |
|                                              | 1-14   | 5    |
|                                              | 0      | 2.5  |
| Total Maximum                                | 35     |
| Total Minimum                                | 17.5   |

Source: *) [6]; **) [7]; ***) Research data
Table 2 Scoring assessment matrix for source-identified seed stand

| Parameter                                | Class                   | Score |
|------------------------------------------|-------------------------|-------|
| Total number of mother trees **          | >= 25                   | 60    |
|                                          | 20-24                   | 40    |
|                                          | 11-19                   | 20    |
|                                          | = <10                   | 0     |
| Accessibility                            | <500 m                  | 10    |
|                                          | 500 m - <1 km           | 7.5   |
|                                          | 1 - <3 km               | 5     |
|                                          | >= 3 km                 | 2.5   |
| Time needed to reach***                  | <10 minutes             | 10    |
|                                          | 10 - <20 minutes        | 7.5   |
|                                          | 20 - <30 minutes        | 5     |
|                                          | >= 30 minutes           | 2.5   |
| Slope*                                   | I (0 - <8%)             | 10    |
|                                          | II (8 - <15%)           | 8     |
|                                          | III (15 - <25%)         | 6     |
|                                          | IV (25 - <45%)          | 4     |
|                                          | V (> 45%)               | 2     |
| Quality stands                           | The average TT ***      |       |
|                                          | >= 25 m                 | 10    |
|                                          | 20 - <25 m              | 7.5   |
|                                          | 15 - <20 m              | 5     |
|                                          | <15 m                   | 2.5   |
|                                          | On average Dbh ***      |       |
|                                          | >= 50 cm                | 10    |
|                                          | 40 - <50 cm             | 7.5   |
|                                          | 30 - <40 cm             | 5     |
|                                          | <30 cm                  | 2.5   |
| Flowering / fertilization                | History flowering / fertilization *** |       |
|                                          | > 2 times               | 10    |
|                                          | 1 times (the first time)| 5     |
| Security***                              | unmolested              | 10    |
|                                          | low noise               | 7.5   |
|                                          | Disturbances were       | 5     |
|                                          | high interference       | 2.5   |
| Medical history (Within 1 year) ***      | Never before had attacked | 10 |
|                                          | ever had                | 5     |
| The origins of the tree                  | Clear                   | 10    |
|                                          | Not clear               | 5     |
| total Maximum                            |                         | 150   |
| total Minimum                            |                         | 94    |

Source: *) MoF (2013); **) KLHK (2016); ***) Data processing research
3. Result and discussion

3.1. Mother trees
Mother tree is very important to produce good quality seeds. Good physical or physiological appearances of mother tree are more likely to have ability to produce good offspring. Data on selected mother trees of *S. leprosula* for each plot was presented in Table 3.

| Parameter                                      | Class         | Score |
|------------------------------------------------|---------------|-------|
| Time needed to reach the plot***               | <10 minutes   | 10    |
|                                                | 10 - <20 minutes | 7.5   |
|                                                | 20 - <30 minutes | 5     |
|                                                | >= 30 minutes  | 2.5   |
| Slope*                                         | I (0 - <8%)   | 10    |
|                                                | II (8 - <15%) | 8     |
|                                                | III (15 - <25%) | 6    |
|                                                | IV (25 - <45%) | 4    |
|                                                | V (> 45%)     | 2     |
| Stands quality                                 |               |       |
| Average Total Height ***                       | >= 25 m       | 10    |
|                                                | 20 - <25 m    | 7.5   |
|                                                | 15 - <20 m    | 5     |
|                                                | <15 m         | 2.5   |
| Average Dbh ***                                | >= 50 cm      | 10    |
|                                                | 40 - <50 cm   | 7.5   |
|                                                | 30 - <40 cm   | 5     |
|                                                | <30 cm        | 2.5   |
| Stands flowering / fruiting                    |               |       |
| Flowering/fruiting history ***                 | > 2 times     | 10    |
|                                                | 1 times (the first time) | 5 |
| Stands security***                             | Undisturbed   | 10    |
|                                                | Low disturbance | 7.5 |
|                                                | Moderate disturbance | 5 |
|                                                | High disturbance | 2.5 |
| Stands health history (Within 1 year) ***      | Never had attacked | 10 |
|                                                | Ever had attacked | 5  |
| Trees parentage                                | Clearly       | 10    |
|                                                | Not clearly   | 5     |
| Total Maximum                                  | 150           |       |
| Total Minimum                                  | 94            |       |

