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A study on the development and implementation of enrichment planting in Peninsular Malaysia

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ABSTRACT

Hill dipterocarp forest areas in Peninsular Malaysia are inherently poor within the natural regeneration. Enrichment planting scheme was implemented with the main objective of expediting the restructuring of the forest content to a desired level in terms of marketable and high quality economic species composition. Effective rehabilitation action plan for degraded logged-over forests such as enrichment planting has been developed to ensure that stocking of commercial trees in the next harvest is sufficient to sustain the supply of logs for the domestic and international market requirements. Besides that the implementation also aimed to support the reforestation of forest abandon areas during the post-harvesting period. The implementation was also considered as an integral part of the silvicultural system. At the high cost in establishment of the enrichment planting, it compensated the economic return with a greater yield of commercial and variable economically timber species. The absence of adverse growing seasons and high growth rate of dipterocarp trees with valuable and quality commercial timber species further accentuates the economic necessity for enrichment planting. The objectives of this paper were to discuss the development and characteristics of enrichment planting in Peninsular Malaysia. With regard to the sustainable forest management practices, key constraints and future prospects of the enrichment planting in Peninsular Malaysia will also be assessed.

Key words: Dipterocarp forest, forest rehabilitation, logged-over forest, silviculture, Peninsular Malaysia, Enrichment planting

INTRODUCTION

Peninsular Malaysia's (PM) future timber supply is largely dependent on the availability of the productive permanent forest estate particularly in the hill dipterocarp forests. Since 1900s when systematic approach of forest resource management was introduced, the basic principle of the sivilcultural practice in logged-over forest has been to ensure that sufficient commercial indigenous species are available for the next rotation cut. In this regard, the implementation of the Enrichment Planting (EP) is considered to be the effective treatment option when the forest is poorly stocked.

Silvicultural measures are required in order to ensure adequate residual stocking or natural regeneration in the logged-forest for the next cutting cycle. The roles of the EP become more essential as an important silvicultural treatment for the logged-over forest based on the requirements by the practicing Selective Management System (Thang, 1987). In addition, the EP also aimed for converting the virgin tropical lowland rainforest (rich, complex multi-species and multi-aged forest) to a more or less even-aged forest containing a greater proportion of the commercial species. It was achieved by a clear-felling release of selected natural regeneration or varying age, aided by systematic poisoning of unwanted species (Wyatt-Smith, 1963).

The practice of the EP in the early 1900s was very minimal in comparison to the period in the mid-1960s and onwards. During the gutta percha (*Palaquium gutta*) era (1900-1922), silvicultural operations were confined to the establishment of taban forests and para rubber (*Heavea brasiliensis*) plantations schemes with the EP of chengal (*Neobalanocarpus heimii*). Taban and para rubber trees were important for their latex,

while the chengal was harvested for timber. During the pre-Japanese occupation improvement and regeneration felling era (1922-1942), several other commercial dipterocarp and non-dipterocarp species were subsequently harvested for their timber when harvesting emphasis changed and the evolution of the sawmill silviculture began (Barnard, 1954). The advances in wood utilization technology have allowed the processing of timber in wider spectrum and almost any shape, dimension and species into an ever expanding range of new commercial products (Cheah, 1995).

In its implementation to the lowland dipterocarp forests, the EP as a silvicultural operation for post-felling regeneration reached its peak of an imperative need during the era of the Malayan Uniform System (MUS) in 1948. The areas were subsequently enriched with high economic value of hill dipterocarp species. However, the government due to poor results and effectiveness did not pursue the effort aggressively. Henceforth, the EP was reintroduced in 1970s in PM following a shift in forest management procedures from the formal MUS to Modified Malayan Uniform System (M-MUS) as shown in Table 1.

