GTZ KIEN GIANG BIOSPHERE RESERVE PROJECT

MELALEUCA TIMBER

RESOURCE POTENTIAL AND ITS CURRENT USE IN KIEN GIANG PROVINCE

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Melaleuca Timber- Resource potential and its current use in Kien Giang Province

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Introduction

Kien Giang is one among few provinces home to two types of Melaleuca forests concurrently, namely natural forests and plantation forests. The Melaleuca forests represent a valuable natural resource: in addition to its function as a means for environment protection, the products from Melaleuca forests also generate remarkable income for local people, contributing to the maintenance and improvement of their livelihoods. At present, natural Melaleuca forests are only to be found in Natural Reserves and National Parks and are strictly protected.

In the past 6 years, changes in the forest area have reflected the unsustainable development of Melaleuca forests. From 2002 to 2005, the area increased rapidly (by 23,967 ha) then decreased gradually in the period 2006 – 2008 (mainly in the area of production forests: in 3 years, the area of Melaleuca production forest decreased by 3,039 ha).

Among other reasons for the increase and decrease of the dimensions of Melaleuca forests there is one main reason to state: with market priced depending on supply-demand balance selling prices change considerably, especially for Melaleuca pole products, a main yield of melaleuca plantations now.

Studying the processing of Melaleuca timber for producing valuable goods is a useful step on the way to enhance the value of Melaleuca timber and stabilize its market outlets.

There have only been few studies on Melaleuca timber in recent years, but still sufficient to confirm that Melaleuca timber can be used as raw material for industrial processing of a number of valuable products such as: pulps, MDF boards, particle boards, and finger joint boards.

This paper aims to evaluate the possibilities of the use of Melaleuca timber in industrial processing of various timber products by compiling available data and by analysing the potentials of Melaleuca timber resources in Kien Giang.

The recommendations made in this study aim to improve the quality of Melaleuca timber in order to better meet the requirements specified for the materials used in industrial processing of diverse products, enabling forest growers to increase their income from Melaleuca forests, and contribute to the maintenance and sustainable development of Melaleuca forests in Kien Giang.

I. Overview of Melaleuca species and the area changing of Melaleuca forest in Mekong delta

Melaleuca tree, multi – purpose species and a crucial element of Vietnamese bio diversity.

While conducting research on Melaleuca products, Vietnamese forestry scientists have discovered its unique adaptability to differing ecological zones and acknowledged Melaleuca species as a crucial element of Vietnams bio-diversity. Melaleuca can grow in many habitats; from seasonally flooded areas to those wet all year round to arid regions in northern mountainous areas. It is able to adapt to almost all regions of hot climate with average monthly temperatures ranging from 23^0C to 27^0C. It also grows in areas of cold climate with winters of relatively low average monthly temperatures of 13^0C. Naturally, Melaleuca species is distributed in dry areas with an average rain fall below 1500 m/ year (Ba Ria, Vung Tau, Long An) and in regions with average rainfall of approximately 3000 mm/ year, such as Phu Quoc Island, Hue and Ky Anh. Capable of adapting to diverse ecological zones, Melaleuca species have the potential to prosper in almost all regions and areas of Vietnam.

With its particular characteristics, Melaleuca is considered a multipurpose native species. Of all the advantages of Melaleuca forests, the most important benefit seems to be their environmental protection function. In addition to its ability to contribute to climate protection Melaleuca forests also play a critical role in regulation of water levels: Melaleuca forests preserve a remarkable amount of water in the rainy season and in turn, provide an important source of ground water (fresh water) during the dry season, thus being a primary water source for daily life and agriculture production in adjacent areas. Furthermore, Melaleuca forests represent a crucial factor in soil erosion control, soil improvement and also prevent the formation of alum. These benefits, however, do not create direct monetary values. Therefore, local people solely pay attention to direct cash values of Melaleuca forests which are Melaleuca timber and Melaleuca oil. Research results show that Melaleuca timber currently can be used not only for construction poles (by traditional methods) but also as a material for industrial production of paper and base panel such as chipboards, fiberboards, finger joint boards, as well as for production of charcoal and vinegar as a byproduct of charcoal processing. Thoroughly maintained and sustainably used Melaleuca forests can provide a promising source for the development of versatile use, such as aquaculture, apiculture, and eco – tourism.

Current situation of harvesting and utilization of Melaleuca timber

Currently, the traditional products of Melaleuca forest are Melaleuca timber and Melaleuca oil.

The primary and most valuable products of Melaleuca forests are round timber and Melaleuca poles, followed by fuel wood and charcoal. For recent years, Melaleuca timber has also been sold as raw material for wood chip production.

Round timbers are wood logs with a length > 1.2 m and a diameter > 8 cm (under bark). This type of product presents the smallest portion among all products harvested from

Melaleuca forests but fetches higher selling prices than other products (including melaleuca poles).

Melaleuca poles and logs are the relatively straight parts of a tree and comply with the size specification mentioned in Table 1- 1.

The Melaleuca timber used for wood chips must be barked and have a length > 2 m and a diameter > 3 cm. For marketing, the product is measured by weight.

Melaleuca fuel wood is measured and priced by length (m), it consists in logs > 0.3 m and a diameter > 3 cm (including bark).

For production of charcoal, logs with a diameter > 3 cm (including bark) and unlimited length are used.

Table 1- 1: Classification of Melaleuca pole types

No	Prodcut type	Length (m)	Top diameter (cm)
1	Nóng 5 (cừ cột)	5	>5.5
2	Cừ 5		
2.1	1st Class	4.8	4.5 – 5.4
2.1	2nd Class	4.8	3.8 – 4.4
2.3	3rd Class	4.8	3.5 – 3.7
3	Cừ 4		
3.1	1st Class	3.8	4.5 – 5.4
3.2	2nd Class	3.8	3.8 – 4.4
3.3	3rd Class	3.8	3.5 – 3.7
4	Cừ 3		
4.1	1st Class	2.7	4.5 – 5.4
4.2	2nd Class	2.7	3.8 – 4.4
4.3	3rd Class	2.7	3.5 – 3.7
4.4	4th Class	2.7	3.0 – 3.4

Melaleuca oil, which is extracted from Melaleuca leaves, is a valuable product in the pharmaceutical and cosmetic industries. The Terpinent-4-ol content in the Melaleuca oil produced in Vietnam meets the requirements of international standards. However, Melaleuca oil production is presently carried out at household scale; neither product quantity nor quality are high.

Prices and markets

Timber is the main product of Melaleuca forests (man-made production forests); however, it has not yet been used as a material source for industrial processing but instead used primarily as raw material (cừ tràm). Thus, the market outlet for this product is limited and consequently the selling prices of Melaleuca timber products are unstable and seemingly undergoing a gradual decrease.

