SUSTAINABLE SUPPLY of WOOD and FIBRE
DOES MALAYSIA HAVE ENOUGH?

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ABSTRACT

Malaysia is the world's largest exporter of tropical timber (all products), at FOB value of RM 21.5 billion in 2005, followed by Indonesia and Brazil. In 2004, Malaysia overtook Indonesia as the leading exporter of plywood with just over 4.35 million cubic metres (m^3), but in 2005 China outstripped all producer countries including Malaysia (5.13 million m^3) as the largest exporter of tropical plywood. Although the timber industry accounts for less than 3% of total manufactured exports, it has strong industrial linkages integrating about 750 small and medium enterprises (SMEs) with another 1,500 smaller production units. Moreover, this sector is one of the few successful industry clusters developed under the Second Industrial Master Plan. To ensure continuity of sustainable supply of wood and fibres to industries, the government needs to strengthen and harmonize some policies related to:

Sustainable Forest Management through:

- Better management of forest resources in accordance with the prescriptions given in Forest Management Plans and compliance with SFM (Sustainable Forest Management) requirements et al, in ensuring continuity of log outflow at sustainable levels;
- Review cases of harvesting in excess of prescribed allowable cuts, as in Sabah, to ensure reversion to sustainable-level log production; and
- Management of log production in the interest of meeting domestic needs especially in log-deficit Sabah, with a view to banning log exports.

Forest Plantations, through:

- Encouraging private-sector initiatives in forest plantations with financial incentives;

- Coordinating and monitoring, nationwide, the progress of forest plantation activities that benefit from Malaysia Plantation Industries Corporation's (MPIC) assistance programme for forest plantations; and
- Permiting agro-forestry practices in forest plantation projects.

Biomass Development through:

- Intensification of use of non-conventional raw materials (kenaf, oil palm, bamboo, rattan and other non-wood resources), where technically and economically feasible.
- Review of the existing R&D policies to encourage more private sector participation in R&D for processing technology and use of non-conventional raw materials.

Resource Recycling and Wood Wastes through:

- Full utilisation of wood residues from logging and wood-processing industries such as saw-milling and plywood and particle board manufacturing; and
- Intensification of use of wood residues generated by management of perennial crop plantations by activities such as pruning and replanting of trees (rubber, coconut, palm oil and crop residues generated by agricultural production);

Importation of Raw Materials:

- Increase importation of raw materials and components at competitive prices and allow the timber industry to focus on the possibility of producing tertiary products.

If all the strategies mentioned above are followed, we believe that the industry has the fundamentals to remain competitive. However, it has to compete

with greater intensity to remain ahead in the increasingly competitive world market. The timber sector has a lot to contribute to the national economy, in return for the supportive services that it has received from the government.

INTRODUCTION

The Malaysian wood-based industry has grown to become an important segment of Malaysia's dynamic manufacturing sector since the emergence of sawmilling and plywood industries that grew in tandem with the massive land development programmes of the 1960s (1970s, in Sabah and Sarawak). The industry has also played a significant role in international timber trade. Having come a long way from being just an exporter of unprocessed or semi-processed wood, Malaysia has established itself as a major tropical timber producer country with exports of wooden furniture, panel products (plywood, medium-density fibreboard and chipboard), flooring, doors and various other joinery products.

The two outstanding export earners are the plywood and furniture sectors. The Malaysian furniture industry has been identified as an important component of the country's manufacturing sector. Although it accounts for less than 3% of total manufactured exports it has strong industrial linkages integrating about 750 small and medium enterprises (SMEs) with another 1,500 smaller production units. Furthermore, this sector is one of the few successful industry clusters under the Second Industrial Master Plan (1996-2005), according to the Malaysian Institute of Economic Review (MIER, 2005).

Malaysia was the world's largest exporter of tropical timber (all products) with FOB value of RM 21.5 billion in 2005 (MPIC, 2006), followed by Indonesia and Brazil (ITTO, 2006). Malaysia overtook Indonesia in the export of plywood at just over 4.35 million cubic metres (compared to Indonesia's 3.13 million m^3), followed by Brazil (1.00 million m^3) and China (0.96 million m^3). However in 2005, China exported plywood amounting to 5.4 million m^3 and it has now outstripped all other producer countries including Malaysia (5.13 million m^3). Malaysia is also the world's 10th largest exporter of furniture (second to China but very far behind in Asia), with over 60 export destinations (MPIC, 2006). It is common knowledge that rubberwood products account for roughly 70-80% of wood furniture manufactured in the country.

The wood-based industry's performance has been very good, setting the pace for other SMEs to follow. According to MIER the industry belongs to the SME category, which the Government has identified as the cornerstone of the Malaysian manufacturing sector. The sector is poised to play a critical role under the Third Industrial Master Plan (2006-2020). Malaysian wood furniture exports have been growing at creditable rates in recent years and establishing a strong Malaysian identity in foreign markets. The industry has the potential, and provided that it has the will as well, it will in good time be transformed into an intensively knowledge-based industry by harnessing the advances in information and communication technology (ITC), wood science and design technology.

FOREST RESOURCES

Natural Forest

The crucial roles of forests are many and is as a production unit providing long-term availability of forest resources, including the long-term supply of timber. At the end of 2002, the total area of forest in Malaysia was estimated to be 19.54 million hectares or 59.5% of the total land area, with the percentage of forested land being higher in the states of Sabah and Sarawak compared to within Peninsular Malaysia which is more developed, as shown in **Table 1**, below:

Table 1 Distribution and Extent of Major Forest Types in Malaysia, 2002
(Million ha)

Region	Land Area	Natural Forest			Plantation Forest	Total Forested Land	% Total- of Forested Land
		Dry Inland Forest	Swamp forest	Mangrove Forest			
Peninsular Malaysia	13.16	5.40	0.30	0.11	0.08	5.89	44.8
Sabah	7.37	3.81	0.12	0.34	0.14	4.41	59.8
Sarawak	12.3	7.92	1.12	0.15	0.05	9.24	75.1
MALAYSIA	32.83	17.13	1.54	0.60	0.27	19.54	59.5

Source: Thang, H.C. 2004

Malaysia also has 5.52 million hectares of perennial agricultural tree crops which are mainly rubber, oil palm, cocoa and coconut. These crops are also being looked upon as alternative sources of wood supply, especially the rubber and oil palm plantations.

With the declining forest resources and efforts towards sustainable forest management, log production has been declining in Peninsular Malaysia and has been around 4 million m3 since 2001 (see **Table 2**). However, in Sabah log production (from natural forest, forest plantations and imports) showed a similar decline only until 2002 where it recorded an increase from 5.2 million m^3 to 6.2 million m^3 in 2004 (see **Table 3**).

The gradual increase in the production of logs from the natural forests in Sabah, beginning year 2002, is attributed to a number of factors such as the conversion of degraded areas for the Industrial Tree Plantation Program, the restructuring of royalty rates for domestic processing to a differentiated rate based on diameter class (formerly it was one flat rate for all types of logs irrespective of diameter class) and the introduction of a minimal royalty rate of RM5/m^3 for logging residues (stumps, log ends) and pioneer species (namely, *Macaranga sp*). Following the timber royalty restructuring, log production records were still low but there was an increasing trend of utilization of logging residues and small diameter logs resulting in increasing figures for log production from natural forests.

Plate 1 Dipterocarp Forest

Plate 2 Rubber wood plantation

In the case of Sarawak, log production trends showed a general decline from a high of 16.3 million m^3 in 1994 to an estimated 12.0 million m^3 in 2005.

Table 2 Log Production, Peninsular Malaysia and Sarawak

Year	Production (m3)	Production (m3)
1995	9,029,852	16,292,000
1996	8,418,992	16,038,000
1997	7,155,453	16,823,000
1998	5,126,370	11,307,000
1999	5,356,058	13,096,000
2000	5,072,150	14,274,000
2001	4,155,130	12,179,000
2002	4,358,290	12,259,000
2003	4,419,396	12,150,000
2004	4,572,918	12,050,000
2005e	4,515,754	12,035,000

Source: FDPM, FD Sarawak

Table 3 Total Supply of Log/Timber for Sabah (1997-2004)
(In Cubic Metres)

Year	Natural Forest	Forest Plantation	Import	Total Supply
1997	6,958,897	488,275	41,849	7,489,021
1998	5,265,242	261,764	5,078	5,532,084
1999	3,435,522	472,226	114,712	4,022,460
2000	3,727,762	423,727	204,645	4,356,134
2001	2,588,417	511,632	442,549	3,542,598
2002	4,436,381	434,353	311,772	5,182,506
2003	4,959,460	459,729	168,832	5,588,021
2004	5,415,760	672,037	130,399	6,218,232
2005e	5,678,754	n.a.	n.a.	n.a.

Source: FD Sabah

Rubberwood and Other Resources

As mentioned earlier, other crops such as planted rubber serves as alternative sources of timber. With the conversion of rubber trees to the more favoured oil palm, the total area under rubber is, unfortunately, decreasing. The area under rubber was reported to be around 1.15 million hectares in Peninsular Malaysia, in 1998, much of which (about 85%) was under smallholders. The average replanting carried out by smallholders and plantation owners from 1998 to 2003 is estimated to be 53,734 hectares a year. For the same period, the amount of rubberwood was estimated to be 4.86 million m3 with an average annual supply of only about 800,000 m3. This amount is very low and insufficient for the highly demanding industry which required more than twice that supply in 2003 (see **Table 4,** below).

Table 4 Peninsular Malaysia: Supply and Demand for Sawn Rubberwood

Year	Total Supply (m^3)	Total Demand (m^3)	+/- (m^3)
1998	588,871	1,161,437	-572,566
1999	663,483	1,387,781	-724,298
2000	922,011	1,597,073	-675,062
2001	834,539	1,842,171	-1,007,632
2002	887,075	2,054,093	-1,167,018
2003	961,269	2,175,511	-1,214,242

Source: MTIB (Note: Figures for demand are indicative only)

The expected focus on forest plantations and the choice of rubber trees as one of the planted species is very appropriate given Malaysia's long history and tremendous knowledge on rubber trees.

Oil Palm Biomass

Various studies have also been carried out on the use of oil palm biomass as an alternative new source for fibre for the future. Malaysia's oil palm plantations presently occupy around 3.7 million hectares of which over two million are in Peninsular Malaysia and the rest in Sabah and Sarawak. Thus there exists huge potential for the commercialization of oil palm biomass. Added to this is the advantage of oil palm biomass having been accepted globally as environmentally friendly material. The commercialization of oil palm biomass in the form of trunk, frond and EFB has come a long way since the beginning of R&D on the utilization of oil palm residues in the early eighties. Since then research findings have been reported in seminars as well as in journal publications (Edi Suhaimi *et.al.,* 2008; Mohd. Hamami *et.al.,* 2005; Edi Suhaimi *et.al.,* 2005). It is known that oil palm residues in the form of fibrous material have potential to be utilized

for pulp and paper as well as composite products and core plywood, among others. If the two major factors of economic feasibility and product quality are overcome, this material will be the new resource of the future and could probably overtake rubberwood in order of importance.

Rattan

Another non-wood forest product which represents about 14% of the total NWFP is rattan. In the early 90s, there were 653 rattan mills throughout the country manufacturing rattan furniture and rattan products such as walking sticks, rattan balls, baskets, toys and mats. Of this total, 46 percent were classified as cottage enterprises, 34 percent as small-scale enterprises, and the remainder as medium and large-scale enterprises.

About 15.5 percent (101 mills) are involved in rattan processing, 12.6 percent (82 mills) operate in both processing and manufacturing, and the remaining 71.9 percent (470 mills) are involved only in manufacturing. The industry employs 16,120 people. Cottage enterprises employ 4 to 5 workers each, small-scale factories employ 10 to 20 workers each and medium-scale or large-scale firms employ 50 to 100 workers each.

Bamboo

Bamboo is another great potential fibre resource. The planting of bamboo, as well as management of natural bamboo stands have been implemented in Peninsular Malaysia since the late 80's. At the end of 2002, a total of 490 hectares had been planted, mainly with *Dendrocalamus asper*, while the 2,275 hectares of natural occurring bamboo, *Gigantochloa scortechinii* in Kedah (Thang, 2003) were being managed. In the last decade or so, the Forest Research Institute Malaysia (FRIM) has given very high priority to bamboo development, both in terms of growth as well as manufacturing aspects. However, there has never been a complete inventory of bamboo resources in Malaysia(Salleh and Wong

1987). The Second National Forest Inventory (NFI II- 1981/82) showed that the average number of bamboo cuttings (6 m/ cutting with more than, 3 cm in diameter at breast height) extracted per ton basis was about 95.5 and 118.3 pieces from the undisturbed and disturbed forests, respectively. From these figures, it was estimated that there were 587 million culms of bamboo in the forests (Kamaruzaman 1992).

Kenaf

There also exist great prospects for the use of kenaf as a source of fibre. Although the usage of kenaf is not common in Malaysia, its commercial applications are well recognized in other countries such as the United States and Western Europe. Various research and studies showed the plant to be very suitable as a base material for numerous commercial products. As a bio-composite material, kenaf is a viable alternative to wood fibre for use in the manufacture of MDF, particleboard and pulp for paper. Intensive research is still required, particularly in the area of product development, to ensure that the products meet international standards and can compete with similar products from other countries. The aims if the newly established Bio Composite Development Unit at MTIB is to promote research and the applications of kenaf and other fibres in the timber industry.

