# Reduced-impact logging (RIL) Research and Development in Malinau Research Forest, East Kalimantan: A challenge of RIL adoption[1]

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## Abstract

Research and trainings related to reduced-impact logging have been conducted in CIFOR Malinau Research Forest (MRF), East Kalimantan since 1998. Indonesian selective logging and planting system (called TPTI: *Tebang Pilih Tanam Indonesia*) is a current silvicultural system in Indonesia. It is stipulated that all dipterocarps (i.e timber trees in family Dipterocarpaceae) with a diameter at 1.3 m in dbh (diameter at breast height) over 50 or 60 cm can be harvested with a polycyclic felling schedule of 35 years. However sustainable forest management in Indonesia is still long way to go. Harvesting intensity in Indonesian dipterocarps forest exceed 100 $m^3$/ha and more than 10 trees/ha. Conventional logging generally damages more than 50% of the original stand. Several experiments in mixed dipterocarps forests have demonstrated that RIL techniques can reduce damage by at least 30-50% compared with normal operation, also called conventional logging. Training, close supervision and proper planning are among others required by RIL technique. Based on RIL results studies in Borneo, some silvicultural rules are suggested: (1) there is a need for simple and practical prescriptions which limit the densities of trees harvested to 8 per hectare, (2) a minimum spacing distance between harvested trees (35-40 m), (3) single tree gap formation from harvesting using directional felling, (4) a maximum (as well as a minimum) dbh limit for harvesting (60 – 100 cm dbh). Considering these results, Ministry of Forestry has issued a decree, SK No. 274/VI-PHA/2001 that all timber company in Indonesia should implement RIL in their concession. This is an example of impact from the field/local to the national policy. However, detail technique guide should be more described following this decree. Also rewards and punishment to the logging company should be well implemented.

*Keywords: Reduced-impact logging; conventional logging; hill mixed-dipterocarps forest; felling intensity; sustainable forest management, forest related capacity building, Malinau Research Forest*

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# Introduction

Any efforts at sustainable management in mixed dipterocarps forest carry considerable risks due to the lucrative short term gains from destructive timber extraction. The question of how to achieve 'sustainable forest management' in Malinau is clearly neither purely a biophysical question, nor purely a social or economic one.

In general, forest logging may cause detectable changes on environmental variables, depending on the intensity of disturbance and the extent of cover removed. By the same token, forest clearance and forest conversion to other land use are expected to cause greater impacts on hydrology and soil erosion processes. With the progress towards sustainable forest management, an improved harvesting techniques (i.e. RIL) is being implemented and promoted in various regions. The aim of this techniques is to reduce damage on residual trees, soil disturbance, and impacts on wildlife (Sist et al. 1998 and Elias et al. 2001).

The RIL technique is one of the important elements of sustainable forest management. The present reduced-impact logging studies constitute a development phase within a longer-term research strategy on sustainable forest management in Malinau Research Forest. This work was conducted in the Malinau concession of Inhutani II with technical supervision by CIFOR. Research on the immediate and long term impact of timber harvesting with conventional and RIL techniques from both environmental and economic perspectives was carried out. The overall objective was to promote the integration of RIL into logging techniques at the concession scale.

# Study Site and Methods

*Study site*

The study area was located in the Indonesian Province of East Kalimantan (Borneo Island), in the district of Malinau ( 2°52'-3° 14'N, 116° -116°40'E), within a 50,000 ha forest concession managed by INHUTANI II, a state-own logging company. The climate

is equatorial with a annual rainfall in the concession of 2265 mm for 1998. The topography is steep with elevations ranging from 200 to 600 above sea level.

*Permanent sample plots and treatments*

Three experimental blocks (27, 28 and 29) of about 100 ha each were selected in the 1998-1999 annual coupe because of their similarity in topography and the presence of *Agathis borneensis* , a very valuable timber species, which occurred at similar density in these blocks (3 to 4 trees/ha, INHUTANI II forest survey). Because both blocks 28 and 29 comprised about 50 % of swamp forest unsuitable for logging, they were merged to have a productive forest area similar to that of 27. Blocks 28/29 were logged with conventional logging in 1998 and block 27 with RIL in 1999. In conventional logging, harvesting operations were not planned and loggers worked unsupervised. In RIL, all the operators were trained to apply the technical guidelines published in Sist et al. (1998). As part of RIL, the pre-harvesting inventory in block 27 led to the production of an operational map at 1:2000 scale, showing 5 m contour lines and position of harvestable timber trees. To help fellers in selecting the best felling direction, skidtrails were opened before felling, following the skidtrail network planned and drawn on the operational map. In RIL logs were extracted by two Skidders CAT 527. In conventional a bulldozer D7G was used for both log extraction and road construction.

