Original paper

A Selective Management System (SMS): A case study in the implementation of SMS in managing the dipterocarp forests of Peninsular Malaysia [*1]

Hassan-Zaki Pakhriazad [*2], Takeo Shinohara [*3], Yuei Nakama [*3], Kiyoshi Yukutake [*4]

Hassan-Zaki P., Shinohara, T., Nakama, Y. and Yukutake, K. : **A Selective Management System (SMS) : A case study in the implementation of SMS in managing the dipterocarp forests of Peninsular Malaysia Kyushu J. For. Res. 57 : 39-44, 2004** The Selective Management System (SMS) is a bicyclic tropical shelterwood system practiced as the main forest management system in managing the dipterocarp forests of Peninsular Malaysia. SMS was adopted for management in 1978 to replace the monocyclic Malayan Uniform System (MUS). The SMS is a flexible system which allows the determination of the most appropriate cutting regime based on analysis of Pre and Post Felling forestry inventory data, considering the need for leaving behind sufficient stocking of intermediate sized trees, optimal growth and mortality rates and, maintaining the species composition of the residual forest stand at a minimal damage. This paper attempt to evaluate the various technical requirements applied for the successful implementation of SMS in managing the hill dipterocarp forest of Peninsular Malaysia.

Key words : silviculture, dipterocarpus, residual stand, enrichment planting, Peninsular Malaysia

Ⅰ. Introduction

The silvicultural systems applied in tropical forest ecosystems are clear felling or clear-cutting, selection felling and shelterwood system (Vandana, 1992). In 1920s, forest management by Departmental Improvement Felling (DIF) in Peninsular Malaysia (PM) was aimed solely at improving the existing stock through the removal of inferior species to promote the development of species having economical value such as *Neobalanocarpus heimii* (Appanah and Putz, 1984). During the 1930s, Commercial Regeneration Felling (CRF) and Regeneration Improvement Felling (RIF) were designed to establish natural regeneration of the natural durable hardwood species in lowland dipterocarp forest. In 1940s, the Malayan Uniform System (MUS) was introduced for converting the virgin tropical forest to a less even-aged forest containing a greater proportion of the commercial species (Wyatt-Smith, 1963). During 1970s, the Selected Management System (SMS) was implemented for management of the hill dipterocarp forests based on preliminary and indicative growth rates of logged over forests obtained from studies conducted by the UNDP and FAO to ensure a second cut in 25 to 30 years (UNDP/FAO, 1978).

The objective of this study was to assess the implementation process and the effectiveness of SMS in managing the hill dipterocarp forests of PM that allows more flexible timber harvesting regimes, which are consistent with the environmental need, to safeguard the environment as well as to take advantage of the domestic and international timber market demands.

Ⅱ. Study area and method

The study was conducted in Block 88, Balah Land Forest Reserve in the West District and Nenggiri Land Forest Reserve in the South District, East Coast State of Kelantan (5° 16'N to 5° 19N and 101° 42'E to 101° 45'E) (Fig-1). The area with a size of 316.88 ha is managed under the state subsidiaries companies, Kompleks Perkayuan Kelantan.The average rainfall is 2,664 mm per year with annual average temperature 24.6° C. The forested land in this area comprised of hill dipterocarp forest Dipterocarpaceae family dominated the forest canopy with Shorea Platyclados as the dominant species.

Both primary and secondary data were collected. The primary data were collected by interviewed the professionals related to the development and implementation of the SMS. Respondents consisted of 25 personnel from government

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[*1] ハサンザキ　パクリアザド・篠原武夫・仲間勇栄・行武　潔：半島マレーシアのフタバガキ科経営における択伐法（SMS）の展開と実施に関する研究

[*2] United Grad. Sch. Agric. Sci., Kagoshima Univ., Kagoshima 890-0065　鹿児島大学大学院連合農学研究科
[*3] Fac. Agric., Univ. Ryukyus, Okinawa 903-0213　琉球大学農学部
[*4] Fac. Agric., Miyazaki Univ., Miyazaki 889-2192　宮崎大学農学部

institutions such as Forest Plantations and Silvicultural Division, Forestry Department Headquarters PM, State Forestry Department, District Forest Offices, Department of Environment Malaysia (DOE), Forest Research Institute of Malaysia (FRIM) and Faculty of Forestry University Putra Malaysia (UPM). The secondary data were collected from the State Economic Development Corporations and subsidiaries related to forest silvicultural and enrichment planting activities, project consultants and private contractors.