USES OF WOOD AND FIBRE RESOURCES

The Wood-based Industry in Malaysia

The wood and wood products industry comprises sawntimber, panel products (such as veneer/plywood, particleboard, medium density fibreboard and laminated veneer lumber), mouldings and builders' carpentry and joinery (BCJ) and wooden furniture. In 2004, exports of wood-based products amounted to RM19.8 billion (US$5.2 billion), an increase of 18.9 per cent over 2003

(RM16.6 billion). The major products exported were plywood (RM5.6 billion), furniture (RM5.5 billion), builders' carpentry and joinery (RM1.1 billion) and fibreboard (RM1 billion).

This industry is predominantly Malaysian-owned and, to date, more than 4,000 wood processing mills are in operation. It is estimated that more than 80 per cent of the wood-based companies, including furniture companies, are SMEs. The industry has successfully developed and diversified into the production of a significant number of downstream products such as veneer and plywood and higher value-added products, including blockboard, mouldings, BCJ, reconstituted wood-based panels (particleboard, fibreboard), furniture and furniture components.

Sabah and Sarawak attracted most of the projects which utilise tropical hardwood for the production of sawntimber, veneer, plywood and other veneered panel products. More than 70 per cent of the 154 plywood mills are located in Sabah and Sarawak, while for mouldings, out of the 177 mills in operation, 85 are in Sabah and 26 in Sarawak.

The downstream processing mills for the production of mouldings, fibreboard, BCJ as well as furniture and furniture components are mainly located in Peninsular Malaysia. These mills mainly utilise rubberwood (Malaysian Oak) which are sourced from sustainable plantations.

Plate 3 Major uses of wood

Plate 4 Oil Palm, new material for plywood production

Major Uses

Plywood

In the panel products sub-sector, plywood remains a significant contributor (28.5%) to total export earnings from timber products. The range of plywood produced includes common veneer-faced plywood, overlaid plywood such as printed paper and polyester plywood, plywood for concrete formwork and marine plywood. Malaysian plywood has achieved international standards such as Japan Agriculture Standards (JAS), British Standards (BS) and International Hardwood Products Association Standards (IHPA) for the US market and Harmonised European Standards (EN) for Europe. Malaysia is the second largest exporter of tropical plywood in the world.

Particleboard

In view of the need to maximise utilisation of wood resources, the industry has diversified into the production of high value-added reconstituted panel products such as particleboard and medium density fibreboard. The particleboard industry has grown and currently there are nine (9) companies in operation. The industry has, over the years, successfully exported its products particularly for use in the furniture industry. In 2004, exports amounted to RM197.2 million and the main destinations were China, Vietnam, Korea and Taiwan. Today, Malaysia is a major exporter of particleboard and Malaysian particleboards are able to comply with international standards such as BS, EN and Japan Industrial Standards (JIS). Malaysia is the 10th largest exporter of particleboard in the world.

Medium Density Fibreboard (MDF)

The MDF industry currently has 10 companies in operation with eight (8) located in Peninsular Malaysia and two (2) in Sarawak. Exports for 2004 totalled RM1 billion, representing 5.2 per cent of total timber export earnings. Currently,

Malaysia is the world's fourth largest exporter of MDF mainly to China, Japan, UAE and Saudi Arabia. Malaysian MDF has attained international standards such as BS, Asia-Pacific: Japan, Australia and New Zealand (JANS) and EN standards. A number of companies have also ventured into the production of laminated/ printed MDF for export and currently Malaysia is the 10th largest exporter of MDF in the world.

Veneered Panels Products

Besides MDF, the industry has continued to develop engineered products from veneer such as laminated veneer lumber (LVL), laminated veneer cross-band (LVB) and laminated veneer sandwich (LVS) to meet the demand for structural and industrial applications. The industry combines modern technology with the efficient use of natural resources to produce these products for the export market. Besides being environmentally friendly, these products, with their enhanced structural quality to meet different climatic conditions, are increasingly being used in the construction industry. The industry has also diversified into the manufacture of high value-added reconstituted composite products such as fibre-reinforced polymer composites (FRPC), reflecting the growing global demand.

Mouldings and BCJ

The products under BCJ include architectural mouldings (panelling, skirting, crowns, chair rails), doors/windows and accessories, wooden flooring and wooden railings. Exports of mouldings and BCJ are mostly to USA, Japan, Australia and United Kingdom. In 2004, exports of mouldings totalled RM649.1 million while exports of BCJ registered at RM1.1 billion. The major products under this category were wooden doors and wooden floorings, and together they contributed 75 per cent of exports of BCJ.

Furniture and Fixtures

The wooden furniture sub-sector is one of the major contributors to the wood-based industry, accounting for 27.7 per cent of total export earnings for the wood sector. In 2004, Malaysia exported RM5.4 billion worth of wooden furniture mainly to the USA, United Kingdom, Japan, Australia and Singapore. Malaysia ranks as the 10th largest world exporter of furniture and the third in Asia, after China and Indonesia, with exports to more than 160 countries. Among the furniture exported are bedroom sets, upholstered furniture and kitchen furniture, of which over 70 per cent are made from rubberwood, a light coloured, medium hardwood popularly called *'Malaysian oak'*. The main export markets are the US, UK, Japan and Australia. The exports of garden/outdoor furniture made from tropical hardwood are mainly for the European market. The solid tropical wood species used are known for their durability under different climatic conditions.

Malaysian furniture companies, numbering more than 2,000, are located mainly in Peninsular Malaysia. A high concentration of furniture establishments are in Johor (Muar and Kluang), Selangor (Klang and Sungai Buloh) and Melaka (Bukit Rambai). With the challenges of globalisation and liberalisation, Malaysian furniture manufacturers have given greater emphasis to the finishing, design and production of higher quality products coupled with local branding, mostly for the export market.

WOOD AND FIBRE REQUIREMENTS

Peninsular Malaysia

The timber industry, traditionally dominated by the primary processing sector, with the production of mainly sawn timber, plywood and veneer, has since the early 1980s, expanded extensively into production of reconstituted wood panels and higher value-added wood manufactures such as mouldings, joinery and furniture, in tandem with strong global demand. By far, the largest contributor

to foreign exchange earnings today is furniture, the bulk of which comes from the Peninsular. Exports of furniture expanded by 8% in 2004, reaching RM6.3 billion in terms of value while exports in 2005 were estimated to have escalated further to RM7 billion, giving an annual increment of at least 11%. This is in line with the objectives of the First and Second Industrial Master Plans (IMP 1 and IMP II), which emphasised on further industrialization through the development of downstream, value-added products.

The total export value of timber in 2004 amounted to RM9.58 billion, about 55% of which comprised earnings from wooden and rattan furniture. The breakdown of export of major wood products 2004 is as follows:

Volume of sawn timber produced: 3.2 mil m^3; Export value: RM1.33 bil.
Volume of plywood produced: 516,000 m^3; Export value: RM250 million;
Volume of mouldings produced: 218,000 m^3; Export value: RM409 mil.
Export value of wooden furniture: RM5.3 bil. Export value of rattan furniture: RM48.1 mil.

The set-up of major mills in Peninsular Malaysia, in 2004, did not change substantially compared to 2002 except for slight increases for moulding and furniture plants as shown in **Table 5** below:

Table 5 Peninsular Malaysia: Number of Mills

Mills	No. of mills (2002)	No. of mills (2004)
Sawmill	660	657
Plywood/Veneer	52	52
Moulding plants	157	173
Parquet flooring	26	26
Chipboard	11	12
MDF	7	8
Furniture and Woodworking	1,724	1,756

Source: MTIB

Peninsular Malaysia faces the common problem of reduced log supply with annual production, between 2002 and 2004, hovering between 4.3 million m^3 to 4.5 million m^3. To overcome this setback the industry needs to be supplemented by outputs from forest plantations and to develop more creativity in processing. In addition steps have been taken for the conversion of wood residues and agricultural wastes, such as oil palm, into reconstituted and composite wood products. In the face of current competition, the industry will need to be more innovative and also to work towards achieving a higher level of productivity in manufacturing.

Sabah

The Forest industry in Sabah has traditionally been export driven, with advantages of a large resource supply. The forest resource has been, and still is the biggest direct contributor to the state's revenue. This advantage created positive conditions for growth of the timber industry. The bulk of export sales is derived from logs, sawn timber and plywood. However, the momentum of development also resulted in the creation of excess capacity especially in sawmilling and plywood/veneer production.

Forestry has been the major contributor to Sabah's economy for most of the 1970s and 1980s, accounting for more than 50% of the state government's revenue. The timber industry had in the past been dominated by log and sawn timber production. In recent years, production of veneer, plywood and wood moulding has increased tremendously; but there has been negligible increase in joinery and furniture production.

Total production of logs (from the natural forest, forest plantations and imports) decreased drastically from approximately 7.4 million m^3 in 1997 to 3.5 million m^3 in 2001, but records show that there was increased production totalling 5.2 million m^3 in 2002, and 6.2 million m^3 in 2004. This was attributed to the clearing of degraded areas for industrial tree plantations, increased output

of small logs from alienated land encouraged by the recent reduction in royalty rates; and improved demand for forest residues leading to the extraction of log-ends and branches. The log supply situation in Sabah is, nevertheless, expected to revert to a declining trend in the near future.

Overall the total set-up of wood processing mills showed a reduction of around 25% over a seven year period from 1997 to 2004 (see **Table 6,** below).

Table 6 Sabah: Total Set-up of Wood Processing Mills

Sector	1997		2004		Percentage change	
	Active	Total	Active	Total	Active	Total
Sawmill	159	233	116	179	-27	(23)
Plywood	56	79	40	67	-28	(15)
Moulding	99	182	74	156	-25	(14)
Preservation	33	64	15	39	-55	(39)
Kiln-drying	66	90	48	74	-27	(18)
MDF	0	1	1	2	-	100
Particleboard	1	6	2	3	100	(50)

Source: FD Sabah

The average volume currently available for domestic consumption is around 4.7 million m^3, compared to the estimated installed mill capacity of about 8 million m^3 . Log output from plantation forests has been on the increase. The estimated area under forest plantations (including enrichment planting, rattan and rubber plantations) is 202,494 hectares. There was a big jump in the area planted in 2004 due to the involvement of a number of SFMLA (Sustainable Forest Management Licence Agreement) holders in planting of degraded areas. However, there is a need for good record/assessment of the age distribution of plantation forests which would assist the industry in charting long-term

strategies. In 2004, logs from plantation forests (the majority of which comprised *Acacia mangium* and *Paraserianthes falcataria)* stood at 672,037 m^3.

Total export value in 2004 amounted to RM3.5 billion, more than 80% of which comprised earnings from primary products. The breakdown of export of major wood products in 2004 is as follows:

Volume of plywood produced: 1.36 mil m^3; Export value: RM1.61 billion;
Volume of logs produced: 973,000 m^3; Export value: RM381.2 million;
Volume of sawn timber produced: 566,000 m^3; Export value: RM663 mil.
Volume of mouldings produced: 69,000 m^3; Export value: RM141 mil.

Sarawak

With 75% of its land under forest, Sarawak has the largest forest resource in the country. Known as a major producer of Ramin sawn wood in the 1960s, Sarawak's timber industry gradually moved to the hill forests to become an important source of tropical logs for the Far East market. The last two decades, particularly since the late 1980s, saw historic growth of Sarawak's wood-manufacturing industry, under the auspices of STIDC, whose core function is "to stimulate planned expansion" of the industry consistent with the State's economic and technological growth, and effective management of its forest resources. Sarawak's manufacturing base has expanded beyond traditional Ramin mouldings to hill forest plywood, sawn timber, wood mouldings, furniture, and wood composites such as fibreboard, chipboard and LVL (laminated veneer lumber). Sarawak is Malaysia's biggest producer of plywood and veneer. Timber is the third highest export earner at RM7.1 billion in 2004, or 16%, after Liquefied Natural Gas (RM17.1 billion, or 40%) and petroleum (RM11.9 billion, or 27%). Log production, which totalled around 0.8 million cubic metres in 1975 (60% of which comprised swamp forest species, mainly ramin), has now reached around 12 million cubic metres, 90% of which comprises mixed species from hill forests.

Current situation and challenges:

2004 major wood products export earners:
Production of plywood: 3.06 million _m^3; Export value: RM3.78 billion (53% of total earnings);
Production of logs: 12 million m^3; Export value: RM1.68 billion (24%);
Production of sawn timber: 1.01 million m^3; Export value: RM852 million (12%).

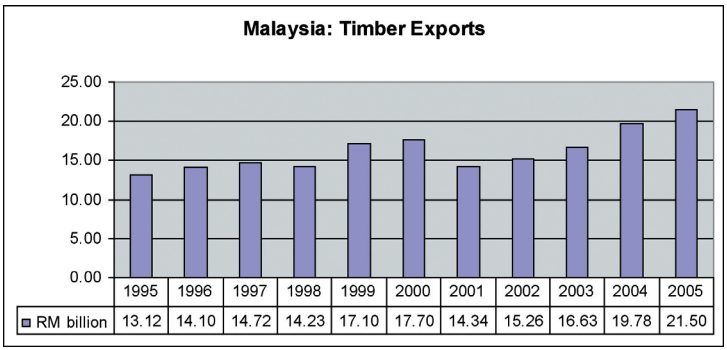
Based on inputs from Sabah and Sarawak, apart from the export of logs from the natural forest, their timber related policies are similar to those that apply to Peninsular Malaysia. However, as a matter of policy, more emphasis should be given to improving the physical infrastructure in Sabah and Sarawak to create greater interest in downstream processing and enhance the export of value-added wood products. This Study is aware that even at this point of time, Sarawak is already encouraging complete utilisation of wood, the outstanding example being the production of MDF and charcoal briquettes, utilising mill wastes.

