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A Comparison Analysis of Logging Cost Between Conventional and Reduce Impact Logging Practices

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ABSTRACT

The operational application of the 'Logfisher' technology and system were undertaken at Sungai Betis, Gua Musang Forest Reserve in 2007 as an alternative to existing logging technologies. It has since been widely accepted and acknowledged as an efficient and cost effective alternative to existing low and reduced impact logging technologies such as skyline, Mobile Tower Yarder and Helicopter. This paper examined the various committed new and improved logging activities ascribed in the Reduce-Impact Logging (RIL) particularly using 'Logfisher' rather than Conventional Logging (CL). The cost function of present value is developed to analyse the logging cost between these two types of harvesting systems. The result of this study shows that the cost constitutes under RIL is higher than under CL. Incremental average per ha total cost rose by 46.86% to RM13,576/ha. While the incremental average per m^3 total cost increased by 57.41% to RM267.80/m^3. With increasing fuel prices and other cost related to labour, the logging cost is expected to increase in the near future. This situation will have adverse affect on the profitability of the practice of Sustainable Forest Management (SFM).

Keywords: Reduce Impact Logging (RIL), Conventional Logging (CL), 'Logfisher', Cost of harvesting activities.

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Any remaining errors or omissions rest solely with the author(s) of this paper.

INTRODUCTION

Among millions hectares of tropical rain forests in the world, Malaysia has a total of 14.33 million hectares of forested land designated as the Permanent Forest Estate (PFE) which is under sustainable management. Approximately 10.84 million hectares of the PFE are production forests with the remaining 3.49 million hectares being protection forests. In Peninsular Malaysia, the Dipterocarp Forest of the production forest of the PFE is managed through two management systems, namely the Modified Malayan Uniform System (55-year cutting cycle) and the Selective Management System (30-year cutting cycle). In brief, the Modified Malayan Uniform System consists of removing the mature crop in one single felling of all trees down to 45 cm diameter at breast height (dbh) for all species while the Selective Management System (SMS) entails the selection of optimum management (felling) regimes based on pre-felling forest inventory data.

Forest harvesting in the inland forest in Malaysia is generally carried out by a combination of crawler tractor-winch lorry. Under this harvesting system the crawler tractor skids the logs from the felling sites to the skid trails where the winch lorry continues the transportation to the roadside landings. In Malaysia, the skidder generally does not pick up its load from the felling site because of adverse soil and terrain conditions. In the early nineties, reduced impact logging (ground skidding) was being carried out in some forest areas in Peninsular Malaysia and in the state of Sabah, while low impact logging (helicopter logging) was being carried out in the state of Sarawak.

Owing to the helicopter logging, (MTCC, 1999) mentioned that, it has been estimated that the costs of extraction of logs to log landing under helicopter logging range from US$50/m^3 to US$60/m^3, while that for conventional tractor logging, it is estimated to be US$10/m^3. Although the cost of helicopter logging is relatively much higher than the conventional crawler tractor-winch lorry system, the harvesting damage to surrounding trees is found to be 3.8 times lower than the conventional system. Land erosion resulted from forest road construction is also minimised as a result of the 3 km flying range of the helicopter as compared to the optimum skidding distance of 1 km from the tractor (Gan *et al.*, 2006).

A recent technology to be developed in this region is called the 'Logfisher'. The 'Logfisher' was mainly deployed to retrieve logs from rocky and deep narrow ravine which was deem uneconomical, difficult and dangerous for the crawler tractor to undertake. It was seriously introduced as a commercial and viable alternative to other reduced and low impact technologies like Skyline, Mobile Tower Yarder, and Helicopter in the middle of 1999. According to Gan *et al.* (2006), the New Ground Base Reduced-Impact Logging (NGB RIL) System, featuring a combination of crawler tractor and 'Logfisher' became fully operationalised in July 1999 in Block C, Compartment 54, Jengai Forest Reserve in the state of Terengganu, Peninsular Malaysia. The site was provided by Kumpulan Pengurusan Kayu-Kayan

Terengganu, the largest forest concessionaire in Peninsular Malaysia. Prior to the harvesting operation, planning for the implementation of the system was conducted earlier after careful study and field planning to include marking of trees to be felled and simple tree location mapping