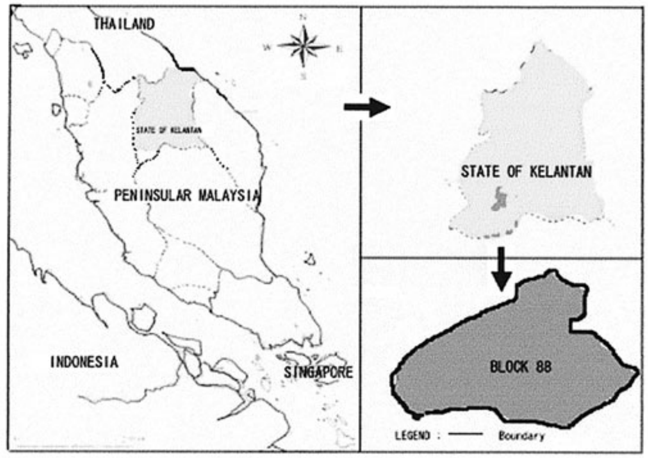


Fig －1. Observation area map

Ⅲ. Results and discussion

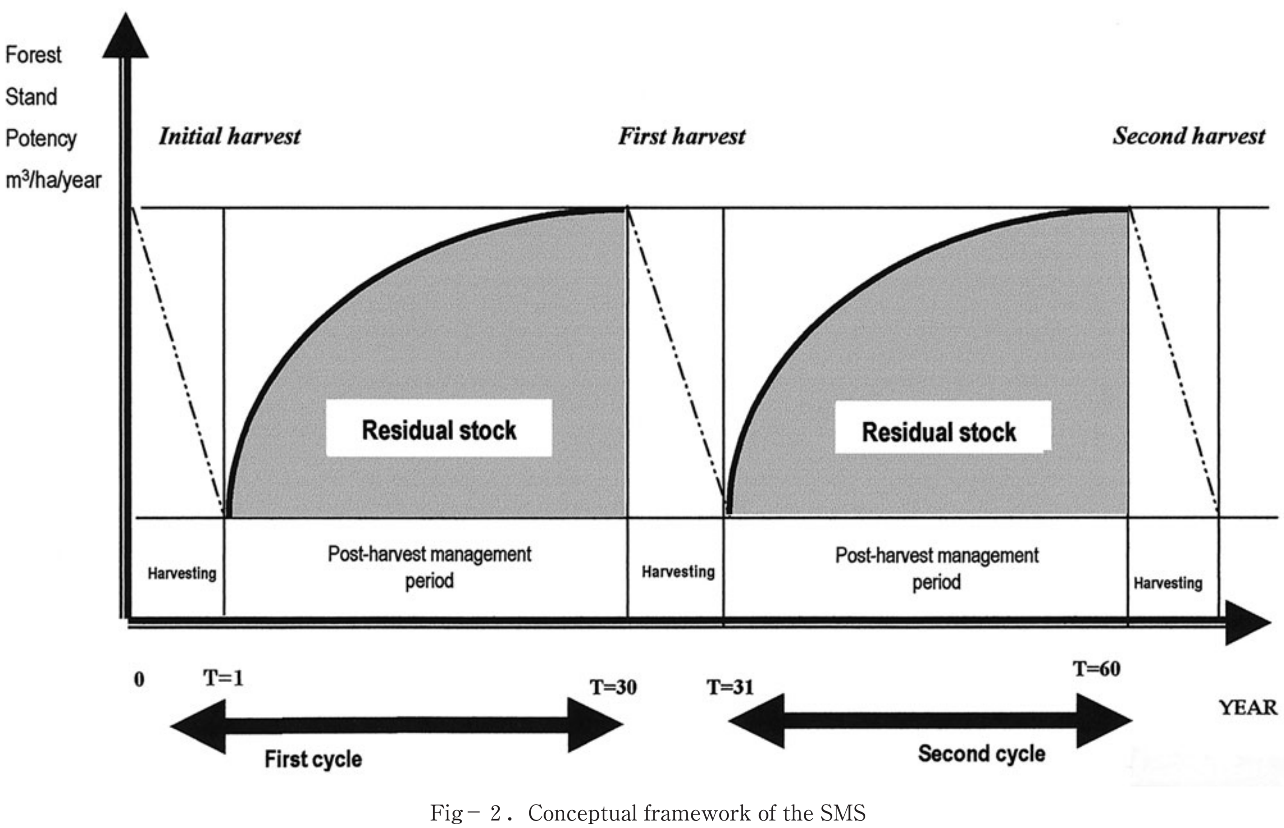
1. SMS factors of implementation

Large stretches of PM lowland forest were cleared for agriculture as a result of Federal Government land policy on poverty eradication during the 1960s. Forestry activities have been pushed towards steeper and hilly areas. The remaining virgin forests are left on steeper slopes in the remote part mainly in the central and eastern regions.

SMS was introduced due to the shifting of harvesting areas from lowland forest to the hill forest. The hill forest of PM has a different silviculture characteristic such as lack of seedlings in the original stand, slow growing and shade demanding in nature. Other problems include the danger of soil erosion on steep slopes and the heavy presence of the wood species of Eugeissona triste Griff (bertam), which discourage a drastic opening of the canopy. SMS implementation is considered as the new dimension of forest management to sustain timber supply and efficient harvesting of hill dipterocarp forest of PM to replace the MUS.

2. SMS concept and objectives

The important concept favoring the adoption of SMS are ; i) it is the most economically and surest means of restocking the dipterocarp forest (infrequency of good seed year) ; ii) the stand structure, reproduction, growing habits, response to light after harvesting and selective logging within variations ; iii) the



Fig－ 2 . Conceptual framework of the SMS
Source : Awang, N. (1997) (modified)

intermediate sized trees and poles (30-45 cm dbh) grow faster to harvestable size compared from the seedling to grow to timber size); iv) the sufficient number of young trees of many size classes can be saved under careful directional felling and vigorously survive ; and v) SMS can be adapted to different silvicultural conditions because of the floating (variable) diameter limits for specific area and