Seven different treatments, each with three replicates and a control were defined to take into account felling intensity. Before logging, 24 one-hectare plots (12 in 28/29 and 12 in 27, Table 1), were selected randomly and treatment allocated according to the respective timber density in each plot. Each plot (100 x 100 m) was divided into 25 subsquares (20m x 20m) delimited by 36 points PVC stakes. Before logging, the girth of all trees and lianas with dbh ? 20 cm in the plots were measured and their position located in the subsquares. In the three control plots of the CNV blocks and the 9 plots of RIL1, 2, 3, canopy openness was measured using a concave spherical densiometer at each the 36 grid points. Canopy openness was defined as the proportion of sky hemisphere not obscured by the vegetation when viewed from a single point (Jennings *et al*. 1999).

During the harvesting period of block 28/29, there was a strong demand of *Agathis borneensis*. Consequently, the extraction focused in priority on this species neglecting dipterocarps. Among the nine plots in 28/29, only five included harvestable *Agathis* were logged, whereas the other four plots, with no *Agathis*, were left undisturbed. In order to restore the original treatment allocation, four new plots were set up (two in both CNV2 and CNV3) in the conventional blocks, in August 1999. Taking into account both standing living trees and those destroyed by logging (dbh = 20 cm), it was possible to assess the original tree density and basal area before logging. In the RIL1 treatment, one plot was excluded from the logging damage analysis because only one tree, located at the border of the plot, was felled outside the plot limits, generating no damage inside it.

In both conventional and RIL, logging damages were assessed eight months after logging. In the plots, all trees (dbh ? 20 cm) measured prior to logging were recorded as untouched, injured or dead. Canopy openness was also re-assessed in the 17 logged plots. In each block, all the skid-trails were mapped and classified as main or secondary. The total volume extracted in each block was measured to compare their respective skidtrail area per timber volume extracted. Along each skidtrail, every 50m, width and depth of the track were measured.

# Results and Discussion

### Harvested areas and volume

Overall, mean diameters of measured trees in CL and RIL blocks were significantly different (CL X=92 cm vs 82 cm, t=7.08, df=799, P<0.01). Mean diameters of harvested logs of Agathis were similar in CL and RIL blocks (CL:?x = 96 cm vs 93 cm, t=1.42, df=366, P=0.16) . In contrast, logs of dipterocarps were bigger in the conventional blocks than in RIL (CL: 88 cm vs 73 cm , df = 374, t=10.17, P < 0.01). It resulted that the average extracted volume in the conventional blocks was higher than in the RIL compartment (10.5 $m^3$ vs 9.0 $m^3$, t =3.76, df = 708, P < 0.01). Number of extracted trees in the harvested area showed a difference of only one tree per ha between conventional and reduced-impact logging (6 trees/ha and 7 trees/ha, respectively, Table 1).

Table 1 Characteristics of extracted timber volume and density in conventional (CL) and Reduced-Impact Logging (RIL)

| Characteristics | CL | RIL |
|---|---|---|
| Total area (ha) | 244 | 138 |
| Extracted volume per ha based on total area ($m^3$/ha) | 19.7 | 24.7 |
| Harvested area (ha; %) | 91; 37 | 56; 41 |
| Extracted volume based on harvested area ($m^3$/ha) | 52.8 | 60.9 |
| Total no. of felled trees | 536 | 386 |
| No. of felled trees on harvested area per ha | 5.9 | 6.9 |
| Average extracted volume per tree ($m^3$) | 10.3 | 9.0 |