LITERATURE REVIEW

Cost of Logging Operation

Past studies on logging cost in Malaysia indicated that the average logging cost range from RM117.02 to RM284.93 (Ahmad Fauzi *et al.,* 2002; Mohd Shahwahid *et al.,* 1999; Awang Noor and Mohd Shahwahid, 1997; Lehuji, 2003; Badrul Hisham, 2004; Awang Noor *et al.,* 2007). A study by Mohd Shahwahid *et al.* (1999) indicates that the average fixed cost constitutes about 83% of the total logging cost which is RM237.67/m^3. However, Badrul Hisham (2004) found that the component of fixed cost in logging operation is relatively lower compared to variable cost component which constitute about 46% of the total logging cost (RM56.98/m^3). In addition, recent study by Awang Noor *et al.* (2007) found that the mean total logging cost in Pahang was estimated at RM204.65/m^3, in which, the fixed cost and the average variable cost comprise of 53.1% (RM108.63/m^3) and 46.9% (RM96.01/m^3) respectively. The divergent of fixed and variable costs of logging operation reflect different logging operations, government policies and other factors.

'Logfisher' Practices in RIL Implementation

As mentioned by Gan *et al.* (2006), the 'Logfisher' system employs a technique of log extraction which combines the function of winching and lifting, performed by a single machine. The 'Logfisher' actually embodies the body of an excavator and basic structure of a crane. In the winching operation, a cable rope with a total length of 300 meters (approx. 1000 ft) is pulled out from the drum and dragged to the respective trees which have been felled in the forest. The open end of the cable rope is then tied and hooked on the felled log.

The boom is then placed in the position to execute the pull. The winch, which is mounted at the rear end of the boom, is activated to provide an equivalent of a minimum of 40,000-kilogram force (kgf) to winch the log out of the forest along pre-planned corridors towards the access road. The log is reeled in a sliding manner from a distance and as it is pulled upward the choked end gets lifted and suspended. Once the log comes near the forest road, it is lifted out of the forest and placed along the roadside landings. It is then stacked and ready to be transported out from the forest by specially designed winch lorry. This extraction procedure is then repeated for every log and the only damage to the forest is a narrow corridor on the forest

floor along which the logs have slid through. The corridors do not entail any canopy opening or need for any earth cutting or clearing except for a small depression as a result of the weight of the log sliding through the forest floor.

In this extraction method, there is no need for the machine to enter the forest to haul or winch out the logs from the forest as in the case of the conventional or modified RIL ground based system, which uses exclusively crawler tractor to winch the logs from the forest. But rather the 'Logfisher' sits on the forest road and logs are winch or haul out from the forest without pushing over trees and no excessive earth cutting to construct the skid road.

Comparison of the Functions of the Crawler Tractor in the Current Conventional & Modified Ground Based RIL System and the Crawler Tractor & 'Logfisher' in the NGB RIL

Gan *et al*. (2006) has mentioned about the various functions of the crawler tractor in the current conventional and modified ground based RIL in Table 1. Altogether 8 functions are identified in the conventional system involving 4 processes and over 4 sites namely; skid trial, log landing, feeder road and main road. In comparison Table 2 highlights the functions of the crawler tractor and 'Logfisher' in the NGB RIL combining both machines. In this new system, under the 4 similar processes (from processes 1 to 4), the crawler tractor functions have been reduced to 4 as compared to the original 8 functions in the current conventional and modified ground based RIL. The 'Logfisher' needs only to conduct 1 function and an optional two processes involving 4 additional functions is not possible with the current systems using only crawler tractors.

