11) Revenue

The revenue in this project is summarized in Table III-31, and the annual nominal revenue was calculated by assuming the same price rise of 4% as in the case of expenditure and shown in Table III-33.

12) Annual Revenue and Expenditure and Cumulative Balance

The cumulative balance was calculated as shown in Table III-34 based on Table III-32 Annual Expenditure and Table III-33 Annual Revenue.

B. Summary of Revenue and Expenditure in This Project

1) Revenue

In this project, incomes are expected to accrue between the eighth and twenty-fourth years. Based on the current values, they total RM754.7 million. If the annual income is inflated by the price rise of 4% as in the case of expenditure, the total of nominal revenue in twenty-five years will be RM1,499.4 million.

2) Expenditure

The total expenditure based on current values is RM591.6 million. If price-fluctuation and physical contingency are included, this translates into a figure of RM1,190.7 million.

3) Revenue and Expenditure and Financial Internal Rate of Return (FIRR) and Net present Value (NPV)

The annual revenue and expenditure are shown in Table III-34. A surplus in balance will begin to occur in the eleventh year. The cumulative deficit will reach a peak of RM121.9 million in the tenth year and be resolved in the sixteenth year. Nevertheless, FIRR is a low figure of 9.25%. Calculated at an 10% discount rate from Table III-34, net present value (NPV) is as low as M$7,546,000 as shown in Table III-35. This is because the calculation includes also expenses for other species and dipterocarp species from which no income will accrue, and *A. mangium* and *P. falcataria* which will not be harvested within the period of this project. These expenses include the costs of forestation, seedling production, facilities, vehicles, forest roads, vehicle maintenance, and administration and operation.

5-1-2 Calculation of Expenses for Planted Trees to be Harvested within the Period of This Project

The financial analysis of this project will be made by calculating expenses for planted trees of *A. mangium* and *P. falcataria* which will be harvested within the period of this project.

A. mangium trees planted by the seventeenth year and *P. falcataria* trees planted by the fourteenth year will be harvested within the period of this project. Harvesting the former will begin in the eighth year and continue until the twenty-fourth year. Harvesting the latter will begin in the eleventh year and continue until the twenty-fourth year. The following expenses for their planting and harvesting were drawn from all cost items and calculated as outgoings which will eventually bring about income.

1) Forestation Costs

Expenses for planting *A. mangium* from the first to seventeenth years and *P. falcataria* from the first to fourteenth years were also included. Expenses for planting other species and Dipterocarp species were not added because they will not be harvested or very few volume to be harvested. Forestation costs (Table III-36) were calculated according to the standard processes of forestation by species and the annually planned forestation area.

2) Seedling Production Costs

Like forestation costs, seedling production costs were calculated according to the seedling production plan under the forestation plan and the standard processes of seedling production by species as shown in Table III-37.

3) Forest Road Costs

(a) The construction cost of new roads for planting *A. mangium* and *P. falcataria* was estimated at RM26.50/m on the assumption that they would be constructed at a rate of 5 m per hectare of initial extraction area.

(b) The improvement cost of existing roads was estimated at RM13.25/m on the assumption that they would be improved at a rate of 4 m per hectare of annual plantation area of these species.

(c) The repair cost of existing roads was estimated at RM4.17/m on the assumption that they would be repaired at a rate of 16 m per hectare of annual plantation area of these species.

(d) The costs of concrete side-ditches and gravelling for supplemental improvement of forest roads were estimated at RM25.00/m and RM15.00/m, respectively. It is assumed that the former's length will be 10% of the length of improved and repaired forest roads (m) combined, while the latter's length will be 20% of the same.

These expenses for forest roads were calculated on an annual basis as shown in Table III-38.

4) Costs of Facilities and Vehicles

(a) The cost of nursery facilities was allocated in proportion to the number of produced seedlings of each species. As the share of *A. mangium* and *P. falcataria* is 92%, the cost of nursery facilities was estimated at RM1,762,000 (92% of RM1,915,000 at the outset) and RM1,370,000 (92% of RM1,489,000 in the first year).

(b) Housing and Lodging Construction Cost

The construction cost of houses and lodgings was allocated in proportion to the total plantation area of *A. mangium* and *P. falcataria*. The share of these species in the area is 76% to 80% until the start of harvesting. Therefore, the annual construction cost of houses and lodgings from the outset to the third year was estimated at 80% of the total. The construction cost in the eighth year was 100% because new houses and lodgings will be constructed for the increased workers for harvesting.

(c) Lookout Tower Construction Cost

The construction cost of lookout towers was fully reckoned in because they are designed to watch the whole of this area for fire prevention and fighting.

(d) The annual costs of heavy duty machinery, vehicles and a power generator were allocated in proportion to plantation area until the planting year of trees to be harvested (the seventeenth year for *A. mangium* and the fourteenth year for *P. falcataria)*. It is assumed that the share in the area is 80% from the outset to the seventeenth year. From the eighteenth to the twenty-fourth years, during which operations will be focused on harvesting rather than planting and seedling production, 30% of the annual cost will be allocated to administration.

The costs of facilities and vehicles were annually allocated to every cost item as shown in Table III-39.

5) Vehicle Maintenance Costs

The costs of vehicle maintenance including repair, fuel and oil were calculated at an allocation rate of 80% (from the outset to the 17th year) or 30% (from the 18th to 24th years), as for heavy duty machinery, vehicles and the power generator.

The costs of vehicle maintenance and the above-mentioned costs of forest roads are summarized in Table III-40.

6) Administration and Operation Costs

The administration and operation costs, salaries and wages of the staff and daily-employed workers were allocated in proportion to area by species. From the

outset to the seventeenth year, 80% of the initial total cost was included. From the eighteenth to twenty-fourth years, 30% of the same was included. From the eighth year as the first year of harvesting to the twenty-fourth year, the administration and operation costs, salaries and wages of the staff and workers required for harvesting will be added to the allocated cost. Administration and operation costs were calculated as shown in Table III-41.

7) Reserves

A reserve for price fluctuation was estimated at 4%, while the physical contingency was 10%.

All annual expenses were aggregated, and price-fluctuation and physical reserves were added to the total. Annual expenditure was then calculated as shown in Table III-42.

8) Revenue

For revenue, see Table III-33 Annual Revenue.

9) Annual Revenue and Expenditure and Cumulative Balance

The cumulative balance was calculated according to Table III-42 Annual Expenditure and Table III-33 Annual Revenue as shown in Table III-43.

5-1-3 Summary of Revenue and Expenditure for Planted Trees to be Harvested within the Period of This Project

1) Revenue

As in the overall plan, incomes will accrue from such trees between the eighth and twenty-fourth years. At the current values, they are estimated at RM754.7 million. If the annual income is inflated by the same price rise of 4% as in the case of expenditure, the total of nominal incomes in twenty-five years is estimated to be RM1,499.4 million.

2) Expenditure

The total expenditure at current values is RM497.3 million. If price-fluctuation and physical reserves (10%) are included, it becomes RM989.3 million.

3) Revenue and Expenditure and Financial Internal Rate of Return (FIRR) and Net Present Value

The annual revenue and expenditure are shown in Table III-43. A surplus will begin to occur in the ninth year. The cumulative deficit will reach a peak of RM91.5 million in the eighth year and be resolved in the fifteenth year. FIRR is 13.66%. This figure is sufficient to implement this project. If the following untangible effects

are taken into account, this project is judged to be feasible. Calculated at an 10% discount rate from Table III-43, net present value (NPV) is M$38,419,000 as shown in Table III-44.

Untangible effects:

(a) Creation of forest resources by forestation

(b) Conservation of forest land and headwaters

(c) Improvement of land productivity

(d) Creation of employment opportunities

5-2 Cost-Benefit Analysis of Small-Scale Plantation

Small-scale forestation will be mainly carried out by farms, which will occasionally plant generally small areas of trees. Tree farming will probably be undertaken by surplus labour at farms. The cost-benefit analysis of small-scale forestation is based on the model's assumption that an individual will plant *A. mangium* trees in an area of 1 ha and sell them as pulpwood for the eighth year of planting.

The following conditions and asusmptions are applied to the analysis:

(1) The number of trees planted is 1,250 pieces per ha with 10% supplementary planting, as in the case of large and medium-scale forestation.

(2) The cost of foresting work is RM890.3 per ha, as in the case of large and medium-scale forestation.

(3) Seedlings will be purchased from SAFODA at a unit price of RM0.30.

(4) MAI is 20 m^3/ha. Harvesting will begin in the eighth year of planting. The stock of standing trees will be 140 m^3/ha, and harvesting yield will be 80%. Thus, log output will be 112 m^3/ha.

(5) Whereas the harvesting and transportation cost is RM29.80/m^3 in the case of large and medium-scale forestation, it will be increased by 30% to RM35.90/m^3 for small scale forestation requiring more costly manual yarding, loading and transportation.

(6) The cost of forest roads is RM120.00/ha in anticipation of repairs and improvement at harvesting.

(7) Expenses for administration, vehicle maintenance and facilities will not be included because tree farm is a side job for individuals.

(8) The price of *A. mangium* ex chip mill will be RM71.66/m^3 as in the case of large- and medium-scale forestation.

(9) Decimal fractions under RM1 will be rounded.

(10) The price-fluctuation reserve will rise at an annual rate of 4%, and nominal revenue will rise at the same rate. The percentage of the physical contingency to total expenditure is 10%.

Based on these conditions, total expenditure is RM7,434, and nominal revenue is RM10,561 as shown in Table III-45. Thus, the internal rate of return is 18.26% as shown in Table III-46, about 4.6% higher than that for the planted trees of *A. mangium* and *P. falcataria* in large and medium-forestation to be harvested within the period of this project. Calculated at on 10% discount rate from Table III-45, net present value (NPV) is MR920 as shown in Table III-47. This figure is affected by the increased cost of harvesting and transportation despite the exclusion of expenses for administration, vehicle maintenance and facilities.

From this figure of FIRR, the small-scale management of forestation is judged to be sufficiently feasible even though the selling lot of logs is small and price is somewhat low.

Table III–13 Standard Forestation Process (*Acacia mangium*)

Area in hectares

Year	Work	Item	Workers per ha	Quantity	Unit Cost (RM)	Cost (RM)
1	Site Preparation	Surveying, zoning	2.4	2.4 men	15.00	36.00
		Low-layer clearance	4.3	4.3 men	15.00	64.50
		Felling	5.7	5.7 men	15.00	85.50
		Lopping, piling	2.0	2.0 men	15.00	30.00
		Burning	0.4	0.4 men	15.00	6.00
		Clearance of planting lines (2 m wide)	4.0	4.0 men	15.00	60.00
		Total		18.8 men		282.00
	Planting	Marking	2.6	2.6 men	15.00	39.00
		Digging 1,250 holes	5.7	5.7 men	15.00	85.50
		Planting, carrying 1,250 seedlings	8.0	8.0 men	15.00	120.00
		Supplementary planting (125 seedlings)	1.0	1.0 men	15.00	15.00
		Transporting seedlings by contract		1,375 sdlng/ha	0.02/sdlng	27.50
		Baskets of seedlings		2 pcs/ha	2.50	5.00
		Labour cost		17.3 men		259.50
		Material and transportation costs				32.50
		Total				292.00
	Tending	First weeding (in lines 1 m wide)	2.7	2.7 men	15.00	40.50
		Fertilization (50 g NPK per sdlng)	2.0	2.0 men	15.00	30.00
		Fertilizer cost (62.50 kg/ha)		62.50 kg	0.66/kg	41.30
		Survey of survival and growth	2.5	2.5 men	15.00	37.50
		Assistance for workers lodges			5.00/ha	5.00
		Labour cost		7.2 men		108.00
		Material and other costs				46.30
		Total				154.30
	Total in 1st year	Labour cost		43.3 men		649.50
		Material and other costs				78.80
		Total				729.30
2	Tending	Second weeding (in lines 2 m wide)	5.4	5.4 men	15.00	81.00
		Third weeding (entire)	5.4	5.4 men	15.00	81.00
		Total		10.8 men		162.00
Total		Labour cost		54.1 men		811.50
		Material and other costs				78.80
		Total				890.30

Table III-14 Standard Forestation Process (*Paraserianthes falcataria*)

Area in hectares

Year	Work	Item	Workers per ha	Quantity	Unit Cost (RM)	Cost (RM)
1	Site Preparation	Surveying, zoning	2.4	2.4 men	15.00	36.00
		Low-layer clearance	4.3	4.3 men	15.00	64.50
		Felling	5.7	5.7 men	15.00	85.50
		Lopping, piling	2.0	2.0 men	15.00	30.00
		Burning	0.4	0.4 men	15.00	6.00
		Clearance of planting lines (2 m wide)	4.0	4.0 men	15.00	60.00
		Total		18.8 men		282.00
	Planting	Marking	1.7	1.7 men	15.00	25.50
		Digging 833 holes	3.8	3.8 men	15.00	57.00
		Planting, carrying 833 seedlings	5.4	5.4 men	15.00	81.00
		Supplementary planting (84 seedlings)	0.7	0.7 men	15.00	10.50
		Transporting seedlings by contract		916 s/ha	0.02/sdlng	18.40
		Baskets of seedlings		2 p/ha	2.50	5.00
		Labour cost		11.6 men		174.00
		Material and transportation costs				23.40
		Total				197.40
	Tending	First weeding (in lines 1 m wide)	2.7	2.7 men	15.00	40.50
		Fertilization (50 g NPK per sdlng)	2.0	2.0 men	15.00	30.00
		Fertilizer cost (0.05 kg/sdlng × 833 = 41.7 kg)		41.7 kg	0.66/kg	27.60
		Survey of survival and growth	1.7	1.7 men	15.00	25.50
		Assistance for workers lodges			5.00/ha	5.00
		Labour cost		6.4 men		96.00
		Material and other costs				32.60
		Total				128.60
	Total in 1st year	Labour cost		36.8 men		552.00
		Material and other costs				56.00
		Total				608.00
2	Tending	Second weeding (in lines 2 m wide)	5.4	5.4 men	15.00	81.00
		Third weeding (entire)	5.4	5.4 men	15.00	81.00
		Total		10.8 men		162.00
Total		Labour cost		47.6 men		714.00
		Material and other costs				32.60
		Total				746.60

Table III-15 Standard Forestation Process (Others)

Area in hectares

Year	Work	Item	Workers per ha	Quantity	Unit Cost (RM)	Cost (RM)
1	Site Preparation	Surveying, zoning	2.4	2.4 men	15.00	36.00
		Low-layer clearance	4.3	4.3 men	15.00	64.50
		Felling	5.7	5.7 men	15.00	85.50
		Lopping, piling	2.0	2.0 men	15.00	30.00
		Burning	0.4	0.4 men	15.00	6.00
		Clearance of planting lines (2 m wide)	4.0	4.0 men	15.00	60.00
		Total		18.8 men		282.00
	Planting	Marking	1.7	1.7 men	15.00	25.50
		Digging 833 holes	4.6	4.6 men	15.00	69.00
		Planting, carrying 833 seedlings	8.1	8.1 men	15.00	121.50
		Supplementary planting (84 pieces)	1.0	1.0 men	15.00	15.00
		Transporting seedlings by contract		916 s/ha	0.04/sdlng	36.70
		Baskets of seedlings		2 p/ha	2.50	5.00
		Labour cost		15.4 men		231.00
		Material and transportation costs				41.70
		Total				272.70
	Tending	First weeding (in lines 1 m wide)	2.7	2.7 men	15.00	40.50
		Fertilization (50 g NPK per sdlng)	2.0	2.0 men	15.00	30.00
		Fertilizer cost (0.05 kg/sdlng × 833 = 41.7 kg)		41.7 kg	0.66/kg	27.60
		Second weeding (entire)	5.4	5.4 men	15.00	81.00
		Fertilization (2) (50 g NPK per s.)	2.0	2.0 men	15.00	30.00
		Fertilizer cost (41.7 kg)		41.7 kg	0.66/kg	27.60
		Survey of survival and growth	1.7	1.7 men	15.00	25.50
		Assistance for worker lodges			5.00/ha	5.00
		Labour cost		13.8 men		207.00
		Material and other costs				60.20
		Total				267.20
	Total in 1st year	Labour cost		48.0 men		720.00
		Material and other costs				101.90
		Total				821.90
2	Tending	Third weeding (in lines 2 m wide)	5.4	5.4 men	15.00	81.00
		Fourth weeding (entire)	5.4	5.4 men	15.00	81.00
		Fifth weeding (in lines 2 m wide)	5.4	5.4 men	15.00	81.00
	Total	Labour cost		16.2 men		243.00
Total in 2nd year		Labour cost		58.2 men		963.00
		Material and other costs				101.90
		Total				1,064.90