Current Decade Requirement

Looking at the statistics over the past ten years, the growth of the timber industry as an export sector has been truly impressive, showing growth from a mere RM 13.12 billion in 1995 to RM 21.45 billion, despite the drop in exports in 1998 and 2001 (see **Figure 1**). The average annual increment for timber exports for the period 1995-2005 was 5.6%. An almost similar trend applies to the furniture sector (see **Figure 2**) and is only matched by the sharp increase in furniture imports over the last couple of years (**Figure 3**). Year-to-year increments, including for furniture exports, have not been a smooth curve. Through the years, they increased in varied degrees with a significant fall in 2001. Nevertheless overall, it has been a decade of high performance.

The annual increase in furniture exports for the period 2001-2005 averaged 13%. There was a noticeable dip in the growth of exports in 2005 compared to 2004 at 6.6%, compared to the double digit increments achieved since 1995, (with the exception of the 2000-2001 drop of 14%, which was an outcome of the economic downturn in the US market). The incremental growth for furniture has noticeably been flattening out in recent years. Going by the trends over the past ten years, with an average 5.6% annual increment for all timber exports, and 13% for furniture, one would have been drawn into making a straight line regression for year 2010, but it may not be that straightforward as one needs to take into account several variables that will come into play, such as:

- Price trends for tropical timber;
- Market situation in the world's major economies;
- Future supply of wood; and
- Malaysia's production capability.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
RM billion	13.12	14.10	14.72	14.23	17.10	17.70	14.34	15.26	16.63	19.78	21.50

Figure 1 Timber Exports 1995-2005

Source: MTIB

MTIB's *Maskayu* has reported continuous price increases over the last three years, boosted more recently by a 30% jump in the price of most species across the board. There have also been parallel improvements in world prices of tropical timber in general (ITTO, 2006). This is reflective of sustained world demand. However, an overly high price may lead to substitution and, to an extent, diversion to softwood. However with the geometric rise in demand for wood in China, India and Vietnam coupled with the revival of Japan's economy, there is increasing competition from these countries for tropical timber. There is little likelihood that under the present circumstances of world vigilance on rainforest conservation and environmental protection, there will be outright attempts to destabilise the market by flooding it with fresh supplies of logs from new sources.

The geometric rise in timber imports since 2001 (see **Figure 3**), gives an average increment of 60% annually. Given the current optimism about the local economy, and the assumption that the same average figure applies for the period 2006-2010, imports of furniture is expected to reach around RM 4 billion, by 2010.

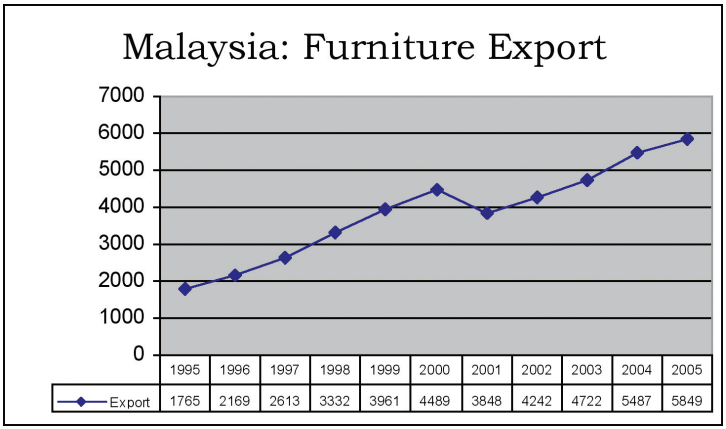


Figure 2 Furniture Exports 1995-2005
Source: MTIB

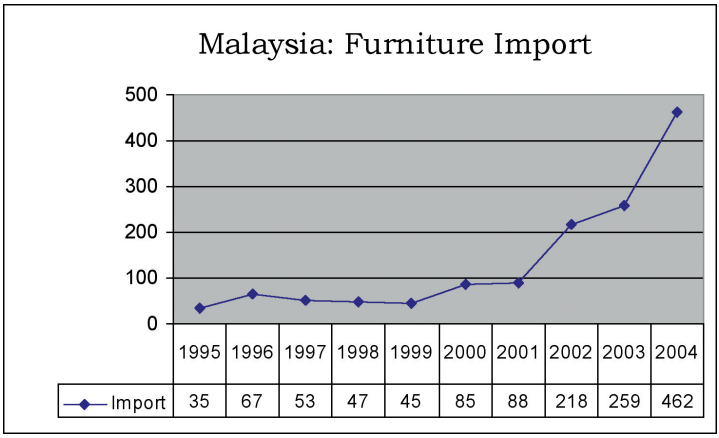


Figure 3 Furniture Imports 1995-2004

Source: MTIB

Next Decade and on to 2020

By 2020, it is anticipated that Peninsular Malaysia's production of timber from natural forests will stabilize at around 4.5 million m^3 while for Sabah and Sarawak it will be approximately 2.5 million m^3 and 9.2 million m^3 respectively. See below figures in **Table 7A**, and the Plantation Yield Assumptions used for determining plantation outputs.

Plantation forests in Peninsular Malaysia produce 2 million m^3 of wood, largely rubberwood, more than half of which comes from the replanting schemes of existing Rubber small-holdings and plantations. The highest forest plantation production occurs in Sarawak with 10 million m^3 of largely Acacia wood. The second largest producer, Sabah contributes 4.8 million m^3 of plantation timber, mainly Acacia.

Table 7 Resource and Installed Mill Capacity By 2020

A. Major Sources of Raw Materials

	Peninsular Malaysia	**Sabah**	**Sarawak**
Timber resource:			
i) Natural forest	4.5 million m^3	2.5 million m^3	9.2 million m^3
ii) Planted	0.9 million m^3	4.8 million m^3	10 million m^3 [1]
iii) Rubber (estates, smallholders)	1.1 million m^3		
Total:	6.5 million m^3	7.3 million m^3	19.2 million m^3
Installed mill capacity:	6 million m^3	7 million m^3	19 million m^3

Source: FD Peninsular Malaysia; FD Sabah; STIDC; MTIB.

Notes:

[1] Based on the yield assumptions used in this paper (see below), the anticipated volume of forest plantation output for Sarawak differs from that given by STIDC.

Apart from wood and fibre from traditional sources, agricultural wastes, forest and mill residues are useful alternative raw materials that serve the needs of the smaller scale industries well (refer to **Table 7B**). The dilemma posed by oil palm fibre to fibre consumers - MDF and chipboard plants, is still not completely resolved. The industry has yet to come to grips with the tricky problems posed by oil palm fibre, which prevents the latter from matching solid wood as raw material for top quality MDF or particleboard.

The industry's mill capacity is expected to stabilize at around 6.0 million m^3 for Peninsular Malaysia, 7.0 million m^3 for Sabah and 19 million m^3 for Sarawak. This consolidates further Sarawak's position as Malaysia's timber industry hub, outside of furniture. Sawmills and plywood mills have undergone restructuring to adjust themselves accordingly, in competition with the MDF and chipboard plants, for more efficient processing of smaller dimension plantation wood.

B. Ancillary Sources of Raw Material

1.Industrial Residues:	
- Forest residues	5.10 million m^3
- Mill waste	4.73 million m^3
2. Agricultural residues:	
- Rubberwood	10.58 million m^3 /y
- Oil palm trunks	20 million m^3/y
- Oil palm fronds	24 million m^3/y
- Empty fruit bunch (EFB)	2.4 million tonnes/y
- Coconut stems	3,200 tonnes/y

Source: Papers presented at the Roundtable Meeting with the Minister of Plantation Industries and Commodities (February 2006).

Plantation Yield Assumptions:

The following estimations are made using yield assumptions derived from the field findings of FRIM and LGM:

Timber volume from rubber trees (latex timber clones): 0.45 m^3/tree @ 500 trees/hectare.

Acacia: 0.4 m^3/ tree @ 300 trees/ha.

Peninsular Malaysia

Anticipated by 2020:

- In addition to the current area of 75,000ha under forest plantations, new planting will have been made covering 5,000 ha to 8,000 ha. (Total area: 80,000 to 83,000 ha.)
- Species selection: 60% -70% Rubber; up to 30% Acacia and the rest, Sentang, Teak, etc.
- Felling cycle: 12 to 16 years, on the average, 15 years.
- Estimated net annual planting area: 5,000 ha.

Raw material from forest plantations expected at 2020:
Rubberwood: 730,000 m^3 and Acacia: 180,000 m^3, provided that annual planting of 5,000 hectares begins soon.

Sabah

Anticipated by 2020:
Current area under plantation: 175,000 ha; Additional areas planted: 600,000 ha, giving a total of 775,000 ha. Species selection: 75% Acacia, and 25% Rubber. Estimated net annual planting area (at 15-year felling cycle): 51,000 ha.

Raw material from forest plantations expected at 2020:
Acacia: about 4.5 million m^3, and Rubberwood: 2.5 million m^3., provided that the annual planting of 51,000 hectares begins this year.

Sarawak

Anticipated by 2020:
Current area under plantation: 60,000ha. Additional area planted: 1.2 million ha (net workable area), giving a total of 1,260,000 ha. Species selection: 100% Acacia. Annual planting (at 15-year felling cycle): 84,000 ha.

Raw material from forest plantations expected at 2020:
Acacia: 10 million m3 (based on FRIM's yield estimation of 0.4 m^3 of wood per tree, at plantation intensity of 300 individuals per hectare), provided that the annual planting of 84,000 hectares begins this year.

Milling Capacity

Peninsular Malaysia retains its current operating capacity but appropriate adjustments have to be made to cater for the processing of smaller-sized plantation timber. Sawmills in Sabah will need to make similar changes in

processing machinery, to cope with the significant increase in the proportion of plantation logs. Sabah also has to reduce mill capacity by more than a million m3. Based on the above assumptions, Sarawak milling capacity will be appropriately around 19 million m3 rather than the planned 24 million m3 .

Future Scenario

There will likely be visible changes, within the next decade, in wood supply and usage patterns as demand for wood, being a scarce material, narrows down in usage towards more luxurious applications. Changes will probably be even more pronounced in the decade that follows. Further reductions in output from the natural forests are expected. These are the final adjustments to forest resource management upon arriving at a stable level of production under SFM. Stringent rules and regulations will apply to forest resource allocations for conservation and protection reasons as local as well as international pressures intensify to conserve forest resources here, and the world over.

Plantation wood and oil palm fibre will grow in prominence, providing the timber industry with an estimated 30 percent of its requirements by 2020 and could double that if the expanded planting programmes achieve their targets. Areas for plantations are expected to increase between three to four times their existing areas, particularly in Sabah and Sarawak where large tracts of land are available.

Technological advancement will enable practically all types of wood fibre to be processed and utilised. Where constraints in production or transportation economics had in the past prevented utilisation of logging waste or secondary species at the fringes of the forest, improvements in physical access and mobility of "portable" mills for *in situ* production, such as wood chipping, precision-sawing or peeling plants, may convert these forest leftovers into marketable materials (Mohd. Hamami *et.al.,* 1994). There will probably be radical changes in the management of the forest resource to allow the application of these

machines without detriment to the forest. Systems modernisation through the use of electronic means of data gathering, detection and monitoring, and revised methods of supervision with less dependence on conventional systems of control and reporting, ought to bring about a reasonable level of safety from forest abuse.

Silviculture systems may be adjusted to permit removal of the pioneer tree species of the natural forest to be replaced by planting with the increasingly marketable secondary forest species. What has hitherto been ignored for being too light or too soft may turn out to be excellent material for pulpwood or chips if they are available in large enough volume. These timbers, whether in solid or reconstituted wood form, can by that time be highly feasible for use as concealed or platform timber in the form of blockboard or for the production of exclusive veneer-faced, solid conference tables. The fact that they are not on the market today is not so much due to reasons of physical defects as due to the ready availability of other superior species which are usable as solid hardwood.

Before too long, there is likelihood of interest created in commercialising secondary species like Acasia (*Acacia mangium* and *A. auriculiformis)*. Mahang (*Macaranga* sp.), Sentang *(Azadirachta excelsa)* or Kelempayan *(Anthocephalus cadamba)***.** These are all fast-growing and hardy trees, plantable on short rotations. They are capable of producing good volumes of light hardwood that can be put to use in solid form for special applications, or as fibre. In time, these species can bring about an evolution in the management of the natural forest, which will accommodate dual rotation harvests to allow for the latter's extraction in short rotations. New emerging wood species such as *A. mangium* and *A. excelsa* becoming more familiar research materials and attract more attention together with ever popular rubber wood (*H. brasiliensis*). Some new findings in the characteristics and properties, pocessing parameters and new products has been discovered and research results were presented and discussed in many national and international meetings and published in many journals (Mohd. Hamami *et. al.,* 1998: 2005a; 2005b).

Plate 5 Improvement of oil palm wood

Plate 6 Kenaf new material for wood composite

Sources of wood fibre are not limited to tree species. Equally promising are oil palm, kenaf or bamboo. The MDF industry has indicated that it is not ready to switch to oil palm fibre on account of the inferior quality of the finished products, due to discoloration caused by the persistent presence of residual oil. Moreover, the stringy nature of the tough fibre tends to interfere with the smoothness of the panel face among others. The industry has also expressed caution about the transportation economics of the hefty oil palm trunks and for that matter, of the ultra light kenaf and hollow bamboos. All these disadvantages will need to be addressed by concerted efforts in R&D which must find solutions soon. Further delays will mean loss of opportunities for the industry (Azmy Mohamed *et.al.,* 1998; Edi Suhaimi *et.al.,* 2008).

The scenario in the use of wood is bound to be dramatically different by 2020. Presently, the use of smaller diameter logs, plantation timber and secondary forest species is on the rise but limited to the production of lower grade materials

such as chips or short-length lumber strips. Such products will continue to characterise plantation material for as long as plantation harvests are based on short rotation forests (Mohd. Hamami *et.al.,* 2008; 2005a; 1998). However, their value may change for the better if the products come onto the market as creatively designed and highly finished items. Otherwise they will remain as second tier materials, good enough only as concealed parts in furniture.

