Rehabilitation of degraded forest area using dipterocarp species in Merlimau Forest Reserve, Melaka

M M Farah Shahanim*, M A Nurcahaya Khairany and M T Zahirah

Forest Research Institute Malaysia, 52109, Kepong, Selangor, Malaysia

* Corresponding author: farahshahanim@frim.gov.my

Abstract. The rehabilitation of degraded sites is now recognized as major issue globally. One of the means in rehabilitating degraded areas is through replanting. In this study, a variety of dipterocarp species were planted in a 1.5 hectare degraded forest area in Merlimau Forest Reserve, Melaka. The main objective of this study is to rehabilitate degraded site with commercial timber species. Combinations of slow-release fertilizer and organic fertilizers as well as big planting hole were applied as a part of the improved planting technique. In order to sustain the flora biodiversity of the site, line clearing for planting was adopted. Suitable species were matched to the topography of the site to increase the survival and growth. Growth and survival of saplings planted were monitored and data obtained were analyzed using SPSS program. After 62 months of planting, the survival rate recorded was very high which was 78% in average with Merawan siput jantan exhibiting the highest increment in both height and diameter throughout planting measurements.

Keywords: Rehabilitation; degraded site; improved planting technique; dipterocarp.

1. Introduction

A large tract of forest area has been degraded as a consequence of deforestation, excessive forest harvesting and shifting cultivation [1]. These degraded forests can be broadly divided into three types of degraded vegetation, namely, grassland after burning, early successional secondary forest, and logged over forest after commercial logging [2]. In recent decades unsustainable exploitation of timber, and forest clearance for agriculture, has caused massive losses of dipterocarp forests, and many dipterocarp species are now listed as endangered, and all too often critically so [3]. Dipterocarp species are the predominant tree species of the upper canopy Malaysian rainforest [4]. Dipterocarp species are hardwood, tropical tree, and shade tolerant. These species are widely planted for forest ecosystem maintenance and for the restoration of degraded lands [5].

Forest rehabilitation is a way to overcome the inadequate control and overexploitation of forest production. The rehabilitation of degraded tropical forest ecosystems is therefore a major issue in both regional and global context [5]. In order to rehabilitate such degraded forest land and accelerate recovery of the original ecosystems in Malaysia, high quality indigenous of dipterocarp as well as fast growing exotic species have to be used [6]. Therefore, a study on the species-site suitability with an objective to rehabilitate degraded site with dipterocarp species in Merlimau Forest Reserve, Melaka has been conducted. The selection of the site in the Merlimau Forest Reserve, Melaka is due to forest logging activities which are categorized as degraded forest. The degraded areas need to be restored to improve the quality of forest resources. There are various of advantages using dipterocarp species. The main benefits are it helps to increase the socioeconomic development of the country to meet and balance economic and environmental purposes. Thus, planting dipterocarp species helps to restore the endangered species which indirectly rehabilitate the soil nutrient, hydrology, and ecology of the forest.
ecosystem. Consequently, restoration of these species in degraded forest provides benefits and large impact to economics such as food, timber, and medicinal products.

In this study, planting dipterocarp species with an improved planting technique was conducted to rehabilitate degraded forest. Many rehabilitation efforts using different techniques have been carried out in Malaysia with varying degrees of success [7]. Combinations of slow-release and organic fertilizer as well as big planting hole were applied as a part of the improved planting technique to increase the survival and growth of timber species. Assessment of growth performance of planted species is important for determination of species site of suitability towards an improvement of both strategy and techniques for future rehabilitation efforts [1]. Hence, survival rate and growth performance were also recorded and evaluated in this study.

2. Methods

2.1. Study area

Merlimau Forest Reserve is located at the southwest region of Peninsular Malaysia. This area was previously cleared for logging activities. These species were selected based on previous results of replanting in degraded sites [8]. In this study, a total of 1.5 ha area of the Merlimau Forest Reserve were planted with dipterocarp species.

2.2. Tree planting

Tree planting in degraded forest area require improved planting technique compared to conventional planting. To restore a degraded forest area, it is suggested that the height of the plant should be between 1-2 m and the diameter of the stem is between 1-2 cm. In this study, dipterocarp species sized 1-2 m of height and 1-2 cm diameter namely *Shorea guiso* (Balau membatu), *Neobalanocarpus heimii* (Chengal), *Hopea odorata* (Merawan siput jantan) and *Shorea platyclados* (Meranti bukit) were planted in the study area (Table 1). These species were selected based on previous results of replanting in degraded sites. Using “filling the gap” concept, the planting distance between plant depends on the area.