**Felling and skidding**

In the Malinau concession, RIL increased felling and skidding productivities by 28% and 25% respectively in comparison with CL. Cost of skidding was also reduced by 27 % in RIL. In Brazilian Amazonia, Holmes et al. (1999) reported that RIL increased skidding productivity by 41% in comparison with CL while felling and bucking decreased by 20% ( Table 2). Hout (2000) also reported reduced felling performance by 37% in RIL while skidding output increased from 14.4 $m^3$/h to 15.9 $m^3$/h. The RIL study by NRM Project in 1994 in West Kalimantan reported an increase of feller's daily productivity by 24% and skidding productivity by 14% in term of the number of felled trees and extracted logs. In another RIL study in PT Inhutani I 's concession in Berau, East Kalimantan, RIL increased the skidding hourly productivity from 7.8 $m^3$ to 11.7 $m^3$ or 50% in comparison with Conventional logging (Natadiwirya, Personal Communication). RIL in the Berau study showed decrease in the skidding cost by 50% in comparison with Conventional logging. The unit cost of skidding both in CL and RIL in Malinau was lower than that in Berau due to higher productivity.

Table 2. Productivity of felling and skidding in CL and RIL in different places

| Location | Felling | | Skidding | |
|---|---|---|---|---|
| | CL | RIL | CL | RIL |
| Cauaxi, Brazil ($m^3$/h) | 20.46 | 18.65 | 22.39 | 31.66 |
| West Kalimantan (trees/d) * (logs/d) | 14.0 | 17.4 | 14 | 16 |
| Berau, East Kalimantan ($m^3$/h) | n.a. | n.a. | 7.8 | 11.7 |
| Malinau ,East Kalimantan ($m^3$/h) | 17.8 | 22.8 | 15.1 | 20. |

* Both CL and RIL production figures were based on regular daily working hours.

Felling and skidding are two very dependent activities. Directional felling in RIL was primarily intended to facilitate skidding in order to avoid damage. Further improved practice in the felling might improve further skidding productivity although it might reduce feller's productivity. Therefore, in order to maintain the quality of work in the RIL an incentive should be given to the feller even though productivity increase was achieved. In the light of cost reduction skidding productivity increase is preferred than that in felling as it would result in higher unit cost reduction.

In light of waste reduction, volume of logs falling into ravine in RIL was lower than in CL i.e 4.20 m3 (1 log) vs 49.4 m3 (5 logs), these accounted for 6.4% of total logs left in RIL and 8.5% in CL or 0.12% of total extracted volume in RIL and 0.9% in CL. This reduction could be attributed to directional felling in RIL. The technique showed its benefit especially in moderate to heavy terrain like in Malinau.

## Forests related capacity building in MRF from 1998-2005.

Since 1998, CIFOR has promoted RIL in Malinau Districts with several activities and targeted to wide range of audiences (Table 3). How ever, request to advance trainings are still demanded.

Table 3. RIL related trainings that promoted by CIFOR and its partner

| Date | Type of Training | Training Recipients |
|---|---|---|
| Mar. 1998 | Field survey procedures and contour mapping | All Inhutani inventory crews |
| Aug. 1998 | Training of fallers | 5 fallers |
| Feb. 1999 | Refresher course in contour mapping | All Inhutani inventory crews |
| Feb. 1999 | Training in skid trail planning and location | Selected Inhutani staff |
| Mar. 1999 | Course in the use of computer software for contour mapping<br>Road Engineering (RoadEng softree) Training I | 6 Inhutani staff from Malinau, Samarinda and Jakarta |
| 2000 | Course in the use of computer software for contour mapping Road Engineering (RoadEng softree) Training II | Foresters from various timber company (including Inhutani II) attended this course at CIFOR, Bogor |
| Nov.2000 | Reduced Impact Logging (RIL) Training | Organized by Australian institution,MoF and CIFOR. 33 participants from private companies, Dinas Kehutanan in Kaltim, University, BUMN, SKMA,and BLK |
| April 2004 | Sustainable Forest Management (SFM) Training | 22 participants attended the training from various parties (District officials, Concession companies, head of village and forestry students) |
| Jan. 2005 | Reduced Impact Logging (RIL) with participatory approach | 19 participants from various representatives were attending six days training (local timber company, officers from Malinau District and representative from villages surrounding Malinau forest) |
| April 2005 | Utilization of wood waste by the local communities: making charcoal and wood-crafting | 16 participants from representative of Malinau sub-districts |

Latest training on RIL was held in CIFOR research station at Seturan, East Kalimantan from 10-15 January 2005. 19 participants from various representatives were attending six days training. They were from local timber company, officers from Malinau District and representative from villages surrounding Malinau forest.