Table 1 The functions of crawler tractor in the current conventional and modified ground based RIL logging system

Processes	Sites			
	Skid Trail	**Log Landing**	**Feeder Road**	**Main Road**
1. Clearing, leveling and cutting of earth	Crawler Tractor	Crawler Tractor	Crawler Tractor	Crawler Tractor
2. Clearing, cutting and blading of earth	Crawler Tractor	none	none	none
3. Winching logs from the forest	Crawler Tractor	none	none	none
4. Skidding to log landing	Crawler Tractor	none	Crawler Tractor	none

Source: Gan *et al*. (2006)

Table 2 The functions of crawler tractor and 'Logfisher' in the NGB RIL logging system

Processes	Sites		
	Log landing	**Feeder road**	**Main road**
1. Clearing, leveling and cutting of earth	Crawler Tractor	Crawler Tractor	Crawler Tractor
2. Clearing, cutting and blading of earth	none	none	none
3. Winching logs from the forest	none	none	none
4. Skidding to log landing	none	Crawler Tractor	None
5. Construction of bridges and culverts	none	'Logfisher'	'Logfisher'
6. Stacking of logs along feeder road and log landing	'Logfisher'	'Logfisher'	none

Source: Gan *et al*. (2006)

Therefore the new system provides a better and more specific distribution of functions best suited to the individual machines in terms of minimal impacts to the environment. The residual stands are best suited in the implementation of RIL. The working sites in the new system have also being reduced from 4 to 3. Thus further minimizing the forest areas to be opened or damaged. The particular site that has become obsolete is the one involves in the construction of skid trials, which apparently is considered as one of the most destructive activities in the current conventional, and modified ground based RIL system.

MATERIAL AND METHODS

Availability of more appropriate harvesting cost data can help nations in the planning of the implementation of forest management activities. The knowledge and awareness on the area will influence actions that have potential impacts on financial viability. This paper presents the costs incurred in new logging system activities. It specifically highlights the following:

- The costs incurred in carrying the harvesting activities in Compartment 220, Sungai Betis Forest Reserve, Gua Musang, Kelantan which under RIL using 'Logfisher' practice (LP) and in Compartment 109, Nenggiri, Gua Musang, Kelantan which under conventional practice (CP) and their comparison.
- The incremental costs involved in complying to the LP
- Observations and explanations on the trend of the results.

These costs account for the following:

- Harvesting operational activities which included cost of mitigation of the environmental impact of ground-based crawler tractor.
- New ground-based harvesting systems using improved or new technologies harvesting.

The analysis will focus on the costs to be incurred with and without compliance to 'Logfisher' activities. The conceptual framework for obtaining the incremental or additional cost of conducting each of the harvesting activities when implementing the 'Logfisher' is shown in Figure 1. Each of these activities occurs within the license time periods. The costs of these activities were compounded to the year harvesting was conducted in 2007 as the reference base period.

The combined system is termed as the NGB RIL System and requires only minor adjustment to the current conventional and modified ground based system which utilises only crawler tractor to extract logs from the forest. In the NGB RIL, the crawler tractor undertakes all the previous planned functions involving construction and skidding of logs to temporary log landings. However, log extraction using this system is limited to areas not more than 30 – 50 meters from the planned roads, beyond which will be carried out by the 'Logfisher'.

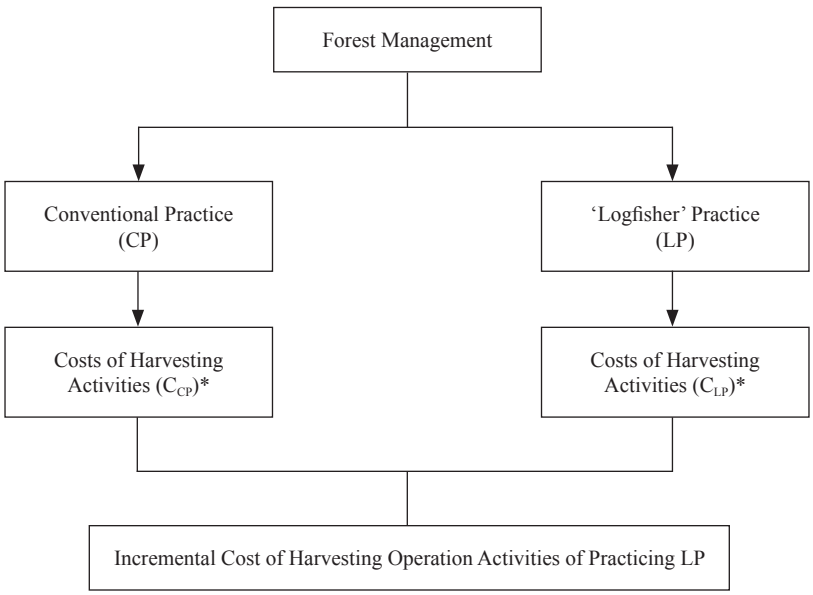

Figure 1 Analytical framework of cost analysis for harvesting operations**

Aggregate Incremental Cost of Complying to

$$LP = \sum_{j}^{n} C_j/(1+r)^t - \sum_{i}^{m} C_i/(1+r)^t$$

where;