With advances in the technology of gluing, lamination and plastic injection, composite panels like fibreboard and particleboard will be strong and durable enough to replace solid wood in its traditional applications. They are already proven excellent material for flooring and cabinets. One can expect more and more fibre-based panels to be made into standard material for solid doors and windows, door jambs, skirting, and other joinery items for the home.

There will be also, more and more raw materials entering the market in the form of enhanced or fortified wood composites as substitutes for solid wood. They may be made of non-timber fibres of plants such as oil palm, coconut palm, bamboo and kenaf. For example, there are already in the market, substitutes for the traditional solid wood pallets, as solid wood pallets are getting expensive. The use of plastic pallets is discouraged - the material being non-biodegradable – and also perhaps not too attractive pricewise, as the oil price will be very high in the future. Today, work has already started on commercial scale production of pallets out of moulded wood chips.

Wood fibres however will continue to be combined with non-wood materials like plastics to form wood-plastic composites for which there already is good demand which is on the increase in US for external applications like decking and railing. The current technology in wood processing has increased the efficient use of wood/fibre as a raw material, allowing greater utilization of a wider range of species and small-diameter plantation wood. The rationale in the future will be to use modified products to compensate for the scarcity of natural produce.

As waves of demand for home materials are expected to continue with increasing intensity from Asia's giant economies, China and India (both of which even today are massive timber deficit countries), and while the supply of wood and fibre from all sources remains level at best, it is possible that indigenous tree species like Balau, Merbau or Meranti will eventually reach the status of rarity which is currently enjoyed by the likes of Rosewood, Chengal, Teak or Mahogany.

METHODS TO INCREASE SUPPLY

Proper Forest Management

Malaysia is committed to managing her forests in a sustainable manner not just for economic reasons but also to maintain environmental stability and ecological balance. To achieve this, Malaysia is committed to maintaining 50% of her land area under forest cover. With a land mass of 32.9 million hectares, the natural forest base is 18.9 million hectares. Out of this, a total of 14.1 million hectares of natural forests have been designated as Permanent Forest Estates or PFE which will be permanently managed to ensure proper balance among various purposes such as production, protection, social and educational objectives will be achieved. Further, 3.39 million hectares have been allocated as protected forests in the form of national parks, wildlife sanctuaries and nature reserves. These protected areas bear testimony to Malaysia's commitment to the maintenance of suitable habitats for fauna and flora to ensure the preservation of bio-diversity.

In PFEs designated as Production Forests, commercial logging is undertaken in a rotational cycle, under a sustained yield management system. Only a few mature trees (7 to 12 trees per hectare) are earmarked for felling during each rotation of harvesting thus giving the logged over area time to recover and regenerate before the subsequent round of harvesting. Under this selective

logging system, Malaysian forests have the ability to return to their former eco-balance, allowing for better biological functioning of the forests.

In line with the country's aspirations, a National Forestry Policy was promulgated and approved by the NFC in 1977. The National Forestry Policy was revised in 1992 to accord greater emphasis to environmental protection and the conservation of biological diversity. Furthermore, the National Forestry Act 1984 was amended to strengthen its effectiveness in dealing with forest encroachment and illegal logging. Consequently, the penalty for any forest offence has been increased from a maximum of RM10,000 or an imprisonment term not exceeding 3 years to a maximum of RM500,000 and imprisonment not exceeding 20 years with mandatory imprisonment of at least one year.

To further strengthen the country's capacity to implement sustainable forestry practices, a National Forestry Act was subsequently formulated and passed by Parliament in October 1984. In Sabah the Sabah Forest Enactment 1968 provides legal backing to ensure that the status of the PFE is secure while in Sarawak the Sarawak Forest Ordinance 1954 provides the necessary legal framework.

As a member of the International Tropical Timber Organisation (ITTO) Malaysia has been fully committed to the achievement of sustainable forest management by the year 2000. In this respect, Malaysia has taken several measures to operationalise the ITTO guidelines for the sustainable management of Natural Tropical Forests and its criteria for the measurement of Sustainable Tropical Forest Management.

In recognition of the need to strengthen sustainable forest management, Malaysia has also undertaken the critical step to reduce the annual coupe or allowable cutting rate in the country. Thus the annual coupe has been reduced from 52,250 hectares per annum for Peninsular Malaysia during the Sixth Malaysia Plan (1991 to 1995) to 46,040 hectares per annum during the Seventh Malaysia Plan (1995 to 2000). This planned reduction in logging rate will help to ensure that the extraction of forest resources is in line with the sustainable capacity of the forests.

Currently Malaysia has 2.13 million hectares of conservation areas protected by legislation. Of these, 1.8 million hectares are located outside the PFE whilst another 0.33 million hectares are within the PFE. In addition, Malaysia has also set aside pockets of Virgin Jungle Reserves (VJRs) to serve as permanent nature reserves and natural arboreta. Since its inception a total of 120 VJRs covering 111,726 hectares have been established in Malaysia. Taking into account the network of protected areas and VJRs the area that Malaysia has designated for the conservation of biological diversity totals about 5.19 million hectares or 27.3% of its total forested land.

Forest Plantations

It is clear that future requirements for timber will never be met fully by the natural forest, according to the Forestry Department, and thus, the only way to source additional timber locally would be through intensive planting of forest trees. It also gave a figure of 310,553 hectares as the total forest plantations established to-date in Malaysia. Of this total, 75,807 hectares were established in Peninsular Malaysia, 174,746 hectares in Sabah and 60,000 hectares in Sarawak (Shaharuddin Mohamad Ismail, 2005). By allocating RM200 million to support forest plantation activities for the year 2006, the Ministry of Plantation Industries and Commodities (MPIC, 2006) gave hope and encouragement to investors to look seriously into such programme. The Sarawak State Government has identified 1.0 million hectares of marginal lands to be converted to forest plantations within the next twenty years while Sabah has earmarked an additional 598,123 hectares of land with potential for forest plantation development.

MTIB has established a special purpose company, Forest Plantation Development Sdn. Bhd. to oversee the plantation programme. It has the long term objective of fully supplementing the industry's needs for local timber with plantation wood. For the first stage, a total of 375,000 hectares has been reported to have been developed and earmarked for government assistance, including

on-going projects, in selected sites throughout the country, mainly in Sabah and Sarawak where most of the land is available. An eventual annual planting target of 25,000 hectares has been set.

Plate 7 Jati *(Tectona grandis)* produce good quality furniture timber

Plate 8 Garden furniture made from locally planted *A. mangium*

Objective of Forest Plantation

The objectives of the plantation programme would include:

- To supplement the increasing timber requirements in Malaysia;
- To increase productivity of degraded forest lands;
- To alleviate rural poverty through implementation of social forest plantation programmes;
- To reduce excessive loss of foreign exchange by increasing production of raw materials for the timber industry;
- To diversify into low-labour demanding crops timber plantations which offer excellent opportunities with the increasing shortage of labour in the country; and
- To introduce timber plantations which, with their higher productivity, would reduce pressure on the PFEs, so that the latter can be managed in a sustainable basis.

Issues and Challenges in Forest Plantations

In Malaysia, while forest plantations are a lucrative option to supply the ever increasing demand for wood on a sustainable basis, the planting of timber trees on a plantation scale is constrained by a number of other factors that are critical.

Choice of Species and Land Availability

Species Selection

A review of about 45 reforestation projects in the tropics revealed that about 95% of all projects utilized exotics in the reforestation programmes. Sixty percent of all projects carried out their species trials in parallel with their project activities.

About 60% of the projects received additional information during their life span that resulted in new species selection (Evans 1982, Abod 1995). For plantations, although indigenous species are available, greater preference is given to the selection of exotic species. The reasons for this are:

- There is generally a lack of adequate knowledge about the propagation and silvicultural management of indigenous species;
- There is generally plentiful supply of seeds of the exotic species;
- The exotic species are easy to handle; and
- The exotics are fast growing and high yielding.

There is a great challenge ahead to carry out adequate studies on indigenous species to ascertain their viability for forest plantations.

Land

It is an established fact that land is the world's most valuable resource and public scrutiny of land is becoming more intense with each passing year. With increasing population competition for land for agriculture and development is ever increasing.

For a forest plantation investment to be commercially viable a large area is required. The size of the land required will vary with the objective of the plantation. If the timber is for sawmilling and furniture manufacturing then an area of around 15,000 to 20,000 ha would suffice. On the other hand, if the objective is to establish a chip or pulp and paper mill then an economically-sized plantation should be in the range of 90,000 to 200,000 ha. It would always be desirable to have a single contiguous piece of land area and if not, the required land area should be in about just two or three nearby parcels. This is to ensure easy and efficient management of the activities. It is always preferable that the acquired land is close to basic amenities and near a relatively accessible road system and within economic range to a processing mill or market. As an example, to

efficiently operate a pulp or chip mill the plantation should be located within a 100 km radius. Otherwise, exorbitant costs for the transportation of logs would render the operations uneconomical.

Another factor is that land is under State jurisdiction. In Peninsular Malaysia a large plantation project may stretch across several state borders. Hence, land being a state prerogative implies that commercial organisations may have to deal with different procedures adopted by the individual State governments. Often inquiries for information regarding land can become very difficult. Details, for example, on forest reserves are obtainable from the respective State Forest Departments while that on State land is obtainable from the Department of Land and Mines or the Department of Agriculture. The setting up of a coordinating agency is desirable to overcome this and thus encourage the easier establishment of plantation forests.

Finance

The planting of timber on a plantation scale is constrained by a number of economic factors as well. These are:

- The high initial capital investment to establish the forest plantations;
- The long period between initial planting efforts and harvesting and thus the corresponding concern about the high capital cost or interest having to be carried until harvesting period;
- The high biological and economic risk involved in forest plantations; and
- Unattractive and inappropriate investment incentives provided by the government for forest plantation investments in the past.

Government Tax Incentives and Regulations

Considering the constraints to private ventures in forest plantations, in order to attract such ventures, the Government has recently offered monetary incentive

packages in the form of:

- Pioneer Status: 100% Tax exemption from corporate tax of for 10 years on all statutory income;
- Investment Tax Allowance: An investment tax allowance at the rate of 100% of the statutory income for 5 years.

Although the above incentives are in place it is still not sufficient to attract private sector ventures into plantation forestry. Perhaps the situation could be improved if the following could be put in place:

- Provision of 'group relief' which would encourage companies with other business ventures to undertake forest plantation activities since losses incurred in forest plantation in the initial years can be offset against income from other profitable ventures.
- Exemption, at the state level, on royalty payments and quit rent for at least the first rotation
- Setting up of a plantation forestry fund which offers soft loans or subsidies for establishing new forest plantations and management costs.

Rubberwood Issues

Rubberwood will remain an important raw material not only in its solid form but also as chips and fibre. The recent policy announcement about the banning of rubberwood exports was meant to ease the shortage of rubberwood supply as the furniture industry had to compete with exporters for the timber. The full implications of this move is yet to be seen, but already, there were views from the industry that the move might breed smuggling. Smallholders were particularly concerned about the potential loss of revenue, as the processing industry had begun to foresee a drop in rubberwood price and therefore the value of standing trees, with the anticipated excess supply. As it turned out,

smallholders - the biggest suppliers - were unwilling to clear their rubber land for replanting at pittance value and furthermore, the price of latex had since, improved considerably. There has so far been no sign of the expected drop in the price of rubberwood (Mohd. Shahwahid *et.al.,* 1995).

In terms of marketing, rubberwood has several advantages. The image of rubberwood can be projected to buyers as environmental friendly material not only due to its sustainability of production, but also due to its socio-economic linkages. Clearing of land under rubber for replanting, has in recent years been a source of income, instead of a cost to rural-based smallholders. This is a good public relations point for rubberwood. However, there are also views about the replanting policy being unclear and this causes vacillations in rubberwood supply. It is a well-known practice as well, that replanting is put on hold during the rainy seasons and whenever latex prices are good.

Choosing rubber trees as plantation material is considered a good move as Malaysia has a long history with the industry. There is a tremendous amount of accumulated knowledge on the technology and economics of rubber planting, from their growth and cloning characteristics, soil suitability, tapping to harvesting, etc. There are also no marketing problems as rubberwood is a well known raw material for furniture in the world timber market.

Biomass from Non-Wood Materials

With the increasing global demand for environmental protection and conservation, alternative sources of raw material for the timber industry are also being explored by scientists. There are a number of interesting bio-resources such as oil palm, coconut trunk, bamboo and other agricultural residues (Azmy Mohamed *et.al.,* 1998; Edi Suhaimi *et.al.,* 2008; Mohd. Hamami *et.al.,*1998). Although these resources cannot completely replace timber, they can play an important supplementary role, especially in the form of fibre. There is an increasing demand for natural fibre for products such as paper, composites

and engineered materials. The recently introduced herb, Kenaf (*Hibiscus cannabinus*), shows great potential as an alternative crop for fibre, and is creating a lot of excitement among the plantation and scientific community.

Kenaf

Kenaf, which is a tropical plant from the hibiscus family, is currently being promoted by the government. Results of research work done overseas and findings by local researchers at MARDI, FRIM and UPM, as well as the trial manufacture of kenaf boards undertaken jointly by MIECO and Matsushita Denko, suggest a bright future for kenaf as an industrial crop in this country. What is more interesting is that its fast growth allows two harvests a year. This would ease the pressure on forests. The establishment of a Kenaf plantation to support just a single MDF plant would require a massive area of agricultural land to make it viable. This factor alone makes it difficult for one to visualize how Kenaf can find entry onto the wood-based market. It is already difficult enough to sufficiently accommodate large accessible space in non-agricultural land for forest plantations. This makes the Kenaf project a non-starter.