Table III-16 Standard Forestation Process of Enrichment Planting (Dipterocarpaceae)

Area in hectares

Year	Work	Item	Workers per ha	Quantity	Unit Cost (RM)	Cost (RM)
1	Site Preparation	Surveying, zoning	4.8	4.8 men	15.00	72.00
		Low-layer clearance	0.8	0.8 men	15.00	12.00
		Felling	2.5	2.5 men	15.00	37.50
		Lopping, piling	2.0	2.0 men	15.00	30.00
		Clearance of planting lines (2 m wide)	3.0	3.0 men	15.00	45.00
		Total		13.1 men		196.50
	Planting	Marking	0.7	0.7 men	15.00	10.50
		Digging 250 holes	1.4	1.4 men	15.00	21.00
		Planting, carrying 250 seedlings	2.5	2.5 men	15.00	37.50
		Supplementary planting (25 seedlings)	0.3	0.3 men	15.00	4.50
		Transporting seedlings by contract		275 s/ha	0.04/sdlng	11.00
		Baskets of seedlings		2 p/ha	2.50	5.00
		Labour cost		4.9 men		73.50
		Material and transportation costs				16.00
		Total				89.50
	Tending	First weeding (in lines 5 m wide; 2,500 m^3/ha)	3.0	3.0 men	15.00	45.00
		Second weeding (in lines 5 m wide)	3.0	3.0 men	15.00	45.00
		Total labour cost		6.0 men		90.00
	Total in 1st Year	Labour cost		24.0 men		360.00
		Material and other costs				16.00
		Total				376.00
2	Tending	Third weeding (in lines 5 m wide)	3.0	3.0 men	15.00	45.00
		Fourth weeding (in lines 5 m wide)	3.0	3.0 men	15.00	45.00
		Total labour cost		6.0 men		90.00
	Total			6.0 men		90.00
3	Tending	Surrounding pruning (one man/day for 40 seedling lines; 250 sdlng a day)	6.3	6.3 men	15.00	94.50
	Total			6.3 men		94.50
Total		Labour cost		36.3 men		544.50
		Material and transportation costs				16.00
		Total				560.00

Table III-17 (1) Forestation Costs and Required Workers

Cost (RM1,000)
Workers (1,000)

Year	Acacia mangium							Paraserianthes falcataria							Other species						
	Area	Cost			No. of workers			Area	Cost			No. of workers			Area	Cost			No. of workers		
		1st year	2nd year	Total	1st year	2nd year	Total		1st year	2nd year	Total	1st year	2nd year	Total		1st year	2nd year	Total	1st year	2nd year	Total
0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
1	2,500	1,823	0	1,823	108.3	0.0	108.3	500	304	0	304	18.4	0.0	18.4	0	0	0	0	0.0	0.0	0.0
2	3,000	2,188	405	2,593	129.9	27.0	156.9	600	365	81	446	22.1	5.4	27.5	400	329	0	329	19.2	0.0	19.2
3	3,000	2,188	486	2,674	129.9	32.4	162.3	800	486	97	584	29.4	6.5	35.9	700	575	97	673	33.6	6.5	40.1
4	3,500	2,553	486	3,039	151.6	32.4	184.0	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
5	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
6	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
7	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
8	4,000	2,917	567	3,484	173.2	37.8	211.0	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
9	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
10	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	700	575	170	745	33.6	11.3	44.9
11	4,000	2,917	648	3,565	173.2	43.2	216.4	500	304	130	434	18.4	8.6	27.0	500	411	170	581	24.0	11.3	35.3
12	4,000	2,917	648	3,565	173.2	43.2	216.4	600	365	81	446	22.1	5.4	27.5	0	0	122	122	0.0	8.1	8.1
13	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	97	584	29.4	6.5	35.9	0	0	0	0	0.0	0.0	0.0
14	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
15	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
16	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
17	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
18	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
19	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
20	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
21	4,000	2,917	648	3,565	173.2	43.2	216.4	500	304	130	434	18.4	8.6	27.0	0	0	0	0	0.0	0.0	0.0
22	4,000	2,917	648	3,565	173.2	43.2	216.4	600	365	81	446	22.1	5.4	27.5	0	0	0	0	0.0	0.0	0.0
23	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	97	584	29.4	6.5	35.9	0	0	0	0	0.0	0.0	0.0
24	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	0	0	0	0	0.0	0.0	0.0
Total	90,500	66,002	14,013	80,015	3918.7	934.2	4852.9	17,700	10,762	2,738	13,499	651.4	182.5	833.9	6,500	5,342	1,580	6,922	312.0	105.3	417.3

Table III-17 (2) Forestation Costs and Required Workers

Dipterocarps									Total								
	Cost (RM1,000)				No. of workers					Cost (RM1,000)				No. of workers			
Area	1st year	2nd year	3rd year	Total	1st year	2nd year	3rd year	Total	Area	1st year	2nd year	3rd year	Total	1st year	2nd year	3rd year	Total
0	0	0	0	0	0.0	0.0	0.0	0.0	0	0	0	0	0	0.0	0.0	0.0	0.0
0	0	0	0	0	0.0	0.0	0.0	0.0	3,000	2,127	0	0	2,127	126.7	0.0	0.0	126.7
500	188	0	0	188	12.1	0.0	0.0	12.1	4,500	3,069	486	0	3,555	183.2	32.4	0.0	215.6
500	188	45	0	233	12.1	3.0	0.0	15.1	5,000	3,438	725	0	4,163	205.0	48.4	0.0	253.4
500	188	45	47	280	12.1	3.0	3.2	18.2	5,500	3,802	831	47	4,680	226.6	55.4	3.2	285.2
500	188	45	47	280	12.1	3.0	3.2	18.2	5,500	3,802	912	47	4,761	226.6	60.8	3.2	290.6
500	188	45	47	280	12.1	3.0	3.2	18.2	5,500	3,802	912	47	4,761	226.6	60.8	3.2	290.6
500	188	45	47	280	12.1	3.0	3.2	18.2	5,500	3,802	912	47	4,761	226.6	60.8	3.2	290.6
500	188	45	47	280	12.1	3.0	3.2	18.2	6,000	4,167	912	47	5,126	248.3	60.8	3.2	312.2
500	188	45	47	280	12.1	3.0	3.2	18.2	6,000	4,167	993	47	5,207	248.3	66.2	3.2	317.6
500	188	45	47	280	12.1	3.0	3.2	18.2	6,000	4,167	993	47	5,207	248.3	66.2	3.2	317.6
500	188	45	47	280	12.1	3.0	3.2	18.2	5,500	3,820	993	47	4,860	227.7	66.2	3.2	297.0
500	188	45	47	280	12.1	3.0	3.2	18.2	5,100	3,470	896	47	4,413	207.3	59.7	3.2	270.2
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	790	47	4,429	214.7	52.7	3.2	270.5
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
500	188	45	47	280	12.1	3.0	3.2	18.2	5,000	3,409	823	47	4,279	203.7	54.8	3.2	261.6
500	188	45	47	280	12.1	3.0	3.2	18.2	5,100	3,470	774	47	4,291	207.3	51.6	3.2	262.1
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	790	47	4,429	214.7	52.7	3.2	270.5
500	188	45	47	280	12.1	3.0	3.2	18.2	5,300	3,592	823	47	4,461	214.7	54.8	3.2	272.7
11,500	4,324	990	992	6,306	277.2	66.0	66.2	409.3	126,200	86,430	19,320	992	106,742	5159.2	1288.0	66.2	6513.3

Table III-18 Seedlings Produced per Hectare of Plantation Area

Species	Planting seedlings	Supplementary seedlings	Total	Outplanting ratio	Produced seedlings
Acacia mangium	4m×2m 1,250	125	1,375	80%	1,719
Paraserianthes falcataria	4m×3m 833	83	916	80%	1,145
Others (*Tectona grandis, Gmelina arborea*, etc.)	4m×3m 833	83	916	80%	1,145
Dipterocarp species	250	25	275	70%	393

Table III–19 Standard Process of Seedling Production
(Acacia mangium & Paraserianthes falcataria)

(per 1,000 seedlings)

Work	Item	Number per man	Quantity	Unit Cost (RM)	Cost (RM)
Preparation for Sowing	Sieving, mixing compost, potting	900 pots	1.11 men	15.00	16.67
Sowing	Sowing, watering		0.50 men	15.00	7.50
Transplanting	1,500 pots per man		0.67 men	15.00	10.05
Tending & Maintenance	Watering, shading, weeding, spraying of chemicals		1.25 men	15.00	18.75
Outplanting	Pot arrangement, selection and loading of seedlings		1.67 men	15.00	25.05
Compost Making	3.75 men per 1 m^3 of ripened compost; 0.0846 m^3 per 1,000 pots		0.32 men	15.00	4.80
Survey	Growth, availability and other items		1.5 men	15.00	22.50
Subtotal of Labour Costs			7.02 men		105.32
Seeds	100,000/kg; 70% germination; RM1,400/kg as for *A. mangium*		0.014kg/1,000 pots	1,200/kg	16.80
Potted Soil	Pot capacity: 0.283 m^3/1,000 pots Topsoil: 70% of a pot 0.198 m^3/1,000 pots		0.193m^3/1,000 pots	40/m^3	7.92
Potted Soil	Compost: 30% of a pot 0.085 m^3/1,000 pots Rice straw to make ripe compost: 2.5 m^3/m^3 Rice straw cost and freight		0.085m^3/1,000 pots	25/m^3	2.13
Potting Soil	Sawdust for sowing trays: 0.01 m^3/1,000 pots		0.01m^3/1,000 pots	30/m^3	0.30
Polyethylene Bags	4.46 cm in diameter × 18 cm in height			13/1,000 bags	13.00
Fungicide	For sowing–sawdust: Tersan 75 WP 0.005 kg per 1,000 pots For seedbed: Benlate WP 0.003 kg per 1,000 pots			38/kg 90/kg	0.19 0.27
Insecticide	Decis EC 0.002 ℓ/1,000 pots Siputon 0.175 kg/1,000 pots			30/ℓ 7/kg	0.06 1.23
Fertilizer	Bifolax (NPK liquid) 0.007 ℓ/1,000 pots			12/ℓ	0.09
Subtotal of Material Costs					41.99
Total					147.31

Table III–20 Standard Process of Seedling Production (Others)

(per 1,000 seedlings)

Work	Item	Number per man	Quantity	Unit Cost (RM)	Cost (RM)
Preparation for Sowing	Sieving, mixing compost, potting	300 pot/men	3.33 men	15.00	49.95
Sowing	Sowing, watering	1,000 pots	1.00 men	15.00	15.00
Tending & Maintenance	Watering, shading, weeding, spraying of chemicals		3.75 men	15.00	56.25
Outplanting	Pot arrangement, selection and loading of seedlings		3.40 men	15.00	51.00
Compost Making	3.75 men per 1 m^3 of ripened compost; 0.0846 m^3 per 1,000 pots		1.00 men	15.00	15.00
Survey	Growth, availability and other items		1.5 men	15.00	22.50
Subtotal of Labour Costs			13.98 men		209.70
Seeds	120,000/kg; 90% germination; 0.93kg/1,000 pots as for *E. camaldulensis*			120/kg	111.60
Potting Soil	Pot capacity: 0.905 m^3/1,000 pots Topsoil: 0.634 m^3/1,000 pots Compost: 0.271 m^3/1,000 pots Rice straw to make compost: 2.5 m^3/m^3 (RM10/m^3)			 40/m^3 25/m^3	 25.36 6.78
Polyethylene Bags	8 cm in diameter × 20 cm in height			24/1,000 bags	24.00
Fungicide	Benlate WP 0.009 kg per 1,000 pots			90/kg	0.81
Insecticide	Decis EC 0.006 ℓ/1,000 pots Siputon 0.525 kg/1,000 pots			30/ℓ 7/kg	0.18 3.68
Fertilizer	Bifolax 0.021 ℓ/1,000 pots			12/ℓ	0.26
Subtotal of Material Costs					172.67
Total					382.37

Table III-21 Standard Process of Seedling Production (Dipterocarpaceae)

(per 1,000 seedlings)

Work	Item	Number per man	Quantity	Unit Cost (RM)	Cost (RM)
Preparation for Sowing	Sieving, mixing compost, potting	300 pot/men	3.33 men	15.00	49.95
Sowing	Sowing, watering	1,000 pots	1.00 men	15.00	15.00
Tending & Maintenance	Watering, shading, weeding, spraying of chemicals		3.75 men	15.00	56.25
Outplanting	Pot arrangement, selection and loading of seedlings		3.40 men	15.00	51.00
Compost Making	3.75 men per 1 m^3 of ripened compost; 0.0846 m^3 per 1,000 pots		1.00 men	15.00	15.00
Survey	Growth, availability and other items		1.5 men	15.00	22.50
Subtotal of Labour Costs			13.98 men		209.70
Seeds	Estimated at double teak incl. collection and sundry expenses				227.20
Potting Soil	Pot capacity: 0.905 m^3/1,000 pots Topsoil: 0.634 m^3/1,000 pots Compost: 0.271 m^3/1,000 pots Rice straw to make compost: 2.5 m^3/m^3 (RM10/m^3)			 40/m^3 25/m^3	 25.36 6.78
Polyethylene Bags	8 cm in diameter × 20 cm in height			24/1,000 bags	24.00
Fungicide	Benlate WP 0.009 kg per 1,000 pots			90/kg	0.81
Insecticide	Decis EC 0.006 ℓ/1,000 pots Siputon 0.525 kg/1,000 pots			30/ℓ 7/kg	0.18 3.68
Fertilizer	Bifolax 0.021 ℓ/1,000 pots			12/ℓ	0.26
Subtotal of Material Costs					288.27
Total					497.97

Table III-22 Numbers and Cost of Seedlings and Workers

Area (hectares)
Seedlings (1,000)
Workers (1,000)
Cost (RM1,000)

	A. mangium				P. falcataria				Other spp.				Dipterocarp spp.				Total			
Year	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost
0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
1	2,500	4,298	30.2	633	500	573	4.0	84	0	458	6.4	175	0	197	2.7	98	3,000	5,525	43.3	990
2	3,000	5,157	36.2	760	600	687	4.8	101	400	802	11.2	306	500	197	2.7	98	4,500	6,842	55.0	1,134
3	3,000	5,157	36.2	760	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	5,000	7,071	56.6	1,299
4	3,500	6,017	42.2	886	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	5,500	7,931	62.6	1,426
5	3,500	6,017	42.2	886	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	5,500	7,931	62.6	1,426
6	3,500	6,017	42.2	886	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	5,500	7,931	62.6	1,426
7	3,500	6,017	42.2	886	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	5,500	7,931	62.6	1,426
8	4,000	6,876	48.3	1,013	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	6,000	8,790	68.7	1,552
9	4,000	6,876	48.3	1,013	800	916	6.4	135	700	802	11.2	306	500	197	2.7	98	6,000	8,790	68.7	1,552
10	4,000	6,876	48.3	1,013	800	916	6.4	135	700	573	8.0	219	500	197	2.7	98	6,000	8,561	65.5	1,552
11	4,000	6,876	48.3	1,013	500	573	4.0	84	500	0	0.0	0	500	197	2.7	98	5,500	7,645	55.0	1,414
12	4,000	6,876	48.3	1,013	600	687	4.8	101	0	0	0.0	0	500	197	2.7	98	5,100	7,760	55.8	1,212
13	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
14	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
15	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
16	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
17	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
18	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
19	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
20	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
21	4,000	6,876	48.3	1,013	500	573	4.0	84	0	0	0.0	0	500	197	2.7	98	5,000	7,645	55.0	1,195
22	4,000	6,876	48.3	1,013	600	687	4.8	101	0	0	0.0	0	500	197	2.7	98	5,100	7,760	55.8	1,212
23	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	197	2.7	98	5,300	7,989	57.4	1,246
24	4,000	6,876	48.3	1,013	800	916	6.4	135	0	0	0.0	0	500	0	0.0	0	5,300	7,792	54.7	1,246
Total	90,500	155,570	1092.1	22,917	17,700	20,267	142.3	2,985	8,500	7,443	104.0	2,846	11,600	4,520	63.2	2,251	126,200	187,798	1401.6	31,272

Table III-23 Forest Roads and Vehicle Maintenance Costs

(RM1,000)

