REFORESTATION WITH NATURALLY REGENERATED TREES AND SELECTED FOREST PLANTATION SPECIES BASED ON MOSAIC PLANTING APPROACH

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ABSTRACT

The paper highlights the concept of Mosaic Planting Approach by retaining the remaining commercially forest species both dipterocarps and non–dipterocarps of diameter sizes below the prescribed cutting limit to be silviculturally managed in the next cutting cycle. The rehabilitation of cut–over forests under the Mosaic Planting Approach was initiated by Maxland Sdn. Bhd/Rakyat Berjaya Sabah and jointly studied with the Forest Research Institute Malaysia (FRIM) in Sungai Pinangah Forest Reserve/Sabah Foundation Concession, Sandakan, Sabah. The approach includes the rehabilitation of left over forests by planting fast–growing forest plantation species including (batai) Paraserianthes falcataria, kelempayan (laran) Neolamarckia cadamba and to some extend with potential Eucalyptus spp. The establishment of N. cadamba was done by selecting and liberating the naturally regenerated stands found in low lying areas or areas having high moisture content or along waterways. The stands were later thinned and silviculturally treated including climber cuttings. The remaining poorly stocked areas found within the cut–over forests of sizes ranging from one to two hectares were semi–mechanically prepared, by crushing and spreading on sites all remaining debris or mulching and later planted with either P. falcataria or Eucalyptus spp. The approach would anticipate both the production of medium sized diameter logs of natural forest species and fast–growing hardwood plantation species in the next 15 to 20 years.

Key words: natural regeneration, plantation species, rehabilitation.

Introduction

The timber industry in Malaysia has been one of the most significant contributors towards the economic earnings and the major resource-based industries in Malaysia. In 2014, exports of timber and timber products were valued at MYR 20.52 billion (Anonymous 2015) and has provided employment of about 300,000 workers. Despite being one of the significant contributors, the Malaysian Government through the Ministry of Plantation Industries and Commodity (KPPK) has recognized that the country cannot solely relied from natural forests as source of revenue and identified forest plantations as an alternative source and as a strategy to overcome the scarcity of timber supply in the near future.

Under the National Timber Policy (NATIP) 2009-2010, exports of timber and timber products is targeted at MYR 53 billion by 2020. In ensuring an adequate and reliable supply of raw materials, various steps have been implemented by KPPK, to meet the growing needs of timber industry including the launching of the Forest Plantation Development Programme (PPLH) in 2006. The Government believes that the establishment of forest plantations supports the future supply of wood materials and expansion of the industry and at the same time reduces harvesting pressure on natural forests.

In line with NATIP, the task was mandated to KPPK to establish large scale commercial forest plantation in the country. In this regards, the Government through the Malaysian Timber Industry Board (MTIB) a statutory body has formed a Special Purpose Vehicle to accelerate the development of forest plantation by forming the Forest Plantation Development Sdn. Bhd. (FPDSB) in 2006. The responsibilities are to provide financial assistance and incentive besides providing and facilitating adequate technical support during the implementation of the project. In order to attract more investors venturing into forest plantations, a funding scheme was developed accountable for soft loans management and recoupment of all payback payments from the borrowers undertaking the forest plantation projects based on the projection of a 15 year rotation.

In this programme a list of companies, government agencies and cooperatives have been selected and awarded in carrying out the tasks of reforestation in all regions of Sabah, Sarawak and Peninsular Malaysia. One of the companies involved in the reforestation was Maxland Restoration Sdn Bhd. operating in eastern part of Sabah under the Yayasan Sabah Concession areas.

Maxland Sdn. Bhd. a forest restoration company has been mandated to implement the reforestation programme in the Forest Management Unit (FMU) 17 A (Area 1) and FMU 17B (Area 2 and 3) in Sungai Pinangah Forest Reserve, within the concession of Rakyat Berjaya/Sabah Foundation in Sandakan. The company has been awarded the fund under the soft loan agreement of PPLH of the Malaysian Timber Industrial Board. Under this programme, Maxland Sdn Bhd. planned to reforest based on

Mosaic Planting approach an area of 1,654 hectares (MTIB, 2014) with fast growing hardwood plantations based on Mosaic Planting. The approach has been approved under the leasing agreement by the Forestry Department of Sabah, under Sustainable Forest Management Licence Agreement (SFMLA) 1/2007 Sungai Pinangah Forest Reserve, Sandakan, Sabah. The species selected for planting under this reforestation approach include Binuang (*Octomeles sumatrana*), Kelempayan (*Neolamarckia cadamba*), *Khaya ivorensis* and Batai (*Paraserianthes falcataria*). Since the project was first conducted in Malaysia, the study highlights the reforestation based on Mosaic Planting approach both by using naturally regenerated and planted seedlings, achieved growth from early plantings and problems related with expected growth of the species.

