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THE GOVERNMENTS OF MALAYSIA AND THE STATE OF JOHOR

RUBBER

WORKING PAPER

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RUBBER

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R U B B E R

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1. INTRODUCTION

Malaysia is the world's largest producer of natural rubber and its Rubber Research Institute is the foremost centre for study of rubber production. As a result the country is the major repository of know-how on the rubber plant and its exploitation. This paper therefore will not discuss production techniques but will merely summarise the assumptions made in evaluating rubber as a potential enterprise in the project area.

2. MARKET AND PRICE ASSUMPTIONS

2.1 World Projection

Natural rubber is an important component of the overall supply of elastomers. The other source is from so-called synthetic rubbers which are produced primarily from by-products of petroleum refining. Elastomers are used for a wide variety of purposes, the most important of which is in tyres for moving vehicles. Other uses exist in foot-wear, hoses and piping, belting, wire and cable insulation, flooring and foam products.

Not all elastomers are equally suitable for any one of these purposes. Each of the synthetics has particular individual characteristics which limit its use. Styrene-butadiene rubber (S.B.R.) is the most widely produced as well as being the cheapest of the general-purpose synthetics. However its resilience is less than that of natural rubber. Polyisoprene rubber is most like natural rubber in its characteristics but is only produced on a relatively small scale at present.

Trends in production and use of natural and synthetic rubbers over the past two decades are shown in Table 1.

TABLE 1 WORLD CONSUMPTION OF NATURAL AND SYNTHETIC RUBBER ('000 TONS)

	1953-55	1955-57	1961-63	1965-67	1968 (pre- lim)	Annual rate of growth 1954 - 1968
Natural	1,746	1,860	2,135	2,340	2,772	3.0
Synthetic	1,292	1,420	2,704	3,960	4,651	10.0
Total	3,038	3,280	4,839	6,300	7,423	6.5

Total consumption of rubbers expanded at about 6.5 percent per annum between 1954 and 1968. But this growth was not equally shared between natural and synthetics. While natural rubber consumption rose

by about three percent per annum that of synthetics forged ahead at ten percent. As a result the share of natural in the overall elastomer market fell steadily. (Table 2).

TABLE 2 WORLD CONSUMPTION SHARES (PERCENTAGE) OF NATURAL AND SYNTHETIC RUBBER 1954 - 1968

	<u>1954</u>	<u>1956</u>	<u>1962</u>	<u>1966</u>	<u>1968</u>
Natural	58	57	44	37	37
Synthetic	42	43	56	63	63

A number of reasons have been offered for this increased penetration of the market by synthetics:-

(a) Perhaps the major single reason was that more natural rubber was not available. Little planting of rubber took place in the main South East Asian producing region immediately prior to World War II and none during it. Plantations were ravaged. The period after the war was one of instability in the area and planters concentrated on rehabilitating and replanting old holdings rather than extending their acreages. As a result expansion of production was relatively slow.

(b) World War II had the dual effect of spurring the development of techniques of synthetic rubber production and emphasising the strategic risk for importers in relying on supplies from one area of the world.

(c) Because of their individual characteristics, individual synthetic rubbers are preferred to natural rubber for specific uses at likely prices.

(d) The marginal cost of producing synthetics is well below average cost because of the heavy capital cost involved. Thus once synthetic capacity is installed it will continue to be used even if natural rubber prices fall. This makes it difficult for natural rubber to recapture lost markets.

(e) Natural rubber prices have traditionally fluctuated widely whereas synthetic prices have been relatively stable. Costs are involved in most processes in switching from one type of rubber to another. Thus given uncertainty about natural prices many users have chosen synthetics. Natural rubber prices during the decade 1950-1960 were generally in the region of 90 cents to \$1.00 per ob. f.o.b. Singapore which was above the price of many synthetics. Since then it has fallen to about 50 cents per lb. The cost of polyisoprene rubber is thought to be about 66 cents per lb. which gives natural rubber a slight price edge at present.

F.A.O. in its indicative World Plan for Agriculture has projected that total elastomer usage in 1985 will be approximately 18.5 million tons (Table 3). This represents a growth rate of six percent per annum, just slightly below the rate attained in the recent past. Usage of natural rubber is expected to continue to grow at 3 percent per annum while synthetic usage is expected to grow more slowly in future at 7.5 percent per annum. The market share of natural rubber will therefore continue to drop to only one quarter of total rubber usage.

TABLE 3 RUBBER 1962 BALANCE AND PROPOSALS FOR 1985

	<u>Utilization</u>		<u>Rate of Growth</u>	<u>Market</u>
	<u>1962</u>	<u>1985</u>	<u>1962-85</u>	<u>Split</u>
	('000 tons)		Percent per year	1985
Natural	2,236	4,452	3.0	24
Synthetic	2,724	14,048	7.5	76
Total	4,960	18,500	6.0	100

2.2 Malaysian Projection

Production of rubber in Malaysia since 1955, together with projections of output over the next decade made by the Rubber Research Institute, are summarised in Table 4. These show a steady increase in output over the past decade of 5.5 percent per annum, and a projected growth over the next of slightly less (4.7 percent). In fact the period of fastest expected growth is already upon us, 10 percent per annum between 1967 and 1972. This results from the initiation of production on the replanted schemes of the late 1950's. These estimates exclude the effects of novel stimulants such as Ethrel which have just been released. It is estimated that these, used on older trees, could expand output by an additional five percent or more i.e. 100,000 tons in 1980. A continuation of this rate of growth to 1985 would mean production in Malaysia of 2.5 - 2.7 million tons or 60 percent of the world usage projected by F.A.O. Given expected efforts by other producers to expand output this suggests that the F.A.O. may be a little on the low side. Whether rubber prices will have to fall to accommodate this increase will be influenced by a number of factors:-

(a) Pressure on oil supplies is resulting in rapidly rising crude oil prices. This together with recent high interest rates and low margins in rubber manufacturing may have resulted in some stretching out of investments in synthetic plants. Prospects of still higher oil prices is likely to cause some reevaluation of future investments.