C_i and C_j are costs of harvesting activities under CP and LC respectively.
r is the interest rate.
t is the year of activity.
Activities include harvesting plan, pre-felling , delineation of compartment boundary and proposed road alignment, tree tagging and 'Logfisher' machine.
* are the identified activities conducted under both CP and LP options.
** are adapted and modified from Ahmad Fauzi, *et al*. (2002)
i, j are various itemized activities and m,n are the total number of these activities respectively.

This system makes planning much easier and less time consuming by removing the need to plan, mark, measure, map, construct and rehabilitate the extensive network of skid trials associated with the conventional and modified crawler tractor RIL System. The NGB RIL system has been effectively and consistently applied since 1999, incorporating the application of RIL planning procedures and processes in road alignment and construction, marking and mapping of trees to be felled and protected trees, directional felling, marking and mapping of protected areas and buffers in the preparation of a comprehensive harvesting plan.

Data Collection

The data for this case study were collected from primary sources. They were provided by the concessionaire from Compartment 220, Sungai Betis Forest Reserve, Gua Musang, Kelantan which under RIL using LP and in Compartment 109, Nenggiri, Gua Musang, Kelantan which under CP. Several types of questionnaires were designed accordingly to capture the specific information under this case study. In certain cases, the loggers were also interviewed to seek further clarification on data obtained.

Timber harvesting was conducted using two systems: the LP in a 90-ha research plot and the CP which was conducted in a 100-ha. Table 3 shows the basic characteristics of the study sites. Total timber productions from the LP and CP plots were 4560 m^3 and 5430 m^3 respectively. Theoretically, both plots were bound by the SMS. Hence, buffer areas along rivers and steep slopes were marked and protected from harvesting. Thus, the timber volumes not harvested in both the LP and CP plots were 101 m^3 and 103 m^3 respectively.

Table 3 Summary of study sites

Option	'Logfisher' Practice (LP) Sungai Betis Forest Reserve, Gua Musang, Kelantan	Conventional Practice (CP) Nenggiri, Gua Musang, Kelantan
Area (ha)	90	100
Buffer and protected area (ha)	2	3
Net production area (ha)	88	97
Volume of harvest (m^3)	4560	5430
Volume of harvest per ha (m^3/ha)	50.7	54.3
Volume of commercial timber not harvested from buffer area (m^3)	101	103
Road density (m/ha)	60	40
Skid trail(m/ha)	0	300

Source: Anon (2007)

RESULTS AND DISCUSSION

Table 4 provides for the present value per hectare cost of harvesting activities conducted at Compartment 220 and 109 under LP and CP options respectively. The overall harvesting present value per hectare costs were RM13,575/ha under LP and RM9,244/ha under CP. Focus of interest in this table is the distribution of the cost among the pre-felling, felling proper, additional timber harvester activities, and foregone timber revenues.

Additional machine was required to operate the LP activities that are called 'Logfisher'. This took up a big proportion of the total cost. The pre-felling activities comprise of pre-felling inventory of commercial timber trees, compartment boundary demarcation, proposed road alignment and tree tagging and road planning. The cost of pre-felling activities was higher under the CP option (7.24%) than under LP option (4.95%). Tree tagging is usually conducted by a team of contract workers who are supervised by a field staff from the Forestry Department and normally the rate charged is RM3/tree tagged.