Concept of Mosaic Planting

The concept of Mosaic Planting Approach involved retaining small patches of natural forest areas containing young commercial tree species during harvesting and establishment of man–made forests within the planting sites. The small patches of natural forests comprises the commercially forest species both dipterocarps (*Shoreas*, *Dipterocarpus*) and non–dipterocarps (*Koompassia*, *Palaquium*, *Octomeles*) of diameter sizes below the prescribed cutting limit (50–55 cm diameter size) or pole size trees (20–30 cm in diameter) to be silviculturally managed in the next cutting cycle. These remaining commercially poles or trees will be silviculturally treated including climber cuttings, culling (removal of badly shaped trees) or thinning.
Subsequently, the open areas left after the extraction were later mechanically cleaned, debris crushed on sites and formed as mulching and planted with selected forest plantation species. The species planted includes *Khaya ivorensis*, (laran) *Neolamarckia cadamba*, Batai (*Paraserianthes falcataria*) and potential *Eucalyptus* species. In an area with high moisture content, or along waterways, only *N. cadamba* will be planted along these areas as observed by the presence of naturally regenerated stands.

Research Methods

Sites preparation for planting

The areas left after harvesting were semi–mechanically prepared using light excavator (Figure 1) or caterpillar tractor to pull down the remaining trees and evenly spread within the planting areas. The trees, palms including wild bananas or herbaceous plants were later crushed forming layers of debris or mulching, which will be an added materials or source of fertilizers. Mulching will return the organic materials to the soils, thus will improve the soil physical properties. An added advantage using this approach is minimizing erosion as fewer soils are exposed. This approach holds the rules of no burning or zero burning.

Figure 1: Sites prepared for planting, some of the commercial trees are left intact and naturally regenerated *N. cadamba* stands

Measurements

During the study, measurements on achieved diameter, height and calculations on increments and volume were carried out in stands established earlier. Soil samples from the areas of naturally regenerated *N. cadamba* were also collected and sent for analyses.

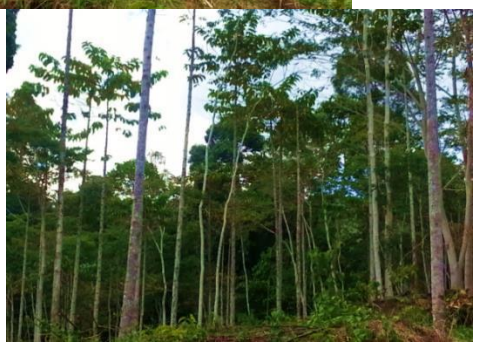
Planting activities

The potential areas will be ready for planting after leaving the debris partly decomposed or mulching on sites normally after 1 month, followed by lining, holing, manuring and planting. The planting of the selected species will be systematically conducted either at 4x3 m (833 stems ha^{-1}) or by 4x4 m (625 stem ha^{-1}) based on species. Seedlings were prepared in the nursery strategically located in nearby source of water, accessible for transportation to planting sites and ready for planting after 6 months old or 60 cm in height. The stands of *P. falcataria* forests were first established in August 2013 followed by species of *Eucalyptus* hybrids and *N. cadamba* (Figure 2 & 3) (Albert 2015).

Figure 2: Seedlings of *N. cadamba* and *P. falcataria* raised in the nursery before planting


Figure 3: Stands of *P. falcataria*, *E.* hybrid and *N. cadamba*, note the remaining patches of natural forest





In the management of *N. cadamba*, plantings were conducted in suitable areas in accordance with the principle of *species to site–matching*. Prior investigations in relation with ecological requirements are needed as the species is mainly found in areas with high moisture regime as compared with other plantation species.

Results and Discussion

The information on the soil chemical and physical properties are important in deciding the sites for future planting of the species. The results of the analyses are as shown in Table 1 and 2. Figures in Table 1 obtained from earlier measurements have shown that the growth and yield of planted *P. falcataria* were higher than naturally regenerated *N. cadamba*. Being an exotic, records from various studies (A. Zuhaidi 2014, Anonymous 2010) the growth of this species has been one of the highest recorded after being introduced in Malaysia. Subsequently *N. cadamba* being native, the species has relatively high growth rate in comparison with the former as shown by other studies (A. Zuhaidi 2012, A. Zuhaidi 2015).

Table 1: Stand and Stock Table of Planted and Naturally Regenerated Tree Species as of 10th February 2015

No	Species	Av. Dbh (cm)	Av. Ht (m)	Dmai (cm/year)	Av. Vol (m / tree)	Vol m^3/ha	Age
1	*P. falcataria*	22.4	14.87	3.7	0.22	88	6.25
2	*N. cadamba*	17.8	11.52	2.8	0.11	44	6.25

Remarks:
DBH; diameter at breast height (cm), HT; clear bole height (m), DMAI; diameter mean annual increment (cm), VOL; volume per tree (m^3).

In the analyses of soil samples obtained from areas of naturally regenerated stands, the average moisture content (MC) at 30–45 cm depth was higher than with average value in planted *P. falcataria* stands at 2.35 (2.04–2.64) and 1.95 (1.36–2.49) percent. Subsequently the average pH values in both sites were 4.72 (4.69–4.84) and 5.49 (4.71–6.45) indicating sites in naturally regenerated *N. cadamba* were slightly acidic and favourable for the growth of the species. The results from these analyses may

help in explaining the observed distribution of naturally regenerated *N. cadamba* found in areas with high moisture regime and low lying areas along waterways.