Year	Forest road cost					Vehicle maintenance cost			Total
	New construction	Improvement	Repair	Special Repair	Total	Repair	Fuel	Total	
0	398	159	200	330	1,087	191	240	431	1,518
1	530	239	300	495	1,564	191	280	471	2,035
2	596	265	334	550	1,745	191	280	471	2,216
3	663	292	367	605	1,927	191	280	471	2,398
4	663	292	367	605	1,927	191	280	471	2,398
5	663	292	367	605	1,927	191	280	471	2,398
6	663	292	367	605	1,927	191	280	471	2,398
7	398	318	400	660	1,776	191	280	471	2,247
8	331	318	400	660	1,709	191	280	471	2,180
9	331	318	400	660	1,709	191	280	471	2,180
10	133	292	367	605	1,397	191	280	471	1,868
11	66	270	340	561	1,237	191	280	471	1,708
12	66	281	354	583	1,284	191	280	471	1,755
13	66	281	354	583	1,284	191	280	471	1,755
14	0	281	354	583	1,218	191	280	471	1,689
15	0	281	354	583	1,218	191	280	471	1,689
16	0	281	354	583	1,218	191	280	471	1,689
17	0	281	354	583	1,218	191	280	471	1,689
18	0	281	354	583	1,218	191	280	471	1,689
19	0	281	354	583	1,218	191	280	471	1,689
20	0	265	334	550	1,149	191	280	471	1,620
21	0	270	340	561	1,171	191	280	471	1,642
22	0	281	354	583	1,218	191	280	471	1,689
23	0	281	354	583	1,218	191	280	471	1,689
24	0	0	354	0	354	191	280	471	825
Total	5,567	6,692	8,777	13,882	34,918	4,775	6,960	11,735	46,653

Table III-24 Facilities and Vehicles Costs

(RM1,000)

Year	Nursery facilities	Housing/lodging	Lookout tower	Heavy machinery	Vehicle	Power generator	Total
0	1,915	1,253	0	805	1,106	130	5,209
1	1,489	1,281	340	0	0	130	3,240
2	0	266	340	0	0	0	606
3	0	32	340	0	0	0	372
4	0	0	340	0	0	0	340
5	0	0	340	805	1,106	0	2,251
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	453	0	0	0	0	435
9	0	0	0	0	0	0	0
10	0	0	0	805	1,106	130	2,041
11	0	0	0	0	0	130	130
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	805	1,106	0	1,911
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	805	1,106	130	2,041
21	0	0	0	0	0	130	130
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
Total	3,404	3,285	1,700	4,025	5,530	780	18,724

Table III-25 Housing/Lodging Construction Costs

Class	Year	Number of Unit									
		0	1	2	3	4	5	6	7	8	Total
Project Manager		1	0	0	0	0	0	0	0	0	1
A Class Staff		3	3	0	0	0	0	0	0	1	7
B Class Staff		8	7	1	0	0	0	0	0	1	18
C Class Staff		3	4	0	0	0	0	0	0	0	7
D Class Staff		6	6	3	1	0	0	0	0	4	20
Checkroll Workers		14	20	6	0	0	0	0	0	8	48
Total		35	40	10	1	0	0	0	0	15	101

Housing Expenditure

Class	Unit Cost (RM1,000)	Year 0	1	2	3	4	5	6	7	8	Total
Project Manager	78	78	0	0	0	0	0	0	0	0	78
A Class Staff	65	195	195	0	0	0	0	0	0	65	455
B Class Staff	50	400	350	50	0	0	0	0	0	100	900
C Class Staff	36	108	144	0	0	0	0	0	0	0	252
D Class Staff	32	192	192	96	32	0	0	0	0	128	640
Checkroll Workers	20	280	400	120	0	0	0	0	0	160	960
Total		1,253	1,281	266	32	0	0	0	0	453	3,285

Table III-26 Organization and Staff

Section	Title	Number	
Project	Project Manager	1	
Administration	Administration Manager	1	
General Affairs	Executive Manager	1	
	Secretary to Project Manager	1	
	Clerk	4	
	Typist	1	
Accounts	Accounting Manager	1	
	Accountant	1	
Plantation Section	Plantation Manager	1	
	Assistant Plantation Manager	3	3 districts
	Field Assistant	6	
Nursery	Nursery Manager	2	2 nurseries
	Assistant Nursery Manager	2	
	Field Assistant	2	
Planning & Mapping	Surveyor	1	
	Assistant Surveyor	3	
Research Section	Research Manager	1	
	Assistant Research Manager	2	
Roading & Fire Control Section	Roading & Fire Control Manager	1	
	Assistant R & F Manager	3	
	Field Assistant	3	
Mechanical & Building Section	Mechanical & Building Manager	1	
	Assistant M. & B Manager	1	
	Store Keeper	1	
	Senior Mechanic	1	
	Assistant Technician	1	
Extraction Section	Extraction Manager	1	from the 8th year
	Assistant Extraction Manager	2	
	Field Assistant	4	
Total		53	

Checkroll Workers

Administration	Typists, Assist Clerks	8	
Plantation Section	Conductors	10	
Research Section	Conductors	6	
Roading & Fire Control Section	Drivers, Watchmen, Machinery Operators	18	
Mechanical & Building Section	Mechanics, Power house, Electricians	10	
Extraction Section	Scaler, Conductors	8	
Total		60	
Grand Total		113	

Table III-27 Administration Costs

Unit: Number in persons
Amount in M$1,000

(Staff Salaries and Titles)

Position	Salary M$ 1,000	Number of Staffs																							
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Project Manager	72	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Administration Manager	32	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Plantation Manager	32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Surveyor	32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Reserch Manager	32	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Roading & Fire Control Manager	32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mechanical & Building Manager	32	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Extraction Manager	32	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<A Class Total>		3	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Executive Manager	25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Accounting Manager	25	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Plantation Manager	25	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Nursery Manager	25	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Assistant Surveyor	25	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Assistant Reserch Manager	25	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Assistant Roading & Fire Control Manager	25	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Assistant Mechanical & Building Manager	25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Extraction Manager	25	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<B Class Total>		8	15	16	16	16	16	16	16	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Secretary	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Accountant	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Nursery Manager	20	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Store Keeper	20	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Mechanic	20	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant Technician	20	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<C Class Total>		3	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Clerk	15	0	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Typist	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Field Assistant(Plantation)	15	2	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
〃 (Nursery)	15	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
〃 (Roading & Fire Control)	15	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
〃 (Extraction)	15	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
<D Class Total>		6	12	15	16	16	16	16	16	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
T o t a l																										
Checkroll Workers (Administration)	9	2	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
〃 (Plantation)	9	2	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
〃 (Reserch)	9	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
〃 (Roading & Fire)	9	6	12	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
〃 (Mechanical & Building)	9	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
〃 (Extraction)	9	0	0	0	0	0	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Casual Workers Total		14	38	48	48	48	48	48	48	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
(Management Staff Salary Total)																										
Position	Unit Cost																									
Project Manager	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
A Class Staff	32	96	192	192	192	192	192	192	192	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224
B Class Staff	25	200	375	400	400	400	400	400	400	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
C Class Staff	20	60	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
D Class Staff	15	90	180	225	240	240	240	240	240	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Sub-Total		518	959	1,029	1,044	1,044	1,044	1,044	1,044	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186
Checkroll Workers	9	126	342	432	432	432	432	432	432	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
T o t a l		644	1,301	1,461	1,476	1,476	1,476	1,476	1,476	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690	1,690

Table III-28 Administration and Operation Costs

(Unit: RM1,000)

Year	Administration & Supervision Costs	Operation Costs	Total
0	644	644	1,288
1	1,301	1,301	2,602
2	1,461	1,461	2,922
3	1,476	1,476	2,952
4	1,476	1,476	2,952
5	1,476	1,476	2,952
6	1,476	1,476	2,952
7	1,476	1,476	2,952
8	1,690	1,690	3,380
9	1,690	1,690	3,380
10	1,690	1,690	3,380
11	1,690	1,690	3,380
12	1,690	1,690	3,380
13	1,690	1,690	3,380
14	1,690	1,690	3,380
15	1,690	1,690	3,380
16	1,690	1,690	3,380
17	1,690	1,690	3,380
18	1,690	1,690	3,380
19	1,690	1,690	3,380
20	1,690	1,690	3,380
21	1,690	1,690	3,380
22	1,690	1,690	3,380
23	1,690	1,690	3,380
24	1,690	1,690	3,380
Total	39,516	39,516	79,032

Table III-29 Harvesting Costs by Species (per m^3 of harvested tree volume)

1. *A. mangium* (to log yard work at chip mill)

Operation Type	Remarks	Cost (RM/m^3)
Zoning for harvesting		0.30
Low-layer clearance	RM45/ha	0.25
Cutting	Whole-stem, chain saw	1.30
Yarding	Whole-stem, yarder	9.30
Bucking	in timber-yard, chain saw	4.20
Loading	Grapple-loader	2.25
Transporting	Average distance: 40km, 0.22/m^3/km	8.80
		3.40
Total		29.80

2. *P. falcataria* (to barge loading)

Operation Type	Remarks	Cost (RM/m^3)
Zoning for harvesting		0.30
Low-layer clearance	RM45/ha	0.25
Cutting	Whole-stem, chain saw	1.20
Yarding	Whole-stem, yarder	8.50
Bucking	in timber-yard, chain saw	3.80
Loading	Grapple-loader	2.05
Transporting	Average distance: 40km, 0.20/m^3/km	8.00
Unloading/inspection/ bandling/log-deck work		3.80
Barge loading		2.50
Total		30.40

Table III–30 Comparisons of Relative FOB Prices between *A. mangium, A. auriculiformis* and Marketed Eucalyptus Chips in Terms of Specific Gravity in Oven Dry and Craft Pulp Yield

Species	Chip Type	Basic Density (kg/m^3)	Screened Yield (Kappa number: 20)	Bleached Yield	Percentage Difference in FOB Price		
					Specific gravity in oven dry	Screen Yield	Bleached Yield
A. auriculiformis	Wood	497	55.0	–	0	0	–
A. mangium	Wood	420	52.3	50.9	–9	–7	0
Mixed eucalyptus	Wood	615	44.5	41.6	+10	–29	–27

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Area (hectares)
Harvest (1,000 m^3)
Cost (RM1,000)
Income (RM1,000)

Table III-31 Harvesting Costs and Revenue

	A. mangium				P. falcataria				A.m, P.f Total		
Year	Harvesting area	Harvest	Cost	Income	Harvesting area	Harvest	Cost	Income	Harvest	Cost	Income
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	2,500	280	8,344	20,065	0	0	0	0	280	8,344	20,065
9	3,000	336	10,013	24,078	0	0	0	0	336	10,013	24,078
10	3,000	336	10,013	24,078	0	0	0	0	336	10,013	24,078
11	3,500	392	11,682	28,091	500	120	3,648	9,307	512	15,330	37,398
12	3,500	392	11,682	28,091	600	144	4,378	11,169	536	16,060	39,260
13	3,500	392	11,682	28,091	800	192	5,837	14,892	584	17,519	42,983
14	3,500	392	11,682	28,091	800	192	5,837	14,892	584	17,519	42,983
15	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
16	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
17	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
18	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
19	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
20	4,000	516	15,377	36,977	800	192	5,837	14,892	708	21,214	51,869
21	4,000	516	15,377	36,977	500	132	4,013	10,238	648	19,390	47,215
22	4,000	560	16,688	40,130	600	158	4,815	12,286	718	21,503	52,416
23	4,000	560	16,688	40,130	800	211	6,420	16,381	771	23,108	56,511
24	4,000	560	16,688	40,130	800	211	6,420	16,381	771	23,108	56,511
Total	62,500	7,812	232,801	559,814	10,200	2,512	76,390	194,898	10,325	309,191	754,712

Table III-32 Annual Expenditure

in RM1,000

Year	Seedling production	Forestation	Harvesting	Facilities/Vehicles	Forest road	Vehicle maintenance	Administration	Total	Price-fluctuation reserve	Physical reserve	Total
0	0	0	0	5,209	1,087	431	1,288	8,015	0	802	8,817
1	990	2,127	0	3,240	1,564	471	2,602	10,994	440	1,143	12,577
2	1,134	3,555	0	606	1,745	471	2,922	10,433	851	1,128	12,412
3	1,299	4,163	0	372	1,927	471	2,952	11,184	1,397	1,258	13,839
4	1,426	4,680	0	340	1,927	471	2,952	11,796	2,004	1,380	15,180
5	1,426	4,761	0	2,251	1,927	471	2,952	13,788	2,988	1,678	18,454
6	1,426	4,761	0	0	1,927	471	2,952	11,537	3,061	1,460	16,058
7	1,426	4,761	0	0	1,776	471	2,952	11,386	3,597	1,498	16,481
8	1,552	5,126	8,344	453	1,709	471	3,380	21,035	7,754	2,879	31,668
9	1,552	5,207	10,013	0	1,709	471	3,380	22,332	9,453	3,179	34,964
10	1,552	5,207	10,013	2,041	1,397	471	3,380	24,061	11,554	3,562	39,177
11	1,414	4,860	15,330	130	1,237	471	3,380	26,822	14,470	4,129	45,421
12	1,212	4,413	16,059	0	1,284	471	3,380	26,819	16,118	4,294	47,231
13	1,246	4,429	17,518	0	1,284	471	3,380	28,328	18,841	4,717	51,886
14	1,246	4,461	17,518	0	1,218	471	3,380	28,294	20,703	4,900	53,897
15	1,246	4,461	21,214	1,911	1,218	471	3,380	33,901	27,151	6,105	67,157
16	1,246	4,461	21,214	0	1,218	471	3,380	31,990	27,927	5,992	65,909
17	1,246	4,461	21,214	0	1,218	471	3,380	31,990	30,323	6,231	68,544
18	1,246	4,461	21,214	0	1,218	471	3,380	31,990	32,815	6,481	71,286
19	1,246	4,461	21,214	0	1,218	471	3,380	31,990	35,407	6,740	74,137
20	1,246	4,461	21,214	2,041	1,149	471	3,380	33,962	40,452	7,441	81,855
21	1,195	4,279	19,390	130	1,171	471	3,380	30,016	38,384	6,840	75,240
22	1,212	4,291	21,503	0	1,218	471	3,380	32,075	43,940	7,602	83,617
23	1,246	4,429	23,108	0	1,218	471	3,380	33,852	49,583	8,344	91,779
24	1,246	4,461	23,108	0	354	471	3,380	33,020	51,620	8,464	93,104
Total	31,276	106,737	309,188	18,724	34,918	11,735	79,032	591,610	490,833	108,247	1,190,690

Table III-33 Annual Revenue

(RM1,000)

Year	Revenue	Nominal revenue
0		
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	20,065	27,461
9	24,078	34,270
10	24,078	35,640
11	37,398	57,574
12	39,260	62,855
13	42,983	71,571
14	42,983	74,434
15	51,869	93,411
16	51,869	97,151
17	51,869	101,036
18	51,869	105,076
19	51,869	109,278
20	51,869	113,650
21	47,215	107,594
22	52,416	124,221
23	56,511	139,283
24	56,511	144,855
Total	754,712	1,499,360

Table III-34 Annual Revenue and Expenditure

(RM1,000)

Year	Revenue	Expenditure	Balance	Cumulative Balance
0	0	8,817	-8,817	-8,817
1	0	12,577	-12,577	-21,394
2	0	12,412	-12,412	-33,806
3	0	13,839	-13,839	-47,645
4	0	15,180	-15,180	-62,825
5	0	18,454	-18,454	-81,279
6	0	16,058	-16,058	-97,337
7	0	16,481	-16,481	-113,818
8	27,461	31,668	-4,207	-118,025
9	34,270	34,964	-694	-118,719
10	35,640	39,177	-3,537	-122,256
11	57,574	45,421	12,153	-110,103
12	62,855	47,231	15,624	-94,479
13	71,571	51,886	19,685	-74,794
14	74,434	53,897	20,537	-54,257
15	93,411	67,157	26,254	-28,003
16	97,151	65,909	31,242	3,239
17	101,036	68,544	32,492	35,731
18	105,076	71,286	33,790	69,521
19	109,278	74,137	35,141	104,662
20	113,650	81,855	31,795	136,457
21	107,594	75,240	32,354	168,811
22	124,221	83,617	40,604	209,415
23	139,283	91,779	47,504	256,919
24	144,855	93,104	51,751	308,670
Total	1,499,360	1,190,690	308,670	

IRR = 9.25%

Table III-35 Net Present Value (NPV)

(RM1,000)