The felling activities constitute road construction, felling & bucking, skidding, log loading, short distance haulage, log yard administration, 'Logfisher', royalty and cess and premium. In aggregate, these activities dominated the total harvesting cost under both forest management options taking up 63.15% under LP and 75.91% under CP. Payments for premiums, royalty and cess charges, skidding and administration which includes margin of profit for the contractor were the major cost elements. Cost of road construction was low under CP (14.83%) but large under LP (30.51%) owing to the need to follow road specification. This causes the need to require additional rental of 'Logfisher' and longer work time to abide to the more rigid road specification listed in the RIL technique.

This specification considers environmental impacts by minimizing movements of heavy equipment in the stand, minimising the construction of non-permanent

feeder roads and cable log trails without soil protection structures, optimizing the lay-out of feeder road and cable log trails, and properly compact and shape road camber. The use of excavator rather than bulldozer in the road formation cut is to reduce unnecessary road corridors and to prevent excessive blading of the soil. In the LP area, the road density was quite high at 60m/ha but the beauty of this practice was there is no need for skid trails. On the other hand, in the CP area, the road density was only within the 40m/ha but there is skid trails at 300m/ha respectively (refer Table 3).

Table 4 RM/ha average present value cost of harvesting activities[1]

Activity	'Logfisher' Practice (LP)		Conventional Practice (CP)	
	RM/ha	%	RM/ha	%
Process and licensee fees	7	0.05	6	0.06
Pre-felling Inventory	100	0.74	100	1.08
Compartment Boundary Demarcation	110	0.81	109	1.18
Proposed Road Alignment	70	0.52	70	0.76
Tree Tagging	330	2.43	330	3.57
Road Planning	60	0.44	60	0.65
Road Construction	4142	30.51	1371	14.83
Felling & Bucking	504	3.71	540	5.84
Skidding Trail	0	0	1137	12.30
Log Loading	126	0.93	135	1.46
Short Distance Haulage	1820	13.41	1950	21.11
Other Expenditures	700	5.16	750	8.11
Royalty and cess	1432	10.55	1546	16.73
Premium	750	5.52	750	8.11
Log yard administration	196	1.44	210	2.27
'Logfisher'	3045	22.43	0	0
Rehabilitation treatment	150	1.10	150	1.62
GPS Plan	33	0.25	30	0.32
Total	13575	100.00	9244	100.00
Foregone Revenue from Buffer Areas	1400	9.35	1500	13.96
Grand Total	14975	100.00	10744	100.00

The above elements alluded on direct financial transaction costs. The licensee, contractors and harvesting crews incurred opportunity cost from unearned timber income from buffer areas. The average production cost only rose by 9.35% to RM14,975/ha when the foregone timber revenue from buffer areas were included in the LP option. While the average production cost increased by 13.96% to RM10,744/ha with the inclusion of these foregone revenues in the CP option. The opportunity cost is computed as potential gross revenue net of direct cost of extraction. These foregone revenues comprised of foregone timber revenue incurred by the licensee and loss of royalty charges not collected by the Government.

Table 5 shows the harvesting cost on per cubic meter basis. Similar trends were observed as on a per hectare basis. This information is useful as the timber harvesting industry is more familiar in measuring financial viability in terms of per volume units. The costs of harvesting were RM295.44/m^3 and RM197.76/m^3 under LP and CP options respectively.

Table 5 Average total cost of harvesting activities per cubic meter timber production[2]

Activity	'Logfisher' Practice (LP)		Conventional Practice (CP)	
	RM/m^3	%	RM/m^3	%
Process and licensee fees	0.13	0.05	0.11	0.06
Pre-felling Inventory	1.97	0.74	1.84	1.08
Compartment Boundary Demarcation	2.17	0.81	2.01	1.18
Proposed Road Alignment	1.38	0.52	1.29	0.76
Tree Tagging	6.51	2.43	6.08	3.75
Road Planning	1.18	0.44	1.10	0.65
Road Construction	1.18	30.53	25.25	14.84
Felling & Bucking	81.97	3.71	9.94	5.85
Skidding Trail	0	0	20.93	12.30
Log Loading	2.49	0.93	2.49	1.46
Short Distance Haulage	35.92	13.41	35.91	21.11
Other Expenditures	13.82	5.16	13.81	8.12
Royalty and cess	28.26	10.55	28.48	16.74
Premium	14.80	5.53	13.81	8.12
Log yard administration	3.87	1.44	3.87	2.27
'Logfisher'	60.11	22.44	0	0
Rehabilitation treatment	2.96	1.11	2.76	1.62
GPS plan	0.66	0.25	0.55	0.32
Total	267.80	100.00	170.13	100.00
Foregone Revenue from Buffer Areas	27.63	9.35	27.62	13.97
Grand Total	295.44	100.00	197.76	100.00