In the formal M-MUS, the adequacy of natural regeneration was not a prerequisite for the area to be harvested because inadequacy of natural regeneration will be supplemented by the EP (Ismail, 1966). Since some of the lowland forest area in PM has been cleared for various agriculture and plantation schemes timber harvesting activities have reached to the hill areas. The MUS only successful when applied to the lowland dipterocarp forest but unsuccessful in the hill dipterocarp forest. This is due to the silvicultural and environmental difficulties of the hill forest. Among the problems are difficult terrain, uneven stocking and lack of natural regeneration on the forest floor before logging. Uncertain seedling regeneration during post-harvest also result irregular seedling from potential mother trees. Other constraints are heavy seedling mortality felling damage on the steep slope and poor viability of Seraya (Shorea curtisii), the dominant commercial species. As a result of these difficulties, 'artificial regeneration' became important and was materialized in the mid-1960s. The silvicultural and environmental difficulties thus became more apparent and resolved as timber-harvesting activity in the subsequent years shifted from lowland dipterocarp forest to hill dipterocarp forest. The long rotation and the single cycle of the MUS had failed to encourage large-scale investment in forestry sector and also would require a larger

Table 1. Modified Malayan Uniform System (M-MUS) and Selective Management System (SMS) Sequence of Operations

Year	M-MUS Sequence of Operation	Year	SMS Sequence of Operation
n-2 to n-1	Pre-felling forest inventory of 10% sampling using systematic-line-plots. Analysis of data and determine volume and number of trees to be harvested (+45 m dbh).	n-2 to n-1	Pre-felling forest inventory of 10% sampling using systematic-line-plots determine appropriate cutting regimes (limits)
n-1 to *n*	Marking of trees to be felled incorporating direction of felling.	*n*-1 to *n*	Tree marking incorporating direction felling. No marking of residual trees for retention.
n	Felling of all commercial and utilizable species of 45 cm dbh and above.	*n*	Felling of all trees as prescribed.
n+1/4 to *n*1/2	Forest survey to determine fines on trees unfelled and damage to residual and royalty on short logs and tops.	*n*+1/4 to *n*1/2	Forest survey to determine fines on trees unfelled and damage to residual and royalty on short logs and tops.
n+2 to *n*+5	Post-felling inventory of 10% sampling intensity using systematic-line plots to determine appropriate silvicultural treatments. Generally, poison-girdling of all defective and unwanted trees down to 15 cm dbh and climber cutting. Retention of advanced growth of potentially commercial trees.	*n*+2 to *n*+5	Post-felling inventory of 10% sampling intensity using systematic-line plots to determine residual stocking and appropriate silvicultural treatments.
n+20	Forest inventory of regenerated forest to determine status of the forest.	*n*+10	Forest inventory of regenerated forest to determine status of the forest.

Source: Thang, H.C. and Salleh, M., 1991

forest base for the practice of sustained-yield forestry. Hence, in 1978 the Selective Management System (SMS) replaced MUS.

Under the system two most important and commonly applied silviculture treatments options particularly significant in the silvicultural practice of the natural inland forest are the EP and girdling of defective relic trees including climber cutting (GCL). The success of system implementation in the hill forest is an adequacy of residual stocking for a particular diameter class that will form the next crop so as to ensure sustained yield management. Therefore the EP would provide the timber sources for the next cut to ensure sustained yield management practices.

The implementation of EP became more prominent and important in the effort to ensure that relatively poor stocking of logged-over forests was enriched with selective indigenous commercial species for the next rotation. The condition of residual stand under stocking where the EP is prescribed, the bicyclic cutting has reverted to a monocyclic to allow for sufficient time for the crop to be matured into harvestable size.

In addition the EP is increasingly important as a proactive measure to rehabilitate and ameliorate degraded soils, normally former logging roads, skidding trails and *mataus*[1] in the abandoned hill dipterocarp forests of PM. Moreover the EP is also functioned as restorative plantings and is not dissimilar to the EP in comparative to the traditional line plantings.

METHODOLOGY

1.Study area

The present study was conducted in the State of Kelantan Forest Department EP nurseries zone located at Semerak (Pasir Putih District) and Sungai Sam (Kuala Krai District) East Coastof Peninsular Malaysia from July to September 2002(Fig.1).

