

# **The Selection of Silvicultural Systems for the Management of Primary and logged-over Dipterocarp Forests in Indonesia:**

## **The case against the application of TPTJ.**

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## **SUMMARY**

The Indonesian Selective Felling and Planting System (TPTI) is a silvicultural system intended for use in the low and upland tropical forests of Indonesia. The system has been applied since 1989, in accordance with the Minister of Forestry Decree No. KPTS 564/KPTS/IV – BPHH/1989 and as subsequently modified in 1993 as 151/KPTS/IV – BPHH/1993.

The general guidelines for TPTI cover pre and post harvesting inventories, diameter limits for trees felled and post harvesting treatments to ensure adequate regeneration with the aim of implementing a 35-year cutting cycle. The objective of the system as stated in the Decree is to *“maintain and utilise optimally and sustain natural production forest”*. This has also be interpreted as *to ensure that forest management promotes the recovery of the forest after logging, to rejuvenate the growing stock and achieve the maximum possible yield for further harvests on a sustainable basis.*

TPTI has now been applied for almost ten years and it is considered that results in some areas have been disappointing. Forest management under TPTI has been criticised for poor regeneration, decreases in the growing stock and environmental degradation, especially watercourses. All of these factors will adversely affect future yields and sustainability. There is now debate about the causes of the apparent failure of forest management under TPTI.

The Department of Forestry and Estate Crops has concluded that the failure of forest management is due in part to the lack of supervision by government officials and part due to lack of commitment by the companies to applying the TPTI system. This recognises a criticism that the TPTI system is complex and difficult to apply. There is evidence that many HPH do not apply TPTI correctly. The reasons are varied, including lack of a suitably trained staff in the field, poor supervision in the field and the complexity of the TPTI regulations. Implementation in the field may also be influenced by commercial pressures, with the need for short-term profit or cash-flow outweighing any long-term economic or environmental benefit of better management.

This has led to a proposal by the Department of Forestry and Estate Crops to introduce an alternative system called Selective Cutting and Line Planting (TPTJ). It is considered that this system will be easier to implement and monitor, but there are no results to support this assertion.

This report suggests an alternative conclusion, which is that there are no fundamental problems with the TPTI system and that problems of forest management are linked to external factors, in particular a lack of commitment to good forest management by HPH and illegal harvesting. Illegal logging is required to support the increasing demand for timber by the local Indonesian economy. It is also suggested that success of the TPTI system could be significantly improved through modifications targeted to reduce environmental impact and simplify existing regulations. The most important modification is the correct implementation of reduced impact harvesting techniques linked to appropriate yield regulation.

## **Demand for Timber**

Almost all production forest in Indonesia has been allocated by forest concessions (HPH),

and managed by large commercial companies. Each HPH is required to have associated industrial plants that process logs into products for export mainly plywood. The volume of plywood exported over the past 10 years has accounted for almost the whole volume harvested from HPH.

There is, however, a large demand for wood products on the domestic market, which has been increasing as a result of population growth and rising average living standard. It has been estimated that domestic consumption of logs is currently approximately 25 million m<sup>3</sup> annually, or about the same as is used by the export industry (DFID internal report). Logs to meet this demand can only be obtained from illegal felling, since there is no other source, and this is considered one of the main causes of the forest degradation following logging by the companies applying TPTI. The roads constructed by the companies during harvesting provide access for subsequent illegal logging. This illegal logging results in damage to regeneration and removes trees growing to form the future growing stock. Where forest stands are located far from population centers with difficult access by river, such as in the Pilot KPHP in Central Kalimantan at Kuala Kurun, there is very limited illegal felling, and the stands normally recover well after logging.

**It is concluded that the principle causes of the poor results from TPTI are poor technical application of the system, and illegal logging, rather than any deficiency of the system itself.**

#### **TPTJ Silvicultural system.**

TPTJ was introduced to deal with the perceived problems of lack of commitment by concession holders (increase discipline) and the lack of supervision through simplification. If the main reason for failure of TPTI is illegal logging, the new system is unlikely to achieve the desired objectives. The system has also been criticised by HPH as being more difficult to implement than TPTI.