(b) The strategic argument, which worked against natural rubber in the past, may operate in the other direction in the future as rubber users wish not to be completely dependent on oil supplies from unstable areas.

(c) Changes in final products can have considerable effects on demands for individual rubbers. There is a current trend towards radial ply high performance car tyres which have a higher proportion of natural rubber content than conventional tyres. Entirely new markets for elastomers may be developed e.g. in road surfacings.

(d) The increasing proportion of output in the form of standardized and special rubbers will enable natural rubber to compete more directly with synthetics with guaranteed characteristics, although more work needs to be done to produce rubbers of the required form.

(e) As noted earlier buyers have been inhibited from buying natural rubbers because of price fluctuations. Now that the previous price premium for natural rubber over many synthetics appears to have disappeared permanently they might be more interested in buying on a contractual basis at an agreed price. This would require some modification of existing marketing arrangements to achieve but could pay useful dividends for both producers and consumers.

(f) A major breakthrough could be achieved in synthetic production which could lower production costs dramatically, e.g. reduction in the cost of isoprene, the major component of polyisoprene rubbers. This could lower costs to about 45 cents per pound and force down natural rubber prices to 40 cents or lower. However, such a breakthrough is not yet in sight.

Therefore the balance of current and foreseeable forces suggest that market equilibrium between supply and demand in the near future will lie in the range 50-55 cents per pound for R.S.S.I. f.o.b. Singapore with the upper limit being determined by synthetic prices. For the purposes of analysis of profitability of plantings from 1972 onwards the price level only really becomes of interest in 1980 when yield builds up. In the analysis outlined in this paper an average f.o.b. price of 50 cents per pound has been used throughout. The product unit has been assumed for costing purposes to be 85 percent SMR 5CV and 15 cent SMR 20, or equivalents. SMR 5CV has normally traded at a premium over R.S.S.I. of up to 4 cents per lb. while SMR 20 has traded at a discount of up to $4\frac{1}{2}$ cents per lb. These premia and discounts vary over time, but the net effect over the past two years has been a premium, for such a unit, of about one cent per pound. Assuming this product mix and a continuation of similar premia and discounts for the different products the projection of 50 cents per pound f.o.b. for

the mix is therefore equivalent to an R.S.S.I. of about 49 cents per pound throughout.

TABLE 4 SUMMARY AND PROJECTION OF RUBBER PRODUCTION, MALAYSIA ('000 TONS)

<u>Year</u>	<u>West Malaysia</u>		<u>Total</u> (1)+(2)	<u>Annual</u> <u>increase(%)</u>	<u>East</u> <u>Malaysia</u>	<u>Total</u> (3)+(5)
	<u>Estates</u>	<u>Smallholdings</u>				
<u>Summary</u>	(1)	(2)	(3)	(4)	(5)	(6)
1955	352	285	637	8.89	58	695
1956	351	255	606	-4.87	61	667
1957	368	250	618	1.98	59	677
1958	389	249	638	3.24	58	696
1959	407	263	670	5.01	64	734
1960	413	272	685	2.24	67	752
1961	428	278	706	3.06	67	773
1962	438	277	715	1.27	56	771
1963	458	295	753	5.31	65	818
1964	447	314	791	5.05	66	857
1965	491	348	839	6.07	64	903
1966	514	386	900	7.27	57	957
1967	526	397	923	2.55	51	974
1968	563	472	1,035	12.13	48	1,083
1969	603	587	1,190	14.97	68	1,258
<u>Projection</u>						
1970	638	635	1,273	6.97	75	1,348
1971	672	717	1,389	9.11	77	1,466
1972	701	786	1,487	7.05	79	1,566
1973	724	846	1,570	5.58	81	1,651
1974	740	894	1,634	4.08	83	1,717
1975	751	929	1,680	2.82	85	1,765
1976	764	971	1,735	3.27	88	1,823
1977	775	1,013	1,788	3.05	91	1,879
1978	785	1,066	1,851	3.52	94	1,945
1979	791	1,132	1,923	3.89	97	2,020
1980	800	1,200	2,000	4.00	100	2,100

3. PRODUCTION ASSUMPTIONS - BASIC MODEL

3.1 Introduction

The profitability of rubber planting was assessed on the basis of an estate operation of 10,000 acres gross, of which 8,500 acres are planted. It was assumed that the area of the estate would be cleared and

planted in year 1 of the operation. This is perhaps slightly unrealistic, but phasing will vary depending upon individual circumstances. A 20 year life for the project has been assumed. This again is unrealistic; rubber will certainly remain in the ground for more than this length of time, because maximum yields are generally not reached until almost 20 years after planting. The assumption was made to enable the project to be compared with an oil palm project.