Year	Revenue	Discount (10%)	Present Value	Expenditure	Discount (10%)	Present Value
0		1.0000		8,817	1.0000	8,817
1		0.9091		12,577	0.9091	11,434
2		0.8264		12,412	0.8264	10,258
3		0.7513		13,839	0.7513	10,397
4		0.6830		15,180	0.6830	10,368
5		0.6209		18,454	0.6209	11,458
6		0.5645		16,058	0.5645	9,064
7		0.5132		16,481	0.5132	8,457
8	27,461	0.4665	12,811	31,668	0.4665	14,773
9	34,270	0.4241	14,534	34,964	0.4241	14,828
10	35,640	0.3855	13,741	39,177	0.3855	15,104
11	57,574	0.3505	20,179	45,421	0.3505	15,920
12	62,855	0.3186	20,028	47,231	0.3186	15,049
13	71,571	0.2897	20,732	51,886	0.2897	15,030
14	74,434	0.2633	19,601	53,897	0.2633	14,193
15	93,411	0.2394	22,362	67,157	0.2394	16,077
16	97,151	0.2176	21,143	65,909	0.2176	14,344
17	101,036	0.1978	19,989	68,544	0.1978	13,561
18	105,076	0.1799	18,899	71,286	0.1799	12,821
19	109,278	0.1635	17,868	74,137	0.1635	12,122
20	113,650	0.1486	16,893	81,855	0.1486	12,167
21	107,594	0.1351	14,539	75,240	0.1351	10,167
22	124,221	0.1228	15,260	83,617	0.1228	10,272
23	139,283	0.1117	15,555	91,779	0.1117	10,250
24	144,855	0.1015	14,706	93,104	0.1015	9,452
Total	1,499,360		298,839	1,190,690		306,385

NPV = 298,839,000 - 306,385,000
= -7,546,000

Table III-36 Forestation Costs and Required Workers (2)

(Hectares)
Cost (RM1,000)
Workers (1,000)

Year	Acacia mangium							Paraserianthes falcataria							Total						
	Area	Cost			No. of workers			Area	Cost			No. of workers			Area	Cost			No. of workers		
		1st year	2nd year	Total	1st year	2nd year	Total		1st year	2nd year	Total	1st year	2nd year	Total		1st year	2nd year	Total	1st year	2nd year	Total
0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
1	2,500	1,823	0	1,823	108.3	0.0	108.3	500	304	0	304	18.4	0.0	18.4	3,000	2,127	0	2,127	126.7	0.0	126.7
2	3,000	2,188	405	2,593	129.9	27.0	156.9	600	365	81	446	22.1	5.4	27.5	3,600	2,553	486	3,039	152.0	32.4	184.4
3	3,000	2,188	486	2,674	129.9	32.4	162.3	800	486	97	584	29.4	6.5	35.9	3,800	2,674	583	3,258	159.3	38.9	198.2
4	3,500	2,553	486	3,039	151.6	32.4	184.0	800	486	130	616	29.4	8.6	38.1	4,300	3,039	616	3,655	181.0	41.0	222.0
5	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	4,300	3,039	697	3,736	181.0	46.4	227.4
6	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	4,300	3,039	697	3,736	181.0	46.4	227.4
7	3,500	2,553	567	3,120	151.6	37.8	189.4	800	486	130	616	29.4	8.6	38.1	4,300	3,039	697	3,736	181.0	46.4	227.4
8	4,000	2,917	567	3,484	173.2	37.8	211.0	800	486	130	616	29.4	8.6	38.1	4,800	3,404	697	4,100	202.6	46.4	249.1
9	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	4,800	3,404	778	4,181	202.6	51.8	254.5
10	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	4,800	3,404	778	4,181	202.6	51.8	254.5
11	4,000	2,917	648	3,565	173.2	43.2	216.4	500	304	130	434	18.4	8.6	27.0	4,500	3,221	778	3,999	191.6	51.8	243.4
12	4,000	2,917	648	3,565	173.2	43.2	216.4	600	365	81	446	22.1	5.4	27.5	4,600	3,282	729	4,011	195.3	48.6	243.9
13	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	97	584	29.4	6.5	35.9	4,800	3,404	745	4,149	202.6	49.7	252.3
14	4,000	2,917	648	3,565	173.2	43.2	216.4	800	486	130	616	29.4	8.6	38.1	4,800	3,404	778	4,181	202.6	51.8	254.5
15	4,000	2,917	648	3,565	173.2	43.2	216.4	0	0	130	130	0.0	8.6	8.6	4,000	2,917	778	3,695	173.2	51.8	225.0
16	4,000	2,917	648	3,565	173.2	43.2	216.4	0	0	0	0	0.0	0.0	0.0	4,000	2,917	648	3,565	173.2	43.2	216.4
17	4,000	2,917	648	3,565	173.2	43.2	216.4	0	0	0	0	0.0	0.0	0.0	4,000	2,917	648	3,565	173.2	43.2	216.4
18	0	0	648	648	0.0	43.2	43.2	0	0	0	0	0.0	0.0	0.0	0	0	648	648	0.0	43.2	43.2
19	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
20	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
21	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
22	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
23	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
24	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0.0	0.0	0.0
Total	62,500	45,581	10,125	55,706	2706.3	675.0	3381.3	10,200	6,202	1,652	7,854	375.4	110.2	485.5	72,700	51,783	11,777	63,562	3081.6	785.2	3866.8

Table III–37 Numbers and Cost of Seedlings and Workers (2)

Area (hectares)
Seedlings (1,000)
Workers (1,000)
Cost (RM1,000)

	A. mangium				P. falcataria				Total			
Year	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost	Area	Seedlings	Workers	Cost
0	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
1	2,500	4,298	30.2	633	500	573	4.0	84	3,000	4,870	34.2	717
2	3,000	5,157	36.2	760	600	687	4.8	101	3,600	5,844	41.0	861
3	3,000	5,157	36.2	760	800	916	6.4	135	3,800	6,073	42.6	895
4	3,500	6,017	42.2	886	800	916	6.4	135	4,300	6,933	48.7	1,021
5	3,500	6,017	42.2	886	800	916	6.4	135	4,300	6,933	48.7	1,021
6	3,500	6,017	42.2	886	800	916	6.4	135	4,300	6,933	48.7	1,021
7	3,500	6,017	42.2	886	800	916	6.4	135	4,300	6,933	48.7	1,021
8	4,000	6,876	48.3	1,013	800	916	6.4	135	4,800	7,792	54.7	1,148
9	4,000	6,876	48.3	1,013	800	916	6.4	135	4,800	7,792	54.7	1,148
10	4,000	6,876	48.3	1,013	800	916	6.4	135	4,800	7,792	54.7	1,148
11	4,000	6,876	48.3	1,013	500	573	4.0	84	4,500	7,449	52.3	1,097
12	4,000	6,876	48.3	1,013	600	687	4.8	101	4,600	7,563	53.1	1,114
13	4,000	6,876	48.3	1,013	800	916	6.4	135	4,800	7,792	54.7	1,148
14	4,000	6,876	48.3	1,013	800	916	6.4	135	4,800	7,792	54.7	1,148
15	4,000	6,876	48.3	1,013	0	0	0.0	0	4,000	6,876	48.3	1,013
16	4,000	6,876	48.3	1,013	0	0	0.0	0	4,000	6,876	48.3	1,013
17	4,000	6,876	48.3	1,013	0	0	0.0	0	4,000	6,876	48.3	1,013
18	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
19	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
20	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
21	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
22	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
23	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
24	0	0	0.0	0	0	0	0.0	0	0	0	0.0	0
Total	62,500	107,438	754.2	15,827	10,200	11,679	82.0	1,720	72,700	119,117	836.2	17,547

Table III-38 Forest Road Costs

Area (hectares)

Year	New construction					Improvement			Repair		Side-ditch	Gravelling	Total
	Initial extraction area (ha)			New length	Cost	Forestation area	Improved length	Cost	Repaired length	Cost	Cost	Cost	Cost
	A. m.	P. f.	Total	(m)	(M$1000)	(ha)	(m)	(M$1000)	(m)	(M$1000)	(M$1000)	(M$1000)	(M$1000)
0	0	0	0	15,000	398	0	12,000	159	48,000	200	150	180	1,087
1	2,500	500	3,000	18,000	477	3,000	14,400	191	57,600	240	180	216	1,304
2	3,000	600	3,600	19,000	504	3,600	15,200	201	60,800	254	190	228	1,376
3	3,000	800	3,800	21,500	570	3,800	17,200	228	68,800	287	215	258	1,558
4	3,500	800	4,300	21,500	570	4,300	17,200	228	68,800	287	215	258	1,558
5	3,500	800	4,300	21,500	570	4,300	17,200	228	68,800	287	215	258	1,558
6	3,500	800	4,300	21,500	570	4,300	17,200	228	68,800	287	215	258	1,558
7	3,500	800	4,300	11,500	305	4,300	19,200	254	76,800	320	240	288	1,407
8	1,500	800	2,300	9,000	239	4,800	19,200	254	76,800	320	240	288	1,341
9	1,000	800	1,800	9,000	239	4,800	19,200	254	76,800	320	240	288	1,341
10	1,000	800	1,800	2,500	66	4,800	18,000	239	72,000	300	225	270	1,100
11	500	0	500	2,500	66	4,500	18,400	244	73,600	307	230	276	1,123
12	500	0	500	2,500	66	4,600	19,200	254	76,800	320	240	288	1,169
13	500	0	500	2,500	66	4,800	19,200	254	76,800	320	240	288	1,169
14	500	0	500	0	0	4,800	19,200	254	76,800	320	240	288	1,103
15	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
16	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
17	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
18	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
19	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
20	0	0	0	0	0	4,800	18,000	239	72,000	300	225	270	1,034
21	0	0	0	0	0	4,500	18,400	244	73,600	307	230	276	1,057
22	0	0	0	0	0	4,600	19,200	254	76,800	320	240	288	1,103
23	0	0	0	0	0	4,800	19,200	254	76,800	320	240	288	1,103
24	0	0	0	0	0	4,800	0	0	76,800	320	192	230	742
Total	28,000	7,500	35,500	177,500	4,704	108,200	432,800	5,735	1,808,000	7,539	5,602	6,722	30,302

Table III-39 Facilities and Vehicles Costs (2)

(RM1,000)

Year	Nursery facilities	Housing/lodging	Lookout tower	Heavy machinery	Vehicle	Power generator	Total
0	1,762	1,002	0	644	885	104	4,397
1	1,370	1,025	340	0	0	104	2,839
2	0	213	340	0	0	0	553
3	0	26	340	0	0	0	366
4	0	0	340	0	0	0	340
5	0	0	340	644	885	0	1,869
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	362	0	0	0	0	362
9	0	0	0	0	0	0	0
10	0	0	0	644	885	104	1,633
11	0	0	0	0	0	104	104
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	644	885	0	1,529
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	242	332	39	612
21	0	0	0	0	0	39	39
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
Total	3,132	2,628	1,700	2,818	3,871	494	14,643

Table III–40 Forest Roads and Vehicle Maintenance Costs (2)

(RM1,000)

Year	Forest road cost						Vehicle maintenance cost		
	Newly-established	Improvement	Maintenance	Drainage ridge	Graveling	Total	Maintenance	Fuel	Total
0	398	159	200	150	180	1,087	153	192	345
1	477	191	240	180	216	1,304	153	224	377
2	504	201	254	190	228	1,376	153	224	377
3	570	228	287	215	258	1,558	153	224	377
4	570	228	287	215	258	1,558	153	224	377
5	570	228	287	215	258	1,558	153	224	377
6	570	228	287	215	258	1,558	153	224	377
7	305	254	320	240	288	1,407	153	224	377
8	239	254	320	240	288	1,341	153	224	377
9	239	254	320	240	288	1,341	153	224	377
10	66	239	300	225	270	1,100	153	224	377
11	66	244	307	230	276	1,123	153	224	377
12	66	254	320	240	288	1,169	153	224	377
13	66	254	320	240	288	1,169	153	224	377
14	0	254	320	240	288	1,103	153	224	377
15	0	254	320	240	288	1,103	153	224	377
16	0	254	320	240	288	1,103	153	224	377
17	0	254	320	240	288	1,103	153	224	377
18	0	254	320	240	288	1,103	57	84	141
19	0	254	320	240	288	1,103	57	84	141
20	0	239	300	225	270	1,034	57	84	141
21	0	244	307	230	276	1,057	57	84	141
22	0	254	320	240	288	1,103	57	84	141
23	0	254	320	240	288	1,103	57	84	141
24	0	0	320	192	230	742	57	84	141
Total	4,706	5,731	7,536	5,602	6,722	30,302	3,152	4,588	7,740

Table III-41 Administration and Operation Costs (2)

(RM1,000)

Year	Administration & Operation Costs (salary & wages)				Operation costs	Total
	Initial total cost	Area-proportional allocation	Increase	Total		
0	644	(X0.8) 515	-	515	515	1,030
1	1,301	1,041	-	1,041	1,041	2,082
2	1,461	1,169	-	1,169	1,169	2,338
3	1,466	1,181	-	1,181	1,181	2,362
4	1,476	1,181	-	1,181	1,181	2,362
5	1,476	1,181	-	1,181	1,181	2,362
6	1,476	1,181	-	1,181	1,181	2,362
7	1,476	1,181	-	1,181	1,181	2,362
8	1,476	1,181	214	1,395	1,395	2,790
9	1,476	1,181	214	1,395	1,395	2,790
10	1,476	1,181	214	1,395	1,395	2,790
11	1,476	1,181	214	1,395	1,395	2,790
12	1,476	1,181	214	1,395	1,395	2,790
13	1,476	1,181	214	1,395	1,395	2,790
14	1,476	1,181	214	1,395	1,395	2,790
15	1,476	1,181	214	1,395	1,395	2,790
16	1,476	1,181	214	1,395	1,395	2,790
17	1,476	1,181	214	1,395	1,395	2,790
18	1,476	(X0.3) 443	214	657	657	1,314
19	1,476	443	214	657	657	1,314
20	1,476	443	214	657	657	1,314
21	1,476	443	214	657	657	1,314
22	1,476	443	214	657	657	1,314
23	1,476	443	214	657	657	1,314
24	1,476	443	214	657	657	1,314
Total	35,878	23,541	3,638	27,179	27,179	54,358

Table III-42 Annual Expenditure (2)

(RM1,000)

Year	Seedling production	Forestation	Harvesting	Facility & vehicle	Forest road	Vehicle maintenance	Administration & operation	Total	Price-fluctuation reserve	Physical contingency	Total
0	0	0	0	4,397	1,087	345	1,030	6,859	0	686	7,545
1	717	2,127	0	2,839	1,304	377	2,082	9,446	378	982	10,806
2	861	3,039	0	553	1,376	377	2,338	8,544	697	924	10,165
3	1,021	3,655	0	340	1,558	377	2,362	9,313	1,582	1,090	11,985
4	1,021	3,655	0	340	1,558	377	2,362	9,313	1,582	1,090	11,985
5	1,021	3,736	0	1,869	1,558	377	2,362	10,923	2,367	1,329	14,619
6	1,021	3,736	0	0	1,558	377	2,362	9,054	2,402	1,146	12,602
7	1,021	3,736	0	0	1,407	377	2,362	8,903	2,812	1,172	12,887
8	1,148	4,100	8,344	362	1,341	377	2,790	18,462	6,805	2,527	27,794
9	1,148	4,181	10,013	0	1,341	377	2,790	19,850	8,402	2,825	31,077
10	1,148	4,181	10,013	1,633	1,100	377	2,790	21,242	10,200	3,144	34,586
11	1,097	3,999	15,330	104	1,123	377	2,790	24,820	13,390	3,821	42,031
12	1,114	4,011	16,059	0	1,169	377	2,790	25,520	15,338	4,086	44,944
13	1,148	4,149	17,518	0	1,169	377	2,790	27,151	18,058	4,521	49,730
14	1,148	4,181	17,518	0	1,103	377	2,790	27,117	19,842	4,696	51,655
15	1,013	3,695	21,214	1,529	1,103	377	2,790	31,721	25,405	5,713	62,839
16	1,013	3,565	21,214	0	1,103	377	2,790	30,062	26,244	5,631	61,937
17	1,013	3,565	21,214	0	1,103	377	2,790	30,062	28,496	5,856	64,414
18	0	648	21,214	0	1,103	141	1,314	24,420	25,050	4,947	54,417
19	0	0	21,214	0	1,103	141	1,314	23,772	26,311	5,008	55,091
20	0	0	21,214	612	1,034	141	1,314	24,315	28,961	5,328	58,604
21	0	0	19,390	39	1,057	141	1,314	21,941	28,058	5,000	54,999
22	0	0	21,503	0	1,103	141	1,314	24,061	32,961	5,702	62,724
23	0	0	23,108	0	1,103	141	1,314	25,666	37,593	6,326	69,585
24	0	0	23,108	0	742	141	1,314	25,305	39,559	6,486	71,350
Total	17,547	63,562	309,188	14,643	30,306	7,741	54,358	497,345	402,012	89,938	898,295

