IMPROVING SILVICULTURAL TECHNIQUES FOR SUSTAINABLE FOREST MANAGEMENT IN INDONESIA

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1. INTRODUCTION

Indonesia has the largest remaining natural Dipterocarp forest in the South-East Asian region. The forest has been playing an important role in Indonesia since the early 1970s, after the Government had enacted the Foreign and Domestic Investment Law in 1967 and 1968. The forests are the main natural resource for the economic growth of the country. After natural gas and oil, forest product exports (mainly plywood, sawn timber, and rattan) are the second highest foreign exchange earners for Indonesia. The natural forest is now receiving more attention from the Government since environmental issues have appeared on the agenda in the last decade.

Nowadays, the forest area of Indonesia is 141.2 million hectares, of which 92.4 million hectares are planned to be retained as forested area. These forests are managed in the form of concessions given out to private and State-owned companies. There are 483 concessions (HPH) in Indonesia, covering an area of 55.6 million hectares (Ardjojoewono, 1995).

During the last 25 years of forest exploitation in concessions, an area of about 40 million hectares throughout Indonesia has been logged-over. The condition of the logged-over areas varies from *belukar* (scrub) to high potential logged-over forest, depending on the way the logging operations were carried out. Most of the logged-over areas from the early 1970-s possess a very good residual stand, at least that is, if no re-logging has been done. These logged-over areas should be regarded as the future timber resource for the Indonesian forestry industry. It is therefore very important to focus attention on the management of logged-over areas for the sustainable production of logs as well as for the future of the forest ecosystem. This is a crucial point for the future of Indonesian forestry.

2. SIVICULTURAL SYSTEMS APPLIED IN INDONESIAN FORESTRY

2.1 The Indonesian selective felling and replanting system (*Tebang Pilih dan Tanam Indonesia, TPTI*)

At the beginning of forest exploitation in Indonesia, no silvicultural systems were applied. There was no felling limit, nor any other requirements for harvesting in natural forest. The only limitation at the time was the limited market for commercial tree species. Only a few species belonging to the red and white Meranti groups were highly commercial on the market. Most of the other tree species belonging to the family of Dipterocarpaceae were known as lesser-known species. The very limited number of commercial trees that were harvested from the natural forest might have created the high potential residual stands in the logged-over areas that were mentioned above.

In 1972, the first silvicultural system, called the Indonesian Selective Felling System (*Tebang Pilih Indonesia*) was introduced. The *TPI* System was a modification of the Malayan Uniform System of Malaysia and The Philippine Selective Felling System. The System was meant for the management of natural forest outside of Java. It consists of selective felling, clear felling with replanting, clear felling

with natural regeneration, and subsequent maintenance. This System was applied until 1989, when a new system for natural forest management in Indonesia was introduced as a revised version of the previous one. The new system was called the Indonesian Selective Felling and Replanting System (*Tebang Pilih dan Tanam Indonesia, TPTI*). Its objectives were to regulate the production in natural forest and to increase the value of the residual stands for the next cycle (rotation), both in quality and in quantity. It was also meant to create the mixed stands that can be expected to function as sources of sustainable timber (Soerianegara, 1995).

Apart from a diameter limit, the main aspect of the *TPTI* System was considered to be the regeneration and maintenance of the residual stand. The *TPTI* System consists of a set of rules for the entire sequence of silvicultural techniques applied before and after harvesting (Table 1).

Table 1 Scheduling of the activities required for the TPTI system

	Activity	**Planning** (years before or after harvesting)
1	Design of the working area	- 3
2	Pre-logging inventory	- 2
3	Road engineering	- 1
4	Harvesting	0
5	Refinement I	+ 1
6	Inventory of residual stand	+ 1
7	Production of planting stock	+ 2
8	Enrichment planting	+ 2
9	First tending	+ 3
10	Refinement II	+ 4
11	Thinning	+ 9
		+ 14
		+ 19
12.	Protection and Research	Continuous

The purpose of the *TPTI* System is to regulate the logging and regeneration of natural forest, especially lowland production forest, which is stocked with at least 25 trees per hectare. The lower diameter felling limit for trees to be cut is 50 cm for lowland forest and 60 cm for hill forest and limited production forest. There are several basic principles to the *TPTI* System:

- Stand inventory, including the structure of the regeneration, species composition, and site characteristics;
- Limits to the diameter and the number of trees to be cut in order to create a highly productive residual stand for the next rotation;
- Maintenance of the residual stand, protecting the forest as a whole, and maintaining the highly necessary biodiversity of the forest.