3.2 Yield Assumptions

The assumed yield above is shown in Table 5

TABLE 5 RUBBER, ASSUMED BASIC YIELD CURVE (LB/ACRE)

<u>Year of Tapping</u>	<u>Panel</u>	<u>I</u>
1		620
2		1,010
3	A	1,260
4		1,420
5		1,500
6		1,600
7		1,700
8	B	1,800
9		1,800
10		1,800
11		1,800
12		1,800
13	C	1,800
14		2,000
15		2,000
16		1,900
17		1,900
18	D	1,800
19		1,800
20		1,700
21		1,700
22		1,600
23	E	1,500
24		1,400
25		1,300
26		1,200
27		1,150
28	F	1,100
29		1,050
30		1,000

These yields are taken from an estimate made by Barlow and Ng (1966). These average estate yields assumed the use of a mixture of modern high yielding clones, planted over a 5½ year period, with tapping of the first trees starting on completion of planting the last ones. The estimates were based on the result of field trials for the first 10 years of the producing life of the clones, and for the next 11 years on hypothesis, in the light of experimental and practical results to 1966. Beyond the 21st year the assumption of gradually declining yield has been made by the Consultants.

3.3 Cost Assumptions

Details of assumed production costs are given in Appendix A and summarised in Table A1. The values are basically self explanatory and do not call for comment beyond that in the appendix, except for labour costs. As explained in the appendix requirements for labour of all types, including tappers, have been assessed on the basis of a given number of workers required per acre. These workers have been charged at a constant \$132 per month, \$120 to include holiday pay, maternity benefits etc., plus 10 percent to cover provident fund and other additional charges. This is approximately 10 percent above currently estimated estate labour costs of about \$4.80 per day. Some differential was assumed to be necessary to attract people into an undeveloped area. Tappers' wages have not been specifically calculated for different yield levels since as average yields rise bonuses will be adjusted.

The costs, value of scales, (including duties), and net cash flow for the basic model are shown in Table 6. The internal rate of return is 8.25 per cent and the net present value at 15 per cent is - \$6,710,000 or - \$790 per acre (Table 8).

TABLE 6 RUBBER SALES, COSTS AND NET CASH FLOW OF BASIC MODEL

Year	Sales	Costs	Net Cash Flow
	(\$'000)	(\$'000)	(\$'000)
1	-	6,253	- 6,253
2	-	1,876	- 1,876
3	-	1,833	- 1,833
4	-	1,680	- 1,680
5	-	1,369	- 1,369
6	-	3,118	- 3,118
7	2,635	3,144	- 509
8	4,292	3,839	453
9	5,354	3,689	1,665
10	6,034	3,771	2,263
11	6,374	3,769	2,605
12	6,799	3,821	2,978
13	7,224	3,871	3,353
14	7,649	3,924	3,725
15	7,649	3,924	3,725
16	7,649	3,924	3,725
17	7,649	3,924	3,725
18	7,649	3,924	3,725
19	7,649	3,924	3,725
20	8,499	4,000	4,499

The importance of the individual components in costs over the whole 20 year period is shown in Table 7. The costs are shown in terms of their present value discounted at 15 percent. The proportion of total discounted costs represented by each individual item is also shown. Labour, (field and factory), and management costs make up almost 50 percent of the total cost over the whole period and thus any changes here will have a considerable effect on profitability. The relative unimportance of some capital items, such as the factory, is also noticeable.

TABLE 7. RUBBER. BASIC MODEL, PRESENT VALUES OF COST STREAMS
(PER ACRE AT 15 PERCENT)

<u>Item</u>	(\$)	%
Clearance and planting	463	16.7
Fertiliser and chemicals	250	9.0
Machinery	42	1.5
Housing and buildings	191	6.9
Factory capital	66	2.4
Factory operating cost	76	2.7
Field labour	1,041	37.5
Factory labour	46	1.7
Management	255	9.2
Rents and premia	132	4.8
Duties and cesses	117	4.2
Other	21	0.8
Transport	43	1.5
	2,744	

The government financial rate of return, i.e. that which would be obtained by the government if it ran the project, including duties and rents which would not be received by it if the project were not carried out, is 10 percent and the net present value at 15% is -\$540 per acre (Table 8).

If labour is valued at \$40 per month throughout, reflecting its real value to the economy is a situation with widespread unemployment and underemployment, the internal rate of return rises to 18 percent per annum and the net present value per acre of the project at 15 percent discount rate is \$239 (Table 8).

TABLE 8. RUBBER. BASIC MODEL. NET PRESENT VALUES AND INTERNAL RATES OF RETURN

Internal rate of return	
(a) Private financial	8%
(b) Government financial	10%
(c) Social	18%
Net present value per acre at 15 percent	
(a) Private financial	-\$790
(b) Government financial	-\$540
(c) Social	+\$239

4. SENSITIVITY ANALYSES

A series of analyses were made to test the sensitivity of the Basic model to changes in some of the assumptions. The effects of the following factors were examined:

- (a) Changes in the length of the project life.
- (b) Changes in yield capacity of clones.
- (c) Changes in costs of management and labour.
- (d) Changes in price of rubber.
- (e) Changes in time of planting
- (f) Stimulation of yields by ethrel.

4.1 Project Life

It was pointed out in section 3.1 that a project life of 20 years, taken to allow comparison with oil palms, was not realistic. A more probable economic life span for rubber is likely to be 30 years. The effect of evaluating the basic model over this longer period is shown in Table 9.

TABLE 9. RUBBER. INTERNAL RATES OF RETURN AND NET PRESENT VALUES OF BASIC MODEL OVER A 30 YEAR LIFE

Internal rate of return (percent)	
(a) Private financial	11
(b) Government financial	13
(c) Social	20
Net present value per acre at 15 percent (\$)	
(a) Private financial	-635
(b) Government financial	-363
(c) Social	489

The internal rates of return have been raised by 3 percent, 3 percent and 2 percent respectively for private financial, government financial and social investments.