The new TPTJ system derived from TTJ, which was intended for the establishment of forest plantation (HTI), in logged forest as laid down in Minister of Forestry Decree No. 435/Kpts-II/97 and No. 338/Kpts-II/1998. However, in accordance with the Ministry of Forestry Decree No. 625/Kpts-II/1998, it is stated that TPTJ is an alternative silviculture system for natural production forest and implicitly can be applied in both logged and primary (virgin) forest. The application of this system in primary forest is highly undesirable, as it will lead to rapid degradation of the forest.

#### **Modifying TPTI.**

Recommendations to improve TPTI are likely to produce greater benefit than its replacement by TPTJ. Important improvements include the implementation of reduced impact logging (RIL) which will reduce environmental impact of harvesting activities. Reducing the volume of timber extracted illegally is the only way of solving the problem of the decline in standing stock following the initial harvesting activity. One way to do this would be to maximise the utilisation of forest to meet part of the domestic wood demand. It has been identified that only 50% of the volume harvested is actually utilised by the HPH with the remainder 50% is left in the forest. Cooperatives (Koperasi) may be an appropriate method to involve communities around the forest in utilising this forest waste. It is important to recognise that technical solutions will not improve the results of

forest management without a strong strategic policy to overcome encroachment and illegal logging.

# **Silvicultural Systems for Natural Forest Management in Indonesia**

## **BACKGROUND**

The management of natural production forest in Indonesia was regulated initially in 1970, through the Indonesian Selective Felling system (TPI) through Government Regulation No. 33 Year 1970. This system was improved and in 1989 in accordance with the Minister of Forestry Decree No. 484/Kpts-III/1989, it was stated that management of natural forest in Indonesia could apply three silvicultural systems. These are: Indonesian Selective Felling and Planting (TPTI); Clear Felling with Natural Regeneration (THPA) and Clear Felling with Artificial Regeneration (THPB).

### *TPTI*

The TPTI system is regulated by KPTS 564/KPTS/IV – BPHH/1989 and subsequently modified in 1993 as 151/KPTS/IV – BPHH/1993. The guidelines for TPTI cover pre and post logging inventory, the diameter limit for trees felled and post harvesting treatments. These aim to ensure adequate regeneration such that the forest can be harvested using a 35-year cutting cycle. The TPTI regulations specify post-logging activities designed to promote regeneration of the residual stand. The TPTI system regulates harvesting according to a diameter limit for commercial species of 50 cm or 60 cm in steep areas designated as limited production forest. This diameter limit is intended to reduce damage to the residual stand leaving sufficient potential crops trees to form the next harvest.

### *THPA and THPB*

The THPA system has not been applied in practice by HPH for the reason that natural regeneration tends to fail after clear felling. THPB is the system that has been applied in areas of logged-over forest area that has low potential, degraded land, or alang-alang area, for conversion into planted forest. Regeneration is using exotic fast growing species which crop yield for paper, chips, furniture etc, purposes. THPB has been applied successfully in many areas but recently there has been concern at the prevalence of fires used for clearance as part of the implementation of THPB. This led to the introduction of a ban on using fire for land clearance, which will make the system much more difficult to implement.

### *TPTJ*

An alternative silvicultural system of selective logging and strip planting (TPTJ) was introduced during 1998 through the regulations in Minister of Forestry Decrees No. 435/Kpts-II/97, No. 338/Kpts-II/1998 and No. 625/Kpts-II/1998. TPTJ has been promoted as addressing some of the perceived problems with the TPTI system. TPTJ originally was intended for application in areas of degraded logged-over forest for conversion into planted forest. The system is applied with a diameter limit of 40 cm. After the initial felling, replanting is conducted along cleared strips using indigenous species.

This paper discusses the implementation of TPTI and its associated problems before considering the alternative TPTJ. This discussion is based on analysis of information pilot KPHP projects in Sumatera and Kalimantan. Other information was collected through discussion with staff from the Ministry of Forestry and Estate Crops in the Forest Utilisation Planning Division (BPPH), Forest Utilisation Development Division (BPH), Forest Research and Development Agency (FORDA).