Oil Palm

Studies carried out by the above research institutions, which began in the early eighties, have also shown that oil palm biomass, in the form of trunk, frond and empty fruit bunches (EFB), is a viable material for products such as pulp and paper and composite wood. The oil palm trunk has also been successfully peeled for use as core plywood. There is clearly, huge potential for enhancing the economics of oil palm planting as more and more applications can be found from the processing of its biomass (Business Esprit, 2005).

Oil palm fibre has made limited headway in the timber market. It has yet to reach fibreboard and particleboard mills for commercial production. Until sufficient progress is made to overcome its physical and chemical shortcomings

(associated with the long strings of hard clumps of oil palm fibre and product staining due to the persistent presence of oil in the fibre), the vast benefits that this material promises to bring to the panel industries will remain untapped (Edi Suhaimi *et.al.,* 2008; 2005). It is not merely a question of economics as the industry has to ensure that it is also technologically sound to use oil palm fibre as material for high quality MDF and particleboard for which our manufacturers are well known, the world over. Consequently, oil palm fibre, for the moment, remains short of reaching its potential in contributing towards solving the timber industry's raw material woes.

Bamboo

With the availability of current technology, bamboo and coconut trunks are also becoming potential materials for fibre utilisation in addition to the traditional uses of these materials in solid form. In the future, it is expected that more and more solid wood products will be replaced by wood composites. What is important is that the new products meet users' quality expectations and that manufacturers are able to produce them commercially (Azmy Mohamed *et.al.,* 1998).

Secondary Wood Species

There are also hitherto, unutilised secondary species in the forest such as Mahang, Kelempayan, etc. that can serve as future raw materials either in their natural state or as fibre. Another traditional forest product that is decreasing in supply but could be of high value in the future is rattan. Rattan is a unique raw material which is capable of commanding a good price when made into designer furniture. More and more bamboo is expected to reach the market in solid form as flooring or furniture material, or in the form of fibre for MDF or pulp and paper.

LOGGING AND MILL RESIDUES

One of the alternative sources for raw material would be mill and forest residues, which will be used either in solid form or as wood fibre. It has been estimated that for every unit of input for sawmills, about 40% ends up as mill waste, while for every ton of logs removed from the forest, two tons are left as forest residue. There are therefore commercial opportunities in mill waste and forest residue as they are potentially excellent raw materials for various wood products. From the solid wood recovered, small pieces could be laminated and jointed to form base material in veneer wrapped mouldings or made into parquet or marquetry items. Certainly they are material for wood pulp and composite products.

The use of recycled timber is an industry in itself in many countries, especially where wood is scarce. The materials could be from old buildings or other applications such as railway sleepers as the industry reverts to concrete sleepers. A tremendous amount of timber is still being used in local construction, for scaffolding and other temporary uses. All this is available for re-use or at least, to be made into simple products such as pallets.

Definitions

"Wood residues" refer to wood left over from any conversion process, whether true refuse, waste wood or material destined for further conversion. Residues can refer to logging waste or mill waste.

"Logging residues" refer to any wood lying on the ground as a direct result of logging operations and trees severely damaged during logging operations. Approximately one-third of all logging residues originate from felled trees and the balance from residual trees destroyed or damaged during logging and extraction (Andersen, 1999a). The residues may range from portions of the trees – including high stumps – to entire trees broken during the logging process and left on the ground. They can be divided into the following categories:

- High stumps (leaving usable wood in the stump)
- Stem section above the first branches (top log)
- Branches
- Off-cuts, rotten log parts
- Standing trees broken or severely damaged in the crown
- Standing trees severely damaged (butt trunk and root damage)
- Splintered trees and logs
- Logs lost and not recovered

Logging residues can be found directly in the stump area, along skid trails and roadside landings. In many publications, residues are described as only those trees that were felled or the parts of felled trees. This explains, in part, the tremendous differences reported in research results. Strictly speaking, damaged trees should also be counted as waste, as they will not contribute to future crop and could have been harvested during regular felling operations (Mohd. Hamami *et.al.,* 1994).

"Wood-processing residues" or "mill residues" consist of any wood fiber not used during the conversion process in a mill – be it a sawmill, veneer mill, plywood mill, or pulp mill. It includes losses due to improper and lengthy storage. The following categories make up mill residues:

- Discarded logs (rotten or visibly or invisibly damaged)
- Bark
- Sawdust
- Slabs, ribs
- Peeler cores
- Grading off-cuts
- Sander dust
- Shavings
- Rejects

Similar to logging residues, the composition of mill residues determines options for its use. In numerous cases, the residues – including scraps and sawdust – of one mill are the raw material for another, depending on downstream and market integration. In such cases, residues are viewed as by-products rather than waste. For more detailed definitions and descriptions, see Wan Tarmeze Wan Ariffin *et al.* (1999)

Current Logging Practices in Asia and the Pacific

More than ten years ago, Poore *et al.* (1989) noted that most of the world's tropical forests were unmanaged or managed in unsustainable ways. Since then, considerable progress has been made towards better forest management in the Asia-Pacific region, although most countries are still far from achieving sustainable forest management. logging intensities in the tropical rainforests of Asia and the Pacific are substantially higher than in other regions (Putz *et al.,* 2000b). Pinard and Putz (1996) recorded an average of 154 m3/ha in the Malaysian State of Sabah and Thurland (1999) estimated intensities of between 80 and 125 m3/ha in Terengganu, Malaysia.

Re-logging (i.e. the premature re-entry into stands that were previously logged) within five to ten years after the first harvest is also common in Asia and the Pacific. A recent study in the Malaysian State of Terengganu concluded that largely unsupervised logging practices resulted in average logging damage percentages to residual stands of between 50 and 75 percent. (Thurland, 1999). Sweeping generalizations regarding logging damage is inappropriate, as substantial differences in forest management can be observed between the different countries of the region. Technological sophistication ranges from manual logging (with or without draft animals) to helicopter logging.

However, appropriate standard estimates of logging residues can be applied in countries where ground-based systems and the use of crawler tractors are still very common. This includes, particularly, Malaysia and Indonesia, and

other countries where companies from Malaysia and Indonesia operate. Local wood production is therefore dramatically reduced and total residue volumes are subsequently less significant than in major wood-producing countries. Hence, refining estimates of recovery rates for countries with partial logging bans would have only a negligible effect on the total volumes potentially available in the region.

Recovery Rates

A traditional "rule-of-thumb" is that for every cubic meter of wood extracted from the forest another is left behind. This rough estimate appears to be generally validated by Chinese and Indonesian case studies.

A study in the Malaysian State of Sarawak (Noack, 1995) showed that, on average, about 54 percent of the total wood volume (diameter above 20 cm) was extracted in the form of logs. The log utilization rate in East Kalimantan is about 53 percent (McLeish and Susanty, 2000). A recovery rate of 56.4 percent is the average for "normal" concessionaires with little or no downstream woodworking capabilities in Terengganu (Andersen, 1999a). The highest utilization rate of 65.9 percent was found for a concessionaire with large downstream wood-processing facilities (Mohd. Hamami *et.al.,* 1994). This operator reduced especially the volume of wasted top logs and various off-cuts (**Table 8**), thereby indicating that the potential for reducing waste in the forest is real and can be profitable. It also highlights that not all residues are usable or can be extracted and transported in a cost-effective manner.

Table 8 Composition of Logging Residues in Comparison to Log Volume Used in Malaysia (In Percent)

Study	Log used (%)	Stump (%)	Top logs (%)	Branche (%)	Various off- cut. (%)
ATTC, 1993	54.0	8.0	17.0	9.0	12.0
Scharai-Rad,1995	56.8	9.7	17.1	16.4	incl. in top logs
Noack, 1995*	53.5	4.6	10.4	26.3	5.2
Jaeger,1999a	65.9	4.8	7.5	17.3	4.5
Jaeger,1999a	56.4	4.5	14.1	14.5	10.5

*includes data for Malaysia, Indonesia, Ghana and Cameroon

Source: Jaeger 1999a; only residues originating from individual trees.

On the other hand, most research has been conducted in the tropical rainforests of Malaysia and Indonesia, where most commercial logging is taking place. In drier forest types and in wood-deficit situations, recovery rates are considerably higher, which needs to be considered in assessing the overall availability of raw materials. Moreover, very little is known about recovery rates for plantations in the Asian tropics. Much depends on the end use, distance to markets, standards of the industry, and whether one considers final harvests or thinning operations.

Andersen (1999b) estimated that only about 30 percent of the felled trees in an *Acacia mangium* plantation was removed during thinning operations. The 60 m3/ha (above 5 cm) left behind in the plantation had no commercial value since there were no wood-based panel producers of chip mills in the vicinity of the plantation. In fact, Andersen's study revealed that the extraction of the thinning residues would result in a loss of RM65.00 (or about US$ 17) per m^3. This highlights the importance of the location of plantations vis-à-vis processing

facilities. In fact, as Ravn (1999a) has shown for Malaysia, available logging residues are now considered too expensive and wood-based panel and chip producers have begun to invest in their own plantations as they believe that they can produce their own raw materials close to their processing site more cost-effectively and for less than the cost of residues.

Increase Recovery Rates

At present, the problem with plantation residues in Malaysia has not been solved. The recovery rate of small logs in the ongoing traditional thinning in the Merchang plantation is only about 30 % of the total thinned volume. The logs are used for pallet wood at a recovery rate of about 25 % (similar to rubberwood processing), which means that only 7 - 8 % of the total felled volume is currently used. Recently, mechanized whole tree thinning was tried out by Merbok Hilir Resources Sdn. Bhd. in Merchang with promising results. The recovery rate is around 80 % of the thinned volume, the damage level is acceptable and the method effectively solves the problem of labor shortage. The whole trees are chipped [in the forest] for the manufacture of MDF [medium-density fiberboards] at Merbok Hilir Resources Sdn. Bhd. in Kedah.

All logging operations generate waste. The question is not one of avoidance, but rather of minimization and utilization. The real question is then how much of the total volume can be used economically. Some analysts find it useful to distinguish between “usable” and “economically usable,” although clear definitions have not been developed as yet. Detailed measurements in Terengganu, Malaysia, indicated that about 20 percent of the total amount of forest residues is directly usable for primary processing (**Table 9**). These estimates must be viewed with caution however, because the extraction of logging residues solely for chips and fiber use is presently not economically attractive relative to the use of mill residues or residues derived from estate crops such as rubber (Azizol Abdul Kadir *et al.,* 1994; Andersen, 1999a).

Table 9 Volume of Recoverable and Usable Logging Residues in Terengganu, Malaysia

	No. of pieces	Volume (m^3)	Percent Species	
Top logs from originally tagged trees (first operation)	123*	67.96	3	All species
Top logs from originally tagged trees and severely damaged trees (second operation)	325**	371.39	17	All species
Total volume of recoverable residues	448	439.26	20	All species
Volume of main logs extracted	n/a	2184.52	100	All species

Source: amended Jaeger, 1999b * Residues from the first operation were extracted simultaneously with the main logs

**280 pieces or 86 percent originated from severely damaged trees

Availability of Logging Residues

In the calculations below, a residue factor of only 0.25 is applied for the six countries above. This means that for each cubic meter cut one-quarter of a cubic meter is left behind. The second group consists of countries whose production does not satisfy demand and whose industrial roundwood production is less then 10 percent of total production. Consumption levels are still below the Asian average of 75 m3/1000 persons: Cambodia (88), Indonesia (176), Laos (101), Malaysia (754), Papua New Guinea (352), Solomon Islands (321), Myanmar (62), Vietnam (58).

As discussed above, for assessment of logging residue availability it is assumed that only 10 percent of the total volume of logging residues can be used economically or is of interest to loggers (**Table 10**). This ratio appears to be low and is based on the current situation, which to a large extent depends on raw material prices. With rising prices, it can be assumed that the economically usable volume will increase, although transport costs may rise at the same time, which would further discourage the extraction of logging residues.

Based on the assumptions made earlier, the total amount of logging residues generated in the 15 selected Asian countries, in 1998, was 245.9 million m^3 , which is almost identical to the total roundwood removals of 244 million m^3 for Asia. In that sense, the rule of thumb that for each cubic meter cut another one is left behind applies, although it may not apply evenly to all the individual countries.

It cannot be assumed that the potentially recoverable residues are also of interest to loggers and the wood-processing industries at the current point of time. As various studies have shown, a maximum of 10 percent is potentially of interest to loggers and the wood-processing industries if logging and wood processing were better integrated. This adds up to 24.6 million m^3 for the 15 Asian countries and 851,000 m^3 for Fiji, Papua New Guinea and Solomon Islands. The reasons for this substantial difference between potentially usable and actual recovered residues are manifold and will be discussed below.

The bulk of economically usable logging residues, i.e. 88 percent, is produced in only three countries, i.e. China, Indonesia and Malaysia. While these three countries probably deserve the most attention in terms of developing strategies for reducing and/or using logging residues, the figures for each country are only rough estimates. Hence, while it can be assumed that the total logging residue volumes for the 15 selected Asian countries presented in Table 10 are reasonable estimates, figures for individual countries may differ by as much as 50 to 100 percent. A more important issue than that of the precise estimation of

residue volumes is what measures should be taken to reduce logging residues and make better use of those residues that cannot be avoided.