4.2 Higher Yielding Clones

The choice of clones for planting in a particular area depends upon a variety of factors; the best will be those that give the highest yields and are least affected by adverse constraints, such as disease, wind damage, and severe wintering. In Johor proneness to wind damage, while not as severe as in Negri Sembilan and Selangor, is still significant and the incidence of the leaf disease gloeosporium is severe. On the other hand wintering is less severe in Johor than in other parts of the country and the incidence of diseases such as oidium is comparatively light.

From among the clones recommended by the RRI for large scale planting R.R.I.M.⁶⁰⁰ has been the most widely used in Johor. Recent results published by R.R.I.M. on yields of this clone in trials and in commercial fields are shown in the Table 10.

TABLE 10 REPORTED YIELDS OF RRIM 600 (LBS/ACRE)

<u>Year of tapping</u>	<u>RRIM trials</u>	<u>Commercial fields</u>
1	641 (13)	778 (60)
2	1,080 (12)	1,000 (47)
3	1,425 (12)	1,329 (36)
4	1,656 (12)	1,572 (22)
5	2,061 (12)	1,567 (18)
Mean 1-5		
6	2,073 (11)	1,831 (8)
7	2,127 (10)	1,755 (5)
8	2,270 (10)	2,111 (2)
9	<u>2,581</u> (8)	<u>2,328</u> (1)
Mean 1-9	<u>1,768</u>	<u>1,586</u>
10	2,269 (1)	
11	2,205 (1)	
12	2,554 (1)	
13	<u>3,004</u> (1)	
Mean 1-13	<u>1,996</u>	

Although the number of commercial fields with more than 5 years results is small, the pattern for the first 10 years closely follows that of the R.R.I.M. trials, and it seems reasonable to predict that this alone will reach 2,300-2,500 lbs. by the last year on virgin bark. The respective 9 year means of 1,768 lb/acre/annum and 1,586 lb/acre/annum are much above that given by Barlow and Ng (1966), (1,412 lb/acre/annum).

Yield projections cannot safely be made on the basis of a monoclonal plantation; they must be derived from the average yields of a number of clones. Owing to the long period of testing needed for a perennial crop, a system of classifying new clones has been adopted by the Rubber Research Institute. Its newest recommendations i.e. those showing promise of giving a marked advantage, are recommended for limited introduction first, and as knowledge about them increases they move into classes recommended for general use. Thus at any one time the recommended planting mixture will contain proportions of clones in the three classes. As time progresses it could be expected that the proportion of the present newest clones will increase and in fact in Johor State in 1968 80 percent of new plantings were with 600 series clones.

Thus for plantings made after say 1976 or 1977 it seems reasonable to assume that the average yield capacity of the available clones will be higher than in the basic model. For this higher curve a roughly rounded mean figure between the R.R.I. trial results shown above and commercial fields for R.R.I.M. 600 has been assumed for the first 2 panels of the bearing life. For the next panel the estimate is based upon the R.R.I.M. 600 figures. For panel D yields are assumed to slowly drop and to fall more rapidly on panels E and F. The assumed yield is shown in Table 11.

TABLE 11 RUBBER. ASSUMED HIGH YIELD CURVE (LBS/ACRE)

<u>Year of Tapping</u>	<u>Panel</u>	
1		700
2		1,050
3	A	1,350
4		1,600
5		1,900
6		1,950
7		2,000
8	B	2,200
9		2,300
10		2,400
11		2,150
12		2,250
13	C	2,500
14		2,800
15		3,000
16		2,800
17		2,800
18	D	2,700
19		2,700
20		2,600
21		2,500
22		2,400
23	E	2,300
24		2,200
25		2,100
26		1,900
27		1,700
28	F	1,500
29		1,300
30		1,100

Table 12 shows the internal rates of return and net present values of the project at the higher yield assumptions, calculated on both a 20-year and 30-year project life.

It should be reiterated that clones with this yield potential are not currently on general release and therefore not available for immediate planting. This evaluation has been made for comparative purposes only. Section 4.5 compares current planting of lower yielding clones against future plantings of higher yield material and Section 4.3 looks at the effect of rising labour and management costs.

TABLE 12 RUBBER. INTERNAL RATES OF RETURN AND NET PRESENT VALUES OF PROJECT, USING ENHANCED YIELDS

	Over 20-year life	Over 30-year life
Internal rate of return(percent)		
(a) Private financial	11	14
(b) Government financial	13	15
(c) Social	20	23
Net present value per acre		
(a) Private financial	-538	-251
(b) Government financial	-267	50
(c) Social	512	902

With the higher yields the private financial rates of return over both life periods are about three percent higher than for the corresponding projects at the lower yield levels.

4.3 Wages and Management Costs.

Two labour and management cost assumptions have been made:-

(a) Constant labour and management bill. This assumes either a constant labour input from maturity and a constant cost of \$132 per worker per month or that reductions in the labour force offset rising wages.

(b) Labour and management costs rising at 3 percent per annum. Again taking labour requirements fixed this means a wage bill rising at 3 percent. Thus a labour cost of \$132 per month per man would become \$238 per month in 20 years or almost \$10 per day. On mature rubber with an average yield of 2,500 pounds this would mean a labour cost of 17 cents to current estate levels and it is perhaps reasonable to assume that estates, whether public or private, would attempt to at least keep within these levels rise only slightly then estates might increase employment to cope with greater quantities of latex.

Thus the two labour cost assumptions taken are viewed as representating the boundaries of likely possibilities with respect to labour costs. That is estates may seek to maintain labour costs per acre at their present levels and thus lower the per pound costs as average estate yields rise. On the other hand the 3 percent per annum growth in labour costs appears to represent the maximum increase consistent with keeping labour costs per pound of product at current levels, something which all producers are likely to strive to achieve, given expected future prices.