In open area, the planting distance was 3 m × 3 m meanwhile in areas with few stands available, the planting distance is 4 m × 4 m. Big planting holes’ technique were also applied in this study as a part of the improved planting technique. The size of the planting holes depends on the compactness of the area, in less compacted area the size of the planting hole is 30 cm in width × 15 cm depth, meanwhile in compacted area the size is 50 cm width × 20 cm depth. Planting holes were dug using skid steer loader machine and hydraulic auger. Higher amount of fertilizer was applied compared to conventional technique in order to improve the physical properties and soil fertility. Combination of 200 gm organic fertilizer and 200 gm slow release fertilizer (SRF) were used as part of the fertilizing method in this study. Fertilizer were only applied once during planting process.

At an early stage, all the seedlings were placed under a black net with 70% light intensity to avoid direct sunlight and photoinhibition of the young plants. As the planting will be done in an open area, the seedlings needs to go through a slow hardening process whereby seedlings are gradually exposed to 9 hours direct sunlight for a duration of 2 months followed by an exposure to natural direct sunlight for a month [9].

| No. | Local name          | Scientific name        | Number of planted trees |
|-----|---------------------|------------------------|-------------------------|
| 1.  | Balau membatu       | *Shorea guiso*         | 185                     |
| 2.  | Chengal             | *Neobalanocarpus heimii* | 440                     |
| 3.  | Merawan siput jantan | *Hopea odorata*       | 150                     |
| 4.  | Meranti bukit       | *Shorea platyclados*   | 94                      |
|     | Total               |                        | 869                     |

Table 1: The list of species and number of planted trees.
2.3. Data collection and analysis
Data collection includes survival, height and diameter of the saplings planted. The first data collection was carried out right after planting to obtain the initial measurements. Growth and survival of tree saplings were observed at 35 months, 51 months and 62 months of planting. The mean increment for each species were calculated using SPSS. The mean increment is important in order to monitor the growth of the saplings as well as determining which species has the best growth under the given conditions.

3. Results and discussion
The survival of seedlings planted in the field is as shown in Table 2. After 62 months of planting, the survival of all species decreased moderately but were considerably high. The analyses of variance (ANOVA) on growth performance of seedlings indicated a significant difference at p < 0.05 in height and diameter increment (Table 3). The applications of SRF as one of the measures in improved planting techniques as well as selection of fit and quality saplings resulted in significant increment of seedlings growth performance. A research plot on Chengal seedlings planted concurs this study in Merlimau, whereby high survival rate was recorded when these seedlings were planted using improved planting techniques [10]. In this study, one of the cause for the greater survival percentage measured for these stands planted were due to the slow hardening process, which the seedlings went through for 3 months in the nursery. The seedlings were sheltered from the full sunlight and helped the seedlings to acclimatise better to the new environment in the forest. Apart from this, a research done by [11] in degraded logged forest, where 23 dipterocarp species planted using conventional methods exhibited only 70% survival percentage after nearly 6.5 years of planting. The species planted were namely Hopea sp., Shorea sp., and other Dipterocarpus sp. The lesser survival percentages of those species were largely due to dryness in the field and those species were not fit enough to stand direct sunlight by land clearing preparation on the site.

| Species                | Survival (%) |
|------------------------|--------------|
|                        | 0 month      | 35 months | 51 months | 62 months |
| Balau membatu          | 100          | 80        | 73        | 70        |
| Chengal                | 100          | 94        | 86        | 84        |
| Merawan siput jantan   | 100          | 99        | 93        | 88        |
| Meranti bukit          | 100          | 82        | 79        | 70        |
| Total                  | 100          | 93        | 83        | 78        |

Table 3: Summary of ANOVA for growth performance of seedlings.

| Source of variance | df | F-value Height (cm) | F-value Diameter (mm) |
|--------------------|----|---------------------|-----------------------|
| MONTH              | 3  | 1021712.55*         | 312642.33*            |
| SPECIES            | 3  | 3678.41*            | 784.87*               |
| MONTH*SPECIES      | 7  | 19722.51*           | 1845.77*              |

Height and diameter increment of species planted after 62 months is shown in Figure 1 and 2. After 62 months, Merawan siput jantan had the highest increment by at least 24 – 29% and 17-44% for both height and diameter respectively compared to other species. Meanwhile, Balau membatu recorded the lowest increment for height and diameter, respectively. The known fast growing species and high growth performance increment of Merawan siput jantan in this study supports numerous study which correspond the equivalent results. The adaptation of Merawan siput jantan to severe surroundings lead
to the greater growth performance. Meanwhile, the growth measured for Chengal and Balau membatu which are categorized as heavy hardwood and slow-growth are considered reasonable and satisfactory since other dipterocarp species which are generally fast growing species, such as *Hopea* sp and *Shorea* sp, record values are similar to the values observed in the other stands in this study [12].

**Figure 1.** Height increment of planted species throughout planting measurement.

**Figure 2.** Diameter of planted species throughout planting measurement.

4. Conclusion
The techniques used in planting which has been improved especially on the usage of semi-mechanized machine for creating bigger planting holes and bigger planting stocks have proved that dipterocarp species can be successfully established in logged-over forest.
5. References

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