During the training, Head of Bapedalda (*Badan Pengendalian Dampak Lingkungan Daerah* or District Agency for Controlling Environmental Impact), Mr. Yunus Poddala said "the training is very important media for giving better understanding for all stakeholders who are working in the forest of Malinau to implement best forest harvesting techniques to reach sustainable forest management. RIL techniques are well designed to achieve sound forest management which is take ecology, economic and social into account". He also mentioned" This objective is in line with Malinau mission to become "Conservation District".

Insructors were from Tropical Forest Foundation (Jakarta), FORDA, Center for Forestry Education and Training (CFET,Bogor and Samarinda), PT Inhutani II and CIFOR.

Technical knowledge on RIL such as: proper harvesting planning, forest inventory, preparing contour map, skid trail planning, climber cutting, directional felling and post harvesting activity were delivered and discussed. During the course, practical manner on how to make a good skid trail, felling, and log skidding were also given. Inhutani II has provided their operational area as well as one unit of skidder to demonstrate timber extracting from the forest to the nearest log landing. Mr. Luther (a skidder operator) and Mr. Manalu (a tree feller) are used to be trained by CIFOR were invited to be a trainer. They still showed their best skill when field practice has taken place. Felling and skidding demonstration were taken place in Camp Selimpuk owned by PT Kayan Putra Pratama in Km 130, altitude 192 m.

To have better understanding about the forest after logging, participant had a chance to visit ex-logging area where RIL was implemented in 1999-2000 and went to conventional (CNV) logging block. In return, they could make a comparison of the harvested forest by two different treatments.

In one day reflection, participants were grouped into two in which they have been assigned to make their own analyze after several days in theory and field practices. During group presentation, they expressed that RIL was proved to create less damage to the residual stand, soil exposure, and canopy openness compare to those in conventional block. Further more, they could find better forest regeneration in RIL (Table 4).

Table 4. Summary of observation in logged over forest of RIL and CNV

| Area observed | RIL | Convensional |
|---|---|---|
| Log Landing | The area are cooler, covered by vegetation, smaller size, no inundated due to well planned water way. Pioneer vegetation looks well growing due to less soil compaction | Bigger size of forest coverage, feel hotter, few vegetation growing (mostly fern, small grass), soil compaction, inundated water, few pioneer vegetation |
| Skidtrail | The skidtrail is less than 4 meter wide, no erosion proven, slope ranges 20-30%, vegetation grow well, many litter and debris, no trees fallen cross the trail, cooler, many shrub and fern like, many seedling found with less than 15 cm dbh. Logging damage is estimated about 10%, skidtrail wide range between 3-4 meter, well drainage | No cross drain, many inundated water, gully erosion, few litter and woody debris, many shrubs and fern, many dead standing trees due to skidding activity, skidtrail size vary from 6-8 m wide, soil compaction, logging damage is estimated about 30-50% |
| Ex-logged forest | Trees still many, massive litter, cooler due to less canopy opennes, trees over 20 cm dbh are still easily found, good water catchment, few fallen trees, less damage due to log winching, abundant seedlings and pioneer species | Few residual stand , few litter mostly in skidtrail tracts, few trees over 20 cm dbh, hotter, few seedlings and pioneer species primarily commercial trees |

In the end, they came up with an idea that this kind of logging technique should be supported by proper law by local government such as a *perda* (district regulation) in order to be well implemented on the ground by timber companies followed by rewards and punishments by local authority. It is expected they will have a good awareness that useful for them where they belongs to. At the end, camp fire was set to farewell the trainings.

## RIL Versus TPTI: From research into policy maker

Modifications on cutting systems in Indonesia have been developed over time. The first cutting system is called TPI (*Tebang Pilih Indonesia*, Indonesian Selective Cutting), which was introduced in 1972. Current cutting method is known as *Tebang Pilih dan Tanam Indonesia* (Indonesia Selective Cutting and Planting System, TPTI).