Table 10 Availability of Logging Residues in Selected Asia Pacific Countries in 1998 (1,000 M^3)

Country	Industrial roundwood	Residue factor	Total volume of residues	Economically usable volume
Bangladesh	617	0.25	154	15
Bhutan	45	0.25	11	1
Cambodia	1040	2	2,080	208
China	100918	1	100918	10092
India	25156	0.25	6289	629
Indonesia	36195	2	72390	7239
Laos	6892	1	378	138
Malaysia	**21735**	**2**	**43470**	**4347**
Myanmar	3444	1.5	5166	517
Nepal	620	0.25	155	16
Pakistan	2270	0.25	568	57
Philippines	3484	1	3484	348
Sri Lanka	706	0.25	177	21
Thailand	2872	1	2872	287
Vietnam	4525	1.5	6788	679
Total	**204316**	**n/a**	**245900**	**24594**
Fiji	557	1	557	56
Papua New Guinea	3239	2	6478	648
Solomon Islands	734	2	1468	147

Potential for Reducing Residue Volumes

In terms of environmental and economic impacts, timber harvesting is usually the most significant aspect of forest operations and management. A considerable body of evidence indicates that forest harvesting operations can damage up to

50 percent of the residual stand (Sist *et al.,* 1998), and even up to 60 percent as reported for Sabah, Malaysia (Tay *et al.,* 2001). Damaged and destroyed trees contribute substantially to logging residues. As discussed above, in the Malaysian State of Terengganu, two-thirds of logging residues consist of trees damaged or destroyed during road construction, logging and extraction (Andersen, 1999a; Mohd. Hamami *et.al.,* 1994). Lower logging intensities reduce damage and in the calculations in the previous section it was assumed that only half the logging residues are composed of damaged trees. It is obvious, however, that reducing the impact of forest harvesting could result in significant reduction in logging residues. In comparison to conventional logging, applying reduced impact logging (RIL) techniques could probably reduce damage by about 50 percent (Pinard *et al.,* 2000; Tay *et al.,* 2001; Killmann *et al.,* 2001), conserve soil and biodiversity and help sustain the productive capacity of the residual forest after logging.

During most RIL operations, essentially the same volume of timber is extracted as during conventional cutting and yarding operations. In some cases, however, yields are reduced because less area is logged due to restrictions to tractor access on steep slopes (Tay *et. al.,* 2001). RIL involves a number of distinct modifications to reduce logging damage. These include:

- climber or liana cutting;
- improved design of roads and skid trails;
- tree identification and marking for directional felling;
- pre-planning of skid trails;
- improved road construction;
- directional tree-felling;
- improved skidding and lower skid trail density;
- removal of stream obstructions and drainage of skid trails;
- rehabilitation of landings; and
- maintenance of riparian buffer strips.

Potential for Extracting and Utilizing Residues

The adoption of RIL will reduce the volume of logging residues but will not eliminate it. Hence extraction and utilization of residues still have to be addressed. Loggers and the processing industry are only interested in a limited amount of recoverable residues. A number of basic questions have to be answered to assess what steps need to be taken to make better use of this underutilized raw material.

- Which parts of the tree can be used?
- When should they be extracted?
- Who should extract residues?
- What is the equipment required?
- What are the costs (and benefits)?
- What are current constraints?

Composition of Logging Residues

On average (in Malaysia) about 58 percent of the tree is extracted; about percent is left in the stump; about 14 percent is in top logs; various off-cuts make up 9 percent; and branches comprise about 14 percent. At present, potential users are interested mainly in the stump and the top logs. In addition, damaged trees of commercial species are also of interest.

Who Should Extract Residues?

Ideally, valuable residues are collected during normal operations by the logging crew. This begs the question of why they are not already taking what others may consider valuable. There are a number of explanations for this. First, due to size limitations many damaged and untagged trees have to remain in the forest and in some cases it could actually be illegal to remove them. Second, much of the material left behind is too small to be handled by the large, heavy

equipment currently used by most operators. Such operators are not currently able to remove it cost-effectively. The alternative would be removal by a second crew with lighter and more flexible equipment.

AVAILABILITY AND USE OF MILL RESIDUES

Statistics for the wood-processing sub-sectors in Asia-Pacific are extremely weak with few exceptions. Wood processing is very diverse and has in recent years experienced a slow but steady shift towards production of wood-based panels and pulp (**Table 8**). The following discussion on the availability and potential uses of mill residues will take into account the existing situation. It focuses on residue generation in sawmills and plywood mills, which together account for the biggest share of the wood-processing sector. Second, although the share of wood-based panel producers is slowly increasing, from a residue-generation point of view, with the exception of plywood, this can only be welcomed. Plywood processing recovery rates are below 50 percent. In the other panel sub-sectors however, the rates are substantially higher. Chen (Appendix 1) estimated the recovery rate for particleboard to be 70 percent and for MDF, 93 percent. Considering that some of the latest production lines installed recover all of their waste for energy production, virtually no waste remains.

Recovery Rates of Sawmills and Plywood Mills

Numerous factors influence the volume of mill residues. The recovery rate is especially dependent on log dimensions. For logs in the range of 30 to 70 cm in diameter, recovery rates drop to about half when the log diameter is halved (Ravn and Jensen, 1999). Recovery rates are also determined by log quality, tree species, defects, sawmilling equipment, mill maintenance, production methods, grading, storage and drying. Ravn (1999a) estimated that improvements in these factors could reduce residue volumes by 5 to 10 percent. However, log

dimensions have been decreasing in Asia and the Pacific, and will decrease even further in the future. Hence, investment in more efficient equipment will not increase overall recovery from present levels, but rather, will only avoid further declines. In the short term, however, and for individual mills where equipment upgrades are made, improvements will be tangible.

Small-spindle Rotaries Reducing Residue Generation

The growing adoption of small-spindle rotaries by Indonesian plywood producers may be having just the same effect [i.e. accelerate the pace of forest destruction]. Introduced in the mid-1990s, the new rotaries allow panel producers to peel logs as small as 15 cm in diameter, leaving a core of 6-8 cm. The old, large-spindle rotaries, in contrast, would generally leave a 15-25 cm core that could not be peeled. According to several producers interviewed, the use of the new technology has had the practical effect of raising their log recovery rates – particularly when their pre-existing machinery had become highly depreciated – from the 45-50 percent range to that of 55-60 percent.

According to detailed studies in numerous countries, sawmill recovery rates range from 42 to 60 percent with an average of 50.8 percent. Plywood recovery rates range from 43 to 50 percent with an average of 46.9 percent (Table 9). In 1998, researchers interviewed 24 mill managers in the State of Terengganu, Malaysia who represented about 70 percent of the production in the State. According to the responses of the managers, sawmills recovered about 52 percent and plywood mills about 49 percent of total input (Ravn, 1999b)..

Composition, Types and Attributes of Mill Residues

The large-scale use of mill residues demands considerable investment in transport and processing capacity. Investments will only be made if a constant supply of raw material can be assured, which, as noted earlier, is already causing problems for some users of mill residues. In addition, the composition and

quality of mill residues must be well known. The composition of mill residues depends on a number of factors. Sawmills produce quite different residues or by-products, than plywood mills (Tables 10 and 11). Basically, mill waste can be divided into two main groups. The first is made up of larger pieces, the bulk waste, while the second group consisting of shavings, sawdust and sander dust, is made up of fine wood particles. Waste in the first group is easier to segregate and handle, which explains the increase in its use. Finally, waste or mill by-products are categorized by six main attributes that determine their appropriateness for further use and processing (Wan Tarmeze Wan Ariffin *et al.,* 1999):

- Species
- Segregation (species mixture)
- Purity (clean or contaminated)
- Moisture content
- Storage (in silos, bins or left on the ground)
- Size

In assessing the volume of residues that is actually available and can be used, horizontal and vertical integration of processing facilities is crucial. The recovery of solid mill off-cuts, which make up a substantial percentage of total sawmill residues, depends on the degree of integration in market and downstream production (Ravn and Jensen, 1999). It is, therefore, crucial to distinguish between real waste that can only be disposed off by dumping or burning, and by-products that can be used as firewood, livestock bedding or in further production processes. Even bark can be used as mulching material, although the cost-effectiveness of such an alternative depends on a number of factors.

Plate 9 Type of residue from forest harvesting

Plate 10 Many forms of wood waste from processing mills.

Turning Waste into Useful by-Products

Sawmills with little integration have few opportunities for recovery of short length pieces. If supplying a moulding plant, small dimension pieces down to 60 cm can be delivered, raising recovery rates. A moulding plant using finger jointing can also use pieces as short as 20 cm, thereby reducing the amount of remaining mill residue.

Potential Availability of Sawmill and Plywood Mill Residues

Estimating the volume of mill residues available for further processing is difficult. Production figures are often not reliable. Recovery rates vary within and between countries depending on log sizes, dominant species processed, standard of processing equipment and level of horizontal and vertical integration. Hence aggregate figures should be viewed with caution. The total amount of residue produced per year in the sawmilling and plywood sub-sectors, in the selected countries, is about 42 million m^3 and 19 million m^3, respectively. Close to 90 percent of the sawmill residues is generated in only four countries (i.e. China, India, Indonesia and Malaysia).

More than 95 percent of the plywood mill residues is generated in only three countries i.e. China, Indonesia and Malaysia. These percentages were even greater before the financial crisis which began in June 1997., In 1996, for example, Indonesia produced 7.3 million m^3 of sawnwood compared to the 2.5 million m^3 produced in 1998 (FAO, 2000). In Malaysia, sawnwood production decreased by almost 40 percent and in China by 30 percent, between 1996 and 1998. The decline in the plywood sector was not as drastic but was also quite pronounced in main producer countries. Hence, total volumes prior to the crisis was probably 30 to 40 percent higher.

Large quantities of mill residues are used as fuelwood for brick making, tobacco curing and domestic cooking in Terengganu, Malaysia. Smaller amounts are used for fencing, resawing for fish boxes and local furniture production. Secondary wood processors in Peninsular Malaysia discovered rubberwood to be a valuable raw material during the 1990s and now hardly use hardwood residues. Hence, not all mill waste is considered a useful by-product. In Sarawak, on the other hand, mill residues are used to the extent that shortages of raw materials are imminent locally (Ravn, 1999a). The efforts of the Sarawak Timber Industry Development Corporation (STIDC) to promote the use of wood waste appear to be “too successful”. There is a serious lack of data indicating the

extent to which the available mill residues are already being used. The volume that is not used and may be of interest from a financial point of view probably does not surpass 45 million m3 per year.

Successful Transformation

The situation is quite different in East Malaysia [Sarawak], where a substantial number of secondary processing facilities have been set up during the last 3-4 years. The raw material used is mill residues of *mixed hardwood species*. The chipboard and MDF plants, chipping stations, cogeneration and boiler plants and briquetting and carbonizing plants in Sarawak are all modern, large-scale operations. The total investment in the plants visited amounts to around RM 600 million [about US$ 240 million] which had been invested in 1995, 1996 and 1997. This development can be credited to the industrial development efforts carried out by the State of Sarawak through the Sarawak Timber Industry Development Corporation (STIDC).

Potential Utilization of Mill Residues

Many sawmills in Asia are set up and managed in traditional ways (i.e. they are equipped with bandsaws and set up to cut large-diameter logs). However, some retooling should be considered to increase recovery rates by raising the performance and productivity of breakdown saws and resaws. Water storage of logs or sprinkler storage can also minimize waste experienced during dry periods (Havelund, 1999). Even substantial investments in the sawnwood and plywood sub-sectors would probably reduce mill residues only by 5 to 10 percent. Thus, the question of how best to utilize residues remains. Wan Tarmeze Wan Ariffin *et al.* (1999, p. 7) disaggregated potential utilization into three broad categories:

Energy production, such as:

- Boiler fuel for kiln-drying, wood conditioning, lacquer-curing, etc.
- Co-generation plant fuel
- Industrial fuelwood (e.g. for brick making, noodle production, tobacco curing, and steam generation.

Secondary raw materials to be used by the wood-based industries for:

- MDF
- Particleboard
- Block board
- Laminated board
- Charcoal briquettes
- Parquet
- Pallet manufacturing
- Small-scale wood products, e.g., in cottage industry
- Use in paper and pulp industry

Secondary raw materials to be used by industries outside the wood industry sector:

- Fertilizer and mushroom growing
- Livestock litter/bedding

Additionally, sawmill residue is an important raw material for moulding industries, and in the small-scale artisan sector in rural areas, wood waste is used in a myriad of ways. Horticultural and agricultural uses are also possible. Any wood-waste management strategy should follow the "4R" approach (i.e., reduce, reuse, recycle and recover) (Wan Tarmeze Wan Ariffin *et al.,* 1999).

- **Reduce:** minimize waste during primary processing and storage
- **Reuse:** use waste in downstream industries without changing its mechanical structure (e.g.off-cuts to the joinery)
- **Recycle** : use waste for reconstituted panel production such as MDF
- **Recover:** use residues as fuel

*Charcoal briquettes:*The most attractive options for using large volumes include turning waste into charcoal briquettes, using it for co-generation, and using it as secondary raw material within the wood-based panel subsector. Wood briquetting includes the conversion of loose wood waste into a dense, compact and consolidated unit through the application of high temperature and pressure (Wan Tarmeze Wan Arrifin *et al.,* 1999)

Both sawdust and bark are suitable for briquetting, although sawdust is the preferred raw material (Ravn, 1999a). Briquettes can also be carbonized to create charcoal of very high quality. In 1998, there were 11 briquetting factories in Malaysia. Briquettes have to compete with other fuels such as wood and agricultural residues, kerosene and diesel, which are often cheaper. Hence in Malaysia most briquettes are exported. Major markets include South Korea and Japan. Due to the economic downturn, the commissioning of new plants has slowed down, although financial analysis conducted by the Forest Research Institute Malaysia (FRIM) indicates that the industry is attractive for new investors (Ravn, 1999a).