The fact that a single silvicultural system was applied universally and indiscriminately in all the different types of natural forest in Indonesia might be the reason why *TPTI* did not work effectively in certain areas. Some disadvantages were encountered during its implementation in Indonesia. Sutisna (1990) has criticised the fact that some of the treatments required by *TPTI* lack a scientific basis, especially the refining and liberation treatments. He observed that refinement of the understorey vegetation might be inadequate to improve diameter increment, because the main factor determining

growth is light intensity, rather than root competition. Similarly, the killing of non-desired species during liberation treatment may not be an effective measure to improve the growth of the potential tree crop (Sutisna, 1997). Liberation thinning, however, has proven to be the most effective silvicultural treatment to induce the growth of the residual stand in Sarawak (Hutchinson, 1981), even though this was with different timing sequences as are required in the *TPTI*.

Another criticism that has often been addressed to policy-makers is that the usual concession right of only 20 years might not stimulate the companies to implement the *TPTI* completely , especially not where the System requires the replanting of those areas in which insufficient regeneration occurs. In reality, *TPTI* is a poly-cyclic silvicultural system with an expected rotation of about 70 years. The annual allowable cut under *TPTI* is based on a 35-year cutting cycle, with the assumption of an average annual tree diameter increment of 1 cm. The uncertainty of the future concession rights stimulates the fast deforestation of a forest area. Most concessionaires try to harvest as much as possible during the 20-year period of concession right given to them, with a minimum of investment returning to the forest.

Many of the concessionaires therefore have less than the expected area of virgin forest left at the end of their first concession period of 20 years. An evaluation of concession-holder performance by the Ministry of Forestry revealed that 11% of the concession holders have a good performance classification, with 73% this is fair, and 16% have a bad performance (Simon, 1997). The Government then recalled the concession rights of the bad performance concessionaires and gave the State-owned companies the responsibility of continuing the management of these concessions. The assessment in 1996 showed that afterwards the performance improved to 21% good, 77.7% fair, with 1.3% remaining bad (Tantra and Hutabarat, 1996).

It is very expensive to implement the entire cycle of activities required by the *TPTI*. It costs about US$10-15 for every cubic metre of log retrieved from the forest. To obtain permission to carry out his annual cut, however, every concession holder has to fulfil all the requirements of the *TPTI*. This situation leads to the manipulation of data and reports from the concessionaire to the authorities, while at the same time the authorities have a very limited capacity to check all activities in the field, because of the lack of proper technology and human resources.

Enrichment planting after logging - one of the requirements of the *TPTI* - is no guarantee that rights will be obtained to harvest these trees in the future. No reliable guidelines are available that show the most efficient way to grow and maintain such plantations. There are very few examples of successful line planting producing future harvests, just because of the lack of management of the plantation in the field. The most important factor in managing line plantations is the optimal light conditions for the seedling after being planted. In the history of *TPTI*, no intensive management has been applied for line plantations.

During the 25 years of implementing the *TPI* and *TPTI* Systems in Indonesia, both have proven difficult to execute correctly in the field. Many of the activities required by the Systems are omitted by concessionaires, and the condition of the logged-over forest is not as good as could be expected. An evaluation of the implementation of the Systems has clearly indicated that production forests were managed inadequately and improperly (Anon., 1990). This situation has forced the Ministry of Forestry to find an alternative reliable system to guarantee the sustainable production forest products as well as the sustainable functioning of the ecosystem, especially in logged-over areas and in the remaining natural forest. *TPTI*, however, is still an official system applied for the management of natural forest in Indonesia.

2.2 Strip-cutting and replanting system (*Tebang Jalur dan Tanam Indonesia, TJTI*)

The Indonesian strip-cutting and replanting system (*TJTI*) is an alternative silvicultural system applied for logged-over areas in Indonesia, following guidelines decreed by the Director General of Forest Utilisation in 1995. The system is based on the strip clear-cutting system developed by the Tropical Science Centre in Costa Rica. The system prescribes that strips that are harvested and replanted alternate with strips that are not harvested (conservation strips). All trees with a diameter of 20 cm and up are removed in the harvested strip. No cutting is allowed in the conservation strip. Replanting of the harvested strip has to be done one year after exploitation (Table 2).