Table 13 shows the private financial rates of return for the two yield levels under these alternative assumptions, with management costs also assumed to rise by 3 percent per annum. The project is assumed to have a 20 year life.

TABLE 13 RUBBER - PRIVATE FINANCIAL RETURNS BY WAGE LEVELS AND YIELD

	<u>Wage level</u>	<u>Basic yield</u>	<u>High yield</u>
(a) Internal rate of return (percent)			
Constant wage level		8%	11%
Wage level rising at 3 percent		3%	8%
(b) Net present value at 15 percent (\$/acre)			
Constant wage level		-\$790	-\$538
Wage level rising at 3 percent		-\$1,147	-\$895

The increased wage and salary costs reduce the overall rate of return quite sharply at the lower yield levels. If wage levels do rise in this way private estates will be forced to reduce labour input unless yields can be increased considerably.

4.4 Price Changes

Rubber planted in 1972 will not begin to yield until 1978 at the earliest and will not reach peak yield for almost ten years after that. Price levels before 1980 have little bearing on the overall profitability. Given the situation of natural rubber with major synthetic competitors where technological breakthroughs could occur at any time, future prices are highly uncertain. Table 14 shows the effect on present value and rates of return of a rise or fall of 10 percent in the projected price level, i.e. to 55 cents per pound f.o.b. throughout the period under analysis. Constant wage rates and a 20 year project life are assumed.

TABLE 14 RUBBER - PRIVATE FINANCIAL RETURNS BY YIELD AND PRICE LEVEL

	<u>Price level</u>	<u>Basic yield</u>	<u>High yield</u>
(a) Internal rate of return (percent)			
	45 cents per pound	5%	8%
	50 cents per pound	8%	11%
	55 cents per pound	10%	13%
(b) Net present value at 15 percent (\$/acre)			
	45 cents per pound	- \$985	- \$741
	50 cents per pound	- \$790	- \$538
	55 cents per pound	- \$595	- \$305

The effect of a 10 percent change in prices is to raise or lower the internal rate of return by 2-3 percent. This is a smaller effect than might be expected but is due to the long gestation period. The effect of a change in an income stream starting 10 years ahead is considerably muted by the discounting process. In the same way increases in yield do not have the dramatic effect on profitability which might be expected.

4.5 Date of Planting

The analyses described to this point assume a project in which, rubber is planted in 1972. However development in South East Johor will extend over at least 10 years and a majority of the area will not be cleared until the later years of the nineteen seventies, or until after 1980. If all costs and revenues remain the same, date of planting will have no effect upon returns. However one of the wage level assumptions that labour and management costs will rise at 3 percent per annum. If this does in fact occur, then costs of establishing and growing rubber will rise progressively. Table 15 shows the private financial rates of return and net present values for plantings in 1972, 1975 and 1980 respectively, assuming a 20 year project life.

TABLE 15 RUBBER-- PRIVATE FINANCIAL RATES OF RETURN AT DIFFERENT PLANTING DATES

	<u>Year of Planting</u>	<u>Basic yield</u>	<u>High yield</u>
(a) Internal rate of return (percent)			
	1972	3%	8%
	1975	2%	7%
	1980	0	4%
(b) Net present value at 15 percent (\$/acre)			
	1972	- \$1,147	- \$ 895
	1975	- \$1,201	- \$ 961
	1980	- \$1,440	- \$1122

As expected there is a steady decline in profitability as planting is delayed, but this can be offset by new material available at the later date if the potential yield improvement is great enough. A 3,000 lb. yield from a 1980 planting is about equally profitable to a 2,000 lb. yield from a 1972 planting. Thus if there is a fair certainty of material with the higher yield potential being available before 1980 and if projects equivalent to rubber planted in 1972 are available to be initiated at that time, it would be better to delay rubber planting even if wages and salaries rise by 3% per annum.

4.6 Ethrel Stimulation

Recent work on stimulation has indicated that substantial yield increases can be obtained using compounds which release ethylene within the plant. Of those tested, 2 chloro-ethyl phosphonic acid, known commercially as ethrel, appears to be the best. Others still under test also show considerable promise.

Since only about 2 years work has been done on the stimulants the long-term effects of their use are unknown. Thus yield projections assuming use of these stimulants are subject to a wide degree of error. However a brief analysis was carried out to investigate the possible effects of stimulation on rates of return. Assumed yields, based upon the application of ethrel to the basic and higher yield curves are given in Appendix B. Three different timings of use of stimulants were taken, (a) application to panels C - F only i.e. beginning in the 11th year of tapping, (b) application to panels B - F and (c) application throughout tapping. Expected yields with stimulation were generally 25 to 40 percent above those without stimulation. Results are summarised in Table 16. For the purposes of this analysis the life of the trees was taken to be 30 years. It has been assumed that stimulation with ethrel costs \$60 per acre throughout.

TABLE 16. RUBBER. PRIVATE FINANCIAL RATES OF RETURN AND NET PRESENT VALUES FOLLOWING STIMULATION OF BASIC AND HIGH YIELDING CLONES. 30 YEAR PERIOD, CONSTANT WAGES

Period of Stimulation	Basic yield	Higher yield
(a) Internal Rate of Return %		
None	11%	14%
Panels C - F	12%	15%
Panels B - F	13%	16%
Panels A - F	13%	17%
(b) Net Present Value at 15%		
None	- \$635	- \$251
Panels C - F	- \$514	\$ 60
Panels B - F	- \$375	\$214
Panels A - F	- \$355	\$280

Although the yield effect is fairly striking the influence of future stimulation on profitability is relatively small, partly because of the long period before stimulation and yield increases occur, especially when stimulation is delayed until panel C. Early stimulation on panel A is marginally more profitable than delaying until panel B. The reduction in profitability if stimulation is delayed until panel C is more marked.