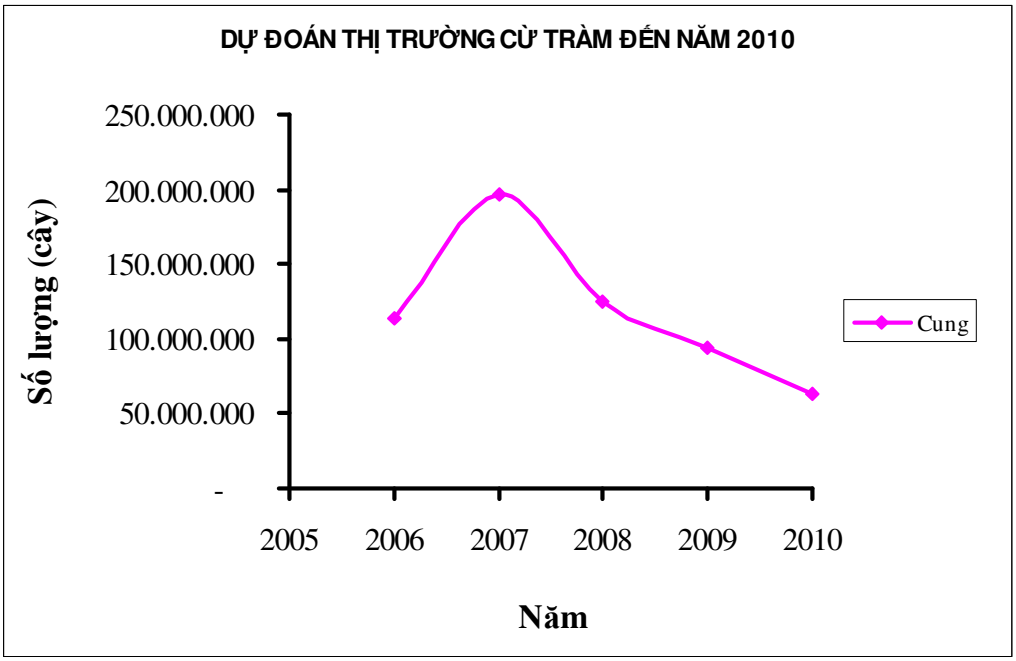
Table 1-2: Changes of selling prices of "cừ tràm" and Melaleuca forests

	Selling price of cừ 5 – 2nd Class (VND/tree)	**Selling price of medium quality (VND million/ha)**
2003	15,000	50
2006	11, 000	25
Decrease in price (%)	26.66 %	50%

There are many causes for the devaluation of Melaleuca forests: the market outlet for "cừ tràm" is narrowing, the qualities of forests are unequal, most areas of the extensive man-made forests produce trees of low quality. Moreover, forest harvesting and selling are not well planned and do not consider market demands. The unavoidable consequences of these factors resulted in a gradual decline in the area of Melaleuca forests and a risk of supply - demand unbalance which is most likely to expect in the future.

Based on the forest area and forest age in 2006, experts project the potential supply of "cừ tràm" until the year 2010 as follows:

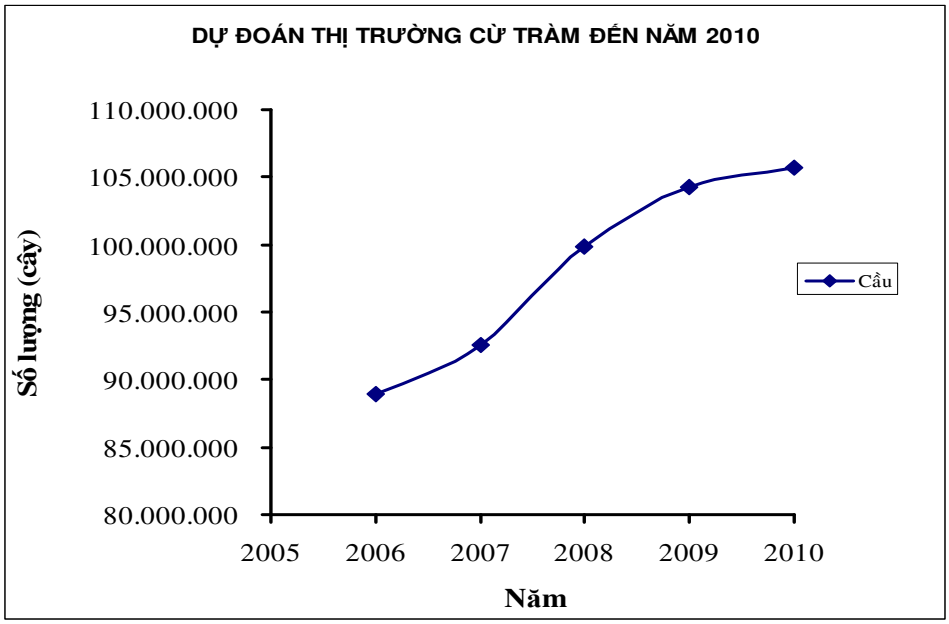
Graph 1-1: Potential supply of "cừ tràm" until 2010 (the Mekong River Delta)



(Source:Trần Thanh Cao, 2006)

Based on socioeconomic data, experts predict that the demands for Melaleuca timber and “cừ tràm” will continue to increase until 2010. The estimated quantity needed is 106 million trees in 2010.

Graph 1-2: The demand prediction for Melaleuca timber until 2010 (the Mekong River Delta)



(Source: Trần Thanh Cao, 2006)

The market for "cừ tràm" in the Mekong River Delta constantly changes and is unbalanced. The peak of the market unbalance was observed in 2007 when the quantity of "cừ” available for selling was 197 millions of trees while the market demand was estimated at 89 millions of trees. Predictably, until 2010, the lowest supply will be around 63 millions of trees – which is lower than the demand by 105 millions of trees. The capacity to supply Melaleuca timber products might be even lower than what is shown in the graph if it is impossible to control the decrease in the area of Melaleuca forests which is the result of the current shifting of farming purposes (conversion of Melaleuca forests into agriculture farming land). Nonetheless, experts also recognize that even if the forest area is sustained and the harvesting quantity is controlled, there still will be a surplus of around 102 millions of trees in the supply in 2010. It is hard for this figure to be realistic because harvesting and forest selling activities of households are unplanned and difficult to control.

The development of Melaleuca forests in the Mekong River Delta

Melaleuca forests in the Mekong Delta mainly concentrate in six provinces, namely Long An, Dong Thap, Tien Giang, An Giang, Kien Giang and Ca Mau. Until 2006, the total forest area is estimated at 176, 295 ha of which production forests, protection forests and special - use forests make up 75%, 15%, 10%, respectively. An area of 82,000 ha (mainly man-made forests) hereof - equivalent to 47% of the total area - is managed by households, the remaining area is managed by governmental agencies.

Table 1-3: Total area of Melaleuca forests in the Mekong River Delta (2006)

No	Provinces	Total Area (ha)	By forest types (ha)		By forest functions (ha)		
			Natural forests	plantation	Production forests	Protection forests	Special – use forests
1	Long An	64,293	800	63,493	60,881	1,292	2,120
2	Đong Thap	10,809	-	10,809	6,602	1,120	3,087
3	Tien Giang	8,019	-	8,019	5,776	2,137	101
4	An Giang	4,822	-	4,822	4,822	-	-
5	Kien Giang	**49,519**	**6,892**	**24,421**	**24,421**	**20,871**	**7,653**
6	Ca Mau	38,832	2,040	29,760	29,760	1,561	7,521
	Total	176,295	9,732	166,558	132,262	26,982	20,473

In the period between 1972 and 2001, the area of Melaleuca forests in the Mekong River Delta underwent a noticeable decease of appropriately 82,000 ha, mainly in the natural Melaleuca forests. This decrease was the result of the local farmer's forest destruction activities for opening agriculture land.