Table III-43 Annual Revenue and Expenditure (2)

(RM1,000)

Year	Revenue	Expenditure	Balance	Cumulative Balance
0	0	7,545	-7,545	-7,545
1	0	10,806	-10,806	-18,351
2	0	10,165	-10,165	-28,516
3	0	10,909	-10,909	-39,425
4	0	11,985	-11,985	-51,410
5	0	14,619	-14,619	-66,029
6	0	12,602	-12,602	-78,631
7	0	12,887	-12,887	-91,518
8	27,461	27,794	-333	-91,851
9	34,270	31,077	3,193	-88,658
10	35,640	34,586	1,054	-87,604
11	57,574	42,031	15,543	-72,061
12	62,855	44,944	17,911	-54,150
13	71,571	49,730	21,841	-32,309
14	74,434	51,655	22,779	-9,530
15	93,411	62,839	30,572	21,042
16	97,151	61,937	35,214	56,256
17	101,036	64,414	36,622	92,878
18	105,076	54,417	50,659	143,537
19	109,278	55,091	54,187	197,724
20	113,650	58,604	55,046	252,770
21	107,594	54,999	52,595	305,365
22	124,221	62,724	61,497	366,862
23	139,283	69,585	69,698	436,560
24	144,855	71,350	73,505	510,065
Total	1,499,360	989,295	510,065	

IRR = 13.66%

Table III-44 Net Present Value (NPV) (2)

(RM1,000)

Year	Revenue	Discount (10%)	Present Value	Expenditure	Discount (10%)	Present Value
0		1.0000		7,545	1.0000	7,545
1		0.9091		10,806	0.9091	9,824
2		0.8264		10,165	0.8264	8,401
3		0.7513		10,909	0.7513	8,196
4		0.6830		11,985	0.6830	8,186
5		0.6209		14,619	0.6209	9,077
6		0.5645		12,602	0.5645	7,114
7		0.5132		12,887	0.5132	6,613
8	27,461	0.4665	12,811	27,794	0.4665	12,966
9	34,270	0.4241	14,534	31,077	0.4241	13,180
10	35,640	0.3855	13,741	34,586	0.3855	13,334
11	57,574	0.3505	20,179	42,031	0.3505	14,732
12	62,855	0.3186	20,028	44,944	0.3186	14,321
13	71,571	0.2897	20,732	49,730	0.2897	14,405
14	74,434	0.2633	19,601	51,655	0.2633	13,602
15	93,411	0.2394	22,362	62,839	0.2394	15,043
16	97,151	0.2176	21,143	61,937	0.2176	13,479
17	101,036	0.1978	19,989	64,414	0.1978	12,744
18	105,076	0.1799	18,899	54,417	0.1799	9,787
19	109,278	0.1635	17,868	55,091	0.1635	9,008
20	113,650	0.1486	16,893	58,604	0.1486	8,711
21	107,594	0.1351	14,539	54,999	0.1351	7,432
22	124,221	0.1228	15,260	62,724	0.1228	7,705
23	139,283	0.1117	15,555	69,585	0.1117	7,771
24	144,855	0.1015	14,706	71,350	0.1015	7,244
Total	1,499,360		298,839	989,295		260,420

NPV = 298,839,000 - 260,420,000 = 38,419,000

Table III-45 Annual Revenues and Expenditures (*A. mangium* per hectare)

(RM)

Year	Expenditure								Revenue	
	Seedling Cost	Planting & Tending	Forest Road	Harvesting	Subtotal	Price-fluctuation Reserve (4%)	Physical Contingency (10%)	Total Cost	Revenue	Nominal Revenue
1	413	729			1,142	0	114	1,256	0	0
2		162			162	6	17	185	0	0
3									0	0
4									0	0
5									0	0
6									0	0
7									0	0
8			120	4,020	4,140	1,308	545	5,993	8,026	10,561
Total	413	891	120	4,020	5,444	1,314	676	7,434	8,026	10,561

Table III-46 Calculation of Internal Rate of Return (*A. mangium* per hectare)

(RM)

Year	Revenue	Expenditure	Balance	Cumulative Balance
1	0	1,256	-1,256	-1,256
2	0	185	-185	-1,441
3	0	0	0	-1,441
4	0	0	0	-1,441
5	0	0	0	-1,441
6	0	0	0	-1,441
7	0	0	0	-1,441
8	10,561	5,993	4,568	3,127
Total	10,561	7,434	3,127	

IRR = 18.26%

Table III-47 Calculation of Net Present Value (NPV) (*A. mangium* per hectare)

(RM)

Year	Discount Rate (10%)	Revenue	NPV of Revenue	Expenditure	NPV of Expenditure
1	1.0000	0	0	1,256	1,256
2	0.9091	0	0	185	168
3	0.8264	0	0	0	0
4	0.7513	0	0	0	0
5	0.6830	0	0	0	0
6	0.6209	0	0	0	0
7	0.5645	0	0	0	0
8	0.5132	10,561	5,420	5,993	3,076
Total		10,561	5,420	7,434	4,500

Net Prevent Value (NPV) = 5,420 - 4,500 = 920

6. Marketability Study

6-1 The Present Condition of Markets for Plantation Logs

Because of the undeveloped markets for processed products, prices of plantation logs of newly introduced species will remain low and markets for the logs will be inactive until wood-processing mills that use such logs as raw materials are regularly supplied with the materials in sufficient quantity to keep such mills operating. When stable quantity and quality of timber supply comes on line, however, evaluation of the plantation logs would be established and markets would be formed.

Plantation logs in Sabah are composed of those harvested from the forestation land of Sabah Softwood Sdn. Bhd. (SSSB), SAFODA and Sabah Forestry Industries (SFI), which are conducting large-scale industrial forestation, and those from the forestation land of small-scale forestation by individuals and companies.

(1) SSSB has tentatively exported plantation logs since the beginning of 1982 to Japan, South Korea and Taiwan. At that time, however, it experienced difficulty in marketing them because superior logs of about 30 million m^3 harvested from natural forests in Sabah, Sarawak and Indonesia were under export to the same countries. Nevertheless, a change has occurred in acquisition of logs from natural forests since 1985, in which Indonesia prohibited the export of logs. This has, in the midst of the development in other wood-processing sectors, caused traditional end users to seek alternative supply sources. One of the alternative sources has been found in SSSB's plantation logs. Consequently, SSSB sales have steadily been increasing. Table III-48 shows SSSB's sales volume by year and species. (Raymund G. S. Tan, 1989 and Investigation with SSSB, 1994)

Table III-48 SSSB Sales Volume by Species (Unit: m^3)

Year	*P. falcataria*	*E. deglupta*	*G. arborea*	*A. mangium*	*P. caribaea*	Total
1982	10,000	0	0	0	0	10,000
1983	44,000	0	0	0	0	44,000
1984	76,000	0	0	0	0	76,000
1985	82,000	0	526	0	0	82,526
1986	150,000	957	764	774	0	152,495
1987	162,000	12,180	887	3	0	175,070
1988	147,000	22,077	13,587	574	0	183,238
1989	194,010	57,662	8,973	10,226	0	270,871
1990	128,271	54,119	6,436	14,637	0	203,463
1991	158,517	32,050	608	577	0	191,752
1992	161,860	35,092	1,294	3,115	25,715	227,076
1993	115,896	39,503	15,813	1,266	56,092	228,570
Total	1,429,554	253,640	48,888	31,172	81,807	1,845,061

Source: Tree Plantation - The Sabah Softwoods Sdn. Bhd. Experience (Raymund G.S. Tan 1989) and Investigation with SSSB

SSSB is currently selling harvested plantation logs only in the form of logs, and has no wood-processing facilities. Details of the sale are as follows:

Paraserianthes falcataria logs are produced at an average rate of 12,000 m^3/month, of which about 40% are exported to Taiwan, and the remaining 60% are sold to two block-board factories in Tawau. *Eucalyptus deglupta* logs are produced at the rate of approximately 7,000 to 8,000m^3/month and exported to Taiwan. *Gmelina arborea* logs are exported to Taiwan and South Korea.

Acacia mangium logs have up to date been exported to Taiwan and Japan, but it is said that they are currently being kept as logs for a chip plant to be constructed. A plan will be established to export *A. mangium* logs at the rate of 750,000 m^3/year in the form of chips (Investigated through interviews with SSSB staff).

(2) In 1988, SAFODA sold *A. mangium* trees in Langkon under stumpage dealing on the condition of overrun production. Dealers who had accepted the stumpage dealing exported the logs to Japan and Taiwan, which had expanded demand for pulp wood and were seeking material sources. However, this export caused both of buyers and shippers to chalk up deficits, resulting in the cessation of exporting logs as pulp wood.

In 1993, SAFODA sold *A. mangium* forestation land of about 500 ha under stumpage dealing in Keningau. A dealer who purchased the logs bundled them in Kimanis after cutting the trees, loaded them onto a vessel using barges, and then exported them to South Korea. However, dealers have recently stopped exporting logs and are shipping wood in the form of sawn timber. In the latter half of 1993, a contract was concluded in the Bengkoka consolidation for the stumpage dealing in *A. mangium* forest of about 600ha, but harvesting has not yet started. This was reportedly because the wood was to be exported in the form of molded products after milling. In addition; a consulting company carried out a feasibility study on the production and export of chips using plantation logs in the Bengkoka consolidation as raw materials (Investigation with SAFODA).

(3) In 1993, SFI harvesting a seven year-old *A. mangium* at forest of 165 ha and carried the logs to its own pulp mill. These were private logs and the harvesting was performed without any relation to markets.

(4) Species of plantation logs obtained from owners of small-scale forestation are mostly *A. mangium*, and almost all the logs are young. In the first half of 1993, the price of logs for pallets that was ordered by Taiwan and South Korea, was comparatively favorable because of an embargo on natural-forest logs. Therefore, small-scale sawmillers targeted privately-owned *A. mangium* forests as log acquisition sources, purchased large-diameter logs only and sawed them to produce pallet boards for export. However, offer prices declined from the latter half of 1993, so that the purchase of *A. mangium* as lumbering materials and commercialization of the materials became unprofitable. Thus, the sawmillers withheld using *A. mangium* as lumbering materials and were waiting for an increase in product prices.

6-2 Market Forecast for Plantation Logs

As a global environmental problem, the protection of tropical forests is gaining momentum throughout the world. Such the movement should be supported in order to accelerate the sustainable utilization and preservation of tropical forests. Markets for plantation logs are closely correlated to natural-forest logs. According to Rahim Sulaiman 1993, results of the forest inventory conducted by FAO/UNDP in 1986 to 1987 lead to the prediction showing that the volume of logs supplied from the Commercial Forest Reserves would decrease sharply (Rahim Sulaiman, 1993). That is, in Scenario 1, the yearly volume of logs supplied from the Commercial Forest Reserves would be 4.13 million, to which the considerable amount of log supply from state land could be added at the rate of 5.62 million m^3/year until 2002 and 0.67 million m^3 until 2017.

In Scenario 2, the supply of plantation logs would be added to the volume of supplied natural-forest logs, at the rate of 0.2 million m^3/year for the period of 1993 to 2002, 0.5 million/year for 2003 to 2012, 0.75 million m^3/year for 2013 to 2022, and 1.0 million m^3/year for 2023 to 2032.

On the other hand, in regard to demand for logs, the Sabah wood-processing industry has, as of December 1992, 217 sawmills whose equipment capacity is 7,746,780 m^3, and 35 plywood/veneer mills and 7 block-board plants, whose total equipment capacity is 3,649,200 m^3. All the mills would need logs of 11,395,980 m^3 for full operation. In addition, pulp and paper mills require logs of 381,424 m^3/year on the average. In fact, however, 187 sawmills are under operation using logs of 5,988,920 m^3, and the plywood/veneer/block-board mills, with 2 plywood/veneer mills suspending operation, need logs of 2,589,455 m^3 in all. Accordingly, recent demand for logs of the Sabah wood-processing industry is about 9 million m^3/year.

The above leads to supply-demand relation concerning logs as follows:

In Scenario 1, natural-forest logs are estimated to be in excess supply by 0.75 million m^3 in the 10 years from 1993 to 2002, but in a supply shortage of 4.2 million m^3 from 2003 to 2017, and 4.87 million m^3 after 2018.

In Scenario 2, logs would be in excess supply at the rate of 0.95 million m^3 in the 10 years from 1993 to 2002. More than 90% of plantation logs are currently exported. The logs are estimated to be in a supply shortage of 3.7 million m^3 from 2003 to 2012, by about 3.45 million m^3 from 2013 to 2017, by 4.12 million m^3 from 2016 to 2022, and by some 3.87 million m^3 after 2023.

Both cases show that the State of Sabah will experience a wood supply crisis after 2002, and accordingly emphasize the necessity of reforestation to develop forest resources. As a matter of course, Sabah's wood-processing industry, which has problems of tropical forests protection and decline in log supply capacity, will have to further develop the utilization and marketing of plantation logs. However, almost no market for plantation logs, except for a few instances, has been formed because natural-forest logs are still supplied, most plantation logs are fast growing species and their cutting volume is small with small to medium diameter class logs.

Based on the present condition, markets are predicted by species as follows:

1 *A. mangium*

For this species, markets have not yet been established as mentioned above. Small-scale sawmillers, who have difficulty in obtaining natural-forest logs, have used the species as materials for inexpensive pallets and crates, but the volume is very small.

In regard to restrictions on the use of the species, Hsu-Ho Chung has showed that *A. mangium* logs have the following inherent characteristics similar to the plantation logs of other short rotation and fast growing species (Hsu-Ho Chung, 1992):

1. Small diameter
2. Knotty
3. Low density
4. Low strength
5. Large portion of reaction wood
6. Greater incidence of spiral grain
7. Greater growth stress
8. Greater proportion of juvenile wood

All of these inherent characteristics constitute potential restrictions on the use of *A. mangium* wood, especially its use as non-fiber. Effects of these characteristics on the use of the species would be summarized as follows:

1) Logs for Lumbering:

The above eight characteristics constitute strong restrictions for lumbering.

2) Logs for Block Boards:

The characteristics mentioned do not constitute problems.

3) Logs for Pulp and Paper:

Although low density would lead to increased in production costs, the species is excellent for producing pulp.

4) Logs for Reconstituted Panel Boards:

The characteristics mentioned do not constitute problems. *A. mangium* logs are superior materials for this use.

5) Logs for Plywood and Veneer:

The above-mentioned characteristics constitute major restrictions.

Results of operations at small-scale sawmills show that the species has a very low lumbering yield due to knots, heart rot, branching on trunks, and trunk shape that is not cylinder-type. Accordingly, there are restrictions on the use of the species as logs for lumbering.

The publication of the Malaysian Timber Industry Board (MTIB) has clarified that *A. mangium* logs are suitable for the following uses (MTIB):

(1) Pulp and paper
(2) Medium density fiberboards
(3) Particle boards
(4) Cement boards

When the species is used for veneer-based products, it is deemed to be suitable for the following uses:

(1) Plywood cross-cores
(2) Laminated veneer lumber
(3) Sliced veneer

However, all the above-mentioned products have only been produced in the laboratory and no commercialized production has yet been conducted. These products would also compete with those produced by other species such as para rubber tree, *Payana* spp. (Nyatoh), *Lophopetalum* spp. (Perupok) and *Peronema canescens* (Sungkai). Notwithstanding, if the species holds a dominant position in terms of price, it would be used as raw materials for reconstituted wood products in the wood-processing industry in the future, and markets will be established with stabilized supply.

As mentioned above, *A. mangium* is acknowledged to be suitable for pulpwood. In particular, hardwood trees are suitable as raw materials for printing paper, for which demand has expanded in recent years. Demand for hardwood-tree chips has expanded with increase in the consumption of printing paper. From environmental considerations in recent years, raw materials have been switched from natural-forest logs to plantation logs, and demand for renewable and qualitatively uniform hardwood pulp materials of plantation logs is increasing.

2 *P. falcataria*

As mentioned above, about 40% of *P. falcataria* logs produced by SSSB are exported to Taiwan, and logs sold to local block-board mills are processed and exported as block boards mainly to Japan and South Korea. Among panel products produced recently in Sabah, the number of block boards has increased markedly because the block boards are easy to produce at comparatively low cost, and because as raw materials such as short timbers and cores are to be used which can be obtained easily

from sawmills and plywood/veneer plants, and plantation logs of *P. falcataria* and *G. arborea*. At one time in 1993 the price of a block board was satisfactory at US$ 500/m^3 FOB or more, but has recently considerably weakened. This is because the products of excessive volume have entered from Indonesia into the same market place, particularly Taiwan. Export duties imposed on block boards by the Sabah State government are RM60/m^3 for Seraya products (since November 1993), but there is no duty for those with cores of plantation logs (According to materials received from Mr. Raymund Tan, SSSB Director).