Table 17 shows corresponding returns when wages and management costs are assumed to rise at 3 percent per annum. It is assumed here throughout that planting takes place in 1975. Again stimulation throughout the period of tapping appears marginally better than delaying until later. Returns are of course correspondingly lower than where wages are constant throughout.

TABLE 17 RUBBER - PRIVATE FINANCIAL RATES OF RETURN AND
PRESENT VALUES FOLLOWING STIMULATION OF BASIC AND
HIGH YIELDING CLONES - 30 YEAR PERIOD, WAGES RISING BY
3% PER ANNUM

Period of Stimulation	Maximum Yield (Unstimulated, lbs/acre)	
	2,000 lb.	3,000 lb.
(a) Internal Rate of Return %		
None	4%	10%
Panels C - F	8%	13%
Panels B - F	9%	14%
Panels A - F	9%	14%
(b) Net Present Value at 15%		
None	- \$1,167	- \$785
Panels C - F	- \$1,054	- \$475
Panels B - F	- \$906	- \$293
Panels A - F	- \$889	- \$254

These results should not be taken as indicating that trees on new developments in South-East Johor should be stimulated with ethrel throughout their yielding life. Yield responses and long term effects are too uncertain for such blanket recommendations to be made, and the potential loss from delaying use of ethrel at least until panel B is relatively small. In the next 10 - 12 years sufficient will be learned about stimulation for general recommendations to be made.

REFERENCES

- (1) Barlow and Ng "Budgeting on the Merits of a Shorter Replanting Period" R.R.I.M. Planters Conference, 1966.
- (2) Ng, Barlow and Chan "Factors Affecting Profitability of Rubber Production on West Malaysian Estates." **Natural Rubber Conference. K.L. 1968**
- (3) Barlow and Chan "Towards an Optimum Size of Rubber Holding" Natural Rubber Conference, 1968.
- (4) F.L.D.A. Development Estimates 1971.
- (5) F.L.D.A. Jengka Phase Two, Development Estimates.
- (6) Bevan and Goering "The Oil Palm In Malaysia An Estimate of Product Prices and Returns to Investment."
- (7) Ng "Some Aspects of Estate Replanting and New Planting Costs" Planters Bulletin, 92. Sept. 1967.

A P P E N D I X A
C O S T E S T I M A T E S

1) Land Clearance

Costs quoted vary widely depending upon location, labour availability and conditions, but vary for manual clearing from \$130 to \$170 per acre. Reports on mechanical clearing suggest a cost of \$160 per acre but since experience here is limited it should be possible to reduce this, especially in a long term clearance programme.

In this report a figure of \$150 per acre has been adopted. This has been applied to the gross acreage and means that the cost per planted acre (85% of gross) is \$176.

2) Costs to Maturity

Land clearance is assumed to occupy the first half of the first year and planting to occur about the middle of year 1. 5½ years are taken from planting to first tapping. This is in line with Barlow and Ng's assumptions (Ref. 1.) but less than assumed in F.L.D.A. standard costs.

(a) Planting.

This has been taken as a contracted task costing \$272 per acre, split as follows:-

	<u>Year 1</u>	<u>Year 2</u>
Cleaning Timber	\$24	-
Lining, Holing and Terracing	\$86	-
Cover Crop	\$82	\$18
Planting or Budding	\$62	-
	<hr style="width: 100%; border: none; border-top: 1px solid black; margin-bottom: 5px;"/> \$254	<hr style="width: 100%; border: none; border-top: 1px solid black; margin-bottom: 5px;"/> \$18
	<hr style="width: 100%; border: none; border-top: 3px double black; margin-bottom: 5px;"/>	<hr style="width: 100%; border: none; border-top: 3px double black; margin-bottom: 5px;"/>

(b) Roads.

These have been taken:-

Year 1	\$11
Year 2	\$ 4
Year 3	\$20
Year 4 on	\$ 4 per annum.

c) Materials.

These include fertilisers, lallang oil, pesticides and herbicides.

For the immature period these have been taken as follows:-

	<u>Year (\$ per acre)</u>					
	1	2	3	4	5	6
Fertiliser	8	22	23	29	28	28
Other Chemicals	18	26	26	19	12	16

d) Labour.

Labour has been charged at a constant \$132 per month. Labour requirements have been taken, in man-year per acre as:-

	<u>Year</u>					
	1	2	3	4	5	6
Requirement (man years/acre)	.06	.06	.06	.06	.042	.04
Cost (\$)	95	95	95	95	66	63

Total Costs to maturity may then be summarised:-

	<u>Year</u>						Total
	1	2	3	4	5	6	
Clearance	176						176
Planting & Roads	265	22	20	4	4	4	319
Maintenance	121	143	144	143	106	107	764
							<u>1,259</u>

This thus gives total costs to maturity of \$1,259 per planted acre. These compare with private sector estimates of \$850 to \$1,100. The former however includes a charge of only about \$50 per acre for clearance. The estimates in this paper also assume a more or less regular labour force, whereas most estimates from existing estates will include only charges for direct use of labour which also carries out tasks elsewhere on the estate.

Cost at Maturity.