Since 1998, under the *5 Million Hectare Reforestation Program*, the Melaleuca tree has been considered the main tree for afforestation in the aluminous soil in the Mekong River Delta. Moreover, thanks to the support of international cooperation programmes, the area of Melaleuca forests (mainly production forests) has increased remarkably.

Statistical data on the development of Melaleuca forests in the six provinces of the Mekong River Delta is presented in Table 1- 4.

Table 1-4: Changes in the area of production forests in the 6 provinces of the Mekong River Delta

No	Provinces	Area (ha)				
		2002	2003	2004	2005	2006
1	Long An	53,719	61,346	64,179	62,706	60,881
2	Đong Thap	3,951	5,289	5,562	5,479	6,602
3	Tien Giang	3,162	5,120	6,212	5,891	5,776
4	An Giang	3,257	3,773	3,810	4,735	4,822
5	Kien Giang	**8,323**	**14,184**	**16,697**	**24,421**	**24,421**
6	Ca Mau	31,816	33,126	32,469	31,329	29,760
		106,922	123,147	129,266	134,898	132,262

Within 5 years there were many changes in the area of the planted Melaleuca forests: for the first 4 years (2002 – 2005) the area increased rapidly by around 7,000 ha/year; however, in 2006, the area had decreased by 2636 ha in comparison to 2005.

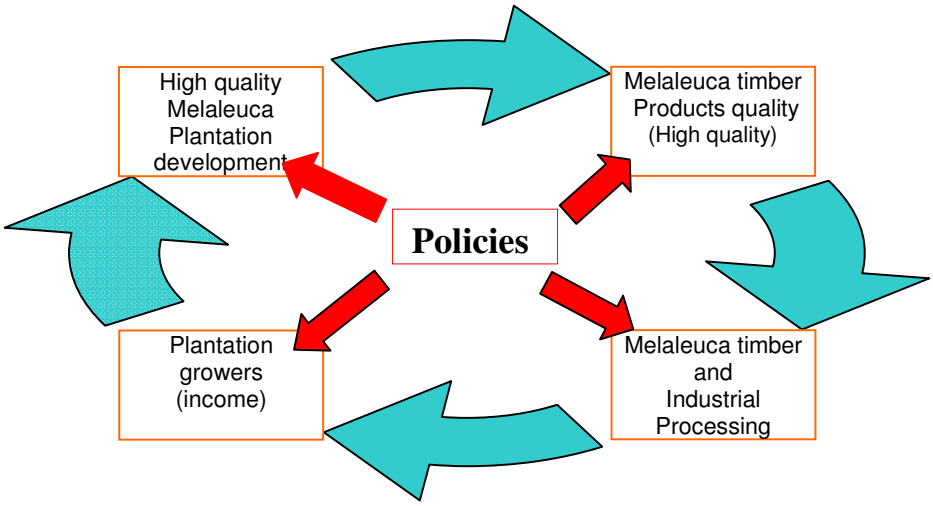
What are the means for a sustainable economic development of the Melaleuca forests in the Mekong River Delta?

Currently, timber is regarded as the prime product of Melaleuca forests. To support the development of Melaleuca as an important species for afforestation appropriate policies

targeting each stage in the value chain of Melaleuca timber products are needed to be formulated by competent authorities.

The sustainable economic development of Melaleuca forests can only be ensured if the forest growers gain adequate and stable income. Since the income of forest growers depends greatly on the quality, hence stable and large consumption of Melaleuca timber products, it is necessary to improve the quality of Melaleuca forests ensuring that Melaleuca timber products meet the requirements specified for the materials used in industrial processing. When Melaleuca timbers are processed into products of high value, the forest growers can obtain adequate income by selling the materials at higher prices and can decide on the investment for maintenance and improvement of Melaleuca forests.

Figure 1 -1: The value chain of the Melaleuca timber products and several influencing factors



In the above graph, the role of the State and local authorities in formulating policies are considered the focal and essential factor in enhancing the value chain of the Melaleuca timber products.

II. Some results of research on Melaleuca timber and its utilization

Research on Melaleuca timber and its utilization has received less attention than research on other tree species, probably due to the fact that Melaleuca trees are less widely distributed and due to the limitation in its utilization in industrial processing (low annual harvesting volume, quality of timber material, etc.) However, the results obtained from the research conducted on Melaleuca timber still shows the direction and the wide variety for the possible use of this potential material source.

II - 1. International research on Melaleuca timber and its utilization

Despite the fact that Melaleuca trees are distributed naturally in many countries such as Australia, Thailand, Indonesia, Vietnam, etc., research on Melaleuca timber and its use in processing industries in those countries does not embrace the potential of this material.

In the context of an afforestation programme, experts of CSIRO-FFP, the Centre for Timber Technology and the Forest Products Commission of Western Australia have conducted researches to assess the growth and utilization of 12 native species, including Melaleuca species. The results obtained from the comparison of physical characteristic of some species are presented in the table below:

Table 2-1: Comparison of the physical characteristic of some species

Species	Log volume (m^3)	Board volume (m^3)	Green sawn recovery (%)	Green density (kg/m^3)	Meen MC (%)	Basic density (kg/m^3)
Acacia aff. Redolens	0,055	0,041	74,5	1001	30	768
Eucalyptus occidentalis	0,068	0,042	62,4	1119	45	771
Eucalyptus ornate	0,056	0,035	63,3	1168	33	878
Melaleuca preissiana	0,093	0,066	70,4	1067	121	489
Melaleuca rhaphiophylla	0.076	0,044	57,7	1054	140	440

Table 2 -1 shows that:

- The Green sawn recovery of Melaleuca timber is lower than that of Eucalyptus and Acacia timber (with equivalent log volumes). This means that the log dimensions reflecting the qualities of Melaleuca timber materials (diameter, roundness, taper, crook …) are lower that those of Acacia timber and Eucalyptus timber)

- Melaleuca timber is a light timber and the fresh timber contains much water.

Table 2- 2: Comparison of wood shrinkage levels

Species	Tangential shrinkage (%)	Radial shrinkage (%)	Longitudinal shrinkage (%)
Acacia aff. Redolens	2.2	1.3	0.08
Eucalyptus occidentalis	9.1	4.5	0.28
Eucalyptus ornate	6.6	3.7	0.06
Melaleuca preissiana	23.2	11.2	1.4
Melaleuca rhaphiophylla	15.0	6.7	0.26

The results obtained form the comparison of the wood shrinkage levels in different dimensions presented in table 2-2 show that the shrinkage levels of Melaleuca timber (especially the radial shrinkage and tangential shrinkage), are relatively high. This also means that processing sawn timber from Melaleuca timber is more difficult than that from Acacia and Eucalyptus.

Dr. Junji Masumura from the Department of Agriculture, Kyushu University, Japan made the following conclusions when studying the physical characteristics and the potential utilization of the *Melaleuca cajuputi* timber planted in Naratiwat, Thailand.