The state land area is 1,493,181 hectares (ha) and a total of 629,687 ha or 60% are Permanent Forest Reserves (West Kelantan, 226,538 ha; South Kelantan, 325,795 ha and East Kelantan, 77,354 ha) (State of Kelantan Forest Department, 2000:p.12). The state is the second largest logs producers in PM after the State of Pahang (Forest Department Peninsular Malaysia, 2000). Both of the study areas were gazetted as the state Permanent Forest Reserves in 1939 and 1989 respectively. The PM is located between latitudes 1^{0} 20' to 6^{0} 45' North of the Equator and longitudes 99^{0} 40' to 104^{0} 20' East, with the total land area of 13.2 million ha (Hassan-Zaki and Shinohara, 2004).

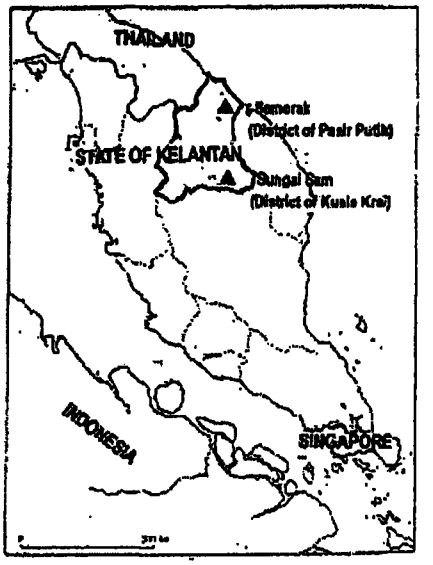

Fig.1. Map of Peninsular Malaysia which shows the location of the study areas
Source: Field study, 2002

2.Data collection

Three methods were employed to collect the data, the review of the official documents, interview and field observations. The reviewed documents included the forestry department headquarters report on promoting the EP activity, Circulars of the Director General of Forestry No: 2/96 (Guidelines for the Enrichment Planting Activity), state gazettes and the private sector planning report on economic species of EP. The interviews were carried out with the Deputy Director (Silvilculture and Forest Plantations) Federal and State Forest Departments; other related state agencies such as the State Economic and Development Corporation (PKINK) and also respondents from the forest private contractors. The interview focused on investigating the establishment and development of the EP activities. The observations were randomly conducted in the state forest reserve areas in order to understand the practical implementation of the EP.

RESULTS AND DISCUSSION

1. Historical Development of the EP

EP was first implemented in 1949 at Kanching Forest Reserve in the State of Selangor with line planting of Kapur (*Dryabalanops aromatica*). (Table 2) Later it was followed by *Shorea* spp. family such as Meranti Tembaga (*Shorea leprosula*), Meranti Rambai Daun (*Shorea acuminata*), Balau Kumus Hitam (*Shorea maxwelliana*) and Mahogany(*Swietenia macrophylla*), Merbau (*Intsia palembanica*), and Chengal(*Neobalanocarpus heimii*).

Few other species were also planted in other forest reserves through out the peninsular. Since its implementation the EP has been passed various changes and modifications as a result of shifting in the paradigm of land policies, forest management, harvesting systems and trends in market demand. Even though the EP started in 1949 proper collective records are only available after the introduction of Fourth Malaysia (1981-1985) in which 2,032 ha of the EP was established in the various forest reserves. Later the allocation of EP increased in almost all the states. Since 1956 a total of 29,000 ha of land have been treated with the EP in PM. Of these cumulative figures the distribution of the EP according to the Malaysia five years planning period since 1956 to the Seventh Malaysia Plan (1996-2000) are as shown in Table 3 and Table 4.

2. The Objectives of the EP

The main objective of the EP is to enrich the poorly stocked residual stand of logged-over dipterocarp forest through planting activity of selected regeneration of indigenous commercial species. During the early practice of the EP the implementation of artificial regeneration was the main focus in the form of *Taungya*[3] system. The main concern was to reforest with selected species around the fringes, patches of forest reserves, which were found to be devastated as a result of continuous illegal cultivation. The

Table 2.Line and GRoup Planting in Peninsular Malaysia Reserves Forest (1945-1959)