Source: *) [8]; **) [3]; ***) Data processing research
Based on Table 3 there were 100 mother trees candidates that have been experiencing of flowering/fruiting history at selected plots. The selection of mother trees using a scoring assessment on stem straightness, health, and total amount of tree seedlings explained that there was only one tree in plot 21A rejected as mother tree because its total score was below minimum requirement (<17.5 points). The tree showed less straight stem that may be, inherited to the next generation [3]. According to Mashudi et al. [9], physical good appearance of mother trees will produce good offspring, and mother trees with good genotype will also be inherited to their next generations. There were 99 mothers tree selected from all trees available in plots, those consisted of: 9 trees at plot 1, 34 trees at plot 2, 27 trees at plot 5, 6 trees at plot 7 and 23 trees at plot 21A.

| Plot | Total number of potential mother trees | Total | Rejected | Accepted |
|------|----------------------------------------|-------|----------|----------|
| 1    | 9                                      | 0     | 9        |
| 2    | 34                                     | 0     | 34       |
| 5    | 27                                     | 0     | 27       |
| 7    | 6                                      | 0     | 6        |
| 21A  | 24                                     | 1     | 23       |
| Total| 100                                    | 1     | 99       |

Selected mother trees in plot number of 1, 2, 5, 7 and 21A have good health because there were no signs of pests and diseases and have a straight stem. The total amount of seedlings that found in each plots are different, plot number 5 has the highest numbers of seedlings, while plot number 1 and 21A has no seedlings. The absence of seedlings in plot number 1 was thought to be influenced by the intensity of infrequent flowering/fruiting and because of understorey characteristic such as dense ferns. This condition made fruits failed to reach the forest floor and germinate. Whereas in plot number 21A the seedlings were absence. Plot number 21A was known to have the first flowering/fruiting time at the time of the observation.

3.2. Source-identified seed stand

Source-identified seed stand is one of developed source seeds with average quality which can be an alternative seed supply for short-term before seed source is established. Condition of plot number 1, 2, 5, 7 and 21A can be seen in Table 4 and results of scoring assessment for S. leprosula seed stand in Table 5.

Based on information presented in Table 5 among five plots observed there were three plots accepted as source-identified seed stand, thus plot number 2 with total score 131 points, plot number 5 with total score 131.5 points and plot number 21A with total score 96.5 points. The two other plots (1 and 7) had total score less than 94 points (74 points and 76 points) and thus rejected as source-identified seed stand. Plot number 2 and 5 with total number of mother trees of more than 25 trees get 60 points, while plot number 21A which has mother trees more than 10 trees, but less than 25 trees get a score of 40 points. According to Directorate General of Social Forestry and Environment Partnership (2004) [10] minimum total number of mother trees required is 25 trees, but if it is difficult to find 25 trees it is recommended not less than 10 mother trees, so plot with total number of mother trees more than 10 trees can be developed to be source-identified seed stand. Plot number 1 and 7 with total number of mother trees less than 10 trees are rejected as source-identified seed stand.
### Table 4  Plots assessment for determination of source-identified seed stand

| Parameter                        | Score          |
|----------------------------------|----------------|
|                                  | Plot 1 | Plot 2 | Plot 5 | Plot 7 | plot 21A |
| **Total number of mother trees** |        |        |        |        |          |
|                                  | 9      | 34     | 27     | 6      | 23       |
| **Accessibility**                |        |        |        |        |          |
| Distance from basecamp (m)       | 25     | 61     | 179    | 215    | 1500     |
| Time needed to reach the plot    | 18 sec | 1 min  | 2 min  | 5 min  | 10 min   |
| Slope (%)                        | 35     | 20     | 35     | 20     | 40       |
| **Stands quality**               |        |        |        |        |          |
| Average Total Height (m)         | 21.5   | 21.1   | 21.03  | 21.08  | 19.74    |
| Average Dbh (cm)                 | 40.79  | 41.6   | 44.86  | 46.67  | 42.7     |
| **Stands flowering/fruiting**    |        |        |        |        |          |
| Flowering/fruiting history       | 3 times | 3 times | 3 times | 3 times | 1 times |
| **Stands security**              |        |        |        |        |          |
| Un disturbed                     |        |        |        |        |          |
| Moderate disturbance             |        |        |        |        |          |
| Low disturbance                  |        |        |        |        |          |
| Un disturbed                     |        |        |        |        |          |
| Low disturbance                  |        |        |        |        |          |
| **Stands health history**        |        |        |        |        |          |
| Ever had attacked                |        |        |        |        |          |
| Ever had attacked                |        |        |        |        |          |
| Ever had attacked                |        |        |        |        |          |
| Ever had attacked                |        |        |        |        |          |
| Ever had attacked                |        |        |        |        |          |
| **Trees parentage**              |        |        |        |        |          |
| Sumatera                         |        |        |        |        |          |