According to the Membership Record of the Sabah Sawmilling Industries Association (SSIA), the number of block-board manufacturers that are the members has increased from 1 in 1989, 4 in 1990, 12 in 1991, 18 in 1992, and 20 in 1993. Among raw materials used by these manufacturers, plantation logs are exclusively supplied by SSSB. In the future, markets for block boards included in panel products (including furniture, cabinets, etc.) are expected to expand because of the development of processing techniques and the availability of raw materials. It is considered that among the uses of plantation logs, the use of *P. falcataria* logs will particularly expand.

3 *G. arborea*

Although this species has so far been harvested and sold by SSSB only in small quantities, it is known in the markets in India and Myanmar as logs for lumbering obtained from natural forest. The species had once been forested to form pulpwood forests in various tropical areas. Trunks of this trees had many crooks and the logs were not in demand for lumbering. However, the logs have been revalued in their properties as logs for lumbering, particularly for furniture, owing to the development of processing and breeding techniques. Since their uses in place of natural-forest logs have been developed the logs need to be supplied steadily in terms of quantity. Before this species is accepted by the lumbering industry, special efforts must be made to develop markets.

6-3 General Situation of Asian Timber Markets

The major trend of timber trading in Asia has shifted from logs to plywood and sawn wood following the promotion of wood processing in producer countries as well as the decrease in resources. As the conservation of tropical forests becomes the subject of controversy, log producer countries will inevitably employ systems of sustainable timber production and change to policies promoting the export of goods with high value added.

According to FAO statistics (FAO, 1993), in 1991 log output in Asia amounts to 1,086 million m^3, of which 251 million m^3 is supplied to industries. The production of sawn timber and plywood are 100.8 million m^3 and 28.8 million m^3, respectively. Japanese and Chinese shares of sawn timber are 28.3 million m^3 and 20.5 million m^3, respectively, while Indonesian and Japanese shares of plywood are 9.9 million m^3 and 8.4 million m^3, respectively.

Exports, including those within Asia, are 22,493,000 m^3 of industrial logs, 7,879,000 m^3 of sawn timber and 12,093,000 m^3 of plywood. Imports, including those within Asia, are 73,789,000 m^3 of industrial logs, 16,156,000 m^3 of sawn timber, and 10,031,000 m^3 of plywood. Thus, Asian imports of logs are more than its exports.

The largest exporter of industrial logs in Asia is Malaysia (19,383,000 m^3) which has the largest share of industrial log exports from Asia. As for plywood, Indonesia is the largest exporter (8,344,000 m^3), followed by Malaysia (1,703,000 m^3). These two countries have the highest share of plywood exports from Asia. By contrast, Japan is the largest importer of industrial logs (49,500,000 m^3), sawn timber (9,400,000 m^3) and plywood (4,121,000 m^3). China and South Korea are also large importers of industrial logs at 9,480,000 m^3 and 9,006,000 m^3, respectively. Despite having an industrial log output of 90,099,000 m^3, China's huge population suggests that it will import more timber following its economic development.

In Japan, one of major timber importers in the world, foreign timber previously imported to compensate a shortage of domestic timber has gradually dominated the Japanese market because of its merits in supply lot and distribution cost compared with domestic timber. Timber is imported mainly from the North America, the South East Asia and Russia. The major exporter of tropical timber was superseded by Malaysia in 1980s due to the problems of resources for producers and every country's policy of industrial protection and encouragement. Although Japan imported most plywood from Indonesia, imports from Malaysia have recently tended to increase. The value of forest product imports from Malaysia increased about 29 times from $66.44 million in 1964 to $1,912.85 million in 1992 (Forestry Agency, 1993).

According to "A Vision of Timber Industries", Japanese demand for timber at the turn of the century will be as follows (National Federation of Timber Corporatives, 1993):

(1) Demand for sawn timber is expected to remain at the current level, judging from trends in new construction of houses, changes in construction method and gradual expansion of floor space.

(2) Although demand for frame plywood made of tropical timber is expected to decrease, demand for wooden panels, including plywood, is expected to slightly rise from the present level due to changes in construction methods, developed demand for conifer plywood, and an increase in product imports.

(3) Although a sharp increase in demand for wood chips cannot be expected as before from domestic paper and pulp manufacturers, the demand is expected to increase as the economy grows.

Looking at trends in imports, on the other hand, it is predicted that imports of sawn timber as a whole will increase, while its domestic production will decrease. Moreover, it is expected that the supply of sawn timber from the North America will substantially increase. Imports of conifer wood chips will remain at the current level, while those of non-conifer chips will increase because the latter are cheaper.

These are projections for the Japanese timber market at the turn of the century. Of other Asian countries, China is especially significant as a new timber market and the prospects of increased timber demand following its economic development.

6-4 Asian Major Markets for Pulpwood

Pulpwood markets will be discussed in more detail in the following.

According to Forest Products 1980-1991, FAO's yearbook, Asian countries that import wood chips and particles and the import quantity are as shown in Table III-46. China means Taiwan in the table and one of two pulp manufacturers in Taiwan terminated its pulp production in 1993. Japan imports the largest quantity of the pulpwood (including chips and some logs) of softwood and hardwood. Since Japan imports a remarkable amount of conifer and non-conifer pulpwood (including chips and some logs) from other Asian countries, trends in its pulpwood consumption have a strong effect on those in Asia's pulpwood imports, especially future demand for and supply of non-conifer pulp wood will be conducive to an outlook for Asian markets for pulpwood.

Table III-49 Importing Countries and Quantity of Wood Chips and Particles

(Unit: 1000 m^3)

Country / Year	Asia Total	China	Japan	South Korea
1980	16,131	200	15,936	-
1981	12,736	228	12,508	-
1982	11,564	239	11,325	-
1983	11,758	356	11,402	-
1984	12,609	337	12,156	116
1985	12,239	400	11,723	116
1986	12,860	688	12,094	78
1987	14,456	593	13,840	22
1988	17,194	839	16,289	66
1989	19,471	600	18,668	203
1990	21,084	1,168	19,783	133
1991	24,096	1,168	22,784	145

Source: FAO yearbook, Forest Products 1980-1991

Pulp consumption by the Japanese pulp and paper industry is shown in Table III-50. The pulpwood of hardwood had increased steadily from the total volume of 15,443,000 in 1983, and amounted to 21,333,000 in 1991. However, volume fell by 3.3% in 1992 and by 3.4% in 1993 because of restraint on the production of pulp and paper in the paper industry, and accelerating use of waste paper, which is required from the environmental viewpoint. The quantity of Japan's pulpwood from domestic hardwood is small due to the low volume of domestic hardwood logs for lumbering and the consequent small quantity of domestic hardwood chips that are made of wastewood. Composition of the pulpwood of Japanese domestic hardwood by log type in 1991 is shown in Table III-51.

Table III-50 Changes in Pulpwood Consumption and Annual Incremental Growth Rate by Domestic/Imported and Softwood/Hardwood

(Unit: 1000 m^3)

		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Domestic	S	8,308	8,435	8,935	8,694	8,717	9,040	9,094	8,957	9,000	8,700	8,476
		6.4%	1.5%	5.9%	-2.7%	0.3%	3.7%	0.%	-1.5%	0.5%	-3.3%	-2.6%
	H	9,909	10,134	10,509	9,967	9,757	9,548	9,344	9,055	8,173	7,293	6,180
		4.9%	2.3%	3.7%	-5.2%	-2.1%	-2.1%	-2.1%	-3.1%	-9.7%	-10.8%	-15.3%
	Total	18,216	18,569	19,444	18,661	18,471	18,588	18,438	18,012	17,173	15,993	14,656
		5.6%	1.9%	4.7%	-4.0%	-1.0%	0.6%	-0.8%	-2.3%	-4.7%	-6.9%	-8.4%
Import	S	5,959	6,298	6,060	6,399	6,912	7,879	8,435	8,811	8,923	8,089	7,146
		-9.0%	5.7%	-3.8%	5.6%	8.0%	14.0%	7.1%	4.5%	1.3%	-9.3%	-11.7%
	H	5,534	5,864	5,626	5,915	7,028	8,220	9,970	11,316	13,160	13,340	13,759
		4.4%	6.0%	-4.1%	5.1%	18.8%	17.0%	21.3%	13.5%	16.3%	1.4%	3.1%
	Total	11,493	12,161	11,686	12,314	13,939	16,099	18,405	20,127	22,083	21,429	20,905
		-3.0%	5.8%	-3.1%	5.4%	13.2%	15.5%	14.3%	9.4%	9.7%	-3.0%	-2.4%
Total	S	14,267	14,733	14,995	15,092	15,625	16,919	17,529	17,768	17,923	16,789	15,622
		-0.5%	3.3%	1.8%	0.6%	3.5%	8.3%	3.6%	1.4%	0.9%	-6.3%	-7.0%
	H	15,443	15,998	16,135	15,883	16,785	17,768	19,314	20,371	21,333	20,633	19,939
		4.7%	3.6%	0.9%	-1.6%	5.7%	5.9%	8.7%	5.5%	4.7%	-3.3%	-3.4%
	Total	29,710	30,731	31,130	30,975	32,410	34,687	36,843	38,139	39,256	37,422	35,561
		2.1%	3.4%	1.3%	-0.5%	4.6%	7.0%	6.2%	3.5%	2.9%	-4.7%	-5.0%
H's Share		52.0%	52.1%	51.8%	51.3%	51.8%	51.2%	52.4%	53.4%	54.3%	55.1%	56.1%
Import's Share	S	41.8%	42.8%	40.4%	42.4%	44.2%	46.6%	48.1%	49.6%	49.8%	48.2%	45.7%
	H	35.8%	36.7%	34.9%	37.2%	41.9%	46.3%	51.6%	55.5%	61.7%	64.7%	69.0%
	Total	38.7%	39.6%	37.5%	39.8%	43.0%	46.4%	50.0%	52.8%	56.3%	57.3%	58.5%
Basic Unit		3.358	3.373	3.361	3.358	3.335	3.337	3.359	3,372	3.352	3.345	3.361

Source: Materials of the Research and Statistics Department, Ministry of International Trade and Industry, Japanese Government

Table III-51 Composition of Domestic Pulpwood by Log Type (1991)

(Unit: 1000 m^3)

	Natural Forest Low-Quality Log		Lumbering Remainder		Woodland Remainder and Small Branches		Total	
Hard-wood	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%
	5,411	66	1,402	17	1,383	17	8,196	100

Source: Materials of the Statistical Information Department, Ministry of Agriculture, Forestry and Fisheries and the Japan Paper Association

However, the slash includes that of imported hardwood logs. Sixty-six percent of Japanese domestic pulp-wood of hardwood are chips produced from the logs of former fuelwood forests. So-called expansive reforestation to convert natural forests into plantations reached a peak of about 300,000 ha/year in 1960 to 1970. At this time, the pulpwood of hardwood supplied from obstacle stands from forestation lands accounted for 40% to 55% of all pulpwood, including the imported (the total of softwood and hardwood being 190,000 m^3 in 1960 and 5,290,000 m^3 in 1970) (Ministry of International Trade and Industry, 1961 and 1971). In 1984, however, the area of expansive reforestation fell to below 100,000 ha (Forestry Agency, 1992). In 1969, the proportion of imported timber reached 50% (Forestry Agency, 1971) and continued to rise to bring about an imported-timber-led age, and prices of Japanese domestic timber fell to a low level.

With this background, the import of chips of hardwood such as Australian eucalyptus expanded. The supply of the Japanese domestic hardwood pulpwood declined to 10,360,000 m^3 in 1975, and stayed at the level of about 10,000,000 m^3 for 11 years until 1986 (Ministry of International Trade and Industry, 1976-1989).

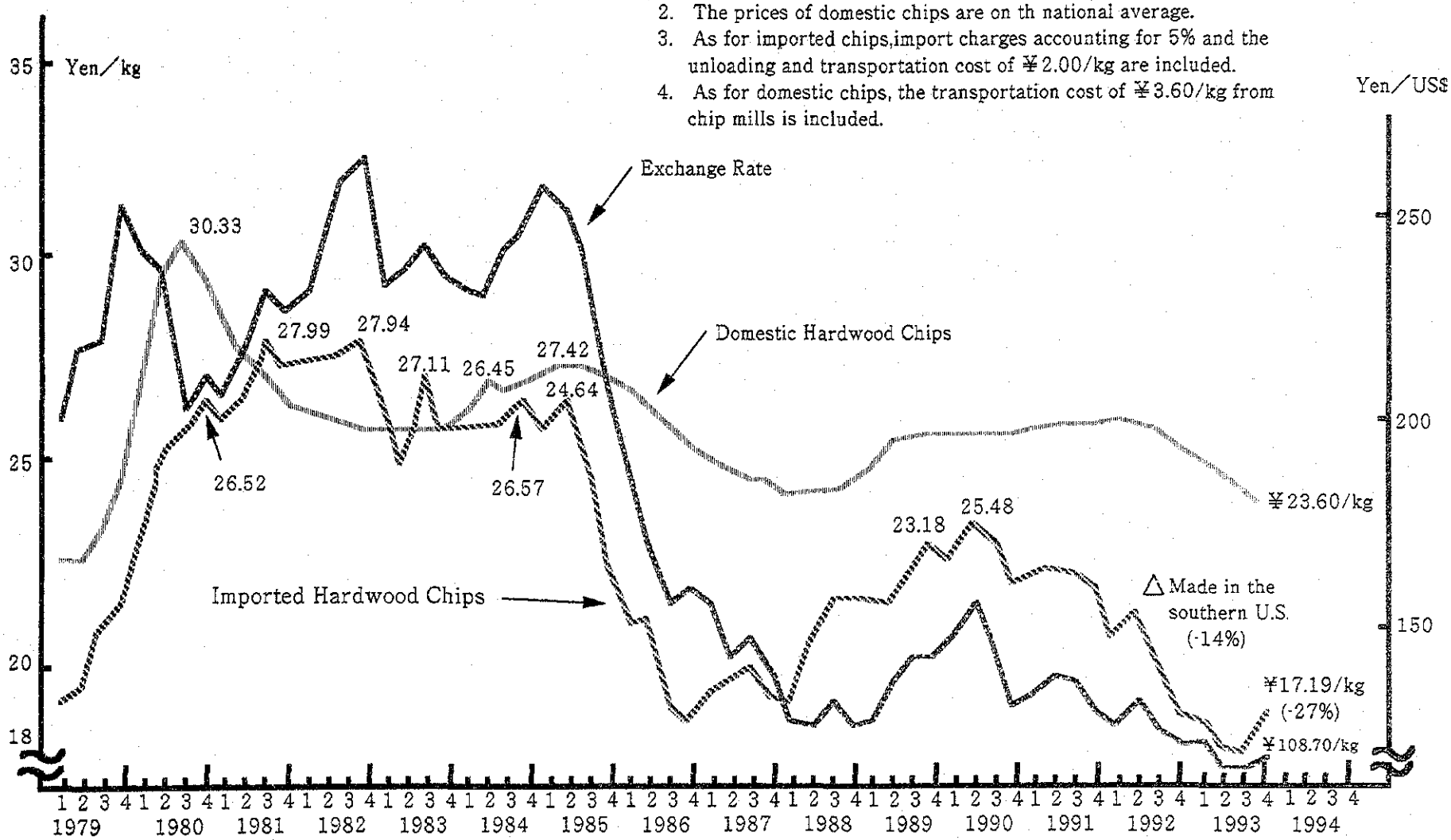
However, the large cost differential between imported and domestic chips due to the appreciation of the yen after 1985, the labour shortage, and the progressing aging of forestry workers have become very serious. Although the price of Japanese domestic hardwood chips was almost equal, on ex pulp-plant basis, to that of imported chips until that time, it became as much as 35% more expensive because of yen appreciation (see Figure III-10). However, users wanted to secure a certain level of stable domestic supply, and supported assistance and cooperation such as the streamlining of chip-plant operations and the introduction of high-efficiency logging machines. Thus, a level of around 9 million m^3 was maintained though total volume had decreased by about 2%. Nevertheless, the system of collecting domestic pulpwood of hardwood, 25% more expensive has been forced to change because of the worsening market conditions for the pulp and paper industry, and production cutbacks for pulp and paper. Accordingly, the supply volume of the pulpwood of hardwood decreased from that of the previous year by 9.7% in 1991, 10.8% in 1992, and 15.3% in 1993. As a result, the import share of pulpwood rose rapidly from below 40% to 55.5% in 1990, 61.7% in 1991, 67.4% in 1992, and 69.0% in 1993. (See Table III-50.)