species groups. The objective of the SMS is to save young potential tree species from damage especially during harvesting of the merchantable timber from the virgin forest, through tree marking and directional felling. This is to retain an adequate stand and volume of healthy trees of desired species after harvesting to assure a future timber crop, after harvesting to assure a future timber crop, forest cover for the protection of soil and water. SMS also has the flexibility to manage the highly variable forest conditions (socio-economic environment), allows for the optimization of forest management goals for an economic cut, the sustainability of the forest and the minimum cost of forest management.

3. SMS technical requirement

a) SMS principles in determining the cutting regimes

Based on the current application of SMS, it has been envisaged that bicyclic cutting of 30 years cycle is practiced. The SMS selectively logged forest has an intention to return at the end of the cutting cycle (30 years) until the next harvest (60 years) (Fig-2). SMS harvesting regimes are based on inventory data instead of arbitrary prescription, which consider equitable to both stakeholders (loggers and forest owners). Pre-Felling inventory is carried out to provide reliable estimates of the population and parameters that are being measured are ; i) all trees with 5 cm dbh and above and tree species having a dbh less than 5 cm but having a minimum height of 15 cm and above by dbh class, species and volume/stems per hectare; and ii) the physiography by slope, elevation, soil types and river systems. After the pre-felling inventory data such as market value and socio-economic considerations, a felling regime will be formulated to optimize the stated goals. All commercial timber based on SMS specified diameter is identified for felling. Following the first cut, number of residual was left behind and the interval required for them to reach merchantable sizes for a second cut.