### Table 5  Assessment results for *S. leprosula* source-identified seed stand

| Parameter                        | Score          |
|----------------------------------|----------------|
|                                  | Plot 1 | Plot 2 | Plot 5 | Plot 7 | plot 21A |
| **Total number of mother trees** |        |        |        |        |          |
|                                  | 0      | 60     | 60     | 0      | 40       |
| **Accessibility**                |        |        |        |        |          |
| Distance from basecamp           | 10     | 10     | 10     | 10     | 5        |
| Time needed to reach the plot    | 10     | 10     | 10     | 10     | 7.5      |
| Slope                            | 4      | 6      | 4      | 6      | 4        |
| **Stands quality**               |        |        |        |        |          |
| Average Total Height             | 7.5    | 7.5    | 7.5    | 7.5    | 5        |
| Average Dbh                       | 7.5    | 7.5    | 7.5    | 7.5    | 7.5      |
| **Stands flowering/fruiting**    |        |        |        |        |          |
| Flowering/fruiting history       | 10     | 10     | 10     | 10     | 5        |
| **Stands security**              |        |        |        |        |          |
| Ever had attacked                | 10     | 5      | 7.5    | 10     | 7.5      |
| Ever had attacked                | 5      | 5      | 5      | 5      | 5        |
| **Stands health history**        |        |        |        |        |          |
| Ever had attacked                | 10     | 10     | 10     | 10     | 10       |
| **Total Score**                  | 74     | 131    | 131.5  | 76     | 96.5     |
| **Judgment**                     | Reject | Accept | Accept | Reject | Accept   |
Slope at most observed sites were ranged from 20-40%. *S. leprosula* stands at GDRF had average height of 19-21 m and average diameter of 40-46 cm and this showed better growth performance than source-identified seed stand in KHDKT Samboja which only has average high of 16 m and average diameter of 24.62 cm at the age of 21 years [11]. Flowering/fruiting history on plot number 1, 2, 5 and 7 had 10 points score because they were known to experience of 3 times flowering/fruiting within period of 5 years, while plot number 21A get 5 points score for its first time of flowering. Plot number 1 and 7 have highest security point (10 points), while plot number 5 and 21A have low disturbance (7.5 points) with point of disturbance was cassava land and buffalo track (plot number 5). Plot number 2 had moderate disturbance (5 points) in the form of tourist sites that cause seedlings disturbance and soil compaction. Human activity often changes habitat characteristics including physical characteristics of soils. Timber harvesting using machine causes soil compaction which then slow down the recovery of forest conditions and forest regeneration [12]. Frequent visitors will also affect soil compaction to designated plots. The presence of soil compaction, will change the structure of soil and soil pores, so that soil water content also changes [13] thus it may alter physiological process of the trees.

*S. leprosula* stand at selected plots have score of stands health history by 5 points because they attacked by pests a year before observation took place but they all already recovered. Trees parentage in GDRF clearly recorded (10 points) that originated from natural habitat of Sumatera Island. *S. leprosula* spread naturally from Gulf of Thailand and Malaysia, Sumatra up to North Borneo [1].

Plot number 5 has the highest total score (131.5 points), indicated that plot number 5 has the greatest potential to be elected as source-identified seed stand of *S. leprosula* species in Gunung Dahu Research Forest compared with other plots. Plot number 2 with higher number of mother trees, have lower potential as seed stands than plot number 5. This was caused by the disturbance in the form of tourist sites, so that plot number 5 has higher stand security and higher potential as source-identified seed stand. Plot number 2 possessed higher risk on quality of regeneration stands because disturbance on their seedling caused by visitor, therefore there is need for restrictions on tourism activities in this location if the plot appointed as source-identified seed stand. Seedling and sapling are very vulnerable to various activities. Excessive canopy opening would also inhibit regeneration [12]. Thus, plots with higher human activity interventions would have lower potential to be assigned as source-identified seed stand.