FOREST RESERVE	*YEAR*	*SPECIES*	*STOCK*	*SURVIVAL (%)*
1. *Line Planting*				
Kanching	1949	Dryobalanops aromatica	bare-rooted, wildings,	9
	1955		tubed, nursery	51
Air Panas	1952	Shorea acuminata	bare-rooted,	50
		Shorea maxwelliana	nursery	30
		Swietenia macrophylla		70
2. Group Planting				
Bukit Sedanan	1951	Swietenia macrpohylla		77
		Shorea acuminata		36
		Shorea pauciflora		44
Ayer Panas	1952	Shorea acuminata	nursery,	92
		Shorea leprosula	wildings	94
		Shorea maxwelliana		89
		Shorea pauciflora		94
		Swietenia macrpohylla		82
Senaling Inas	1952	Neobalanocarpus hemii	nursery,	100
		Intsia palembanica	seedlings	59
FRIM	1959	Shorea leprosula	tubed,	94
		Schima noronhae	seedlings	99
		Dryobalanops aromatica		79

Source: Wyatt-Smith, 1963(adapted)
Note: Based on last measurements in 1962

farmers then were given permits by the state authority to cultivate the land provided that they must plant tree seedlings supplied by the forestry department.

Table 3. Distribution of EP in the Malaysian Development Plan (1956-2000)

National Development Plan	*Year*	*Area Planted (ha)*
From 1956 and the First Malaysian Plan	1966-1970	5,416
Second Malaysian Plan	1971-1975	5,769
Third Malaysian Plan	1976-1980	3,148
Fourth Malaysian Plan	1981-1985	2,032
Fifth Malaysian Plan	1986-1990	1,755
Sixth Malaysian Plan	1991-1995	3,167
Seventh Malaysian Plan	1996-2000	7,713

Source: Malaysian Development Plan Report,1956-2000 and FDPM, 2000

Table 4. Enrichment Planting Distributions by the States (1956-2000)

States	*Area Planted (ha)*
Perli	125
N. Sembilan	817
Terengganu	1,737
Melaka	956
Kedah	1,606
Johor	2,390
Pahang	5,041
Kelantan	3,805
Selangor	4,615
Perak	7,907

Source: Malaysian Development Plan Report,1956-2000 and FDPM, 2000

Under this conditional agreement the farmers began to implement *Taungya* with exotic species such as pine (predominantly *Pinus caribaea*) and indigenous species mainly Kapur (*Dryobalanops aromatica*), Meranti Tembaga (*Shorea leprosula*), Balau Kumus (*Shorea laevis*), Meranti Seraya (*Shorea curtisii*) and Mahagony (*Swietenia macrophyalla*). The agricultural cash crops are mainly banana (*Musa*) and tapioca (*Euphorbiaceae*). However the system was not succeeding due to lack positive response from the cultivators. This was due to the insecurity of land tenure, the accelerated development of large-scale agricultural schemes by the government agency (thus receiving land pressure for agricultural land) and the high costs of supervision incurred by the forestry department.

3. EP Technical Requirements

The phrase of EP is devised from the fact that planting is being done merely to increase the value per ha of a forest area in term of species composition and wood volume. It is essentially a process of supplementing the natural regeneration where it is insufficient with special seedlings raised for the purpose (Appanah and Weinland, 1993). The implementation of the EP was strongly considered when stocking of regeneration following establishment of new crop is inadequate. EP are required in locations such as at the log yards, *kongsi*[n] site, small clear felled and abandoned cultivation areas and when felling took place despite in adequacy of seedling regeneration of economic species. When there is insufficient number of economically valuable trees in the initial stand or if there is a complete lack of such trees such as in logged-over forests, the EP is a better option (Lamprecht, 1989). EP is also one of the silvicultural tools proposed to rehabilitate harvested forests. However the current practice is that the EP is conducted mainly based on the prescriptions of post-felling inventory imposed on particular forest area. This is an aspect of the SMS, which is practicing in PM as an effort to manage the forest resources in a sustainable manner.