- Trees grow rapidly (basal diameter reaches 16 cm in the 11th year), the wood density (750 kg/cm^3) is equivalent to that of Dipterocarpus and Tectona timber .

- The radial shrinkage and tangential shrinkage are higher than those of other species, meaning that the production of sawn timber is more difficult in comparison with other types of tropical timbers.

- To ensure the processing efficiency and product qualities, the materials for producing sawn timber need to have the diameter > 2 cm while for producing peeling veneer the diameter must be > 30 cm. It is recommended that policy makers and silviculture experts pay attention to enhancing the quality of Melaleuca timber.

Under another JICA – funded project, Masatoshi Sato also announced results of the study on utilization of *Melaleuca cajuputi* in Naratiwat, Thailand for producing cement particle boards with the weight ratio of wood : cement at 1: 2. The size of commercial boards are 1.22 x 2.44 m. Results of the inspection of the bending strength of the boards show that it is equivalent to the bending strength of the cement particle boards made of Eucalyptus timber. (The boards are processed by machines of a factory producing cement - wood particle boards, VIVA industry CO. LTD Thailand).

Conclusions:

- The physical and mechanical characteristics of Melaleuca wood are similar to those of other plantation timber species, such as Acacia and Eucalyptus species

- The Melaleuca timber used for producing sawn boards has low sawn recovery rate because radial and tangential shrinkage is higher than shrinkage of Acacia and

Eucalyptus timber. However, Melaleuca timber can be used as material for cement - wood particle boards production of high quality.

II – 2. Research results in Vietnam

The Forest Science Institute of Vietnam has completed some and is currently conducting more research projects on the wood structure, mechanical and physical characteristics of Melaleuca wood and the potential of its utilization in the wood processing industry.

II - 2.1. Results of the researches on Melaleuca timber characteristics

a) Characteristic of Melaleuca logs

Based on experimental results, silviculture experts conclude that the growth of *Melaleucacajuputi* and *Melaleuca Leucadendra* are relatively fast growing species, their growth can reach 25 m^3/ha/year at 4 year old trees (planted in Thanh Hoa, Long An). Nonetheless, since almost all of the existing Melaleuca forests are planted for the purpose of harvesting "cừ tràm", intensive farming practices have not been applied, and no attention has been paid to planting Melaleuca forests for production of sawn timber. The current quality of Melaleuca timber is too poor in comparison with that of other species like Acacia and Eucalyptus.

Comparison of the results of surveys of Melaleuca forests in Ca Mau with Acacia and Eucalyptus species reveals the obvious differences in timber qualities (Table 2 – 3 and Table 2 – 4)

Table 2-3: Comparison of height, diameter of Melaleuca trees with those of Acacia and Eucalyptus species

Species	Height (m)	Diameter <14 cm (%)	Diameter =14<16 cm (%)	Diameter =16<20 (%)	Diameter > 20 cm (%)
Melaleuca.cajuputi , 10 year old	8.07	97.11	2.89		
Eucalyptus Urophylla, 8year old	10.5	27.74	17.54	42.78	11.91
Acacia Auriculiformis, 10 year olds	10.7	6.67		6.67	86.66
Acacia Hybrid, 9th year	11.5				100.00

Table 2 - 4: Comparison of log dimensions of Melaleuca timber and those of some Acacia and Eucalyptus species

Log dimension	*Melaleuca* 10 year old	*Eucalyptus Urophylla* 8 year old	*Acacia Hybrid* 9 yearold	*Acacia Auriculiformis* 10 year old
Conical form (cm/m)	1.1	0.8	1.7	1.2
Oval shape (%)	0.055	0.1	0.07	0.05
Crook (%)	2.55	1.42	1.81	2.30

The log dimensions of Melaleuca timber shown in Table 2- 3 and Table 2- 4 indicate that the currently available Melaleuca timber materials do not qualify for producing sawn timbers. This means, utilization of the existing Melaleuca timber as material for sawn timber production will not be profitable.

b) Results of the researches on the chemical, mechanical and physical characteristics of Melaleuca timber

Before using any type of timber material, it is necessary to identify and evaluate the timber composition and its basic characteristics. In this paper, we present the results of the comparison of Melaleuca timber characteristics with those of several other timber types regarding the possibility of Melaleuca timber use in industrial processing.

Chemical composition of Melaleuca wood

Table 2-5: Comparison of the chemical composition of Melaleuca timber with other trees regarding the possibility of pulp production

Composition	***Melaleucacajuputi***	***Eucalyptus Hybrid U24***	***Eucalyptus U6***	***Acacia Hybrid BV16***
Cellulose (%)	46.8	50.1	45.4	50.9
Lignin (%)	24.8	24.5	25.8	25.8
Resin contents (%)	1.15	1.2	1.86	2.0
Fiber length	1.06	0.86	0.95	1.09
Kapa indication	1.15	1.20	1.86	2.0
Pulp efficiency (%)	42.2	46.7	41.4	49.3
Tearing strength (Nm^2/g)	6.4	5.6	6.7	6.2

Showing the above mentioned chemical composition and fibre structure, Melaleuca timber can fully meet the requirements specified for materials used in pulp production. In comparison with other commonly used materials at present, such as Acacia and Eucalyptus timber, the gain of pulp production from Melaleuca timber is lower; however its bleachability is higher.
Results from inspection of the mechanical and physical characteristics of products made of Melaleuca timber prove that Melaleuca timber does qualify as material for paper and MDF board production.

Some physical properties of Melaleuca timber

Table 2-6: Comparison of some physical characteristics of Melaleuca timber with several other species

Species	***Melaleuca***	***Acacia Auriculiformis***	***Acacia Hybrid***	***Acacia Mangium***
Volumetric shrinkage coefficient (%)	12.6	0.41	0.39	0.46
Specific gravity (kg/m3)	610	560	538	586
Maximum resistance to tangential static bending (MPa)	100.8	99	99	97
Strength of longitudinal compression (Mpa)	46.5	45	41	42

(Source: Sector Standard 04TCN-2002, Vietnamese timber- Name and mechanical characteristics)

Table 2-7: Comparison of Melaleuca timber with other species

Species	*Melaleuca* 10th year	*Eucalyptus* 8th year	*Eucalyptus* 6th year	*Acacia Hybrid* 9th year	*Acacia Auriculiformis* 10th year
Adherent-ability (MPa)	6.77	7.44	6.70	7.15	6.84

Inspection of the mechanical characteristics of Melaleuca timber shows that it is similar to some other timber types, such as Acacia and Eucalyptus. Specifically in terms of its mechanical strength it is comparable to Acacia and Eucalyptus and it can be used for furniture production. However, the coefficient of volume shrinkage of Melaleuca timber is higher than that of other timbers, which is a warning sign of the difficulties in the process of sawing, drying and processing of Melaleuca timber.

Evaluation of the possible use of Melaleuca timber for production of particle boards and finger joint boards

The physical and mechanical characteristics of the particle boards made of Melaleuca timber described in Table 2 - 8 below are not significantly different from those of the particle boards made of other common timber kinds like Acacia and Eucalyptus.