Wood Chips, Particleboards and MDF

Sawmill and plywood mill residues of mixed hardwood species can form important raw material for the chip and board industries. This is particularly attractive for large-scale uses where mills have the opportunity to sell their unwanted waste in a cyclic, well-organized manner based on long term contracts.

In fact, under such conditions, wood residues are no longer viewed as a problem. Rather, they are viewed as valuable by-products that can help increase profit margins (Ravn, 1999a). However, the relative location of residues and the markets for the final products have to be analyzed carefully. This price divergence will probably continue as new technologies make it increasingly possible to use mixed tropical hardwoods. In the future, the role of wood residues as raw material for the expanding particleboard and MDF sub-sectors will increase and, as has already been reported in Sarawak, local raw material shortages and higher prices for mill residues will likely result.

Future Products

Under pressure of price competition, our industry is producing better designed and higher quality furniture items. Rubberwood can stand on its own as solid wood. With improved lamination and gluing technology, the industry uses sliced veneer to produce customized premium solid wood furniture for well segmented markets. It has good support from high income-earning domestic buyers with great interest in special carvings and handicraft work. Solid wood furniture is rare and expensive, much benefiting Sarawak's furniture industry. What is known in the market as wooden products are in effect in composite form. The high cost of oil turned engineered plasticized products into choice flooring materials adding value to plantation timber, in solid or panel form. See **Table 15** below, details current products which are expected to continue to be in great demand in the future.

Plate 11 From Residues to Product

Plate 12 Variety of Products from wood and oil palm wastes.

Table 15 Future Products

	Peninsular Malaysia	**Sabah**	**Sarawak**
CURRENT STRENGTHS IN PRODUCT MANUFACTURING	Furniture (of rubberwood) Sawntimber Mouldings MDF/Chipboard Builders Carpentry and Joinery	Plywood Mouldings Pulp & paper	Plywood Sawntimber Builders Carpentry and Joinery (includes doors, flooring) Charcoal Briquettes
FUTURE PRODUCTS	High-value solid rubberwood, etc. furniture, including choice veneer-faced customised products. High value sawntimber. Laminated and engineered wood BCJ products. Branded particleboard, MDF, and specialty plywood. Wood-plastic composites especially upmarket flooring materials for customised use.	Luxury garden furniture of durable forest species. Own designed furniture from solid plantation timbers, or high value laminated and veneer-faced BCJ (solid doors, flooring) Plantation wood chips for pulp & paper industry.	Branded MDF, particleboard and plywood, including specialty plywood Builders Carpentry and Joinery (including solid doors, flooring and decking). Furniture, solid tropical hardwood; garden furniture Solid wood or veneer-faced solid or panelled cabinet furniture Plantation wood chips for pulp & paper industry.

NATIONAL STRATEGY FOR THE TIMBER INDUSTRY

Competitive Advantage in Availability of Raw Materials Locally

Sustained supply of raw materials is essential to the industry and helps to give it an element of confidence in planning for the future. Three major categories of raw materials are identified as:

- Timber from the natural forest;
- Timber from forest plantations; and
- Biomass – fibre from oil palm and other plants such as kenaf, bamboo, as well as forest residues, mill waste, etc.

The secondary wood processing sector may in addition, import timber in semi-processed form – commonly referred to as components – to supplement its manufacturing needs.

Strategic imperatives for sustained flow of raw materials:

- In implementing SFM, Forestry Departments and participating logging contractors ensure adherence to the principles set out for SFM activities upstream;
- State Governments give preference to meeting the domestic need for logs over exports, while encouraging creation of economic benefits through further processing;
- State Governments match Federal Government's financial assistance for forest plantation establishment, by allocating adequate land with attractive terms, to encourage private sector participation;
- The government promotes private sector participation in R&D work to commercialise the use of non-wood fibre; and
- The government provides incentives to encourage overseas sourcing of raw materials and furniture components, to help ease local supply constraints.

Regional Level Strategies

Sarawak, with its substantial wealth of natural forests and availability of large areas of land for plantations places emphasis on a strategy of growth in the plywood and sawn timber sectors (with the latter moving strongly downstream to mouldings and BCJ), while the State makes plans for major developments in furniture manufacturing and pulp and paper production. The latter two industries are to be fed with supplies from planted forests. This line of strategy will develop a strong forest-based economy in the state, provided that there is assurance of continuity in SFM practices. The system of large long-term forest concessions in Permanent Forest Estates in place today will make it easier to monitor and enforce compliance to sound forestry practices.

It will help Sarawak's image internationally to be seen to be strong in taking forest protection measures, since logging activities take place mostly in areas of difficult terrain and remote countrysides. It is presumed that Sarawak's plantation programmes will be equally constrained by the physical features of most of the planting sites. Economics aside, it will be environmentally challenging to establish forest plantations upstream, especially at high elevation and watershed areas, since the work will involve large-scale land clearing and intensive roading.

Strategically for Sarawak, the emphasis will logically be to strengthen its current production of panel products and downstream solid wood items. Taking advantage of the increasingly acute supply-demand equation for tropical timber, modern technology and creativity can turn BCJ into highly demanded, customised products, and reduce the need to export primary products such as logs and sawn timber.

In the case of Peninsular Malaysia, with smaller land areas under Permanent Forest Estates, and even less space for forest plantations, much depends on the resilience of the industry to run on a reduced level of log output. The panel products industry will have to work swiftly towards success in experimenting

on the use of oil palm trunks as alternative raw materials, to bring some relief to the competition for forest logs.

The well-developed mouldings and BCJ industries may resort to importing supplementary raw materials for high quality products. Generally, however, the local supply ought to be sufficient for tight, efficient production, provided forest management is run strictly on SFM basis.

Limited amounts of the produce of natural forests are used for furniture, although the outdoor furniture industry that uses Balau or Meranti finds good markets in Europe. Future plantations are in favour of growing rubberwood to meet the heavy demands of a thriving industry. Meanwhile, large quantities of potentially utilisable biomass from oil palm hold promise of serving the growing needs of the panel products industry, which in turn provides useful raw materials to the furniture industry. There is however, still much ground to cover before oil palm fibre is accepted as a viable alternative to the traditional wood fibre for this purpose.

The route to sustainability for the timber industry in Peninsular Malaysia is logically, consolidation of current production of wood manufactures while concentrating on improving their value chain. There has to be accelerated planting of rubber trees using the latest clones for the twin benefits of high priced latex and wood. Current financial grants for forest plantations (or special incentives from Felda or Felcra), should also cover replanting schemes for rubber small-holdings. This is to break the current hiatus in replanting due to continued tapping for high priced latex. Undue delays will definitely stultify efforts at prompt replacement of the old stock.

Among all the states in the county, Sabah has the most experience in forest plantation development. However, its shrinking natural forests places a heavy strain on the large-capacity, well-equipped sawmilling and plywood industries. There is plenty of rehabilitation work which needs to be carried out to restore the vast tracts of heavily harvested forest. The delay will prove costly in terms

of the future viability of the timber industry. Meanwhile, forestry activities in Sabah focus on forest plantation development, which is aimed mainly at meeting the needs of the furniture and pulp and paper industries.

Sabah may face problems of a sudden drop in log supply. While it has already begun to adjust to the excess in milling capacity, it still needs to revert to the more sustainable level of output of 2001, at around 2.5 million cubic metres, instead of today's volume, which is about twice as much. There has to be extreme prudence in managing the forest resource, and in planning for the future of the industry in view of this imminent danger, as it is unlikely that log shortage can be effectively offset by additional outputs from plantation forests. Plantation logs are not adequate substitutes for forest logs as they are lacking in both mechanical properties and dimensions.

There seems to be few other options for weaker companies but to divest, as a number have already done, not only in Sabah, but in Peninsular Malaysia as well. The more competitive ones will prepare themselves to face unprecedented difficulties of raw material shortage and elevated costs. Their primary concern will be to operate at high levels of productivity and deliver products of high quality.

In view of the log supply shortage that is already becoming too evident in Sabah, there is no apparent justification for the export of logs, even if it appears to sacrifice government revenue, which, is not the case. There is every justification to help rescue the industry by banning log exports as it helps create more economic activities on the local front. As explained earlier, the government can earn even greater revenue from enhanced charges at stump. The price of logs on the market is so good now that no reasonable member of the industry should object to the government's decision to claim its fair share of the benefits through forest rent.

Support Services

Strategies for development of the timber industry will need varied support from the government.

Lead Agencies and Other Support Organisations

Project Lead Agencies, identified under this programme as MTIB for Peninsular Malaysia and Sabah and STIDC for Sarawak, will be the intermediaries for government-industry rapport and formal communications with bodies in other economic sectors. Their other important roles include spearheading training activities, disseminating information and providing market exposure to smaller enterprises. There are organisations, including those in the timber trade, which can in coordination with the Lead Agencies, provide useful support to smaller industry members in some key areas of development. These organisations include:

- FD in all States and SFC, FRIM, LGM, to provide advisory services on all aspects of forest plantation development;
- MTC, mostly in similar areas of information sharing, marketing and promotion, and training for managerial and technological upgrading. (It will be in national interest to extend the good services of MTC to Sabah and Sarawak, if need be reciprocated by financial contributions from the two State Governments).
- FRIM, UPM, MARDI, LGM for joint efforts in R&D covering such areas as value added processing, commercialisation of biomass for wood products, product testing, etc.
- Financial institutions and government agencies assigned with the task of providing financial assistance to SMEs (see Chapter 10);
- MATRADE, in matters of trade promotions and enquiries;

- MIDA, MID etc., in conjunction with MTIB and STIDC, in industrial development matters; and
- FELDA, FELCRA and LGM on matters pertaining to rubberwood supply, processing and distribution.

Policy Issues and Outline

On Sustainability of Natural Forest Resources

The natural forest is the most important source of raw materials for the industry. MPIC has targeted the country's supply of logs from the natural forest to stabilise at a maximum of 18 million cubic metres per annum.

Recognising the importance of keeping the Permanent Forest Reserves intact, the respective forest authorities assure proper upkeep of this valuable resource by placing it under SFM. With the current world-wide concern for environmental protection and prudence in forest management, more serious efforts are accorded, or need to be seen to be accorded, towards the security of the forests, its tenure, volume control in harvesting and care in the protection of water catchments. Forestry authorities need to be always consistent and transparent in these efforts, especially in the eyes of environmental watchdogs, to gain international recognition. Policies are indeed required for proper:

- Management of the forest resource in accordance with the prescriptions outlined in Forest Management Plans, and in compliance with SFM (Sustainable Forest Management) requirements et al, to ensure continuity of log outflow at sustainable levels;
- Review cases of harvesting in excess of prescribed allowable cuts, as in Sabah, to ensure reversion to sustainable-levels of log production;
- Institution of strict control against excessive damage to the forest during logging;

- curb illegal logging and encroachment into Permanent Forest Reserves; and
- Management of log production in the interest of meeting domestic needs especially in log-deficit Sabah, with a view to banning log exports.

Forest Plantations

Supplementary raw materials are derivable from forest (including rubber) plantations, as well as various other biomass sources, in particular, oil palm. Adequate incentives are provided for establishing forest plantations, a topic fully covered in *Chapter 10 "Fiscal and Monetary Incentives".* The government has allocated an initial RM200 million to support forest plantation activities for the year 2006, which will be coordinated by MTIB. It has the long term objective of supplementing the industry's needs. For the first stage, a total of 375,000 hectares will be planted in selected sites in Sabah, Sarawak and Peninsular Malaysia. An annual planting target of 25,000 hectares has been set.

Where appropriate, forest plantations can also include agro-forestry, in which, a small portion of the area will be allocated for short-term agricultural crops as provision for intermediate income to support the project. Suitable policies are also required for proper:

- Encouragement of private-sector initiatives in forest plantations through financial incentives;
- Nationwide coordination and monitoring of the progress of forest plantation activities that benefit from MPIC's assistance programme for forest plantations; and
- Permitting agro-forestry practices in forest plantation projects.

Biomass Development

With increasing global demand for environmental protection and forest conservation, alternative sources of raw materials such as kenaf, oil palm, coconut trunk, bamboo and other agricultural residues are being researched on for commercial application. Although these resources cannot completely replace timber, they can be useful supplements for industries such as fibre for use in pulp and paper, composite panels and engineered wood products. Proper policies required include:

- To intensify use of non-conventional raw materials (kenaf, bagasse, etc), where technically and economically feasible.
- To review existing R&D policies to encourage more private sector participation in R&D for processing technology and use of non-conventional raw materials.

Importation of Raw Materials

In addition to what is available locally, it useful to encourage importation of raw materials, which in this context also include components (all from legitimate sources), as it helps to supplement our raw material resources and enables our manufacturers to adapt to international pricing. Policy is important:

- To encourage importation of raw materials and components at competitive prices and provide the timber industry with better opportunity to venture into manufacture of tertiary products.

Productivity Improvement

Trade globalisation intensifies competition and narrows the export market for wood products. The industry will have to focus on producing high value-added products to cater to niche markets. In fulfilling market demand, products must be well-designed, of accepted quality, reasonably priced and environment-

friendly. This can possibly be achieved through mill modernisation and by improving (or improvising) current product lines and services to bring about product variations.

New investments should be directed towards greater automation and production flexibility to counter any shortage of skilled workers. The industry must be made aware of the availability of various incentives for technology acquisition and be encouraged to utilise these facilities to adopt modern processing technologies and modern production management systems.

Another area to for the government to work on is to help alter the industry structure through clustering and enhanced industrial linkages. The establishment of furniture complexes with the objective of contributing to industrial linkages and clustering ought to be revived with instituting and executing proper monitoring and control mechanisms.