The EP in PM focuses on various major aspects related to the implementation and the technical requirement such as; i) selection of species, ii) EP in the prime area of logged-over forest, iii) EP procedures, iv) EP field operation, v) tending of the EP area; and vi) EP areas map.

a) Selection of species

Selection of species for the EP is restricted to several factors. This include the procedure of easy handling of the species in the nursery, high rate of germination, regular flowering and fruiting, higher growth rates particularly at the initial stage, shade tolerance, able to withstand competition between trees, good self pruning, and very low prone to disease, insect and fungus attacks. In this regards the use of exotic tropical timber tree species and planting suitable fruit trees such as

Petai (*Parkia speciosa*), Durian (*Durio zibethinus*) and Kerdas (*Pithecellobium bubalinum*) in the forest fringes with the involvement and cooperation of local community. However, potential commercial indigenous timber tree species suitable for the EP schemes by 'line planting technique' is currently easily available in the respective forests of PM.

b) EP in the prime area of logged-over forest

There are two critical areas *vis* poorly stocked stand and opened areas. In poorly stocked stand the major focus of the EP is to increase the number of commercial and good quality indigenous tree species for the production of logs. In an opened area such *mataus*, abandoned logging road (inclusive the skid trail) and abandoned shifting cultivation areas, the major focus of the EP is to rehabilitate or reforestation with those high quality indigenous tree species. Basically the concept and philosophy of the EP in these areas are similar but the approach is relatively different. In this regard the EP activity in the opened areas is relatively more intensive than in poorly stocked stand. For example in the *mataus* areas the site need to be plough prior to planting with suitable indigenous timber tree species.

c) EP procedures

EP procedures based upon the analysis and interpretation of the Post-Felling Forest Inventory (Post-F) in the logged-over forest. Under the SMS, Post-F is carried out within 2-5 years after logging followed by the forest authority field inspection with 20% inspection intensity of the total area. During the field inspection, types and diameter distribution of seedling and saplings, the density and intensity of abandoned logging road and *mataus* opened areas and logging camp are observed. Based on results from the field inspection, the final analysis is made according to the Post-F. The type of species will be planted for that particular site is then determined. EP should be carried out not later than three years after the final analysis of the Post-F.

d) EP field operation

The main aspect of field operation include transporting and handling of planting stock, planting seasons, planting spacing, planting line/hole and the detail description of the area to planted *vis* poorly-stocked logged-over forest or opened area. The procedures should be as follows: i) transporting and handling of planting stock to the planting site should be carefully performed. Planting stock must be handle cautiously while transporting, free from excessive transpiration but with proper ventilation, ii) planting stock should be transported to the planting site before 10.00 am or after 5.00 pm and well watered before transfer. At the planting site, the seedlings should be allocated under the shade and watered at least two weeks before planting, iii) planting activity should coincide with rainy seasons. Planting are abandoned during dry spell period or period without rains that prolong for three consecutive days, iv) EP is normally being carried out by 'line planting' with planting distance of 3m x 10m. Other planting distance may also be adopted to suit the field environment v) the location of the planting line and the base line always perpendicular to one another and is cleared with one meter width. The alignment of the planting line is in east-west direction in order to ensure sufficient or maximum amount of sunlight, vi) the recommended size for the planting hole is 15cm diameter with 30cm depth. Prior to planting, approximately 50 gram of fertilizer '*rock phosphate*' is added per-hole to boost up the initial growth, and vii) the poorly-stocked logged forest, planting activity normally take place immediately after planting line has been marked in the field. In the opened areas such as *mataus* and *kongsi*, the planting site has to be plough prior to planting activity in order to soften or loosen the soil due to previous compaction. In the main logging roads, both side of the road are planted with seedling by adopting similar approach of planting in the logged-over forest, which requires no ploughing.

e) Tending

Tending or treatments and maintenance of planting areas are very important. In order to

ensure that all seedlings are growing, survival count at 100% intensity are performed at the first 6 months after planting to ensure the 100% survival rate is achieved. This is followed by second or subsequent survival count when the trees reached 12 months after planting using systematic sampling at 50% intensity for second sampling. The third account involves 20% intensity at 3 years planting onwards. Tending which involves weeding, under brushing and climber cutting are performed at 6 to 60 months after planting in order to boost up growth. Thinning could be performed at 120 months after planting to retain potential crop trees with quality and healthy bole. Subsequent silvicultural treatments such as climber cutting to release growth to the standing trees may be performed if necessary at 10, 30 and 50 years after planting.

f) Map showing the EP sites

Map with scale of 1:100 showing the planting line and location of planted seedlings should be produced. A color legend are used such as green for planted trees, which are survived, red for planted trees (which are dead), blue for potential crop trees and black for abandoned planting hole. A plan of the planting site should be prepared and updated every time when the survival count is performed. The recommended planting block is normally of 10 ha.