b) SMS sequence of operation

When the next harvesting is expected in 25-30 years after the first logging with an expected net economic outturn of 40-50 m^3 per hectare enriched with dipterocarp species, the prescriptions for implementation applied are ; i) the cutting limit prescribed for dipterocarp species should not be less than 50 cm dbh except for *Neobalanocarpus heimii* (*chengal*) not less than 60 cm dbh; (ii) the cutting limit prescribed for non-dipterocarp species should not less than 45 cm dbh ; (iii) the difference in the cutting limits prescribed between the dipterocarp and that of non-dipterocarp species should be at least 5 cm ; (iv) the residual stocking should have at least 32 sound commercial trees per hectare in the dbh class from 30 to 45 cm dbh (substitutions using trees with dbh larger than 45 cm were given equivalent value of 2 stems/ha, while trees in the dbh class from 15 to 30 cm were given equivalent value of 1/3 stems/ha ; and (v) the percentage of diperocarp species in the residual stand for trees having dbh greater than 30 cm and above should not be less that in the stand prior to harvest. SMS employs a split cut approach, which favors the retention and growth of the dipterocarp species to avoid the eventual elimination from future crops as they have a tendency to dominate higher diameter classes and grow faster than other economic species. The SMS is a viable position for the management of the PM hill dipterocarp forest which offer a reduced cutting cycle and total silvicultural cost provided by the following technical requirements ; i) mortality and optimal growth rates ii) minimal logging damage to the residual stand; and iii) gross volume and net economic cut; and iv) adequacy of the residual stocking (Tang, 1980 ; Shahruddin, 1983 ; Thang, 1988). The SMS sequence of operations is shown in Table-1.

Table-1. SMS sequence of operations

Year	Operation
n-2 to n-1	Pre-felling forest inventory of 10% sampling intensity using systematic-line-plots to determine appropriate cutting regimes (limits).
n-1 to n	Tree marking incorporating direction felling. No marking of residual trees for retention.
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 shot and tops.
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+10	Forest inventory of regenerated forest to determine status of the forest.

i) Mortality and optimal growth rates

Mortality is an important component of any stand growth (Wan-Razali, 1989). There are two types of mortality namely catastrophic and non-catastrophic. Catastrophic mortality is either abnormally high or low for short periods due to factors, which are difficult to predict (e. g. disease, fire, wind throw, logging damage). Non-catastrophic mortality is death as a result of natural causes such as suppression and over topping of small trees in a stand. Mortality and optimal growth rates are dependent on a number species, site factor, age and size, crown development, genetic properties and competition status. Mortality rates also depend on logging intensities, tree diameter class and spaces factors. Variation in original stocking, soils, terrain, location and maeket situation at the time of logging will greatly influence the stock and growth levels of the individual plots. Mortality rates decrease with time. Yong (1996) indicates that mortality of tree 5 cm dbh and larger decreased from 3.75% in the fifth year to 2.5% during 14 years after harvesting. When mortality rate is higher than expected, it will have a great effect on the projection of timber volume for the next cutting. The higher mortality rate would lead to considerably lower yield when the harvesting cycle was maintained at 25-30 years (Tang and Wan-Razali, 1981 ; Tang, 1978 ; Kirkee, 1973 ; Ashari and Kamis, 1988).

ii) Logging damage to residual stand

Timber harvesting in the hill forests would cause higher damage to the intermediate trees compared to the lowland forests. Felling damage to the remaining intermediate sized trees of 30 cm dbh and above are 30% , while wastage due to breakage and bucking is 6.5% to 8.0% of the gross timber volume (Griffin and Caprata, 1977). Logging damage percent increases with decreasing diameter classes (Anon, 1985). The smaller trees have a general higher tendency to be dameged in logging operations (a tree is damaged when it sustains moderate/severe stem and/or crown damage) (Table-2).

Table-2. The relationship between diameter class and logging damage during harvesting

Diameter Class (cm)	Logging Damage
+60	20%
45－60	30%
30－45	40%
15－30	50%

Damaged to the hill forest also dictated by the machinery (Nicholson, 1979). Almost 90% of the heavy machinery was utilized for constructing roads, skid trials and landing sites and only 10% allocated for extracting and pulling logs from the stump (Hamilton, 1988 ; Bruijnzeel and Critchley, 1994). Type of machinery frequently used in logging activities is as shown in Table-3. Kamaruzaman (1991) concluded that the crawler tractor accounted 80% of the area soil disturbance and 40% logging blocks considered seriously disturbed due to the machinery movement. When the skidder tracks are constructed, the trees were hauled along them. The soils become compacted as a result of frequent heavy vehicle movement. Selaginella ferns will colonize the compacted sites and prevent the seedling growth on the forest floor.