Plot number 21A has total score higher than plot number 1 and 7 which is 96.5 points because plot 21A has more mother trees (>10 trees) that has a greater potential to be appointed as source-identified seed stand in comparison to plot number 1 and 7. Each tree showed variations or diversity [7], and based on existing regulation it will need of minimum 25 mother trees to maintain genetic variation in seed source stand. Plot with mother trees fewer than 10 automatically were rejected as this number considered to create low genetic variation followed by decreasing the offspring quality in the future [3]. The total number of mother trees in plot number 1, 7 and 21A are expected to increase in near future considering current condition that most of trees already mature and might be flowering for the next seasons.

4. Conclusion
Plot number 2, 5 and 21A at Gunung Dahu Research Forest, Bogor-West Java have potential to be pointed as source-identified seed stand of *Shorea leprosula*. All three may be proposed as seed stands because they fulfilled the parameters needed in the criteria of source-identified seed stands. Among them, plot number 5 has highest potential to be appointed as source-identified seed stand of *S. leprosula* species with total score 131.5 points.

Acknowledgments
Deep gratitude was delivered to Forest Research and Development Center for providing Gunung Dahu Research Forest as our research site. Author also thankful to Project Collaboration Research and
Development Center – Komatsu for supporting the research budget and support the attendance in the International Conference on Tropical Silviculture 2019.

References
[1] Joker D 2002 Short Information of Seed: Shorea leprosula Miq.. In Indonesia Informasi Singkat Benih: Shorea leprosula Miq (Jakarta: Direktorat Perbenihan Tanaman Kehutanan)
[2] Atmoko T 2008 Evaluate the Feasibility of Datar Alai Forest as Indentified Seed Stand for Shorea spp. In Indonesia Evaluasi kelayakan Hutan Datar Alai sebagai tegakan benih teridentifikasi Shorea spp Di dalam: Gintings AN, Rostiwati T, Leksono B, Effendi R, Wirbowo A, editor. Workshop Sintesa Hasil Penelitian Hutan Tanaman; 2008 Des 19 (Bogor: Pusat Penelitian dan Pengembangan Hutan Tanaman) hlm 357–365
[3] Ministry of Environment and Forestry 2016 Guidelines for Implementation of Seed Source Standard, Second Edition. In Indonesia Petunjuk Pelaksanaan Standar Sumber Benih Cetakan Kedua (Jakarta: Ministry of Environment and Forestry)
[4] Directorate General of Watershed Management and Protection Forest 2019 Foresty Seed Seeding Information System. In Indonesia Sistem Informasi Perbenihan Tanaman Kehutanan [internet] [accessed on 2019 Mar 4] Ready on: http://sipth.sim-pdashl.menlhs.go.id/data_sb/cari_sb.
[5] Putri K P, Supriyanto, Syaufina L 2016 Jurnal Penelitian Hutan Tanaman 13(1):37–48
[6] Department of Forestry 2006 Tree Plus Manual Selection. In Indonesia Manual Seleksi Pohon Plus (Sumedang: Balai PerbenihanTanaman Hutan Jawa dan Madura)
[7] Juanda, Muin A, Wulandari R S 2017 Jurnal Hutan Lestari 5(4):927–934
[8] Ministry of Forestry 2013 Regulation of General Director of watershed management and social forestry Number 3 of 2013 concerning guidelines identifying the characteristic watershed river [Peraturan Direktur Jenderal Bina Pengelolaan Daerah Aliran Sungai dan Perhutanan Sosial Nomor 3 Tahun 2013 Tentang Pedoman Identifikasi Karakteristik Daerah Aliran Sungai] (Jakarta: Ministry of Forestry)
[9] Mashudi, Pudjiono S, Rayan, Sulaeman M 2012 Jurnal Penelitian Dipterokarpa 6(2):97–108
[10] Directorate General of Social Forestry and Environment Partnership 2004 Technical guideline for development and management seed sources. In Indonesia Petunjuk Teknis Pembangunan dan Pengelolaan Sumber Benih (Jakarta: Directorate General of Social Forestry and Environment Partnership)
[11] Adman B 2014 Swara Samboja 3(3):28–30
[12] Meijaard E, Sheil D, Nasi R, Auger D, Rosenbaum B, Iskandar D, Setyawati T, Lammertink M, Rachmatika I, Wong A, et al. 2006. Post harvesting forest. Protect wildlife in production forest activities in Kalimantan. In Indonesia Hutan pasca pemalan. Melindungi satwa liar dalam kegiatan hutan produksi di Kalimantan (Bogor: Center for International Forestry Research)
[13] Rusdiana O, Fakuara Y, Kusmana C, Hidayat Y 2000 Jurnal Manajemen Hutan Tropika 6(2):43–53.