4. Problems Encountered on the EP Implementations

Site specificity is crucial for species planted in hill forests. However, trials on species-site matching for tree species in hill foresters are very limited. Information on site preferences of dipterocarp species is available in Foxworthy (1932), Symington (1943) and Ashton (1982). There are several hitches and obstacles that have been observed during the field study of the EP implementation in the forests of PM. The inherent constraints in particular are related with the unseasonable climate of PM, which would be overcome to some extent by improvement in the respective techniques (Singham, 1980). The areas that are very poor in species composition and wood content are usually in the deeper and remote portion of the forests and thus need to be enriched. Based on our field study, several problems and constraints that have faced executing EP in the forests are as follows:

a) Seedlings transportation

Seedling transportation has always been a hindrance towards achieving total success in the EP. The distance and the shock that has to be endured will render the seedlings unsuitable or not ready for planting if all dead. In some instances, some of the forest areas, which have been selected for the EP, are inaccessible. The only other prerogative to plant this particular area is through the use of manual labor to take the seedlings to the planting site and this method usually results in higher mortality among the seedlings.

As a distance of planting, sites in logged-over hill forests increased. Seedling must be selected through a proper culling process to ensure that those selected can withstand transportation and transplanting shocks. Owing to irregular fruiting and unreliable quality of seeds for producing vigorous seedlings, wildings have often been recommended as another alternative planting stock. A temporary nursery for wildings must be located as closed to planting area as possible to reduce the planting cost and subject the wildings to less transportation shock (Aminah, 1997).

b) Illegal cultivation

Unscrupulous act of cultivating illegally in the Permanent Reserves Forests has been rampant in several states in the past decade. This is one of the major setbacks faced by the forest department in effort to execute EP project. Areas that were once put through EP were suddenly cleared and razed to the ground by this illegal cultivator. In certain situations, a forest area of big, healthy and variable high quality trees is intruded with the planting of fruit trees and other cash crops.

c) Aboriginal interference

Some states in PM facing the problem whereby a certain forest area, which was once planted is suddenly razed which fire set by the aboriginal 3 people in their process of setting up paddy hill cultivation in the forest. These aborigines are usually shifting around in the forests searching for fertile areas to do their hill paddy cultivation and nomadic culture is an accepted norm. Their next destination of cultivation area can be predictable in some instances but that is not necessarily in certain cases.

d) Restricted planting methods

EP could only being executed during rainy seasons and must not proceed when there is no rain for a period of three consecutive days. The seasons in some areas may be very short. The foresters are much wary of it and thus should work hardly to utilize that short period of time to the maximum. For example the planting months usually from late August to January in the Kelantan state according to the raining seasons.

e) Wildlife disturbances

Planted seedlings are sometimes mutilated or destroyed completely by wild animals such as wild boars, porcupine etc. This naturally results in higher mortality rate and renders the success of the EP field applications.

f) Post-planting wood extraction

In some cases planting is carried out to rehabilitate a forest area, which is depleted of its wood content back to its original status. To avoid disturbing the growth of the trees, no form of wood extraction permitted to be carried out on an area, which had just been planted. The particular area should not be disturbed and left to recover the logging ordeal. In some cases there are instances whereby an area, which had been planted a few years before are opened for wood extraction.