The TPTI system was implemented through the Directorate General of Forest Utilization decree number 564/KPTS/IV-BPHH/1989, and subsequently modified by decree number 151/KPTS/IV-BPHH/1993. In the Indonesian selective logging and planting system (TPTI), all dipterocarps with dbh = 60 cm and = 50 cm can be removed based on type of production forests. The TPTI system is based on a fixed 35 – year cutting cycle. Management activities during this period can be divided into three main groups: pre-harvest activities, harvesting activities and post harvesting activities, as detailed in Table 5.

Table 5. Activities under TPTI

| **No** | **Activities** | **Timing (year)** | |
|---|---|---|---|
| 1. | Organization of working area | Et-3 | Pre-Harvest |
| 2. | Forest inventory before logging | Et-2 | Pre-Harvest |
| 3. | Forest Opening | Et-1 | Pre-Harvest |
| 4. | Tree felling (commercial species) | Et0 | Harvest |
| 5. | Liberation | Et+1 | Post-Harvest |
| 6 | Inventory of residual stand | Et+1 | Post-Harvest |
| 7. | Production of seedling | Et+2 | Post-Harvest |
| 8. | Enrichment planting | Et+2 | Post-Harvest |
| 9. | Maintenance/ tending | Et+3 | Post-Harvest |
| 10. | Advanced tending<br>Liberation<br>Thinning | <br>Et+4<br>Et+9<br>Et+14<br>Et+19 | Post-Harvest |
| 11. | Forest protection and Research | Continually | Post-Harvest |

Under TPTI system, each HPH (*Hak Pengusahaan Hutan*, forest concession) is obliged to establish a department of silviculture separated with department of logging. The department of silviculture should be sufficiently supplied with facilities, fund and

infrastructure, and should be led and staffed by forestry educated personnel which understand the science and and practice of silviculture. This is why TPTI system is much more different with what in the TPI system.

In further detail, TPTI system specifies that thinning activities are intended to accelerate the growth of individuals of selected commercial species by removing their competitors. The system specifies two general types of thinning activities: liberation cutting and thinning. Both activities entail the removal of non-commercial and poor quality commercials competitors to ensure that potential crop trees are available for the next cutting cycle. The removal of the competitors may utilize either felling or poisoning treatments.

However, TPTI system is not perfect. Since reduced-impact logging (RIL) has been introduced and implemented in some forest concession several years ago, there were some critics regarding with enrichment planting and liberation treatments under TPTI. It is proven those treatments are not needed when RIL is well implemented. Both treatments are indeed time and cost consuming. Responding these issues, Ministry of Forestry has issued a decree, SK No. 274/VI-PHA/2001 that all timber companies in Indonesia should implement RIL in their concession. It seems like a 'modified' TPTI. The decree emphasis among others on limitation of tree felling intensity 8 trees/ha and using RIL Guidelines that published by CIFOR. Review on this decree comparing with TPTI systems are elaborated in Table 6.

Table 6 Comparison of elements within Two Decrees regarding with TPTI and 'modified' TPTI

| Elements | TPTI Decree | RIL Decree |
|---|---|---|
| | **No. 151/Kpts/IV-BPHH/1993** | **No. 274/VI-PHA/2001** |
| Management commitment (Standard Operational Procedure, Standard and System ) | No specifically mentioned | It is emphasized but without further detail on what kind activities must be done |
| Forest inventory before logging (including vine cutting) | Detail procedures on forest inventory mentioned | Refers to forest inventory in TPTI (without mentioning about cutting liana) |
| Topography and tree mapping | Tree mapping is needed but topography map is not mentioned | Both activities are badly needed as very important requirements with appropriate operational scale |
| Skidtrail planning | It is stated in general view | It is emphasized how important the skidtrail planning is |
| Skidtrail location | Not mentioned | Suggested |
| Establishing skidtrail before cutting | Not mentioned | Suggested |
| Tree cutting | Only general view about better way of cutting trees | It is suggested to do directional felling |
| Skidding | General view about skidding activity | The importance of reducing damage by implementing proper skidding and using winching are discussed |
| Skidtrail deactivation | Not mentioned | Suggested |
| Monitoring on post harvesting activities | It is stated in detail and systematically in the 100% logged over forest (Inventory on residual stand) | Subjectively emphasized more on evaluation and monitoring |