Conclusion

The reforestation programme under the Mosaic Planting is still at its infancy stage and will take years of evaluation. The overall success of this reforestation approach is yet to be evaluated in particular the effect of soil compaction on the growth and yield of the stands from intensive used of heavy machinery during the site preparation. The returns from reduced number of planted trees in a hectare may not be enough to sustain the cost of production after 15 or 20 years.

But in actual facts, the approach offers alternative option and had several advantages in the restoration and rehabilitation of cut–over forests. By adopting this approach, one has to accept that the establishment of these stands with appropriate management schedule will later generate into multiple products of timber species. Besides being diversified in tree species and the remnants of natural forests left, the approach provides a micro climate for the planted trees, nesting ground for the faunas and safe keeping of selected mother trees. The remnant forests will serve as temporary shelter for wildlife, and in case of fire will act as fire breaks and as wind breaker.

Integration of both natural forests and planted man–made will support a greater structural, functional and biological diversity forests as compared with monoculture system.

Acknowledgements

We wish to thank the Director General of the Forest Research Institute Malaysia (FRIM) and Rakyat Berjaya (RBJ) Sandakan, Sabah for the research fund in conducting the study in Maxland Forest Restoration Sdn. Bhd. Our special thanks to the Director, Forestry Department Sabah, and soil scientists from Forest Research Centre for the working permission, soil samples analyses and logistics during our stay in Sandakan.

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Table 2 Results of soil samples analyses from naturally regenerated *N. cadamba* and planted *P. falcataria*

Soil samples	Depth	MC %	pH H2O	Total N %	Total P mg/g	Total K mg/g	Exch. K meq %	Exch.Na meq. %	Exch.Ca meq. %	Exch.Mg meq. %	TCEC meq.%	% Base Saturation
NC S1	0 - 15 cm	1.91	4.78	0.09	0.18	6.38	0.26	0.04	2.14	1.00	9.53	35.97
	15 - 30 cm	1.94	4.59	0.04	0.17	6.06	0.15	0.02	0.62	0.74	8.30	18.51
	30 - 45 cm	2.04	4.69	0.03	0.12	6.61	0.11	0.03	0.35	0.88	7.84	17.43
NC S2	0 - 15 cm	2.22	4.64	0.09	0.21	6.46	0.22	0.04	2.17	1.50	10.60	37.08
	15 - 30 cm	2.65	4.55	0.04	0.16	7.38	0.14	0.06	0.41	0.82	10.46	13.56
	30 - 45 cm	2.64	4.84	0.03	0.16	7.56	0.11	0.08	0.18	0.59	12.06	8.00
NC S3	0 - 15 cm	2.32	4.83	0.04	0.16	6.36	0.18	0.02	1.35	1.56	13.73	22.66
	15 - 30 cm	2.30	4.84	0.02	0.17	7.62	0.18	0.02	0.43	0.59	9.87	12.37
	30 - 45 cm	2.37	4.65	0.02	0.12	5.18	0.15	0.01	0.58	0.73	8.92	16.51
PF Point E1	0 - 15 cm	1.55	5.78	0.03	0.13	4.76	0.21	0.01	4.08	1.55	6.70	87.53
	15 - 30 cm	1.59	6.23	0.02	0.12	3.80	0.15	0.03	3.45	1.27	5.30	92.49
	30 - 45 cm	1.36	6.45	0.03	0.13	5.23	0.18	0.04	4.52	1.48	7.40	84.22
PF Point E2	0 - 15 cm	2.68	5.17	0.04	0.24	9.55	0.36	0.03	3.86	2.35	10.28	64.12
	15 - 30 cm	1.61	4.67	0.02	0.07	2.76	0.14	0.01	0.47	0.36	7.92	12.40
	30 - 45 cm	2.49	4.91	0.04	0.20	9.76	0.27	0.04	5.51	2.22	11.53	69.70
PF Point D1	0 - 15 cm	3.04	5.56	0.03	0.42	8.58	0.31	0.04	5.21	3.34	12.82	69.36
	15 - 30 cm	2.52	3.87	0.03	0.32	10.57	0.31	0.06	6.59	3.19	10.35	98.07
	30 - 45 cm	2.27	5.89	0.03	0.36	8.92	0.25	0.04	6.04	3.17	11.05	86.02
PF Point D2	0 - 15 cm	1.67	4.85	0.03	0.11	3.53	0.13	0.01	1.16	0.74	7.12	28.79
	15 - 30 cm	2.35	6.12	0.03	0.42	13.05	0.26	0.04	6.61	3.16	10.91	92.27
	30 - 45 cm	1.66	4.71	0.01	0.07	2.94	0.11	0.02	0.38	0.27	8.46	9.16

Note: NC *Neolamarckia cadamba*; PF *Paraserianthes falcataria*
Source: Forest Research Centre, Sandakan 2015

Remarks: MC-moisture content, P-phosphorus, K-potassium, Na-sodium, Ca-calcium, Mg-magnesium

NC – *Neolamarckia cadamba*, PF – *Paraserianthes falcataria*