It was observed that the per hectare present value costs of harvesting activities were consistently higher under LP than under CP option mainly due to greater expenditures on improved activities. The incremental proportions of the cost among the various activities were more variable particularly in road construction and 'Logfisher' machine. However, there is zero cost in skidding activity due to the absence of that activity in LP option. In aggregate, compliance to the LP led to an overall increase of RM4230.47/ha or 46.88% and RM97.67/m^3 or 57.41% (Table 6).

The higher percentage of increase in terms of per cubic meter under LP option in comparison to the CP option is due to the lower timber yield productivity that raised the average cost. Among the various activities, the increase was only by 0.92% or RM1/ha in pre-felling activities; by 82.08% or RM1459.37/ha in felling

activities and by RM3045.33/ha in additional machine of 'Logfisher' (Table 6). Activities with significant incremental costs were road construction and the 'Logfisher' machine.

This analysis indicates that complying to the LP for RIL technique lead to an additional cost. The additional cost of shifting from one harvesting practice to another is a burden to the company. This paper has computed the incidence of this burden. Consideration of compensation may have to be addressed explicitly to encourage compliance if improved conservation and sustainability of the forest is to be achieved. Instruments of financing these compensations have to be determined.

LP in RIL implementation is an essential element for sustainable forest management of the tropical forest. Therefore, ecological impacts of logging need to be mitigated using economically competitive technology. It has been clearly demonstrated that RIL system in the context of LP. Felling efficiency can be improved to enable significant reduction of environmental damage especially when there is no skidding activity during the operation. Despite these benefits, full adoption of RIL system in the context of LP in Peninsular Malaysia's forest concessions, still do not have many followers.

Table 6 Average changes in cost by compliance to new logging system activities[3]

Activities	RM/ha	% change	RM/m^3	% change
Process and licensee fees	0.67	11.11	0.02	19.08
Pre-felling Inventory	0.00	0.00	0.13	7.17
Compartment Boundary Demarcation	1.00	0.92	0.16	8.15
Proposed Road Alignment	0.00	0.00	0.09	7.17
Tree Tagging	0.00	0.00	0.44	7.17
Road Planning	0.00	0.00	0.08	7.17
Road Construction	2771.04	202.09	56.50	223.75
Felling & Bucking	-36.00	-6.67	0.00	0.03
Skidding Trail	-1136.67	-100.00	-20.93	-100.00
Log Loading	-9.00	-6.67	0.00	0.03
Short Distance Haulage	-130.00	-6.67	0.01	0.03
Other Expenditures	-50.00	-6.67	0.00	0.03
Royalty and cess	-114.57	-7.41	-0.22	-0.77
Premium	0.00	0.00	0.99	7.17
Log yard administration	-14.00	-6.67	0.00	0.03
'Logfisher'	3045.33	-	60.11	-
Rehabilitation treatment	0.00	0.00	0.20	7.17
GPS plan	3.33	11.11	0.11	19.08
Total	4330.47	46.88	97.67	57.41
Foregone Revenue from Buffer Areas	-100.00	-6.67	0.01	0.03
Grand Total	4230.47	39.40	97.68	49.39

CONCLUSION

The above results have not taken into account the potential response, if any, due to the minimisation of environmental damage with the harvesting options. We would expect improvement in the growth of non-timber goods and services with RIL options. This study has described only the financial cost of logging and calculated with two different logging methods namely RIL and CL. The result of the study shows that the cost constitutes under RIL is higher than under CL. Incremental average per ha total cost rose by 46.8% to RM13,573/ha. While the incremental average per m^3 total cost increased by 57.4% to RM267.80/m^3. With increasing fuel prices and other cost related to labour, the logging cost is expected to increase in the near future. This situation will have adverse affect on the profitability of the practice of sustainable forest management. However, incorporation of several non-timber goods and services in the analysis which refer to the economic analysis, it could illumine the matter and provide a more conclusive analysis.