g) Planting alongside forest roads

Since hill forests are already poorly stocked with natural regeneration, high quantity of the seedlings has been destroyed by heavy machinery. EP would be a local solution to sustain stocking of commercial tree species. Planting should be done immediately after logging where a minimum canopy opening and line clearing are required in degraded areas. Many of this area are still accessible by logging roads. Therefore a delay in planting would increase the total establishment costs. When harvesting operation is being done in a forest, forest roads are constructed to facilitate the extraction of logs. There is an extensive length of roads in the Permanent Reserves Forest and areas alongside are usually poor in species composition and wood content, which require EP to be implemented. Meanwhile in the State of Perak planting along the forest roadside concentrate on logging area of Pengkalan Hulu district with teak (*Tectona grandis*). These forest roadside areas are rich in regeneration since there is abundant amount of sunlight that could reach the forest floor. However, these areas are depleted of the sizeable amount of regeneration of the desired level of species composition and wood content, which it should possess. To solve the problem, the areas then replanted by the EP with more economic and variable specie compositions. In the Kelantan state for example there are 707 km. of forests roads. If both sides of the forest roads are planted in a distance of 20m it can manage to have 28,280 ha of valuable economic species of trees by EP. *Betaus*[4] also provided a good potential for planting a high quality species. Since 1996 the Perak state began this project, which covered all the gap area immediately after logging especially in *betaus* areas, formal logging road and sign trail. In 1996 about 50 ha was planted by loggers with a high quality mainly Sentang (*Azardirachta excelsa*), Merawan Siput Jantan (*Hopea odorata*) and Medang Teja (*Cinnamommum iners*). After one year planting the result showed that good performance in term of survival rates.

h) Seedling supply

Seeds are normally the best source for preparation of planting stock in the EP. In this regards, good keeping record of phenological behavior of certain species would help to ensure good seed collection. The seed from most tropical commercial species however cannot be stored for more than a few days due to 'short dormancy' or 'no dormancy' period. Seeds therefore must quickly be sowed in the Nursery in order to restore higher germination percentage. In this regards, the proper nursery technique and the preparation of planting stock from seeds are very critical. Good quality seed would produce healthy seedlings. On the contrary, wildings may be the best alternative to seed source for the preparation of planting stock. In the natural forest, retaining some mother trees in the logging block would help to ensure the availability of trees for seed productions. The undeniable fact regarding EP is that it is an expensive activity to execute. The cost of seedlings preparation is very high due to its scarcity. At present the simplest way to get them is through the private sector that either collects from the forest floor or germinated seeds from unknown origins. With the setting up a seed bank the problems regarding supply will ease up while guaranteeing the seed source thus reducing uncertainty concerning the origins of planted trees in the future. EP needs to be expanded to larger scale definitely and new timber species is required. Other issue such as total requirement of quality and viable seed are essential in order to produce better quality of log production in the future. For example a total of 17,920 ha of EP areas would be established in all the states in PM under the Seventh Malaysia Plan (1996-2000) and required 6,611,476 seeds (Anon, 1995). The selected species have been Meranti (*Shorea spp.*), Chengal (*Neobalanocarpus heimii*), Merawan (*Hopea spp.*), Merbau (*Intsia palembanica*), Kapur (*Dryobalanops aromatica* and Keledang (*Artocarpus spp.*). The seed from these species must therefore be made available either through 'seed bank' from selected mother trees marked during Pre-F.

i) Maintenance regime and strategy

Since different states make different policies, there is no specific procedure or approach toward the implementation of EP in the respective states. A standard approach and strategy in executing EP is highly required to ensure that what has been done in one state is similar to the other states. Different state is applying different treatments on their planted areas and this gives incomparable results and makes it complicated to make a further study.

CONCLUSION

It can be concluded that past experiences have shown EP was an essential silvicultural treatment in order to ensure the residual stocking in the poorly stocked logged-over forest increases sufficiently in its volume and quality. Future PM log supply would come from logged-over forest in the second cut or rotation since many of the virgin stands has been harvested. The implementation of the EP is very essential as a means to improve residual stocking. Therefore the implementation of EP would definitely be able to overcome some of the management issues based on the following reasons:

a. Composition, constitution and structure of logged-over forest do not support polycyclic systems as a result of the current logging practice. In this respect, the implementation of EP would help to introduce specific good quality timber species into the forest area;
b. Stocking of dipterocarp is not sufficient to sustain continuity of dipterocarp management. The EP would inevitably allowed proportion of the species being introduced into logged-over forest;
c. The regeneration dynamics of the logged-over forest is not as expected. The implementation of EP would also be able to increase the number of specific regeneration artificially into the areas;
d. Growth of commercial residual trees is not as high as expected. In this regards, good, vigorous and quality trees may be introduced into the logged-over forest through the implementation of the EP;

e. Genetic quality of logged-over forests has detracted as a result of the removal of the emergent trees. The implementation of EP would increase the number of selected good genetically timber tree species into the forest areas.