Table 2-8: Comparison of some technological specifications of the particle boards made of Melaleuca timber and other timbers

Technological specifications	***Melaleuca***	***Eucalyptus* 8th year**	***Eucalyptus* 6th year**	***Acacia Hybrid* 9th year**	***Acacia Auriculiformis***
Moisture content (%)	9.87	7.68	7.68	7.99	7.73
Thickness (cm)	16.51	15.45	15.28	13.74	15.42
Density (g/cm^3)	0.70	0.68	0.67	0.66	0.65
Water absorbing degree (%)	35.61	36.36	38.01	39.92	35.66
Elasticity of thickness (%)	10.41	14.54	14.01	14.17	14.22
Static bending strengh (MPa)	11.91	16.75	17.04	16.83	16.71
Tensile strength (Mpa)	0.41	0.32	0.31	0.35	0.34

In order to find ways to improve the static bending strength of Melaleuca particle boards, experiments on blending Melaleuca and Acacia wood chips were carried out with the following results:

Table 2-9: Specifications of the particle boards made of a blend of Melaleuca and Acacia timber materials in comparison with Vietnamese standards for particle boards.

No	Specifications	Unit	Vietnamese standards (TCVN)		Experimental results			
			P1	P3	Experiment 0	Experiment 1	Experiment 2	Experiment 3
1	Moisture content	%	5 – 13	5 - 13	9.97	10.75	10.61	10.97
2	Static bending strength	MPa	≥ 11.5	≥ 14	11.91	14.13	12.01	13.40
3	Tensil strength.....	MPa	≥ 0.24	≥ 0.45	0.41	0.47	0.44	0.43
4	Elasticity of thickness (%) after 24 hours	%	Not specified	≤ 14	10.41	7.36	7.73	10.23

Remarks: Experiment 0: Percentage of Melaleuca wood chips is 100 (%)
Experiment 1: Malaleuca - Acacia wood chips ratio: 60/40(%).
Experiment 2: Malaleuca - Acacia wood chips ratio : 70/30 (%).
Experiment 3: Malaleuca - Acacia wood chips ratio: 80/20 (%).

Table 2-9 shows that if mixing the Melaleuca wood chips with Acacia wood chips at a ratio of 60/40 (%), the particle boards manufactured from this blend can fully meet the requirements of Vietnamese Standard (P3), and the Vietnamese Standards specified for particle boards without loading, used under humid conditions.

Making an overall assessment concerning the use of Melaleuca timber as material for producing finger - joint boards, it can be stated that the biggest limitations identified are the facts that the log diameter is too small and the shrinkage of Melaleuca timber is higher than that of other types of timber. This results in low recovery rate, limited proportion of usable Melaleuca sawn timber and low economic profitability. Further studies are therefore necessary in order to make Melaleuca timber suitable for the production of sawn timber, finger joint boards, and for furniture production.

Table 2-10: Overall assessment of Melaleuca timber in relation to the requirements specified for the materials for finger joint board production

No	Technical specification	Unit	Technical requirement	*Melaleucacajuputi*
1	Logs form characteristic Diameter - Length - Crook - Conical form - Oval	 cm cm % cm/m %	 >14 >50 <15 Not specified Not specified	 Not qualified Qualified Qualified
2	- Specific gravity - barks density - Soft wood density - Hart wood debsyty	g/cm^3 g/cm^3 g/cm^3 g/cm^3	> 0.45 Not specified Not specified Not specified	Qualified
3	Technological specifications - Adherent ability - Wood color - Grain - Processing	 Mpa	 >3 Beautiful Straight Easy	 Qualified Qualified Qualified Qualified
4	Specifications of finger - join boards Crook of length (bow) - cup - Warping - Splitting in joining points	 % % %	 < 5% < 5% <5% Not allowed	 Qualified Qualified
5	The percentage of timber usable for making - Timber with diameter from 14 cm to 16 cm - Timber with diameter from 16 cm to 20 cm	 % %	 > 25 >25	 Not qualified

The possible use of Melaleuca timber as material for particle board production:

Table 2-11: Overall evaluation of Melaleuca timber in relation to the requirements specified for materials used for particle board production.

No	Technical specifications	Unit	Technical requirments	Melaleuca timber
1	Shape characteristics			
	- Diameter	cm	6- 14	Qualified
	- Length	cm	100	Qualified
	- Crook	%	<15	Qualified
	- coniform	%	Not specified	
	- Roundness	%	Not specified	
2	Specific gravity	g/cm^3	0.4 -0.6	Qualified
3	Compositions of timber for making particle boards			
	- Percentage of bark	%	<10	Not qualified
	- Percentage of sorft wood	%	Not specified	
	- Percentage of heart wood	%	Not specified	
4	Specifications of particle boards			
	- Percentage of technological chips	%	>70%	Qualified
	- PH		6-6.5	Not qualified
5	Characteristic of particle boards			
	bloated thickness	%	<15	Qualified
	Static bending strengh (Độ bền uốn tĩnh)	Mpa	15-16	Qualified
	Tensil strength ….. (Độ bền kéo vuông góc)	Mpa	0.3	Qualified

Table 2 – 11 indicates that Melaleuca timber can meet the requirements specified for materials used for particle board production. However, there are many constraints concerning automatic bark peeling (e.g. high bark volume).

III. Potentials of Melaleuca timber resources in Kien Giang

Kien Giang has the second largest area of Melaleuca forests (after Long An) in the Mekong River Delta but the largest area of natural Melaleuca forests countrywide. Besides being a precious source for scientific research, the Melaleuca forest ecosystem provides the environment for natural reserves. In addition it might create income in the field of eco-tourism and also presents a source of timber supply for the local population.

Table 3 -1: Changes in the Melaleuca forest areas in Kien Giang (2002 – 2006)

No	Forest type	2002	2003	2004	2005	2006
1	Total area of Melaleuca forests (ha)	28,988	38,038	39,019	52,945	49,519
2	Area of production forests (ha)	8,323	33,126	32,469	31,329	29,760

The above changes show that the planted Melaleuca production forests increased consecutively in 3 years (2003, 2004,2005). During this period the area harvested was smaller than the newly planted area. In 2006 the forest area decreased substantially (by 1965 ha). In the period 2006 – 2008, in addition to the annually harvested area parts of the planted forests were cut in the context of shifting cultivation. Therefore, the Melaleuca forest area did not increase but decreased (by around 2000 ha per year).

According to the data provided by the Department of Agriculture and Rural Development in 2008, the total area of the remaining production forests is 21,390 ha (including a small area of meager Eucalyptus plantations).

One of several causes for the decrease of Melaleuca production forests is determined by the income of Melaleuca growers. Income gained from farming of other agriculture crops is much higher compared to income from the Melaleuca production forests, which became less and less. In addition to that, unplanned harvesting of Melaleuca trees resulted in a decrease of selling prices of Melaleuca timbers while the market demands for "cừ tràm" and Melaleuca timber did not go down. (Tran Thanh Cao, 2006).