### **Implementation of TPTI in Indonesia**

Natural mixed high forest of Indonesia is characterised by complex biological and environmental diversity. Disturbance following logging will disrupt the natural forest ecosystem affecting the growth and future species composition of the forest. For this reason sustainable forest management of Dipterocarp forest in Indonesia aims to mimic naturally occurring disturbance events to promote regeneration and regrowth of the forest. Harvesting activities are the most important silvicultural treatment in the management of these forests and have been designed to minimise detrimental effects on the residual stand. Selective felling through reduced impact logging techniques are considered to be the most important management intervention. The creation of gaps following harvesting can promote regeneration and enhance growth rates of the residual stand. Under the TPTI system additional post-logging treatments are applied to supplement natural regeneration and enhance the regrowth of the residual stand. Good management of these natural forests using a polycyclic harvesting system such as TPTI depends on maintaining environmental conditions that will promote natural processes of regeneration and regrowth. It is well documented that regeneration is likely to fail if harvesting is poorly implemented.

The excessive extraction of timber leads to extensive canopy opening and environmental conditions that tend to result in poor regeneration of Dipterocarp species with a resulting change in the species composition of the residual stand. Excessive harvesting is also likely to result in environmental degradation through direct and indirect damage to the residual stand. The existing TPTI regulations if applied correctly are adequate to prevent over exploitation by HPH for most forest types under the current market conditions in Indonesia. There is, however a very significant problem associated with subsequent exploitation of logged-over areas through illegal logging activities linked to domestic demand for timber resources.

The harvesting operation results in significant disturbance to the residual stand. Guidelines for reduced impact logging have the potential to significantly reduce the extent of disturbance, creating environmental conditions favourable for recovery of the forest. In contrast regeneration and the regeneration of the residual stand becomes suppressed or may fail if serious environmental disturbance is created by harvesting activities. This is a problem that has been observed with some HPH, that either have poor control of harvesting activities or extract excessive volume.

#### *Harvesting by TPTI*

TPTI was developed during the 1980's from the earlier TPI selective logging system applied for natural forest management in Indonesia. The TPI system emphasised harvesting operations with little consideration of regeneration and growth of future

harvests. This system was evaluated and it was concluded that modifications were required to achieve sustainable forest management. The TPTI system was introduced in order to promote sustainable management of primary forest and subsequent harvests from logged-over forest. Harvesting under the TPTI system is controlled by diameter limits to define the number of felled trees and consequently reduces the disturbance to the residual stand retaining a minimum number of potential crop trees for future production.

The TPTI system has been applied in Indonesia for almost ten years and its performance has been monitored by the Ministry of Forestry and Estate Crops, HPH and international development projects. There is evidence that the system may be sustainable if applied correctly to some forest types. There is, however also much evidence of the apparent failure of the TPTI system to promote sustainable forestry in many regions of Indonesia where there have been very significant reductions in the standing volume of the forest and little apparent commercial volume increment in areas of logged-over forest. These observations led the Ministry of Forestry and Estate Crops to introduce an alternative system called Selective Cutting and Line Planting (TPTJ) which will be discussed in a subsequent section of this report.

#### *Illegal harvesting in areas managed for TPTI*

Almost all production forest in Indonesia has been allocated for Forest concessions (HPH), and managed by large commercial companies. Production by HPH is targeted at the export market and clearly cannot meet the increasing domestic demand for wood-based products. Export orientation of resource use is leading to instability in the domestic market creating significant pressure for illegal exploitation of forests. This level of additional exploitation to meet domestic requirements is leading to accelerated environmental deterioration and resource degradation and exhaustion.

Illegal harvesting tends to utilise smaller size classes of commercial species, damaging the future crop trees in the residual stand following logging. These trees are the fastest growing part of the growing stock. The additional opening of the canopy and soil disturbance creates environmental conditions less favourable for natural regeneration. As a result the condition of the forest may rapidly decline.

The extensive problem of illegal logging in many regions of Indonesia makes forest manager in HPH reluctant to implement improvements to their management that aim to promote the future yield of the forest. They correctly state, that it is highly unlikely that it will be possible to conduct a second harvest under the TPTI regulations in areas that have been subjected to illegal logging. This means that there is currently no incentive for concession owners to invest in future harvests. The illegal logging, forms an indirect incentive for HPH to increase their harvesting intensity. The HPH justify this by stating that there is no point in leaving timber in the forest as it will only be removed by illegal activity and is extremely unlikely to form part of the second (legal) harvest.