## Impact of Decentralization and the Emergence of IPPK's

Euphoria of Autonomy has created a big influence to the District Level. Local governments were quick to seize the initiative following the passage of UU no 22 year 1999 on decentralization. Faced with possible curtailments of budget allocations from Central Government, Bupatis turned to licensing of natural resource exploitation permits as an easy source of revenue. In the absence of any clear implementation guidelines,

many Bupatis capitalized on this new-found power and issued cutting permits or IPPK's[2] to local business men which often contravened the letter if not the spirit of the basic law. Between 2000-2002, there were 16 IPPKs actively operating in Malinau with total size of 15,950 Ha ( Table 7). How ever, in 2002 all IPPKs has no longer operated due to Bupati's revoke based on decree No. 261/2001 issued by Bupati. 5 IPPKs holdrs were stopped which covering area of 4,900 ha.

More over, in 2002 decree No. 68 /2002 has been issued by Bupati about stopping permit of IPPKs in Malinau. Cosequently, 11 IPPKs holders have been stopped covering total area of 11,050 Ha. With this decree, all IPPKs were stopped and no further license given. Bupati changes licence from IPPKs to permit for small HPHs (small concession holder) which is related to total area less tha 50,000 ha per permit.

Table 7. List of timber companies in Malinau

| No. | Company | Decree | Athority of Issuance | Location | Size (Ha) | Current activity |
|---|---|---|---|---|---|---|
| 1 | PT. SUMALINDO Lestari Jaya | 365/Kpts-II/1993 17 Juli 1993 | Ministry of Foretsry | S.Boh | 269,660 | Getting an annual cutting permit |
| 2 | PT. Rangga Jaya | 377/Kpts-II/1988 14 Juli 1988 | Ministry of Foretsry | S. Bahau | 59,000 | Active |
| 3 | PT. Meranti Sakti Indonesia | 87/Kpts-II/2001 15 Maret 2001 | Ministry of Foretsry | S. Malinau /Kelawit | 46,200 | No activity, only administrative works |
| 4 | PT. Intracawood, Mfg | 362/Kpts/Um/1976 6 Juni 1976 | Ministry of Foretsry | Sekatak, Sesayap, Bengalun | 260,000 | No activity, only administrative works |
| 5 | PT. Esam Timber | 633/Kpts-II/1992 22 Juni 1992 | Ministry of Foretsry | S. Kayan & S. Kayaniat | 355,800 | No activity, only administrative works |
| 6 | PT. Civika Wana Lestari | 843/Kpts-II/1999 | Ministry of Foretsry | S. Bahau | 53,000 | Active |
| 7 | PT. Sarana Tri Rasa Bakti | 20/Kpts-II/1990 10 Janurai 1990 | Ministry of Foretsry | S. Bahau | 40,000 | Active |
| 8 | PT. Inhutani II Unit Malinau | 64/Kpts-II/1990 | Ministry of Foretsry | S. Malinau | 48,300 | Active |
| 9 | CV. Sebuku Lestari | 1999 | Head of | Inside of PT | 4,400 | Close down |

[2] IPPK or *"Ijin Pemanfaatan dan Pemungutan Kayu"* (License for extraction and utilization of timber) was introduced with the advent of decentralization and is issued by the Bupati. It was intended to be limited to 100 ha in size and be applied for community development purposes.