Fig. III-10 Changes in the Estimated Prices of Domestic and Imported Chips ex Pulp Mill in Japan

(Hardwood)

Sources: Data from Japan Paper Manufacture Federation.
Ministry of Agriculture,Forestry and Fisheries and customs clearance statistics.

Notes 1. Imported chips are from Australia.
2. The prices of domestic chips are on th national average.
3. As for imported chips,import charges accounting for 5% and the unloading and transportation cost of ¥2.00/kg are included.
4. As for domestic chips, the transportation cost of ¥3.60/kg from chip mills is included.



Next issue is imported pulpwood of hardwood to Japan, whose rate of dependence on natural-forest logs has declined and come into question. With increasing demand for printing and information paper, the proportion of hardwood used for pulpwood (see Table III-50) reached 52% in 1983 and rose to 56.1% in 1993. Despite this expansion of demand for the pulpwood of hardwood, Japanese domestic supply has been decreasing since the time of yen appreciation, as mentioned previously. On the other hand, the importing chips was very favorable for Japan along with the low price of crude oil, and imports of hardwood chips rose from the Gulf of Mexico coast area of the U.S.A. and Chile. Table III-52 shows changes by country in the import volume of chips for pulp, and shares by country in supplying hardwood chips in 1993 were divided into three main areas: 31.0% from Australia, 28.3% from U.S.A, and 20.3% from Chile. Raw materials for imported hardwood pulpwood are dominated by logs from natural forests.

The source of supply in the southern U.S.A. includes many private forests mainly composed of secondary forests of oak which were reportedly regenerated in areas that had once developed as farming land. For the protection of wild life peculiar to the wetlands that exists abundantly in this area, some states have taken regulatory measures against cutting. In regard to Chilean natural forests, which are composed mainly of the *Nothofagus* genus, regulations have gradually been enforced because environmental protection groups have begun to put the cutting of such forests in question, with chip exports to Japan increasing. In this regard, 60% of hardwood chips imported from Chile are natural-forest logs, and remaining 40% are eucalyptus plantation logs. In Australia, even after a local pulp-manufacturing project was discontinued in the state of Tasmania, where the largest quantity of chips are exported to Japan, campaigns against the export of chips from natural eucalyptus logs has continued. However, the state has often negotiated with environmental protection groups from the viewpoints of economic development and employment, and expects an increase in chip exports of one million tons (almost equal to m^3) per year under the approval of the Federal Government (according to Japan Paper Federation).

At any rate, the dependence on natural-forest logs is questionable, and such dependency must be dissolved as soon as possible from the viewpoint of environmental protection. Pulp and paper industry in Japan have plans to gradually expand the material share of plantation logs. The forestation projects of fast growing hardwood like eucalyptus are progressing in areas such as Chile, South Africa, Papua New Guinea, China, Thailand and Vietnam. Although the volume of chips from such forestation accounted for 15% of hardwood-chip imports to Japan in 1991, hardwood chips made of plantation logs rose to about 23% of imports to Japan in 1993, amounting to some 3.4 million m^3. In order to secure a long-term stable supply of hardwood in the context of decreasing Japanese domestic supply volume and international moves toward forest preservation, a programme for switching to plantation logs has become an important task. Accordingly, *A. mangium* in the State of Sabah should have an opportunity to share a source of international hardwood market of plantation logs such as Japanese market in future.

Table III-52 Changes by Country in Import Volume of Chips for Pulp

Unit: 1000 m^3

	1979	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	93 share	Remarks
Softwood Chips													
U.S.A.	7,850 81.8%	4,160 61.1%	4,060 60.7%	4,127 58.4%	4,409 59.2%	4,963 62.4%	5,016 56.4%	4,971 57.5%	5,260 55.5%	4,575 54.1%	3,812 53.7%	53.7%	
Canada	732	1,116	1,110	1,155	1,181	1,623	2,054	1,874	1,572	1,631	1,066	15.1%	
Russia	627	1,085	883	994	962	416	534	504	353	258	251	3.5%	
New Zealand	385	436	463	566	587	344	386	482	809	554	355	5.0%	Plantation
Australia	0	14	168	212	112	184	232	225	672	799	939	13.2%	Plantation
Chile	0	0	0	0	129	306	517	366	570	335	203	2.9%	Plantation
Fiji	0	0	0	0	54	99	143	208	231	293	209	3.0%	Plantation
Taiwan	1	0	0	14	12	14	12	11	14	6	0	-	
PNG	0	0	0	0	0	0	0	5	0	0	0	-	
Malaysia	0	1	4	0	0	0	0	0	0	0	0	-	
China	0	0	0	0	0	0	0	0	0	0	0	-	Plantation
Brazil	0	0	0	0	0	0	0	0	0	0	259	3.6%	Plantation
Subtotal	9,595	6,812	6,688	7,068	7,446	7,949	8,894	8,646	9,481	8,451	7,095	100.0%	
Hardwood Chips													
Australia	3,718 68.7%	3,961 60.1%	3,680 59.5%	3,831 60.4%	4,551 60.6%	4,475 54.8%	4,496 44.3%	4,323 37.1%	4,419 31.7%	4,114 29.3%	4,583 31.0%	31.0%	
U.S.A.	557	608	623	599	1,018	1,910	2,517	3,242	4,259	4,372	4,188	28.3%	
Canada	0	26	11	27	42	91	292	304	184	169	95	0.6%	
Russia	89	537	539	695	613	108	106	79	106	70	43	0.3%	
New Zealand	108	248	210	252	266	166	186	134	108	70	126	0.9%	
Indonesia	106	125	171	173	254	245	366	374	338	375	414	2.8%	
PNG	117	180	117	47	68	67	93	169	145	146	141	1.0%	Plant. 40%
South Africa	409	649	691	627	671	611	584	553	736	740	1,168	7.9%	Plantation
China	0	0	0	5	7	115	209	311	491	497	661	4.4%	Plantation
Taiwan	4	0	0	0	0	0	0	0	0	13	16	0.1%	
Chile	0	0	0	0	1	354	1,170	2,067	3,023	3,245	3,008	20.3%	Plant. 40%
Thailand	0	0	0	0	0	23	86	54	67	157	200	1.4%	Plantation
Singapore	39	12	9	0	10	1	22	22	24	15	24	0.2%	
Malaysia	261	239	124	79	4	6	23	13	22	18	13	0.1%	
Vietnam	0	0	0	0	0	0	0	0	11	39	41	0.3%	Plantation
Philippines	0	7	12	7	0	0	0	0	0	0	0	-	
Argentina	0	0	0	0	0	0	0	0	0	0	65	0.4%	Plantation
Hong Kong	0	0	0	0	0	0	0	0	0	0	2	0.0%	
Total	5,408	6,592	6,188	6,342	7,504	8,173	10,149	11,647	13,932	14,040	14,786	100.0%	
Total	15,003	13,404	12,876	13,410	14,950	16,122	19,043	20,293	23,413	22,491	21,881	-	

Sources: "Customs Statistics" of the Ministry of Finance, Figures are converted into m^3 using a coefficient of the Forestry Agency. However, the material of the Wood Distribution Division, Forestry Agency has been used for 1988; Prepared by the Japan Paper Association.

Japan's total annual productive capacity of pulp is 15,130,000 ton, with operation rates of 82% in 1991 and 74% in 1992 (Pulp & Paper International, 1993). This shows that the output of paper decreased in two consecutive years of stagnancy. While the output of paper declined for two years in a row, the utilization factor of waste paper rose, though slightly, from 52.2% to 53%, and the proportion of imported pulp rose from 18% to 20%. Curtailment of paper production and a rise in the use of waste paper and the proportion of imported pulp resulted in a fall of 9.7% in the production of pulp from 1992 to 1993. The rise in the proportion of imported pulp is due to lower prices caused by the oversupply of marketed pulp and an exchange rate in favor of the yen. Paper making using imported pulp has been considered to be more advantageous in Japan than through-process production from chips.

The consumption of hardwood for pulp in Japan declined as shown in Table III-47, where the total of hardwood decreased from the previous year by 3.3% in 1992 and 3.4% in 1993, but the production of pulp is expected to expand gradually because the supply of pulp seems to be tightening and prices rising, and because the industry is seen as bottoming-out. However, imports of the pulpwood of hardwood plantation logs are increasing gradually, even while the total consumption is decreasing. This trend seems to continue in the future. Hardwood chips of plantation logs produced in each country are to be imported giving priority to those having higher competitiveness in quality, prices and aptitude to pulp. For *A. mangium* in the State of Sabah, therefore, it is necessary, in order to provide it with higher superiority in quality and prices as pulpwood over products in other areas, to raise plantation trees that have large increment through breeding, good trunk shape, little branches and no heart rot, and to produce chips which have been endowed with price competitiveness in exports, by improving the efficiency of raising seedlings, planting, and harvesting.

7. Environmental Assessment

7-1 Initial Environmental Evaluation (IEE)

In Phase I, the outline and locational conditions of this project were studied as the subject matter of the initial environmental evaluation. Subsequently, environmental factors drawn from these conditions were verified by the screening method to focus on what effects they would have on man-made forests.

This study is primarily designed to prepare a master plan for forestation, which is not subject to the Environmental Quality Act (1974) enacted by the Malaysian Government which requires environmental impact assessment. However, every environmental item was checked by scoping based on the results of the screening. In the following, negative effects will be discussed and appropriate measures for their improvement will be proposed.

7-2 Scoping

In drafting a project plan, the question of whether the environmental effects of the project should be taken into consideration or not was examined. It was concluded that environmental aspects of this project should be studied, therefore these were scoped.

1) Criteria for Scoping

The scoping was focused on the following relations to environmental factors at each of the proposed planting sites and each item was evaluated at an average value.

i. Relationship between man-made forests and the natural environment
ii. Relationship between man-made forests and the social environment
iii. Relationship between man-made forests and customary systems.

The alphabets in the table indicate the following evaluations with respect to forestation and the construction of forest roads.

P:	Positive effects are expected.
A:	Since negative effects are evidently expected, a further field survey should be carried out prior to the implementation of the project, and appropriate measures for improvement should be taken, if necessary.
B:	Since negative effects are evidently expected, a further field survey should be carried out prior to the implementation of the project, which should be treated in accordance with A based on the results of the survey.
C:	No significant negative effects are expected.

2) Results of Scoping

Environmental Item			Forestation	Construction of Forest Road
Large	Medium	Small		
1. Social Life				
	* Life of Inhabitants			
		Planned settlement	A	C
		Involuntary settlement	C	C
		Change of lifestyle	P	P
		Conflict among inhabitants	A	A
		Natives, minorities	C	P
	* Population Problems			
		Increase in population	B	B
		Rapid change in composition	B	C
	* Economic Activity of Inhabitants			
		Transfer of economic fundamentals	C	C
		Conversion of economic activity, unemployment	C	C
		Widening of income gap	A	A
	* System and Customs			
		Readjustment of forest rights of common	B	C
		Change of social structure, including organization	C	C
		Reform in existing systems and customs	C	C
2. Health and Hygiene				
		More use of agricultural chemicals	A	C
		Occurrence of endemic diseases	C	C
		Spread of epidemics	C	C
		Accumulation of remaining toxicity	B	C
		Increase in waste and excretion	B	B
3. Historic Sites, Cultural Heritage and Scenic Beauty				
		Damage to and destruction of historic sites and cultural heritage	C	B
		Loss of valuable scenic beauty	C	B
		Effects on resource deposits	C	B

Environmental Item			Forestation	Construction of Forest Road
Large	Medium	Small		
4. Valuable Living Things and Ecosystems				
		Change of vegetation	A	A
		Effects on endemic and valuable species	B	B
		Decline of biological diversity	A	B
		Invasion and growth of harmful organisms	B	B
		Disappearance of marshes and peat bogs	C	B
		Degradation of natural forests	P	B
5. Soil and Land				
	* Soil			
		Erosion	P	B
		Salinization	P	C
		Reduction in fertility	P	B
		Contamination	C	B
	* Land			
		Devastation	P	A
		Occurrence of landslides	P	A
		Degradation of functions such as a windbreak, prevention of shifting sand, control over tides and prevention of fires	P	C
		Subsidence of land	P	C
6. Hydrology and Water Quality				
	* Hydrology			
		Changes in surface flowing water	C	B
		Changes in the flow and level of underground water	C	B
		Occurrence of droughts and floods	P	C
		Sedimentation of earth and sand	C	B
		Lowering of riverbeds	C	C
		Effects on transportation by boat	C	A
	* Water Quality and Temperature			
		Contamination and degradation	B	B
		Eutrophication	P	C
		Percoration of saline water	C	C
		Changes in water temperature	C	C

Environmental Item			Forestation	Construction of Forest Road
Large	Medium	Small		
	* Atmosphere			
		Air Pollution	P	B
		Increase in CO_2	P	C
		Changes in microclimate	C	C
		Occurrence of noise	C	A
7. Sustainability of Forest Resources and their Functions				
		Discontinuation of sustainability of raw material resources	P	C
		Discontinuation of the function of environmental conservation	P	C

7-3 Forestation Standards with Care for Environments

1) Enrichment Planting

Tropical rain forests play a major role in sustainable timber production and providing public benefits, including headwater conservation and fire prevention. They also provide an optimal habitat to wildlife and insects. Moreover, they are a living environment of local inhabitants strongly dependent on forests.

It is obvious that forests in northern Sabah have been logged-over intensively to date. However much they may be degraded, environmental conservation should be placed on their potential roles, and every effort should be made to rehabilitate their diverse functions. The original state of tropical rain forests should be artificially restored by all means.

The most effective measure for such restoration is enrichment planting. Although enrichment planting is intended for eventual timber production, it will take a long time till harvesting, and public benefit functions are expected in the process of being growing. It is too narrow to regard such forestation activities just in terms of economics and make private companies bear all expenses for such activities. The restoration of degraded tropical rain forests is an urgent problem. This is why public funds are expected for implementing enrichment planting.

2) Single-storey Forestation

As previously stated, forests in northern Sabah have obviously been logged-over to a considerable extent. Therefore, there are extensively distributed forest areas that are judged to be impossible to restore through enrichment planting, and these are located mainly on the periphery of possible sites for enrichment planting.

Such forests are characterized by (1) the land being in a bare land and (2) few dipterocarp species typical of tropical rain forests. There is such an apprehension that if they are left unattended, the soil will deteriorate further, and Gramineae species (*Imperata cylindrica*) will invade them and transform them into grassland. Consequently, landslides will eventually occur.

As far as these forests are concerned, it is recommended that efforts for immediate recovery of original forest should be unsuccessful, and instead, they should be uniformly reforested as soon as possible.

Despite having economic merit, uniform forestation will reverse the diverse functions of tropical rain forests. In this case, special care should be taken not to exert adverse effects on the natural environment.

3) Measures for Improving Negative Impact

(1) Shifting cultivation has been traditionally been carried out throughout northern Sabah. This is a living culture practiced by natives for a long time, but it is one of the factors causing forest degradation. Nevertheless, it is not rational to conclude that shifting cultivation is a vicious practice. If forestation as an economic action is carried out near the traditional living area of inhabitants, it is feared that a conflict will occur over their customary right to land.

Improvement Measures:

Fundamentally, full consideration should be given to the life of inhabitants in carrying out forestation in order to avoid infringing on their rights and living basis.

Shifting cultivation seems to have already reached a limit in terms of area and labour force. Many of the local inhabitants wish to start a new life by discontinuing shifting cultivation, if suitable jobs are available. The final decision of this option is left to them. If, however, they choose to start a new life by working for forestation, they will shift from a self-sufficient economy to an economy dependent on society. To adapt them to such society, their life must be modernized and labour must be led intensive. To this end, it is recommended that their houses be incorporated into a community to intentionally promote their settlement by providing living facilities, including a training centre for living improvement, meeting places, churches, schools, clinics, a distribution centre of goods, and public health facilities.

(2) The promotion of forestation and the construction of forest roads will flow workers, goods and various information into the project area from outside. They may have an adverse effect on the psychological well-being of the local people.

Improvement Measures:

Goods brought from outside will serve the local people. Information on preferential treatment in other development projects will, however, also be transmitted by strangers and have a negative psychological impact on the local people. In particular, the issue of pay differentials should be kept in mind because this problem has arisen often in other development projects.

In addition, the construction of forest roads and the transportation of logs will involve the frequent passage of vehicles, and this may cause noise and dust, destroy road surfaces, and raise the risk of accidents. Appropriate measures should be taken in anticipation of these problems.

(3) It is a matter of concern that the spraying of insecticides and herbicides may contaminate water and effect the wild birds and animals.