Illegal logging activities are for these reasons probably the most significant factor leading to the problems associated with sustainable forest management in some regions of Indonesia. It is relevant to note that these are mainly in areas of high population density or domestic demand for wood resources. Any attempt to address the problems of sustainable forest management must consider both, the silvicultural system used by forest managers as well as the problem of illegal exploitation to meet domestic demand.

**Case study. Pilot KPHP, Jambi, Sumatera.**

Data collected by the DFID project can be used to illustrate the problems of forest management using the TPTI system in areas subject to illegal logging. The pilot KPHP in the province of Jambi is a good example of a concession nearing the end of the first 35-year cutting cycle. This KPHP is surrounded by a concession managed by the HPH PT IFA. Logging of the forest commenced in 1968 and the area of primary (virgin) forest has steadily declined through these logging activities and conversion of forest into agriculture or planted forest (Figure 1). Almost all of the forested area of the pilot KPHP is now categorised as logged forest with only a small remainder of primary forest. Forest management must now concentrate on the most efficient methods for sustainable production from the logged-over areas.

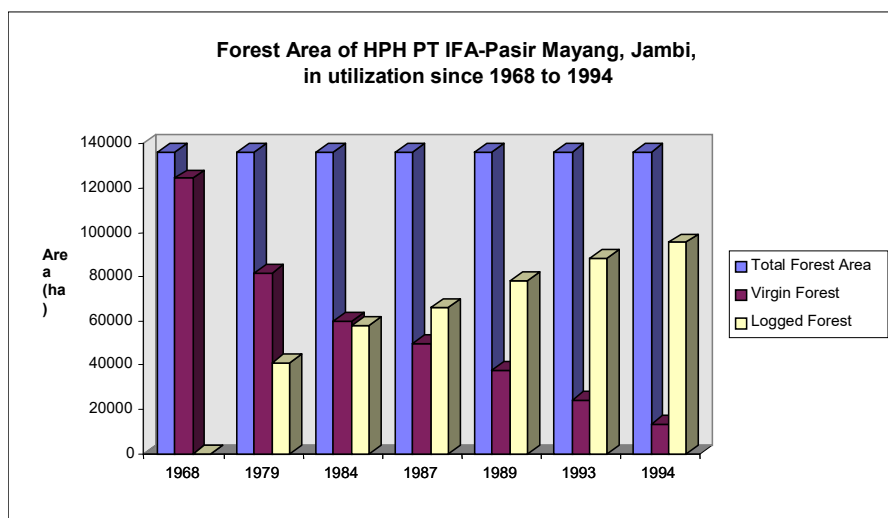


Figure 1. Graph of total forest area of PT IFA and its trend of utilisation over the period of 1968 through to 1994. The trend shows the decline in the remaining area of primary (virgin) forest as areas are logged or converted into agriculture or planted forest..

The decline in area of primary forest in the pilot KPHP and associated increase in logged-over areas has resulted in significant changes in the total volume of timber in the KPHP. Data from sample plots in the Biotrop reserve gives an average standing volume of 370 m<sup>3</sup> ha<sup>-1</sup>. The initial area of primary forest in 1968 was 124 380 ha allowing the calculation of the growing stock volume at the start of the concession period.

Growing stock volume estimated for 1968  
 (124,380 ha) ..... 46,020,600 m<sup>3</sup>.



Since 1968 a significant area of forest has been converted into other land uses removing potential production from the KPHP. This is summarised in Table 1. It should be noted that only the areas converted to agriculture represent a loss of forest. The Biotrop reserve remains under forest cover but is not in production. The areas of timber estate are planted in exotic species are not considered as part of the TPTI production system. These areas should however yield higher volumes than equivalent areas of natural forest.

Land Use	Area (ha)	Volume (m <sup>3</sup> )
Agriculture (including Shifting Cultivation)	6,790	2,512,300
Biotrop Reserve	4,000	1,480,000
Timber Estate (Planted forests)	4,800	1,776,000
<b>Total</b>	<b>15,590</b>	<b>5,768,300</b>

Table 1. Estimates of areas and standing volumes of timber in the Jambi pilot KPHP lost from production through changes in land use.