Table 2 Scheduling of the activities required for the TJTI system

	Activity	**Planning** (years before or after harvesting)
1.	Design of the working area	- 1
2.	Pre-logging inventory	- 1
3.	Road engineering	- 1
4.	Harvesting	0
5.	Refinement	+ 1
6.	Residual stand inventory	+ 1
7.	Production of planting stock	+ 1
8.	Planting	+ 1
9.	Planting maintenance	+ 2 to + 5

The *TJTI* System is now being tested in several concession areas. Several alternative combinations of harvesting and conservation strips are being tested, whereby the width of strips is 50 m, 100 m, or 200 m. The system is based on a rotation time of about 70 years, with a cutting cycle of 35 years. It has not yet been determined whether the conservation strip could be harvested in the next cutting cycle. If that is not so, this would imply that the area of production forest would be reduced to 30 or 50% of the present area. This aspect is still being discussed by forest management scientists.

The preliminary results from the trial have led to two different recommendations, concerning in particular the width of the strip. One recommendation was to use a combination of 100 m cutting strip with 100 m of conservation strip. In contrast, the alternative recommendation was to use a combination of 200 m of cutting strip with 100 m of conservation strip. The argument for the latter recommendation was that a 200 m harvesting strip minimises the damage to the forest, especially the compaction of soil, because tractor movement can be more flexible during skidding. This recommendation was based on technical considerations only, and it was not mentioned whether ecological aspects were considered.

During the implementation of this system, there are some technical as well as economic problems to be considered. Because strip cutting is in a straight line, many conservation areas (e.g. buffer-zones around rivers and steep slopes within the strip) would be damaged during the harvesting. An economic problem is that, on the one hand, many of the smaller logs will remain unsold if all trees of more than 20 cm in diameter are harvested, even though the cost of harvesting small-diameter trees is about the same as harvesting large-diameter trees. Most of the concessionaires are not interested in harvesting these small-diameter trees. On the other hand, there is no guarantee that high potential commercial trees in the conservation strips will not attract the logger and be harvested. This will in fact lead to selective logging in the conservation strip. One should bear in mind that the *TJTI* System legally allows concessionaires to harvest in logged-over areas, something that is not possible under the *TPTI* System.

As an alternative system that was introduced four years ago, it is still open to discussion whether *TJTI* will be effective enough to manage the logged-over area in Indonesia. Before a decision can be taken to adopt *TJTI* as a national policy, we have to await the results of further comprehensive studies that are still being conducted by several research institutions and universities.

2.3 Felling and line-planting system (*Tebang dan Tanam Jalur, TTJ*)

TTJ, the felling and line-planting system, is a new system put forward by the Ministry of Forestry as an alternative silvicultural system for logged-over areas that are not suitable for timber plantation after clear cutting. *TTJ* consists of two main aspects: harvesting and line planting with intensive maintenance. The System was issued in two separate decrees in 1997. Its objectives are:

- To optimise the utilisation of natural production forest;
- To improve the quality of logged-over areas by replanting with high-value commercial trees, especially the species belonging to the family of Dipterocarpaceae;
- To facilitate the supervision and control of forest regeneration activities in the field.

The general principles of *TTJ* are:

- The system is applied in lowland production forest that is not suitable for clear cutting;
- The limit diameter for cutting is 40 cm and above;
- The period of concession right is 70 years (35 years + 35 years of rotation);
- The planting distance is 5 metres in line, and 25 metres between the lines (5 by 25 metres). To counter the effects of mortality after seedlings have been planted, it is recommended that three seedlings be planted per planting site. The total number of seedlings to be planted per ha is 243;
- By having a concession right for a timber plantation, the plantation belongs to the concessionaire and can be regarded as an asset for him. With any legal change in the land-use status of the concession area, he can claim compensation for any investments made in the concession area (e.g. planting, road construction, building, etc.). Here, *TTJ* differs greatly from the concession right given under the *TPTI* System. In *TPTI*, the concession is still legally in the hands of the Government, while the company has the right to manage the existing forest. Under the *TTJ* System, however, the concessionaires also have the right to manage the forest as a plantation, which means that compensation can be claimed whenever the legal status of the land use is changed. This system would also assure the certainty of long-term management of the area - for at least a 70 year period.