Table-3. Appropriate technical machinery/system for harvesting in Peninsular Malaysia

Machinery/System	Slope Capability	Area	Distance/Route
San Tai Wong Lorries	+20%	－30%	6,000m
Wheel Skidder	+25%	－40%	400m
Crawler Tractor	+30%	－45%	200m
Highlead Yarding	+40%	－70%	300m
Skyline	+100%	－100%	450m

iii) Gross volume and net economic cut

a) SMS gross volume of the timber is calculated with the following equation :

$$V = \frac{\pi \times (DBH)^2 \times L \times f}{4 \times 10,000}$$

where:

V = gross volume in m^3

$\pi = 3.1417$;

DBH = diameter at breast height (in cm);

$f = 0.65$ [from factor] ; and

L = merchantable height

Since the merchantable height cannot be measured during the inventory stock, the length of the timber will be calculated according to the following diameter class (Table-4).

Table-4. Calculation of diameter class, length and equivalent merchantable heights

Diameter Class	Logs 5cm (length)	Equivalent merch.heights
+30－60cm	2	10m
+60－75cm	3	15m
+ 75cm	4	20m

b) Net volume

SMS Potential Net Volume available were calculated by reducing the gross volume caused by the defects factors, felling breakage and harvesting waste during the logging activities Currently, the reduction factors for $\geq$ 60 cm diameter class logs is 30% and for $\leq$ 60 cm diameter class logs is 40% . SMS emphasize the significance of ensuring the residual physical and commercial status because insufficient number of residual trees would lengthen the cutting cycle while damaged to the non-commercial trees would affect the quality, quantity and commercial value of future yields. Post-Felling forest inventory data were fully utilized to provide information on the residual stocking after harvesting. The assessment would shed light on whether sufficient stocking of sound and commercial tress having diameter of size 30 to 45 cm are left behind to form the next harvest. In maintaining the species composition, an adequate dipterocarp component is kept for the next cut. The entire stocking of the intermediate sized trees of merchantable dipterocarp is conserved from logging damage. In addition, the number of stand was specified instead in terms of percentage, which could be arbitrary and marked to retain prior to harvest since the dipterocarp are the faster growing species that contribute significantly to the economic volume of the next harvest.

iv) Adequacy of residual stocking

The minimum numbers of trees required for the various dbh classes are based on the overall stock results of the National Forestry Inventory of 1973 as they are considered to represent the average stocking capacity of the PM natural forests. In determining the adequacy of residual stocking for the next cutting cycle, the number of residual stems in the higher dbh classes should have an equivalent value to the proportion of stems required by the standards of the next lower dbh class (Table-5).

Table-5. Minimum residual stocking standards

Class	Size	No.of trees per hectare	Tree (s) equivalent to no. of trees in the 30-45 cm dbh class
Exploitable	+45 cm dbh	25	2
lngrowth	30－45 cm dbh	32	1
Small trees	15－30 cm dbh	96	(trees below 30 cm dbh are not considered for the next cut)

After logging the minimum residual stocking (medium-sized trees) should not be less than 32 sound marketable trees of good from dbh class 30 to 45 cm or its equivalence. This is achieved through tree marking incrporating directional for those trees to be felled resulted minimize damage to the residual stand and enable full utilization of the timber resource. For example, when a stand after logging has 8 trees of +45 cm dbh and 17 trees of dbh class 30 to 45 cm, in total 25 trees of +30 cm dbh would safisfy the rules for class +45 cm, neither for 30 to 45 cm, not even the total +30 cm. However, the 8 remaining trees of +45 cm dbh are equivalent to 16 trees of 30 to 45 cm dbh class and the total equivalence becomes 16+17=33 trees which satisfies the minimum number required for 30 to 45 cm dbh class. The age of the whole stand has to be accordingly lowered and used in the calculations to estimate the expected yield and time of next harvest. In order to enhance the next cut with a greater proportion of dipterocarp species than the non-dipterocarp species, the cutting limit prescribed for the dipterocarp species should be higher than that for the non-dipterocarp species for any cutting block or compartment.