Proper policies is important:

- To encourage industry to take up offers of government assistance schemes to apply latest technology and operational systems, including the application of ICT, for high productivity manufacture of upmarket products with minimal use of manual labour;
- To improve awareness of the timber industry of developments in wood processing technology through regular dissemination of information about the latest technological advancements;
- To encourage technology transfer by way of smart partnerships between local entrepreneurs or with foreign investors; and
- To revive furniture complex developments as a core activity for the creation of linkages and industrial clustering.

CONCLUSION

The wood-based products industry in Malaysia faces a number of challenges, the most critical being the need for an adequate supply of raw materials to sustain the growth in the industry. In this regard, more, aggressive promotion of forest plantation projects including rubber plantation will be undertaken to address the need for a sustainable supply of timber in the long run. Other strategies to further develop the industry include continuing upgrading of existing industries to develop downstream activities and promoting new investments in high value-added and differentiated products. For the export market, potential products to be developed further are panel products for interior décor, up-market goods such as household and home-office furniture and builders' woodwork, which includes wood door and windows.

The utilization of wood waste, efforts will be taken to intensify R & D activities and develop new technologies. The Government will continue to encourage the consolidation and rationalization of industries to replace small, uneconomic and low technology operations in order to compete effectively in the global market.

Malaysia, with its well developed wood processing infrastructure and long experience in the manufacturing and marketing of timber products and the government's strong support for the wood-based sector, particularly for the development of downstream value-added manufacturing, through policies, incentives and financial assistance, the industry will continue to remain a major player in the socio-economic development of the country.

To further improve the competitiveness for the furniture sector, the Government has set-up the Malaysian Furniture Promotion Council (MFPC) to specially focus on the promotion of the furniture sector.

The wood-based industry is one of the resource-based industries with potential growth. In order to maximize the utilization of wood resources, the industry has moved into production of engineered wood products. Products are

now being manufactured from trees of smaller diameter. It is environmentally friendly, easy to use and strong. These products have set new performance standards by minimizing both resources and manufacturing defects enhancing structural features. Currently Malaysian wood manufacturers produce structural plywood, LVL, particleboard and MDF. Efforts should be made in venturing into the production of Oriented Strand Board (OSB) and Glued Laminated Timber (Glulam), which is gaining popularity in the export markets. Besides engineered wood, products encouraged for development with incentives along the Western Corridor of Peninsular Malaysia include the manufacture of solid wooden doors and specialized function doors, solid wooden windows and multi-ply parquet. Also, the development of reconstituted wood-based panel products such as MDF profiles, door skins, cabinets for audio-visual equipment as well as furniture parts. There is vast potential for the development of products utilizing non-wood fibres such as palm biomass and kenaf fibres to substitute wood. With the recent imposition of anti-dumping duties by the US against China-furniture, this action will help increase demand for Malaysian-made furniture.

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BIOGRAPHY

Prof. Dr. Mohd. Hamami Sahri was born on 5th February, 1953 in Batu Pahat Johor. He pursued his undergraduate studies at Universiti Pertanian Malaysia (UPM) in 1974 and graduated with a Bachelor of Forestry Science degree in April 1978. After joining Universiti Putra Malaysia as a tutor in October 1978, he went on to continue his graduate studies at SUNY College of Environmental Science and Forestry Syracuse, New York, USA in September, 1979. He obtained his Master of Science (MS) in Wood Products Engineering in July, 1981. Upon his return to Malaysia, he was appointed a lecturer in the Department of Forest Production, Faculty of Forestry UPM in July, 1981. Mohd. Hamami continued his graduate studies at Universiti Kebangsaan Malaysia Bangi, in the area of plant anatomy, and obtained his Ph. D degree in October, 1994.

Upon being appointed as a lecturer in 1981, Dr. Mohd. Hamami was determined to help the Faculty of Forestry, Universiti Putra Malaysia to become a Centre of Excellence in the field of Tropical Forestry Education. He has since served UPM for more than two decades and in recognition of his excellent service, the University honoured him with Excellent Service Awards in 1994, 1997 and 1998. His administrative duties for UPM came about as early as in 1985 when he was appointed as Head, Department of Forestry UPM Sarawak for 2 years. He was again appointed Head, Department of Forest Production, UPM Serdang for two consecutive terms from 1996 to 1999. During this 4 year tenure, he was involved in many committees at various levels, apart from his routine duties to facilitate the teaching and training activities of the Department. In 2001, he was appointed Deputy Dean (academic affair) and promoted to Acting Dean in April, 2002, and then to the position of Dean, Faculty of Forestry, UPM from January 2003 to February 2008.

Dr. Mohd. Hamami truly enjoys teaching and he teaches various undergraduate and graduate courses related to wood sciences and technology,

including Wood Properties, Wood Structure and Utilisation, Forest Products, Wood Seasoning and Wood Wastes Utilisation. For his dedicated services, Dr. Mohd. Hamami Sahri was promoted to Associate Professor in 1996 and full Professor in Wood Science in May, 2002. In addition to teaching Dr. Mohd. Hamami is also actively involved in supervision of student projects, both at the undergraduate and graduate levels. Since the early eighties, he has had the experience of supervising and guiding more than 80 undergraduate and 40 graduate students conducting research projects. From this pool todate, 7 Ph.D students and 25 Master of Science students have successfully completed their studies and graduated from UPM and a few other students are currently in the process of finalising their work.

For the past 27 years, Dr. Mohd. Hamami has embarked on research in the field of wood anatomy, wood gluing and wood quality studies. One of the main objective of this research group is to characterise and evaluate the properties and quality of many lesser used and plantation timber species. These species are slowly finding their way to processing mills and export markets complementing other popular species. In the last 5 years, the inclusion of small diameter plantation timbers and palm woods has widened the scope of wood utilisation especially for the production of engineered wood panel products.

With the ever increasing demand for wood and other forest products, his research interest is now more focussed on the relationship between wood structure and their properties. New emerging wood species such as Acacia mangium and Azadirachta excelsa are becoming more familiar research material and attracting more attention together with the ever popular rubber wood (Hevea brasiliensis). Some new findings on characteristics and properties, processing parameters and new products have been discovered and research results have been presented and discussed in many national and international meetings and published in many journals.

Dr. Mohd. Hamami has collaborated with many renowned scientists from abroad. His involvement with various scientists from different disciplines such as Tree physiologists and cytologists has strengthened his interest in wood growth and wood quality of many tropical species. His research group attempts to elucidate the relationship between tree growth and local climatic variables, and to quantify wood growth over time through the formation and detection of growth rings. His active participation in many international meetings, through conferences and seminars, enables him to meet many brilliant scientists from all over the world. These professional gatherings allow much interaction and discussion on latest research results and the learning of new research techniques. Todate, Dr. Mohd. Hamami has published over 90 articles in numerous journals and, another 70 has appeared in seminar proceedings. He has also written 2 text books and translated a textbook on wood technology and produced many other technical reports from attachments and consultation works.

Internationally, Dr. Mohd. Hamami has been an active member of the International Association of Wood anatomists (IAWA) since 1988 and participated in most of the association's activities since 1989. In 1998, he was appointed as council member for the Asia Pacific region for the period 1998-2003. Food and Agriculture Organisation,(FAO) Bangkok has invited him as subject expert and he has participated in the workshop on the possibility of integrating the wood energy subject in formal education at college and university level in Asia. He was also been invited to participate in many international conferences and workshops such as Forest and Climate Change in Manila, The Philippines, 6th Round Table Conference on Dipterocarp in Bangalore India, Management of Non Timber Forest Products in Katmandu, Nepal, Bamboo 2000 in Chiang Mai Thailand, Asian University Forest and the Round Table Meeting by CIFOR.

Whilst he is kept busy by his official duties, Dr. Mohd. Hamami still participates in the activities organised by local and national bodies. He has been active in the parent and teachers' association and was once the chairman

of the PTA of Sekolah Menengah Jalan 3, from 1995-1997. He has also been a member of the Institut Rimbawan Malaysia (Institute of Forester, Malaysia) since 1995 and a member of the Advisory Panel on Agriculture and Forestry for the National Accreditation Board (LAN) for the years 1999-2005. More recently Prof. Dr Mohd. Hamami has been appointed as Executive Committee member of the Asia Pacific Forestry Research Institution (APAFRI) for the period 2007-2009.

LIST OF INAUGURAL LECTURES

1. Prof. Dr. Sulaiman M. Yassin
   The Challenge to Communication Research in Extension
   22 July 1989

2. Prof. Ir. Abang Abdullah Abang Ali
   Indigenous Materials and Technology for Low Cost Housing
   30 August 1990

3. Prof. Dr. Abdul Rahman Abdul Razak
   Plant Parasitic Nematodes, Lesser Known Pests of Agricultural Crops
   30 January 1993

4. Prof. Dr. Mohamed Suleiman
   Numerical Solution of Ordinary Differential Equations: A Historical Perspective
   11 December 1993

5. Prof. Dr. Mohd. Ariff Hussein
   Changing Roles of Agricultural Economics
   5 March 1994

6. Prof. Dr. Mohd. Ismail Ahmad
   Marketing Management: Prospects and Challenges for Agriculture
   6 April 1994

7. Prof. Dr. Mohamed Mahyuddin Mohd. Dahan
   The Changing Demand for Livestock Products
   20 April 1994

8. Prof. Dr. Ruth Kiew
   Plant Taxonomy, Biodiversity and Conservation
   11 May 1994

9. Prof. Ir. Dr. Mohd. Zohadie Bardaie
   Engineering Technological Developments Propelling Agriculture into the 21st Century
   28 May 1994

10. Prof. Dr. Shamsuddin Jusop
    Rock, Mineral and Soil
    18 June 1994

11. Prof. Dr. Abdul Salam Abdullah
Natural Toxicants Affecting Animal Health and Production
29 June 1994

12. Prof. Dr. Mohd. Yusof Hussein
Pest Control: A Challenge in Applied Ecology
9 July 1994

13. Prof. Dr. Kapt. Mohd. Ibrahim Haji Mohamed
Managing Challenges in Fisheries Development through Science and Technology
23 July 1994

14. Prof. Dr. Hj. Amat Juhari Moain
Sejarah Keagungan Bahasa Melayu
6 Ogos 1994

15. Prof. Dr. Law Ah Theem
Oil Pollution in the Malaysian Seas
24 September 1994

16. Prof. Dr. Md. Nordin Hj. Lajis
Fine Chemicals from Biological Resources: The Wealth from Nature
21 January 1995

17. Prof. Dr. Sheikh Omar Abdul Rahman
Health, Disease and Death in Creatures Great and Small
25 February 1995

18. Prof. Dr. Mohamed Shariff Mohamed Din
Fish Health: An Odyssey through the Asia - Pacific Region
25 March 1995

19. Prof. Dr. Tengku Azmi Tengku Ibrahim
Chromosome Distribution and Production Performance of Water Buffaloes
6 May 1995

20. Prof. Dr. Abdul Hamid Mahmood
Bahasa Melayu sebagai Bahasa Ilmu- Cabaran dan Harapan
10 Jun 1995

21. Prof. Dr. Rahim Md. Sail
Extension Education for Industrialising Malaysia: Trends, Priorities and Emerging Issues
22 July 1995

22. Prof. Dr. Nik Muhammad Nik Abd. Majid
The Diminishing Tropical Rain Forest: Causes, Symptoms and Cure
19 August 1995

23. Prof. Dr. Ang Kok Jee
The Evolution of an Environmentally Friendly Hatchery Technology for Udang Galah, the King of Freshwater Prawns and a Glimpse into the Future of Aquaculture in the 21st Century
14 October 1995

24. Prof. Dr. Sharifuddin Haji Abdul Hamid
Management of Highly Weathered Acid Soils for Sustainable Crop Production
28 October 1995

25. Prof. Dr. Yu Swee Yean
Fish Processing and Preservation: Recent Advances and Future Directions
9 December 1995

26. Prof. Dr. Rosli Mohamad
Pesticide Usage: Concern and Options
10 February 1996

27. Prof. Dr. Mohamed Ismail Abdul Karim
Microbial Fermentation and Utilization of Agricultural Bioresources and Wastes in Malaysia
2 March 1996

28. Prof. Dr. Wan Sulaiman Wan Harun
Soil Physics: From Glass Beads to Precision Agriculture
16 March 1996

29. Prof. Dr. Abdul Aziz Abdul Rahman
Sustained Growth and Sustainable Development: Is there a Trade-Off 1 or Malaysia
13 April 1996

30. Prof. Dr. Chew Tek Ann
Sharecropping in Perfectly Competitive Markets: A Contradiction in Terms
27 April 1996

31. Prof. Dr. Mohd. Yusuf Sulaiman
Back to the Future with the Sun
18 May 1996

32. Prof. Dr. Abu Bakar Salleh
Enzyme Technology: The Basis for Biotechnological Development
8 June 1996

33. Prof. Dr. Kamel Ariffin Mohd. Atan
The Fascinating Numbers
29 June 1996

34. Prof. Dr. Ho Yin Wan
Fungi: Friends or Foes
27 July 1996

35. Prof. Dr. Tan Soon Guan
Genetic Diversity of Some Southeast Asian Animals: Of Buffaloes and Goats and Fishes Too
10 August 1996

36. Prof. Dr. Nazaruddin Mohd. Jali
Will Rural Sociology Remain Relevant in the 21st Century?
21 September 1996

37. Prof. Dr. Abdul Rani Bahaman
Leptospirosis-A Model for Epidemiology, Diagnosis and Control of Infectious Diseases
16 November 1996

38. Prof. Dr. Marziah Mahmood
Plant Biotechnology - Strategies for Commercialization
21 December 1996

39. Prof. Dr. Ishak Hj. Omar
Market Relationships in the Malaysian Fish Trade: Theory and Application
22 March 1997

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