(a) Maintenance and materials

Annual material costs are taken at \$29 per acre, comprising \$22 for fertiliser and \$7 for other chemicals.

Stimulation has not specifically been allowed for here.

(b) Labour.

Labour requirements have been taken as follows:-

	<u>Year</u>	
	7	8 onwards.
Maintenance man year/acre	0.02	0.02
Tapping	0.105	0.13
Total	0.125	0.15

This results in total labour costs of \$238 per acre taking a labour cost per man-year of \$1,584. This labour cost per acre compares with private sector estimates of \$200 to \$250 per acre. Attempts have not been made to estimate costs on the basis of specific tapping wages including bonuses based on yield since these are bound to vary over time. Current bonuses are based on current yield levels and are not applicable to higher future yields. Actual tapper earnings over a year also depend upon length of wintering period etc.

Management and Overhead Costs.

Management.

Estimates of these costs vary widely, partly because the coverage of items included appears to vary. Typical F.L.D.A. costs for a 4,000 acre scheme are:-

	<u>Salary</u> \$ per month		<u>Optimum</u> Staffing	<u>Actual</u> Staffing	
Manager	1,000 - 1,600		1	1	
Asst. Manager/ Assistant	450 - 720		2	1	
Senior Supervisor	300 - 500		4	1	
Field Assistant	210 - 300		8	6	
Clerks	120 - 180		2	1	
Drivers			4	2	
				\$	
	Monthly Salary	+25% Fringe Benefits & EPF	Annual Cost	Cost of Optimum Staff	Cost of Actual Staff
Manager	1,500	1,875	22,500	22,500	22,500
Asst. Manager/Asst.	600	750	9,000	1,800	9,000
Senior Supervisor	400	500	6,000	24,000	6,000
Field Assistant	250	312	3,750	30,000	22,500
Clerks	150	187	2,250	4,500	2,250
Total				99,000	62,250
Total per acre				24.75	15.56

An R.R.I. study of private sector costs based on 312 estates gave the following figures:-

Size	1,000-3,000 acres		Expenditure in \$ per acre over 3,000 acres	
	European	Chinese	European	Chinese
Managers	25.2	17.9	20.8	19.6
Contractors and Kepalas	15.5	11.9	11.9	10.4
Office and Staff	7.5	6.1	6.4	4.7
Head Office	4.0	2.9	3.5	2.9
T o t a l	52.1	39.4	42.2	31.3

In this analysis costs of management salaries have been taken at \$30 per acre.

In addition \$3 per acre has been taken to cover miscellaneous costs.

Machinery

This is basically to cover latex transport to factory plus intra-estate general transport. Costs will obviously vary widely depending upon individual situations. The analysis was carried out on the basis of a 10,000 acre development with 8,500 acres planted. Initial equipment requirements were taken as:-

		<u>Unit Cost</u>		
Land Rovers	- 3	10,000	=	\$ 30,000
Tractors	- 8	15,000	=	\$ 120,000
				<u>\$ 150,000</u>

This equals approximately \$18 per acre.

Running costs were taken as:-

Land Rovers	- 3 at \$4,000	=	\$ 12,000
Tractors	- 8 at \$5,000	=	\$ 40,000
			<u>\$ 52,000</u>

Total machinery costs were then apportioned:-

	<u>Year. (\$ per acre)</u>							
	1	2	3	4	5	6	7	8 on
Capital	2	4	-	-	-	-	12	-
Maintenance and Replacement	1	2	2	2	2	2	4	8

The average charge of \$8 per acre is possibly somewhat generous.

Processing

Factory Capital Cost:-

Data obtained suggest the following capital costs for factories of 40 ton per day capacity:-

Final capacity 40 tons per day

	Stage 1 20 tons per day	Stage 2 From 20 to 40 tons per day	Total
Machinery	720	330	1,050
Civil Works	380	-	380
Installation & Fees	50	20	70
T o t a l	1,160	350	1,500

For smaller factories of 20 ton per day costs are estimated to be somewhat higher per ton capacity, \$45,000 against \$37,500. Since an estate of 8,500 acres with maximum yield of 2,000 lb. per acre will require a factory of just over 25 tons per day capacity, it has been assumed that the higher cost level remains applicable. Capital costs could be reduced by not designing to meet peak monthly output at maximum yield as has been done here. In calculating capacity it has been assumed that 11.25 percent of total annual output is obtained in the peak month of tapping and the factory is designed to cope with this.

Production costs

Production cost estimates vary widely, but the following appear to be representative.

Production Cost Estimates	¢ per lb.	
	<u>20 tons/day</u>	<u>40 tons/day</u>
Salaries and benefits	1.12	0.94
Packaging materials	1.00	1.00
Fuel power water (1)	0.70	0.70
Chemicals (2)	0.75	0.75
Maintenance materials	0.30	0.30
Miscellaneous	0.20	0.20
	<u>4.07</u>	<u>3.89</u>

(1) own power generation and water supply

(2) for SMR 5CV granulated rubber; if SMR 5L (ABC granulated rubber) is produced this is reduced by 0.60 cents per pound.

Wages and salaries have been computed separately and operating costs have been taken at 2.95 cents per pound throughout.

Labour

Estimates of labour requirements for 40 ton factories obtained ranged from 100 to 180. A standard figure of 3.5 per ton capacity has been used in calculations.

Salaries

It is estimated that a total of 15 staff would be required to operate a 20 ton mill. Assuming an average wage of \$425 per month costs are:-

Salaries	=	\$ 76,500 per year
S.P.F	=	7,650
Health at \$20/month	=	3,600
		<hr/>
		\$ 87,750

This is equal to \$4,387 per ton installed capacity and this figure has been used in the analysis.