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | CV Hanura | Mid 2000 | District/Bupati Head of District/Bupati | Inhutani II Inside of PT Inhutani II | 3,000 ha | Close down |
| 11 | PT Indoprima | Mid 2000 | District/Bupati Head of District/Bupati | Inhutani II Inside of PT Inhutani II | 5,300 ha | Close down |
| 12 | PT. Bumi Anugerah Lestari | 522.11/01/EKPM/XII/2001 14 Desember 2001 | District/Bupati Head of District/Bupati | S. Malinau-Bengalun, S. Gong Solok | 49,650 | Active |
| 13 | PT. Rimba Makmur Sentosa | 522.11/03/EKPM/XII/2001 14 Desember 2001 | Head of District/Bupati | S. Malinau | 48,700 | Slow Down |
| 14 | PT. Rajawali Sakti Perkasa | 522.11/02/EKPM/XII/2001 14 Desember 2001 | Head of District/Bupati | S. Simendurut | 38,000 | Active |
| 15 | PT. Gunung Makmur Perkasa | 522.11/05/EKPM/XII/2002 10 Januari 2002 | Head of District/Bupati | S. Malinau | 46,000 | Close down |
| 16 | PT. Batu Karang Sakti | 522.11/06/EKPM/XII/2002 20 Pebruari 2002 | Head of District/Bupati | S. Mentarang | 49,000 | Slow down |
| 17 | PT. Lestari Rimba Raya | 522.11/07/EKPM/XII/2002 14 Pebruari 2002 | Head of District/Bupati | S. Simendurut, S. Luso | 14,000 | Active |
| 18 | PT. Wana Adi Prima Mandiri | 522.11/08/EKPM/XII/2002 14 Pebruari 2002 | Head of District/Bupati | S. Gita – S. Warod | 32,000 | Active |
| 19 | PT. Glory Sejahtera Mandiri | 522.11/09/EKPM/XII/2002 14 Pebruari 2002 | Head of District/Bupati | S. Sembuak | 12,000 | Active |
| 20 | CV. Gunung Sidi Sukses Makmur | 522.11/10/EKPM/XII/2002 15 Pebruari 2002 | Head of District/Bupati | S. Malinau | 32,000 | Active |
| 21 | CV. Gading Indah | 522.11/11/EKPM/XII/2002 15 Pebruari 2002 | Head of District/Bupati | S. Malinau | 17,000 | Slow Down |
| 22 | PT. Sagita Puspa Mandiri | 522.11/11/EKPM/XII/2002 15 Pebruari 2002 | Head of District/Bupati | S. Tubu | 49,575 | Slow Down |

***Source*** : Dinas Kehutanan dan Perkebunan Malinau, 2004

## Adoption of RIL techniques

Lack of incentives has made timber companies in Indonesia reluctant to implement reduced- impact logging. The Ministry of Forestry has issued a regulation in 2001 that all companies in Indonesia must implement RIL in their concession, but such a move isn't effective because the government doesn't offer any incentives to the firms (Jakarta Post, 2005).

There are many factors constraining the adoption of RIL (Durst and Enters 2001). Among them are the following:

***Lack of awareness and appreciation of the benefits of RIL.*** This is particularly true at the important decision-making levels in governments and

corporations. Without strong leadership from above, progressive mid-level managers and field workers and supervisors have little incentive to change the *status quo*, although there are exceptions to the rule (Suparma *et al*. 2001).

***Lack of security of tenure.*** One of the greatest impediments to the adoption of RIL is lack of resource security. Illegal logging and unplanned forest conversion represent major deterrents to the implementation of RIL (Smith and Applegate, 2001).

***Lack of trained and experienced personnel.*** One of the most critical requirements for the successful application of RIL on a wide scale is the availability of skilled logging personnel at all levels (Dykstra, 2001).

***Lack of government policies and incentives to encourage RIL.*** Most countries in Asia and the Pacific have adequate laws governing forest harvesting and management. What is lacking are not laws and regulations, but rather effective enforcement and incentives for compliance.

***The high relative costs of implementing RIL.*** As indicated above, studies of the costs of RIL versus conventional logging remain inconclusive for a number of reasons. Nonetheless, evidence gathered from several examples around the world indicates that sustainable timber production can produce acceptable financial returns. However, the evidence also shows that, at least over the relatively short periods of time considered by most private investors, unsustainable practices are even more profitable (Contreras-Hermosilla, 1999), in particular where re-entry logging can be practiced (Smith and Applegate, 2001).

***The paramount need for wood.*** An extremely important factor constraining the adoption of RIL is the voracious appetite that the timber processing industry has for wood—especially in Asia, where processing capacity has expanded rapidly. While RIL clearly has the capacity to reduce the volume of logging waste (due to less damage in felling, better bucking decisions, and fewer lost logs left in the forest).

## Conclusion

Based on RIL results studies in Borneo, some silvicultural rules are suggested: (1) there is a need for simple and practical prescriptions which limit the densities of trees harvested to 8 per hectare, (2) a minimum spacing distance between harvested trees (35-40 m), (3) single tree gap formation from harvesting using directional felling, (4) a maximum (as well as a minimum) dbh limit for harvesting (60 – 100 cm dbh).

Adoption of RIL is still challenged in Indonesia take into account some constraints to be faced. However, advance trainings and research on RIL must be conducted.

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