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Endnotes

[1] Average production only rose by 9.35% to RM14,975/ha when the foregone revenue from buffer areas were included in the LP option. While the mean production cost increased by 13.96% to RM10,744/ha when the foregone revenue from buffer areas were included in the CP option.

[2] Average production only rose by 9.35% to RM295.44/m^3 when the forgone revenue from buffer areas were included in LP option. While the average production cost increased by 13.97% to RM197.76/ m^3 when the foregone revenue from buffer areas were included in CP option.

[3] Incremental average per ha total cost rose by 39.40% to RM4,230.47/ha when the foregone revenue from buffer areas of (RM100/ha) were accounted. While the incremental average per m^3 total cost increased by 49.39% to RM97.68/m^3 when this foregone revenue of RM0.01/m^3 from buffer areas were included.

REFERENCES

Ahmad Fauzi, P., Salleh, M., Mohd Shahwahid, H.O., Abdul Rahim, N. Awang Noor, A.G. and Muhamad Farid, A.R. (2002) Cost of Harvesting Operations in Compliance with ITTO Guidelines. In pp. 63-84. A Model Project for Cost Analysis to Achieve Sustainable Forest Management. Volume II: Main Report. N. Abdul Rahim (ed.) Frim/ ITTO, Kuala Lumpur, Malaysia.

Anon. (2007) Telemont Sdn. Bhd. (Unpublished Report).

Awang Noor, A.G. and Mohd Shahwahid H.O. (1997) Forest valuation methodology. Malaysia AIFM Pilot Project Final Report. Chin Tuck Yuan, Mohd. Hizamri Mohd Yassin and Kasinatahan Kengaih (Eds.) AIFM, Kuala Lumpur, Malaysia.

Awang Noor, A.G., Mohd Syauke, M.S. and Tuan Marina, T.I. (2007) Analysis of Logging Cost in Pahang. Paper Presented at the Seminar on Economic Valuation of Forest Goods and Services 2007, December 15-18, 2007, Kuala Terengganu, Terengganu, Malaysia.

Badrul Hisham, K. (2004) Cost and Earning Structure of Logging Industry in the State of Sabah. M.S. Project Report. Faculty of Forestry, University Putra Malaysia, Serdang, Selangor, Malaysia.

Borhan M.and Guglhor, W. (1998) Development of Reduced-Impact Logging Methods/ Techniques in the Project Area. Paper presented at the Workshop on the Malaysian-German Sustainable Forest Management and Conservation Project in Peninsular Malaysia. Forest Research Institute Malaysia (FRIM), Kepong, Kuala Lumpur. Paper No. 11.

Borhan M. and Johari B. (1982) The Effects of Logging in a Mixed Dipterocarp Forest in Peninsular Malaysia. Paper Presented at the Eighth Malaysian Forestry Conference, Sandakan, Sabah, Malaysia.

Gan, B.K., Amir Abdul Nasir, S. and Zulkifli, A. (2006) The Logfisher – Its Development and Application in a New Ground-Based Reduce-Impact Logging System in Peninsular Malaysia. Proceeding of the ITTO – MoF Regional Workshop on RIL Implementation in Indonesia with Reference to Asia-Pacific Region: Review and Experience, 15-16 February 2006, Bogor, Indonesia, pp. 137 – 145.

Lehuji, P.L. (2001) Stumpage Valuation of Compartment 40, Deramakot Forest Reserve, Sabah. M.S. Project Report. Faculty of Forestry, University Putra Malaysia Serdang, Selangor, Malaysia.

Mohd Shahwahid H.O. Awang Noor A.G., Abdul Rahman M.D. and Shaharuddin Ahmad. (1999) Cost and Earning Structure of Logging Industry in Peninsular Malaysia, *The Malayan Forester*, **62**, 107 – 117.

MTCC. (1999) Malaysia's Experiences on Criteria and Indicators for Sustainable Forest Management and Timber Certification, Malaysian Timber Certification Council, Kuala Lumpur on Web sites http://www.mtcc.com.my.