The volume extracted from the KPHP over the period since 1968 can be estimated from the records of the HPH at 4,860,300 m<sup>3</sup> over a 29 year period (Table 2). It has also been estimated that over the same period the volume of timber either damaged or wasted during logging was 5,146,200 m<sup>3</sup>. Data from the Biotrop permanent sample plots have been used to calculate a volume increment over the same period of 2,661,142 m<sup>3</sup> for the KPHP.

Period	Length of Period	Extraction Rate (m <sup>3</sup> yr <sup>-1</sup> )	Total Volume (m <sup>3</sup> )
1968-1979	12	173,914	2,086,971
1980-1984	5	172,421	862,104
1985-1987	3	138,686	416,058
1988-1989	2	314,848	629,607
1990-1993	4	123,675	494,700
1994-1996	3	123,590	370,770
<b>Total</b>	<b>29</b>		<b>4,860,300</b>

Table 2. Estimates of the volume of timber removed from the Jambi pilot KPHP by felling.

A balance book approach can be used to predict the residual volume of the KPHP if the assumption is made that the changes in volume can be attributed to either logging activities or changes in land use (Table 3). This predicted value can then be compared with the KPHP inventory completed by DFID in 1986.

Category	Volume change (m <sup>3</sup> )	Total volume (m <sup>3</sup> )
Estimate of volume in 1968		46,010,600
Loss through land conversion	-5,768,300	
Volume removed in felling	-4,860,300	
Volume damaged in felling or wastage	-4,860,300	
Volume increment	+2,661,142	
Estimate of residual in 1996		32,906,942
Inventory measurement 1994-95		22,628,320
Difference		-10,278,622

Table 3. Summary of changes in the standing volume of the Jambi pilot KPHP over the period 1968 – 1996.

The difference in estimates of standing volume between the KPHP inventory and the balance approach suggests that over the 29 year period of management, over 10 million m<sup>3</sup> of timber has been lost from the concession that cannot be accounted for. Part of this amount could be attributed to enhanced mortality of the forest for a period following logging, but this is not likely to result in such a significant loss of standing volume.

It is well documented that the forests in Jambi and the neighbouring province of Riau in Sumatera suffer from extensive illegal logging activity. It must be assumed that most of the additional volume lost from the forest should be attributed to harvesting by illegal loggers and subsequent damage to the forest. In the KPHP study area in Jambi the forest area has been subjected to very heavy illegal logging activity and as a result most logged-over areas have very low standing volumes and poor regeneration. Overlogging removes more than 50%, and up to 80-90% of the canopy, completely altering the structure and function of the ecosystem. The forest is in a state of decline and its function as a productive, renewable resource, as a habitat for flora and fauna and as an aesthetic and an ecological component of the landscape is rapidly degrading.

The major causes for illegal logging lie in the social and political environment. The demand for timber for the domestic economy creates a demand that can only currently be met through illegal activities. The apparent flouting of rules and disregard of the law by loggers at local operational level and by managers and concession holders can be overcome only if the political and societal will and strength are there and put into action.

## Management and Silvicultural Options for the Jambi Pilot KPHP.

The extraction of timber from the Jambi KPHP through logging by the HPH and illegal activities have resulted in very significant reductions in total standing volume in the concession. The estimate of over 10 million m<sup>3</sup> lost through illegal harvesting and associated damage to the stand equates to over 300,000 m<sup>3</sup> yr<sup>-1</sup>. This value seems excessive for illegal logging alone, and may indicate that there are additional losses that have not been accounted for. Irrespective of the cause of this loss, it is obvious that the natural rate of volume increment is less than the volume lost through logging and other activities. This will have very important implications for management of the KPHP and the choice of silvicultural systems for the area.

The KPHP inventory can be further analysed to provide information on the potential commercial volume in the KPHP (Table 4). It is seen that the average volume is just over half of the value estimated in plots of primary forest in the Biotrop reserve. Furthermore the very low volumes of commercial species that are above the current cutting limits for TPTI (50 cm for the area) suggest that future application of TPTI in this area will not be economically viable for the KPHP as a whole.