Based on the data obtained from surveys on the area, age levels (cấp tuổi), and average growth of Melaleuca forests and on the assumption that the rotation of plantation is seven years, the yields of harvestable Melaleuca timber in the following years ca be estimated as follows:

Table 3-2: Projection of Melaleuca timber yields

	Age level I Planted in 2006	Age level II Planted in 2005	Age level III Planted in 2004	Age level IV Planted in 2003	Age level V Planted in 2002
Areas of production forests by age levels (ha)	2,513	10,784	2,283	2,135	6,706
If assume that the business cycle of Melaleuca forests is 7 years, the areas available for harvesting in different years are:					
Harvesting year	2012	2011	2010	2009	2008
Forest areas available for harvesting by year (ha)	2,513	10,784	2,283	2,135	6,706
If assume that the man- made forests reach a stock volume of 120 m^3/ha in the 7^{th} year (the surveys in Melaleuca forests in the Long Xuyen Quadrangular revealed a stock volume of 128. 4 m^3)					
Projected yields of Melaleuca timber (m^3)	301 560	129 360	273 960	256 200	804 120

The data described in Table III-2 was calculated based on the results of a survey on the areas of man-made Melaleuca forests by different age levels in 2006 and by studies of the growth of Melaleuca forests planted in some areas of Dong Thap Muoi and Long Xuyen Quadrangular.

From the above projections, the total yields of Melaleuca timber available for harvesting in the 2008- 2012 period in Kien Giang might reach 1,756,200 m^3. If the harvesting is controlled based on market demands, the available annual yields of Melaleuca will probably be not lower than 353, 040 m^3.

Table 3- 3: Projection of the yields of Melaleuca production forests by trees

	Planted in 2006	**Planted in 2005**	**Planted in 2004**	**Planted in 2003**	**Planted in 2002**
Areas of production forests by age (ha)	2,513	10,784	2,283	2,135	6,706
If assume that the business cycle of Melaleuca forests is 7 years, the areas available for harvesting in different years are:					
	2,012	2,011	2,010	2,009	2,008
Yields of trees (1000 trees)	33, 242.5	32, 667.5	11,045	20,527,5	15,190

The above data was obtained from the below calculations:

Presently, harvesting 1 ha of Melaleuca forests can render an average of 5,000 melaleuca poles. Assuming that this productivity will not change substantially by 2010, the areas of Melaleuca forests reaching harvesting age are estimated as follows:

- 50% of the area at the age level V in 2006 can be harvested in 2007.

- 50% of the area at the age level V and 50% of the area at the age level IV can be harvested in 2008. It is possible to project the supplies in the consequent years until 2010, alike.

- The possible supply of Melaleuca pole is calculated by multiplying the area of Melaleuca forests ready for the harvest of 5,000 trees.

Conclusions:

Considering only the data of the inventory of existing production forests by age levels in 2006, the potential Melaleuca timber resource in Kien Giang in the period 2008 – 2012 is estimated as follows:

- With a seven year business cycle, the average area of Melaleuca forests harvestable annually is 4884.2 ha.

- The annual harvested yield is estimated at 22,574,500 trees/ year, equivalent to 353,040 m^3/year.

This numbers show, that Melaleuca is a significant resource of timber material which can contribute to meeting the demand for timber used in construction and processing of furniture produce.

However, the current quality of Melaleuca timber material is of rather low quality; the percentage of trees suitable for sawn timber and furniture is inadequate. In order to enhance the value of Melaleuca timber products, it is required to increase the investment scale for afforestion, apply silviculture measures to upgrade forest quality, define rational forest business cycles based on the utilization purposes of timber products and select appropriate processing technologies which are suitable for the characteristics of the current Melaleuca timber materials.

IV. Direction for efficient utilization of Melaleuca forest resources in Kien Giang

IV - 1. Evaluation of the current quality of the Melaleuca plantation and logs

a) Forest quality

Although the researches on the growth of some Melaleuca species in the Mekong River Delta show positive results, in reality the growth rate of the forests differs among regions, and in general the forests are of low quality. One reasons for this is the inadequate scale of investment in tree planting and tending. The fact that almost all of the forest areas are planted at an extensive scale causes low yields, inconsistent growth and a high percentage of curved, small and malformed trees (big root, small top) which develop branches at an early stage.

Forests planted at an extensive scale usually receive low investment. The investment in land preparation, particularly in vegetation treatment is often neglected or very low and investment in maintenance mainly covers managerial and protective activities. Inadequate selection of seedlings is common. The investment scale for extensive planting of Melaleuca forests accounts for only about 2 to 2.5 million VND per ha. If forest growers invest in vegetation treatment prior to planting, the amount is between 2.6 to 3 million VND/ha. For extensive man-made forests of medium quality, the selling price for standing trees ranges from approximately 15 million VND to 20 million VND/ ha after a cycle of 8 years (from previously some 50 million VND/ha in 2005). In anticipation of a low selling price forest growers invest less, hence selling prices keep falling gradually which consequently leads to the growers discouragement to plant trees.

To invest in forests intensively the initial phase of tending and the protection process is relatively costly for the local people (some 10 million VND to 12 million VND/ ha). Expenses cover: acquisition of seedlings and fertilizers, construction of embankment, labour cost for fertilizing, weeding, thinning, etc. The growth of the trees in intensive forests is quite satisfactory: the forest canopy closes in the first year and the tree height reaches approximately 3.4 m – 3.7 m in the second year. The quantity of "cừ 5" available after 8 years is around 2,000 trees/ ha (this information is obtained from interviews with the local farmers). To encourage the farmers to plant forests at intensive scale, the buying price of Melaleuca timber needs to be stabilized and increased. This can only be achieved when Melaleuca timber is industrially processed and when the products processed form Melaleuca timber gain high value.

b) Quality of the Melaleuca timber materials

The general characteristics of Melaleuca timber are presented in detail in Section II- 2. With its unique mechanical and physical characteristics, Melaleuca timber can be used in industrial processing like other types of timber in man-made forests, once its log dimensions are improved, diameter of wood logs become bigger, taper and crook reduced.

Table 4-1: shows the actual quality of Melaluca timber and its potential for its use in artificial board production**.**

TT	Criteria for the material quality.	Characteris-tics of Melaleuca timber	Materials for producing finger joint boards		Materials for producing particle boards	
			Requirements specified for the materials	Comparison of characteristics of Melaleuca timber with the requirements	Requirements specified for the materials	Comparison of characteristics of Melaleuca timber with the requirements
1	Log dimensions - Diameter (cm) - Length (cm) - Crook % - Coniform - (cm/m) - Roundness (độ tròn (%)	 97.11% <14 short 2,55% 1 cm/m 0,05%	 >14 cm >50 cm <15 Not specified	 Not qualified Qualified Qualified	 6- 14 cm >100 cm -- -- ---	 Qualified Qualified -- ---
2	Specific gravity KG/m3	610	>450	OK	400-600	OK
3	Technological characteristics - Adherent-ability (MPa) - Wood Color - Wood Grain - cuttable	 6,77 Light yellow Straight Easy	 >3 nice Straight Easy	 OK OK OK OK		
4	- Percentage of bark - Percentage of soft wood - Percentage of heart wood	Thick bark, automatic bark peeling is difficult	Not specified	Thick bark, automatic bark peeling is difficult	<10% Not specified	Thick bark, automatic bark peeling is difficult