Improvement Measures:

The local inhabitants who settle themselves in forests obtain their drinking water from streams and rivers, and these are also used for bathing and washing clothes. As a rule, no insecticide or herbicide will be used. If for some reason it becomes imperative to spray some chemicals, careful attention must be paid to the direction and velocity of the wind, and empty cans and bottles of chemicals must not be left on animal trails.

(4) Empty pots, bags and other refuse accumulated after the workers and machines leave may have adverse effects on natural and social environments.

Improvement Measures:

Empty pots and bags should be buried in a hole dug after the completion of operations. Other refuse must not be dumped in rivers. Rivers along forest roads will be inspected frequently. If refuse is found to have accumulated in the river, the river should be dredged. An effective step in the prevention of river contamination is to maintain a 10 m wide buffer zone of natural forest along every river.

(5) If exotic species are introduced into industrial forestation, forest composition will become uniform and the diverse functions of tropical rain forests will disappear.

Improvement Measures:

Tropical rain forests which remain adjoining or near the proposed planting sites will be conserved as much as possible. A planting method suitable for the harmony and coexistence with such forests will be employed. For example:

1. Limit the area of one logging area to be less than 100 ha.
2. Create multi-storeyed forests (In order to avoid uniformity of forest composition, multi species or different ages of trees are managed to grow within a forest stand.) comprised by the same or different species.
3. As a rule, conserve tropical rain forests on ridges and along valleys.

(6) It is feared that diseases and insects may occur on a large scale as a result of large-scale plantation.

Improvement Measures:

Dense planting should be avoided and a maximum of 1,250 seedlings should be planted (4 m x 2 m). Even stands for producing pulpwood should be thinned if necessary.

When signs of disease or damage by an insect are found, effective measures for preventing the spread to healthy trees include the cutting of damaged trees immediately, and the spraying of appropriate chemicals. In addition, the measure described in 3. Paragraph (2), above will also be adopted to conserve as much tropical rain forests as possible around plantations.

(7) Repeated forestation may dry soil and deteriorate soil into laterite.

Improvement Measures:

To prevent the soil of aridable topography from drying, indigenous species will be mixed with the exotic species. It is also effective to cover the topsoil with cover crops immediately after the logging-over of standing trees. Moreover, adjusting the density of standing trees by thinning is also an effective measure to facilitate the radiation of sunlight.

In the second and subsequent planting, the rainy season should be avoided for land preparation. The use of fertilizers is indispensable in plowing and planting. It is advisable not to skid logs mechanically but manually in the rainy season, as far as possible.

(8) The soil of tropical areas has a high consistency, and tends to change into clay in rainy weather and harden intensely in fine weather. If felling and yarding are repeated in rainy weather, landslides or erosion are more likely to occur in mountain areas.

Improvement Measures: See Paragraph (4) above.

(9) Felling and yarding operations may change the topography and cause landslides.

Improvement Measures:

Mechanical yarding must be avoided on steep slopes or in areas prone to landslides. Even in other topography, logs should be yarded by using yarding system to draw them up but not down. In steep areas, logs must not be stored, piled up or loaded onto trucks.

If any operation is performed by contract, the above-mentioned restrictions and requirements should be set forth in the contract specifications, and full guidance regarding environmental considerations should be given to the contractors.

(10) The construction of forest roads may cause hillside erosion.

Improvement Measures:

In the construction of a forest road, the cutting or banking part of the site is most likely to cause hillside erosion. To prevent that, the route should be aligned along ridges at the design stage. If the present topography has to be adjusted to the design, it is advisable to minimize the changes as far as possible and in order to reduce the amount of carriage of soil and cutting and banking must be adjusted. If spoiled soil is not disposed of completely, it may cause a landslide. If required, drainage facilities as well as facilities for preventing erosion should be constructed in the area where the earth is dumped.

Conduits of appropriate sizes and side-ditches should be constructed to handle the maximum expected flow rate. A bridge should be constructed across rivers whose flow rates rise to unusual levels.

Appropriate measures should be taken to facilitate the use of water by inhabitants around forest roads and cope with any changes of water quality due to erosion. These include the construction of sedimentation ponds and the conservation of forests.

In rainy weather, road surfaces are washed like riverbeds, and this is likely to cause hillside erosion. An effective countermeasure for this is to fix the surfaces with wood or wood chips.

8. Conclusion

(1) Significance of Forestation

In the development of Malaysian industry, the status of the manufacturing, financing and service industries has rapidly risen. In contrast, the status of agriculture, forestry and fisheries has gradually declined. This is also happening in Sabah State. Nevertheless, they are still emphasized in the state, as compared with Peninsular Malaysia. Manufacturing industries such as electric appliances and machine industries in Sabah have not progressed much, but agriculture, forestry, fisheries and related industries will probably remain key industries for the time being.

Royalties on logs from natural forests have a high share in the state revenue. Log output is, however, expected to fall down to about half the 1990 level in the near future. Therefore, the time has already come to ensure sustainable forest management by adjusting the output of logs from natural forests making up for the deficit with man-made forests.

Man-made forests will eventually generate earnings and there is a huge area of unused land in Sabah. It goes without saying that such land should be used effectively for economic development. In the case of less fertile land, such as the area covered by this study, there are difficulties in this use for agriculture, and forestation is the only effective way to use them. If the productivity of land is improved by forestation, it will contribute not only to timber production, but also to sustainable management of the few residual natural forests and conservation of tropical rain forests which are rapidly decreasing.

State-owned forests covered in this study can largely be divided into two groups according to the forest management system. One group includes mainly medium and high forests, and the other includes low forests, shrubs and grasslands. Although the former have been logged-over several times and degraded, there remain plenty of young trees of dipterocarp species and other species which will become large-diameter trees. They will eventually become stands which can be managed as natural forests, unless they are destroyed by fire. In contrast with this, the latter comprise many stands which are useless for timber production, and the soil is not fertile enough for agriculture. Therefore, they should be used for man-made forest. In the case of low forests, it is advisable to carry out enrichment planting rather than reforestation after clear cutting where few potential large-diameter trees exist, and then manage them as natural forests.

(2) Forestation Policies by Consolidation

The coverage areas of the study were divided by scale of management into three groups, large, medium and small. Large consolidations are the three consolidations of Marak Parak, Sonsogon and Tandek, a medium consolidation is Langkon Consolidation, and the other consolidations are small.

If large consolidations are arranged according to the case of planting operations and the size of plantation, the order is Marak Parak, Tandek and Sonsogon. Main species to be planted are *Acacia mangium* and *Paraserianthes falcataria*, and sites for planting the latter must be under good soil conditions. In the Tandek consolidation, *P. falcataria* grows well naturally. This species is better than *A. mangium* in MAI and timber value and used for sawing. There seem to be many sites suitable for this species in this consolidation. It is possible to extend the area of planting for this species more than in other two consolidations. It is recommended that financially capable entities should carry out forestation because a huge amount of money will be needed for forestation in these consolidations.

Despite being medium-sized, some parts of the Langkon Consolidation has already been used to a considerable extent of land-use and seems to be difficult to extend the area of plantation. *P. falcataria* has naturally grown also in part of this consolidation, and this species is favorable to plant in this consolidation.

Forestation in small consolidations may be undertaken mainly by tree farms as well as small enterprises.

Although enrichment planting is planned for low forests, the supply of seedlings is a factor which may restrain such planting. The area of enrichment planting is estimated at about 500 ha per year. It is important to start such planting on accessible sites.

(3) Plantation Operator

Since the planting of slow-growing species which take a long time to harvest is difficult for private companies on a large scale enough for commercialization, economic forestation should be the uniform planting of fast-growing species. Such difficulty will increase especially when the cutting period is as long as forty years as in the case of enrichment planting. Therefore, it is significant for public agencies like SAFODA to undertake large-scale forestation.

When implementing this project, SAFODA is expected to play a major role in (1) using know-how on administering and managing plantations, (2) developing silvicultural techniques, and (3) extending tree farminig. To support it, the Sabah State Government needs to appropriate budgets for survey and research, forestry extension, personnel training, and the provision of facilities, equipment and materials.

Plantation operators will be summarized by scale of forestation in the following.

In this project, it is assumed that SAFODA alone or its joint venture with a private company (or companies) will serve as a large-scale plantation operator. In any case, no doubt, such forestation will need a great deal of money, which may be provided through public funding or low-interest financing.

In this project, it is assumed that SAFODA will undertake medium-scale forestation. The sporadic distribution of plantation area will raise the administration and operation costs of medium plantations. However, there remains grasslands and shrubs which

needs forestation even in medium consolidations. No entity other than SAFODA is conceivable as the plantation operator.

In this project, it is planned that small-scale forestation will be mainly undertaken by farmers in the form of tree farm. It is expected that the development of tree farms as a result of SAFODA's extension activities will improve farm incomes and contribute to the regional development in the future.

(4) Effects of Forestation on the Coverage Areas of the Study

The effects of large-area forestation on the local society and economy include the utilization of local work force, the development of wood processing industries, and convenience resulting from improvement in related infrastructure.

In the case of tree farm, they will be able to earn incomes from their forest at harvesting time when their plantation reach cutting age. Surplus labour provided by individual farms will be accumulated in the form of standing trees which generate cash income at the time of harvesting. This is very significant for farms which have only little cash incomes. This will also lead to regional development.

If a medium or large entity is involved in this project, forestation or seedling production will give job opportunities to the local people, who will be able to earn cash income. Preferably, labour requirements should be constant every year over a long period in light of locally available labour. If labour is suddenly demanded at particular time, after which labour is not needed, it is detrimental to regional development as well as to forestation in the long term perspective.

Logging and yarding need a different type of labour to that needed for planting and seedling production. The labour needs mechanical operations which require experience. If a large plantation is created, workers will gradually accumulate experience in such operations. Those who can operate large machines, trucks and tractors for repairing forest roads will also gather.

The implementation of this forestation project will have many effects on the local inhabitants. Some parts of state-owned lands which are proposed as sites for medium and large scale forestation are already occupied by people dependent on shifting cultivation. They will inevitably be affected by this project. The settlement of people dependent on shifting cultivation is one of forestry policies proposed and explained by the Chief Minister at the State Assembly on June 13, 1990. Accordingly, the government needs to expand the settlement and improve the land system for nontraditional shifting cultivators on the one hand, and improve the farm management system by promoting agriculture and agroforestry for traditional shifting cultivators on the other. Moreover, it needs to bring benefits to the local people by promoting inhabitant forestry and expanding employment in the area of forestry (Sabah Forestry Department, 1990).

Shifting cultivation is carried out voluntarily by individuals. If they are employed for forestation, they must work in accordance with the directions of the entity in charge

of forestation. Work of this type will need those who have received a certain level of education. Therefore, all local children need to receive better education in order to improve the welfare of inhabitants, secure the desired labour and develop the local industry.

If the living environment of farmers is taken into consideration, tree farm needs to be carried out for the benefit of farmers who live in the area of the large-scale forestation. This idea is to change the shifting cultivation culture of the inhabitants, and this has a social impact on the farmers. In view of improvement in the welfare of inhabitants, tree farm is definitely needed.

(5) Projections for Harvest

The area of new plantations of A. mangium created in the coverage areas of the study until 2020 will be 52,000 ha made up of 28,000 ha of large and medium plantations and 24,000 ha of small plantations. Besides these, the existing plantations of *A. mangium* extend 7,000 ha in the coverage areas, and plantations of the same species extend about 13,000 ha in the Bengkoka Consolidation of SAFODA. If these plantations are regenerated by *A. mangium*, a total area of about 72,000 ha will be covered with plantations in 2020. Accordingly, about 10,000 ha of harvest will be expected annually from *A. mangium* with a cutting period of seven years. Assuming that the MAI is 25 m^3, it is forecast that stocking per ha will be 175 m^3, and about 1.75 million m^3 of standing trees will be harvested in 2020. At a yield of 80%, 1.4 million m^3 of logs will be produced. The sustainable production of logs over 1 million m^3 per year will be a sufficient level for one pulpwood production area.

The area of harvesting *P. falcataria* and other species for producing saw timber will not be very large in 2020, and even that of *P. falcataria* occupying the largest area will not exceed 800 ha per year. Assuming that the MAI of *P. falcataria* is 33 m^3 and the cutting period is 10 years, it is forecast that stocking per ha will be 330 m^3, and about 260,000 m^3 of standing trees will be harvested. At a yield of 70%, about 180,000 m^3 of logs will be produced.

(6) Use of Plantation Logs

Logs from *A. mangium* plantations, which have a comparatively low unit value should not be transported long-distances in economical condition. In this case, it is advantageous to give them primary processing near the production area and then transport them to the final consumption area. For example, a large amount of *A. mangium* logs will be exported to chip market. In this case, if logs are exported, their transportation will cost too much. It would make economic sense to export them after processing into chips. In the case of *P. falcataria*, logs can be processed into sawn timber or blockboard by primary processing industries. As it is planned that a huge amount of logs will be produced from man-made forests in this area in the future, wood processing industries have high development potential. It is desired that sophisticated as well as primary processing industries develop in this area. It is recommended that the government should give incentives for this field.

Some people think negatively about the planting of *A. mangium* because of the absence of markets for this species. There is now no large use of *A. mangium* wood other than pulpwood to manufacture paper and chips to produce medium-density fireboard. In small quantities, they are used to produce finger jointboard, palette or molding. These applications do not seem to increase rapidly to use large volume of *A. mangium* logs. Therefore, *A. mangium* wood will be probably used mainly in the form of chips. If *A. mangium* wood can be profitably used to produce finger jointboard or palette or other value-added materials, these applications should be increased. SSSB has already planned to export *A. mangium* chips. Currently, the company exports *P. falcataria* wood in the form of blockboard or logs on a small scale.

Many managers of operating sawmills in northern Sabah have indicated they will continue operation as long as natural logs are available. They have no intention of sawing logs from man-made forests. Their attitude is understandable because their facilities in operation are designed for large-diameter natural logs but not for the small-diameter ones from man-made forests. The stable supply of logs from man-made forests could, however, facilitate the development of a new wood processing industry. The government should therefore give incentives for the realization of this potential such as preferential treatment in tax, financial assistance, and subsidies for developing timber industrial park. A significant downstream measure is to develop timber industrial park in northern Sabah so that small-diameter logs from man-made forests can be used conveniently.

(7) Environmental Conservation

Large-scale forestation will affect the natural and social environments of the project sites. Forestation activities under this project include the forestation of grasslands and shrubs, and enrichment planting in some of the medium forests for the purpose of rehabilitating forests. Even if a single species is planted, the afforestation of abandoned grasslands with low productivity and the reforestation of degraded forests will contribute to the conservation of the natural environment by covering it with greenery. In addition, this project will bring about social and economic benefits, including watershed conservation, development of downstream forest-product processing industries, and an increase of job opportunities.

The Environmental Quality Act (1974) enacted by the Malaysian Government does not require forestation projects to make environmental impact assessments. Nevertheless, environmental items were checked in connection with large-scale forestation, and measures for improving negative effects were proposed in this study. Environmental assessment was carried out with the focus on the relations between forestation and the natural environment or the social environment or practices and systems. As a result, it was concluded that forestation activities under this project would not have negative effects or difficulties if the proposed improvement measures were taken. However, the species to be planted is exotic and likely to disturb the diversified composition of tree species and conventional shifting cultivation. Diseases and insects must also be controlled. Forest land may be destroyed by constructing forest roads. Agricultural chemicals may affect water quality and wildlife.

Countermeasures for these problems were also proposed.

(8) Necessity of Infrastructure

The implementation of this project requires improvement in infrastructure. If infrastructure is improved, it will be possible to distribute forest products and otehr goods smoothly. This will make a great contribution to the economic development of this area. Bridging the Bengkoka River is especially needed.

(9) Effects of This Project

This area is underdeveloped and economically sluggish conditions prevail in Sabah. If the creation of man-made forests under this project facilitates the development of wood processing industries and activates the regional economy, the income of inhabitants will be improved, underused or unused lands will be used in a sophisticated way, and in addition, the natural environment will be conserved.

Thus, the implementation of this project will have a great economic effect on the whole of Sabah State, and not just to northern Sabah, and is strongly needed. If this project is implemented, forestation will facilitate sustainable timber production, provide job opportunities and raise the currently low incomes of farmers on the one hand, and lead wood processing industries to develop and make a great contribution to the regional economy on the other. The industrial development of underdeveloped areas and the subsequent improvement of incomes of inhabitants will not be limited to one region but expanded to the whole of Sabah State and further contribute to the development of Malaysia into an advanced country. Therefore, the government needs to adopt policies for improving infrastructure related to this project and give incentives for the development of wood processing industries, including but not limited to preferential tax treatment.