Species group	Diameter class (cm)							Total	Cutting limit (cm)	
	10-19	20-29	30-39	40-49	50-59	60-69	>69		50	60
Commercial species	11.8	21.1	27.0	26.0	22.5	17.7	26.7	<b>152.8</b>	66.9	44.4
All dipterocarps	5.0	8.8	11.6	10.2	9.4	7.4	12.9	<b>65.3</b>	29.6	20.3
Other commercial	6.9	12.4	15.4	15.8	13.1	10.4	13.8	<b>87.8</b>	37.3	24.2
Non commercial	9.4	12.8	13.1	8.8	5.1	3.2	2.8	<b>55.2</b>	11.1	6.0
All species	<b>21.2</b>	<b>33.9</b>	<b>40.0</b>	<b>34.8</b>	<b>27.6</b>	<b>20.9</b>	<b>29.5</b>	<b>207.9</b>	<b>78.1</b>	<b>50.4</b>

Table 4. Volume estimates (m<sup>3</sup> ha<sup>-1</sup>) for the pilot KPHP project in, Jambi, Sumatera in the PT IFA concession. Data are mean volumes averaged over all forest conditions and period after logging.

These results have been used to develop alternative management strategies for the KPHP. The DFID project has suggested three key principles. (1) Retire a proportion of the area from production in order to allow the forest to recover through natural processes and volume increment. (2) Implement measures to reduce the impact of illegal logging. (3) Apply alternative silvicultural systems in the remaining forested area to meet reduced production targets. The DFID project recommended the application of THPB in order to maximise production from an area, thus reducing the total area the needs to be converted. The HPH was wanting to apply the new TPTJ system as an alternative, but there is no information about the productive potential of this system.

## TPTI and KPHP and Central Kalimantan

A contrasting result in the apparent impacts and success of the TPTI system has been observed in the pilot KPHP in Kuala Kurun, Central Kalimantan. This KPHP is in a remote area of Kalimantan and does not have a significant problem of illegal logging activity. The KPHP is located in the upper region of the river catchments distant from large community and are thus currently protected from the illegal felling. The condition of the forest following logging is good and regrowth and regeneration of the residual stand is adequate. This is an region where TPTI appears to be resulting in good forest

management, although it is accepted that improvements such as the application of reduced impact logging techniques have potential to enhance the future production of the system.

Results from the KPHP inventory at Kuala Kurun are presented as Table 5. These results should not be directly compared with those from Jambi, as the period of management is much shorter in Kalimantan. These results show that in the Central Kalimantan KPHP, there is sufficient volume for continued application of TPTI. The results from the inventory and field observations suggest that the TPTI system has resulted in good management of the forests in this area.

Species group	Diameter class (cm)							Total	Cutting limit (cm)	
	10-19	20-29	30-39	40-49	50-59	60-69	>69		50	60
Commercial species	23.2	32.0	39.0	49.8	44.8	41.9	92.9	<b>323.6</b>	179.6	134.9
All dipterocarps	17.8	24.6	31.2	41.1	37.1	36.5	84.9	<b>273.2</b>	158.5	121.4
Other commercial	5.4	7.4	7.7	8.6	7.6	5.5	7.9	<b>50.0</b>	21.0	13.4
Non commercial	26.9	27.5	23.4	16.2	10.2	6.4	7.4	<b>117.9</b>	24.0	13.7
All species	<b>50.1</b>	<b>59.5</b>	<b>62.3</b>	<b>65.9</b>	<b>55.0</b>	<b>48.3</b>	<b>100.3</b>	<b>441.4</b>	<b>203.6</b>	<b>148.6</b>

Table 5. Volume estimates ( $\text{m}^3 \text{ha}^{-1}$ ) for the pilot KPHP project in, Kuala Kurun, Central Kalimantan. Data are mean volumes averaged over all forest conditions and period after logging.

The comparison between the two pilot KPHP demonstrate the importance of external factors on sustainable management of the forest resource in Indonesia. TPTI was applied at both locations and appears to have failed in Jambi whilst in Kalimantan it seems to have had much more positive results. The difference between the two locations can only be attributed to the problem of illegal extraction of timber from the Jambi KPHP. It must be concluded that this is the problem that should be addressed rather than proposing to replace the TPTI system with a more severe logging system such as TPTJ.