5	Characteristics of particle boards - Percentage of technological wood chips - Wood PH level	80 %			>70% 6-6.5	Qualified Not qualified
6	Specifications of particle boards - bloated of thickness (Độ dãn nở dày) - Modulus of rupture (MoR - Adherent-ability (MPa)	10,41% 11.91 Mpa 0.41MPa			<15 % 11.5MPa 0.3 MPa	Qualified Qualified Qualified

IV- 2. The prospect for utilization of Melaleuca timber

a) For construction poles

The most common produce made of Melaleuca forests in the Mekong delta are poles for construction material (Cừ tràm). There is a strong demand for the use of "Cừ tràm" for stabilization of basements and as construction material in general by small scale construction projects. "Cừ tràm" does not need to be processed, therefore, harvested Melaleuca products should be classified: straight trees for use as "cừ tram" and big wood logs as material for sawn board production.

b) Sawn timber for finger joint board production

Under the traditional classification method currently applied, trees with big basal diameter (over 10 cm) and curved stumps are used as "cừ tram" after cutting off the curved part. Therefore, wood logs with a length > 50 cm, and a diameter > 10 cm (under bark), and insignificant crook can be used as sawn timber.

Sawn timber is classified in to 2 groups

- Wood logs with a diameter > 18 cm and a length >1.5 m should be sawn for furniture and floorboards. There is however a high risk of splitting the end of boards, other problems such as surface check and warping, which can occur during the drying process are the main limitations of sawn timber from Melaleuca timber. Therefore, before using big wood logs for sawing into boards, it is necessary to examine the sawing chain and the drying treatment and storage of the sawn boards.

- Smaller wood logs with a diameter > 10 cm and a length > 50 cm can be used for finger joint boards and block boards. Finger joint boards are made by joining small timber slats with glue. The commonly used finger joint boards at present have a thickness equivalent to the thickness of the component slats. The boards are used widely to make indoor and outdoor furniture. Most of the materials used to make finger joint boards are timber species from man-made forests which have small diameters, such as Acacia, Eucalyptus, Rubber.

The technology to produce the boards is not very elaborate. The equipment used may originate from domestic production or being imported from abroad. Production scale is flexible, depending on the demand and the available supply of timber materials.

Technological process for manufacturing finger joint boards without covering surface is as follows :

Round timber - sawn timber boards - dried boards - processing of component slats - finger making - prolonged jointing - board making - polishing - storage

Investment for the formation of a workshop to manufacture finger joint boards is relatively low. A workshop producing 500 m^3 of products / year needs funds of around 2 billion VND for the purchase of equipment (might be lower for domestic equipment).

Producing block boards require similar technological processes. The only difference is that timber boards are not sawn into slats but into boxes to increase the Green Saw Recovery. The boxes are later joint together for timber blocks which are used differently for different purposes: either to be sawn for finger joint boards for furniture or used as boxes to build house beams or pillars.

Round timber - lumber sawing - drying - planing - finger making - prolonged jointing board making - resawing - polishing - storage.

Theoretically, it is feasible to build block boards form Melaleuca timber. However, the technological specifications for each stage of the manufacturing process for this product type are not yet properly studied. Based on the available research results, it can be said that Melaleuca timber can be used as material for sawn timber and for building finger joint boards, etc. for furniture production. However, there are many aspects regarding the economic efficiency that need to be considered (see section IV - 3 below).

c) Materials for production of chips and particle boards

Recent studies show that the products made of Melaleuca timber, such as paper products, MDF boards, and particle boards have qualities similar to the qualities of the products made of Eucalyptus of Acacia timber. However, in order to establish factories manufacturing these products and to ensure their continuous operation, it is necessary to investment intensively and ensure a stable supply of material.

Of the factories abroad producing particle boards only those who have modern equipments and technologies available, and are able to maintain a productivity of at least 20,000 m^3/ year can ensure consistent product qualities. Whereas in Vietnam, the

Thai Nguyen particle board factory, with a productivity of 18,500 m^3/year, is considered the biggest particle board producer at present. There are many other manufacturers with a productivity range of between 2,000 m^3 and 5,000m^3/year.

The research results described in Section II – 2.2 show the feasibility of the utilization of Melaleuca timber in producing particle boards.

Considering the actual conditions of the Mekong River Delta, the appropriate productivity for a factory would be around 2,000 m^3 to 3,000 m^3 / year. The establishment of factories producing particle boards could certainly generate jobs, stabilize market outlets for Melaleuca trees, and improve the income of forest growers.

IV - 3. Preliminary assessment of economic profitability

IV - 3.1. Utilization of Melaleuca timber as material for finger joint board production.

In Vietnam there are currently many small scale workshops producing finger joint boards. The main materials used are different types of Acacia timber (Acacia Mangium, Acacia Hybrid, Acacia Auriculiformis. Manufacturing costs and selling prices for particle boards made of Acacia timber with a size of 1.22 x 2.44 m and a thickness of 18 - 20 mm are - roughly estimated - as follows:

- Product selling price: 10 million VND / m^3
- Purchase of timber material: 6 million VND/ m3 (sawn timber)
- Cost of processing 1m^3 of particle board : 2.5 millions VND/ m^3

According to this estimate, the pre-tax profit of a workshop producing 500 m^3 / year of finger joint boards might reach 750 million VND/ year.

Using Melaleuca timber materials instead, profitability is much lower due to the significantly lower quality of Melaleuca timber. Based on the current quality and selling price of Melaleuca timber materials, the funds needed to purchase material for the production of 1 m^3 Melaleuca finger joint boards, are estimated as follows:

- Selling price of one Melaleuca wood log with a diameter of 10 cm (under bark) and a length of 1.2 m (equivalent to a volume of 0.00942 m3) is 12, 000 VND/ log
- The calculated Green Saw Recovery of sawn timber is 10% for a slat of sawn timber with a size of 2.5 cm x3 cm x1.2 m
- Accordingly, for 1 m^3 of sawn timber 11,000 wood logs (of the above -mentioned size) are needed.

- assumed that the percentage of wastage during the production process of 1 m^3 of finger joint boards is 1.25 (which is higher in reality), the quantity of round timber needed to produce 1 m^3 of finger joint boards is: 1,100 x 1.25 = 1,375 logs.

- Consequently, the cost of material needed for producing 1 m^3 of finger joint boards is 1,375 logs x 12,000 VND/log = 16,500, 000 VND.

The cost of material alone is too high, causing the price of 1 m^3 of finger joint boards from Melaleuca timber to be much higher than the price of the currently available commercial finger joint boards from Acacia, Pine and Rubber timber.

It must be concluded that the use of Melaleuca round timber of the current quality is not at all profitable.

IV- 3.1. Utilization of Melaleuca timber as material for block board production.

When using Melaleuca timber as material for making block boards the Green Saw Recovery of sawn timber is higher. The cost for 1 m^3 of joint block board is estimated roughly as follows:

- In theory, the Green Saw Recovery of sawn timber from round wood with the d diameter is 0.71 d.

- Assumed the Green Saw Recovery is 0.7, one would need 151 Melaleuca wood logs with a diameter of 10 cm and a length of 1.2 cm to build 1 m^3 of joint timber boxes. The estimated cost of material for 1 m^3 of joint timber boxes is 1,812, 000 VND.