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Footnotes:

(1) *Mataus* an open area or the loggers log yard.
(2) *Taungya* system is a forest regenerated with Teak *(Tectona grandis)*. In Indonesia similar system is called *Tumpangsari.*
(3) *Kongsi* a logging camps.
(4) *Betaus* abandoned logging road or trails.

REFERENCES

Aminah H 1997 "*Panduan Teknik-teknik engurusan Tapak Semian Spesies Perhutanan Di Malaysia.*" Forest Research Institute Malaysia (FRIM) Technical Information HandbookNo.7, Malaysia, 31 pp.

Anonymous 1995 "*Kajian Awal Mengenai S pecies Pokok dan Keperluan Biji Benih Untuk Program Pembangunan Hutan.*" Technical Paper on Planting Material Procurement Program, Forest Research Institute Malaysia (FRIM), Malaysia.

Appanah S and Weinland G 1993 Will the Management System for Hill Dipterocarp Forests Stand Up? J. Tropical Forest Science 3:140-158.

Ashton PS 1982 Dipterocarpaceae. Flora Malesiana, Series No.1, 92:237-552.

Barnard RC 1954 Manual of Malayan Silviculture for Inland Lowland Forests, Malayan Forest Research Pamphlet No: 14:199 pp.

Cheah LC 1995 Pioneer Species for Fast Growing Tree Plantations in MalaysiaAn Evaluation, Forest Research Institute Malaysia (FRIM) Technical Information No.53, Malaysia 28 pp.

FDPM 2000 Forestry Department Pen. Malaysia Annual Report, 120 pp.

Foxworthy FW 1932 Dipterocarpacea of the Malay Peninsular. Malayan Forestry Record No:10. Forest Research Institute Malaysia (FRIM), Malaysia.

Hassan-Zaki P and Shinohara T 2004 A Study in Timber and Wood-Based Industries Development in the State of Pahang, Pen. Malaysia, J. of Forest Economics Vol.50 No.1, 76-82 pp. 10. Hassan-Zaki P and Shinohara T 2004 A Study on the Implementation of the Selected Management System (SMS) in Managing the Dipterocarp Forest of Pen. Malaysia, Kyushu J. of Forest Science Vol.50 No.1, 76-82 pp.

Ismail A 1966 Enrichment Planting, J. Malayan Forester.27: 3-17.

JPSM 1997 Manual Kerja Luar (Sistem Pengurusan Memilih-SMS), Jabatan Perhutanan Semenanjung Malaysia, Forest Department Headquarters, Kuala Lumpur, 323 pp.

Lamprecht H 1989 Silviculture in the Tropics. *Deutsche Gesellschaftfur Technische Zusammenarbeit (GTZ)* GmbH, TZ-Verlag, 296 pp.

.Singham S 1980 Artificial Regeneration of Forests (Silvicultural Practices in Pen. Malaysia). Forest Training Unit, Forest Department Pen. Malaysia, 205 pp.

State of Kelantan Forest Department 2000 Department Annual Report, 39 pp.

Symington CF 1943 Forester Manual's of Dipterocarp. Malayan Forestry Record No: 16. Forest Research Institute Malaysia (FRIM), Malaysia.

.Thang HC 1987 Forest Management System for Tropical High Forest, With Special Reference to Pen. Malaysia. J. Forest Ecology and Management (21): 3-20.

Thang HC and Salleh M 1991. *Perlaksanaan Dasar Hutan Negara* in *Symposium on National Forest Policy,* Forest Department Headquarters, Kuala Lumpur, 148 pp.

Wyatt-Smith J 1963 Manual of Malayan Silviculture for Inland Forests. Malayan Forestry Record No: 23 (2 Vols.) Forestry Department, Federation of Malaya.