The pilot KPHP in Kalimantan should remain economically viable if managed using TPTI and any subsequent improvements. Previous work from DFID has concluded that the regulations should be modified to promote reduced impact logging techniques as the main silvicultural treatment, and to apply growth and yield data and modelling to determine sustainable levels for the annual allowable cut and length of cutting cycle.

This is not an option for the Jambi KPHP, where a more radical option is required. The Ministry of Forestry and Estate crops has proposed the TPTJ system as a silvicultural option that will address the problems of poor regrowth and regeneration in logged-over areas. It has also been stated that this system may be applied to areas of primary forest. We will now consider the likely effects and possible benefits of such an approach.

## **TPTJ as an Alternative Silvicultural system**

### *Background*

The TPTJ system (Selective logging and line planting) was introduced by the Ministry of Forestry and Estate crops during 1998 in response to the perceived problems with TPTI, and to address the need for a management system for logged-over forests. TPTJ was derived from the earlier TTJ system (Felling and Line Planting (TTJ) designed for forest plantation. The current regulations state that TPTJ can be applied for management of all forests if the slope does not exceed 25 % and at altitudes up to 500 m a.s.l.. The initial cutting limit is specified as diameters greater than 40 cm, leading to a more severe harvesting regime than the TPTI system. The 40 cm diameter limit may be appropriate in some types of logged-over forest, but under the TPTJ regulations, the same limit would apply to primary forest.

### *Implementation*

The TPTJ system is applied in two stages. The first involves selective logging of the whole area using the 40 cm diameter limit. This will be equivalent to the TPTI system but will extract considerably more timber. After the initial felling, planting strips are cleared using essentially clear felling techniques. The system notes that such intensive activity may result in erosion and soil compaction and hence stresses the need to minimise such problems. Planting then takes place on the cleared lines utilising high-value local species.

### *Results from TPTJ*

A number of large-scale trials of the TPTJ system have been approved by the Ministry of Forestry and Estate Crops for implementation in 1998 and 1999. No results are available at present, and it will take several years before information is available to describe the productive potential of this system. It is, however, possible to make predictions of the likely results of TPTJ, based upon existing results from forestry and ecological research.

### *Environmental impact*

The TPTJ system permits the extraction of more timber from management units compared with TPTI and requires more intensive harvesting and clearing activities. The additional usage of heavy machinery will result in enhanced soil erosion and compaction. Canopy disturbance will be considerable. When combined, these environmental impacts will create conditions that are much less favourable for the growth and regeneration of indigenous forest species.

### *Productivity*

Most local commercial species are Dipterocarps which are shade tolerant, where the growth of the seedling and sapling phases need shade rather than direct sun. The growth of these species will not be enhanced by the conditions created by TPTJ. The productivity of the first harvest using TPTJ will be significantly higher than if TPTI was applied. The future productivity of the two systems cannot be compared with the information available at present.

*Sustainability.*

The long-term sustainability of the new TPTJ system cannot currently be assessed. It is however, likely to be criticised by certification bodies because of the potential for significant damage to soil and water resources. The intensive management regime is likely to result in loss of biodiversity, and sustainable production cannot be assured. For these reasons, the TPTJ system is unlikely to be considered as an improvement on the existing TPTI system.

## **Conclusions and Recommendations**

The lack of adequate information describing the likely outcome of the TPTJ system suggests that extreme caution must be adopted before widespread application of the system is adopted. This represents the precautionary approach to land-use management. The following conclusions and recommendations can be made on the basis of existing information.

1. The TPTI system should be able to be applied successfully for sustainable management of most areas of primary and logged-over forest in Indonesia.
2. The TPTI system should be modified to promote reduced impact logging as the main silvicultural treatment and the use of growth and yield data and modelling to set sustainable levels for the annual allowable cut and length of cutting cycle.
3. TPTJ does not address the fundamental environmental problems identified with TPTI. It may result in enhanced environmental degradation.
4. TPTJ does not address the problems associated with illegal logging activities. As such a key cause of forest degradation will continue.
5. TPTJ should not be applied to areas of primary forest.
6. TPTJ should not yet be approved for widespread application in areas of logged-over forest. The results of trials and model simulations should be analysed before further areas are implemented.
7. The regulations permitting operational application of the TPTJ system should be revoked until data are available to justify its usage.
8. Alternative management systems for logged-over forest should be considered, including modifications of the existing TPTI system.