- Assumed that the wastage ratio for 1 m^3 of finger joint boards from joint timber boxes is 1: 2 (i.e. 2 m^3 of joint timber boxes are needed to produce 1 m^3 of finger joint boards), the material cost for timber is only 3,624,000 VND (equivalent to the current material cost for finger joint boards from Acacia timber).

Given a selling price of 12,000 VND for one log with the above mentioned size, survey results show that forest growers can gain remarkable profit from selling this product. Thus purchasing this product will help increase the income of the forest grower.

IV- 3.2. Materials for production of chips and particle boards

Equipment cost for a small scale particle board manufacturing factory (2,000 m^3 of products/ year) is around 3 billion VND; the current selling price of 1 m^3 of particle boards of medium quality is 2 million VND.

Required material supply per year is 2,500,000 tons of Melaleuca timber - equivalent to 6,000 Ster, which equals the harvested yield of 72 ha of Melaleuca forests in the 7^{th} year with a remaining tree density of 5,000 trees/ha

Once factories manufacturing particle boards from Melaleuca timber are established, the buying prices of Melaleuca timber material will increase and the forest growers will have a chance to increase their income. With a buying price of 350,000 VND/ ton (equivalent

to the current buying price of Acacia timber for particle boards), the selling price of Melaleuca timber will have augmented by 5,000 VND/ ton, meaning that the forest growers can have an increase of 1.5 – 2 million in income from selling 1 ha.

V. Conclusions and Recommendations

V- 1. Potential of the Melaleuca timber material resource in Kien Giang

With a total area of 49,519 ha of Melaleuca forests, Kien Giang posesses a resource valuable to many aspects of socio – economic development and environment protection. If there are policies to sustain the current area of Melaleuca forests, annually Kien Giang is able to harvest and utilize 35,040 m^3 of Melaleuca timber/ year.

According to the statistical data provided by the Sub Department of Forest Protection of Kien Giang, for the past three years (2006 – 2008) there has been a rather high demand for round timber and sawn timber of various types: over 4,000 m^3 / year of round timber and 3,000 m^3 / year of sawn timber. The bigger part of the material was either imported from abroad or obtained from other provinces.

The advantages of the available quantity of 35,040 m^3 of Melaleuca timber being efficiently processed and utilized are manifold: not only would this generate jobs and increase the income for the forest growers, but also could the spending of foreign currency be reduced by using domestic timber material and at the same time lessen the pressure on the provinces economic development due to limited timber supply.

V-2. Quality of Melaleuca timber materials and the direction for utilization

V- 2.1 . Material quality

Although the physical, mechanical and chemical characteristics of Melaleuca timber is similar to those of the widely planted timber trees, such as Acacia, Eucalyptus, etc. , the dimensions of Melaleuca timber is too poor (small diameter, curved trees, narrow tops, thick bark), to meet the requirements specified for materials used in industrial production of products like sawn timber and finger joint boards.

V- 2. 2. The prospect for Melaleuca timber utilization

- Since poles made of Melaleuca are by all means suitable for the stabilization of basements of construction facilities in the Mekong River Delta, their use should be prioritized in the absence of efficient processing methods.

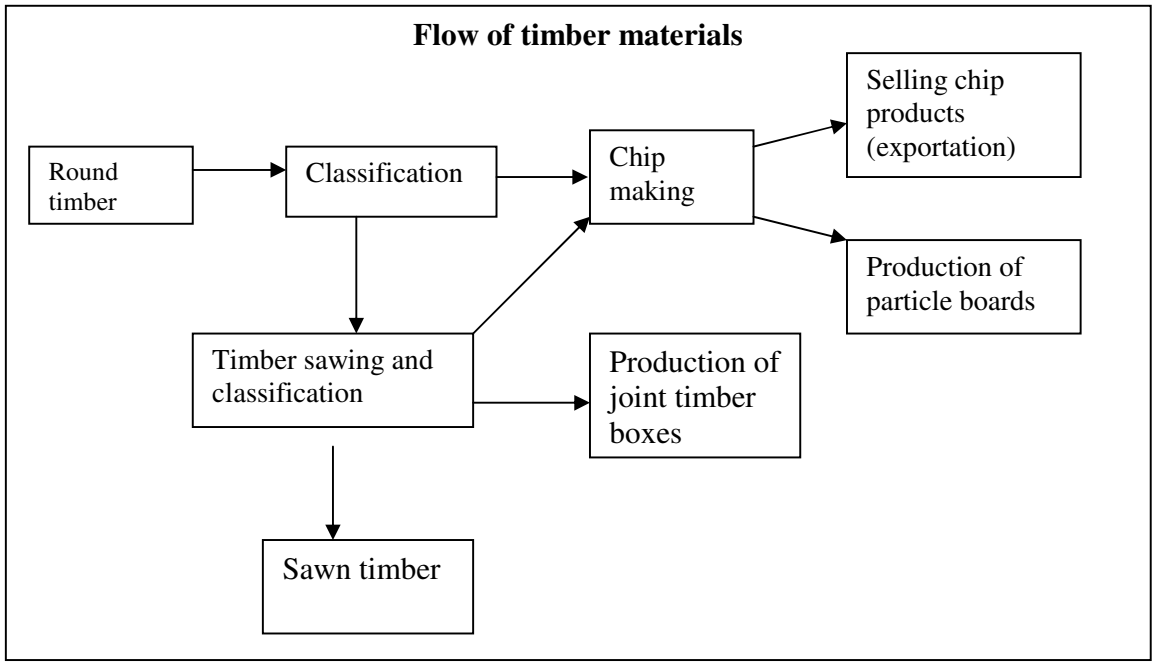
- Using Melaleuca timber as material for the production of wood chips (pulp and MDF boards) and particle boards.

- Wood logs with a diameter > 15 cm and a length > 50 cm can be used to produce sawn timber boards, finger joint boards and block boards.

- To efficiently utilize the post harvesting Melaleuca timber products, it is possible to establish factories manufacturing multi – Melaleuca timber produce, which mainly

produce wood chips and particle boards. The assembly lines for producing sawn timber, finger joint boards and joint timber boxes can be used to make the best use of wood logs with big diameters to create more valuable products.

The material flow in the factories is illustrated below:



V- 3. Recommendations

- It is necessary to improve the quality of Melaleuca forests by means of intensive practices: increase the investment scale in tree planting, apply silviculture measures during the forest establishment process. The plantation of Melaleuca forests should be planned based on specific purposes: forests for wood chips, forests for sawn timber products. Different silviculture techniques and business cycles should be applied for the different forest types.

- The State and local authorities of Kien Giang Province should formulate policies to support and encourage tree planting, for example by creating more favorable conditions for the farmers, such as facilitate borrowing for investment in forest planting, and in prolonging the business cycle of the forests providing material for sawn timber.

- To support implementaiton of networks concerning processing and consumption of Melaleuca timber products. State and local government should formulate policies to facilitate borrowing, hence stimulating the processing of Melaleuca timber.

- Annual harvesting should be carefully planned, considering the market demand in order to avoid mass exploitation and oversupply which will inevitably lead to falling prices of Melaleuca timber.

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