4. Natural regeneration, silvicultural tending and enrichment planting

The nub of all sustained yields natural forests management practices remain in the regeneration process and future cuts ultimately depend on fruiting and seedling establishment. Under SMS, the process of natural regeneration assumed to take place. Whatever is ready on the forest floor in a virgin stand would automatically provide regeneration. Large commercial trees of about 50 cm and above are removed. Therefore, future regeneration would depend on the small residuals. When it was planned to keep the species composition of the forest unchanged, the uncommon or rare species in a forest have to be protected. To be more effective, large clumps mature individuals stand were left behind as sufficient mother trees per unit area of dipterocarp.

Pre-F silvicultural tending aimed to reduce the felling damage. In Post-F silvicultural treatments, weed girdling and climber/tending cuttings entail again. Following logging, the commercial seedings have to compete with some of the fast growing pioneer weed species, particularly when the gap openings are rather extensive. Eugeissona triste Griff (bertam) in the Shorea curtisii ridge forest grew abundantly and retarded the growth of young re-generation.

Enrichment Planting (EP) scheme was developed to restructure the forest content in term of marketable and high quality species composition when stocking of regeneration following establishment of new crop is inadequate, log yards, *kongsi* sites, *mataus*, clear felled and abandoned cultivation areas took place which despite inadequacy of seedling regeneration of economic species. EP is essential to improve residual stocking of a poorly stocked logged-over forest for the next cut or rotation. The composition, constitution and structure of logged-over forest do not support a polycyclic system as a result of the current logging practice. The implementation of EP would help to introduce specific good quality timber and inevitably allowed large proportion of dipterocarp species being introduced into the logged-over forest. The stocking of dipterocarps is not sufficient to sustain continuity of dipterocarp management. The regeneration dynamics of the logged-over forest is often not as expected and EP would be able to increase the number of specific regeneration artificially into the areas. The genetic quality of logged-over forests has also deteriorated as a result of the removal of the emergent trees. EP increase the number of selected good genetically timber tree species into the forest areas. Several potential commercial indigenous timber tree species suitable for EP by line planting technique are Shorea parvifolia, Hopea odorata, Dyera costulata, Dipterocarpus aromatica, Pentaspadon spp., Schima wallichi, Heriteria spp. and Agathis borneensis.

Ⅳ. Conclusions

The SMS is specifically designed to optimize the management objectives of economic and efficient harvesting, sustainability of the forest and minimum forest development cost under prevailing conditions. The SMS is a flexible system as it allows the determination of the most appropriate cutting regime based on the analysis of Pre-Felling forest inventory data, taking into consideration the need for leaving behind sufficient stocking of intermediate-sized trees, an economic cut, and in maintaining the species composition of the residual forest stand.

Under the SMS, the application of Reduced Impact Logging (RIL) harvesting procedure is mandatory since the international market forces requiring forest management and timber certification to ensure Malaysia tropical timber can be exported. SMS implementation and objectives was implemented according to the International Tropical Timber Organization

(ITTO) indicators and criteria for the measurement of sustainable tropical forest management. Under the rotation of this selective harvesting system, PM forests have ability to return to their former eco-balance, thereby allowing for better biological functioning of the forests.

With regard to the socio-economic development, other important factor of the SMS is the diversification of the flora and timber species. Unlike the formal MUS, the SMS could enhace the development of domestic wood-based industry by utilizing a wider spectrum of timber species. Moreover, the increasing technological innovations and sophistication in wood processing coupled with the changing patterns of wood use in the forestry sector render a lot of the presently non-commercial timber species marketable in both domestic and export markets. It can be concluded that the conservational forest management approach adopted under SMS would achieve following beneficial effects (i) conservation and sustainability of the forest resource ; (ii) minimize reinvestment in forest rehabilitation work ; (iii) enhance environment stability and quality ; (iv) minimize logging waste ; and (v) induce optimum utilization of the forest resources.

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