An intensive plantation management will prevent land encroachment and illegal logging after harvesting. These processes are very difficult to control under the *TPTI* System, because the maintenance of the logged-over area after logging is usually omitted by the concessionaires.

Table 3 gives an overview of the activities that form the *TTJ* System.

Table 3 Scheduling of the activities required for the TTJ system

	Activity	**Planning** (years before or after harvesting)
1.	Design of the working area	- 2
2.	Road engineering	- 1
3.	Production of planting stock	- 1
4.	Harvesting of trees above 40 cm	0
5.	Land preparation	0

6.	Preparation of lines for plantation	0
7.	Plantation	0
8.	Maintenance of plantation	+ 1 till harvesting
9.	Plantation protection	continuous

It is too early to judge how effective *TTJ* will be. On the basis of previous experiences of managing plantations, there are several questions to be addressed in this System:

- What is the economic feasibility of the plantation, considering the relatively small number (3 times 83 seedlings per hectare) of seedlings to be planted in the concession area?
- Is it interesting for concessionaires to harvest all trees over 40 cm diameter, as required by the system, knowing that some of the trees belong to lesser-known species?
- What further silvicultural treatments are required for the management of the plantations, including maintenance, thinning, and harvesting? The existing documents supporting this system do not cover these aspects.

3. RESEARCH NEEDED

Cooperative research efforts and programmes are badly needed to support the sustainable management of the expanded logged-over areas in Indonesia. Some specific research needs are:

- To find the proper plantation techniques for local tree species such as Dipterocarps and other high-value tree species;
- To provide a cheap and easy method for post-harvest evaluation for the effective monitoring of concessionaires;
- To develop a management system for logged-over areas by providing reliable guidelines with a scientific basis for improving the residual stand for the next rotation. This can be done by testing existing silvicultural systems and making recommendations for improvement;
- To study the possibilities for, and the effects of, reduced impact logging;
- To establish the criteria and indicators for sustainable forest management that can easily be understood by multi-level management (from field supervisor to top management).

As a leading cooperative research project in Indonesia, the Tropenbos project should review its programme in order to keep in touch with the current issues and forestry problems as outlined above. In this way, it will be able to increase its contribution to sustainable forest management in Indonesia. It should be mentioned that some of the above-mentioned research topics have been addressed in the framework of the International MOF-Tropenbos-Kalimantan Project and should be extended to the concessionaires.

4. CONCLUSION

During the implementation of several silvicultural systems in Indonesia, some disadvantages have surfaced that need to be addressed scientifically. The logged-over areas that result from past harvesting under the *TPTI* system have to be managed with improved silvicultural techniques that are now being developed in Indonesia. Alternative systems that have been introduced still need to be tested comprehensively, in both their technical and ecological aspects. Nevertheless, several research findings have yielded sufficient information on the principal management aspects, but we still need more information in order to optimise the techniques before they become applicable in the field.

Research priorities should be set in order to support the sustainable management of logged-over areas.

5. REFERENCES

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IMPROVING SILVICULTURAL TECHNIQUES FOR SUSTAINABLE FOREST MANAGEMENT IN INDONESIA

Achievements

- Development of several silvicultural systems for sustained timber production.

Challenges and Problems; Information Needs

- Universal application of a single silvicultural system leads to unsatisfactory efficiency in certain areas.
- Problems with the scientific underpinning of certain required management measures.
- Short duration of concession rights incompatible with requirements of sustainable forest management.
- Bad compliance of concession holders with silvicultural prescriptions.

Points for Future Research

- Development of appropriate management techniques for logged-over forests.
- Develop planting techniques for high valued local species.
- Develop techniques for monitoring concession holders.
- Optimisation of strip-cutting systems.
- Development of criteria and indicators for sustainable forest management.

Conclusions

- Present application of silvicultural systems in Indonesia meets with several undesired effects which need to be rectified by developing more sophisticated and scientifically sound techniques.