Transport

The factory is assumed to be located in the project area about 50 miles from the port of export (Singapore/Johore Bahru). Carriage and charges for rubber are estimated to be about 15 cents per ton - mile or \$7.50 per ton. Handling, shipping and F.O.B. charges are estimated to be 0.77 cents per pound, or \$17.25 per ton. These total charges of \$24.75 per ton of product have been used throughout.

Housing and Other Buildings

Housing for general workers have been based on F.L.D.A. estimates with basic cost per house of \$1,600, \$1,500 per house plus \$100 for site preparation. Houses required for field workers have been taken at 1 per 10 net acres. For factory staff houses have been provided at 1 per worker. Maintenance charges have been taken at 4 percent.

Staff housing has been estimated in conjunction with estimates of other building costs based on F.L.D.A. development estimates. A capital cost of \$40 per acre has been taken with maintenance at 4 percent.

Other Costs

(a) Rents and premia have been based upon current Johor practice:-

Premium	-	\$ 50 per gross acre
Rent	-	\$ 10 per gross acre per annum (for estates of over 500 acres).

Premia charged apparently vary somewhat depending upon circumstances but \$50 per acre is a typical charge and has been used in analysis,

(b) Duties and Cesses

Export duty has been taken at 4 percent on f.o.b. price. No surcharge has been made since expected prices are below the 60 cent level.

Research cess has been charged at 1 cent per pound.

Since the enterprise is assumed to be run as an estate, no replanting cess has been calculated.

Year	Clearance Planting & Roads	Ferti- liser & Chemicals	Mach- inery	Housing & Build- ings	Factory Capital	Factory Operat- ing	General Factory	Labour	Manage- ment	Rents & Premia Cesses	Duties & Cesses	Other	Transport	TOTAL COSTS
1	3,527	221	25	892	-	-	808	-	255	500	-	25	-	6,253
2	187	408	59	34	-	-	808	-	255	100	-	25	-	1,876
3	170	416	25	34	-	-	808	-	255	100	-	25	-	1,833
4	25	408	25	34	-	-	808	-	255	100	-	25	-	1,680
5	25	340	25	34	-	-	565	-	255	100	-	25	-	1,369
6	25	374	25	858	917	-	539	-	255	100	-	25	-	3,118
7	25	230	136	171	-	103	1,683	84	371	100	158	25	58	3,144
8	25	230	68	55	279	167	2,020	147	371	100	257	25	95	3,839
9	25	230	68	55	-	209	2,020	147	371	100	321	25	118	3,689
10	25	230	68	55	-	235	2,020	147	371	100	362	25	133	3,771
11	25	187	68	55	-	248	2,020	147	371	100	382	25	141	3,769
12	25	187	68	55	-	265	2,020	147	371	100	408	25	150	3,821
13	25	187	68	55	-	281	2,020	147	371	100	433	25	159	3,871
14	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
15	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
16	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
17	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
18	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
19	25	187	68	55	-	298	2,020	147	371	100	459	25	169	3,924
20	25	187	68	55	-	331	2,020	147	371	100	483	25	188	4,000
N.P.V. @ 15%	3,932	2,129	360	1,624	561	648	8,846	391	2,165	1,120	995	179	368	23,320

A P P E N D I X B

ETHREL STIMULATION

Ethrel has so far revealed itself as a superior stimulant to 2, 4, 5-T and early evidence suggests that it is less damaging to the tree. The greatest effects have been shown in renewed bark (panels C and D) and the least in panel A, though the latter are not negligible. For example with R.R.I.M. 600 stimulation of Panel A with ethrel has increased yield by 33 percent in the first 6 months of tapping. On panel C the increase in the first 6 months has been 90 percent and on panel D 90 percent in the first 2 months. No records for panel B on R.R.I.M. 600 are currently available, but other clones in the 600 series have given increases of 67 percent to 100 percent over 6 months on this panel.

Thus, though more work is required, especially before recommendations can be made for stimulation on Panels A and B, the possibility of future stimulation even of these panels cannot be ignored. The long-term effects of stimulation by ethrel and other chemicals still being investigated are not known. Thus estimates of yields on trees stimulated for a considerable number of years will be subject to a large degree of potential error. Results presented at the 1970 R.R.I.M. Planters' Conference also suggested that ethrel might be best used with slightly different tapping techniques than are used of at present. Because of the high degree of uncertainty surrounding the use of prolonged stimulation basic analysis was carried out assuming the use of only those stimulants in wide use at present e.g. 2, 4, 5-T. However a brief analysis was carried out, using a series of patterns of stimulation and yields responses on the two basic yield curves, to assess the possible effects on profitability. The yield curves used are shown in Table B-2.

TABLE B2 RUBBER ASSUMED FUTURE YIELDS WITH ETHREL STIMULATIONS

g Panel	<u>Basic Yield Curve</u>			<u>High Yield Curve</u>		
	(a)ethrel on panels C - F	(b)ethrel on panels B - F	(c)ethrel on Panels A - F	(a)ethrel on panels C - F	(b)ethrel on panels B - F	(c)ethrel on panels A - F
A	620		710	700		805
	1,010	as in	1,160	1,050	as in	1,210
	1,260	I (a)	1,450	1,350	II (a)	1,555
	1,420		1,630	1,600		1,840
	1,500		1,725	1,900		2,185
B	1,600	2,080		1,950	2,535	
	1,700	2,210	as in	2,000	2,600	as in
	1,800	2,340	I (b)	2,200	2,860	II (b)
	1,800	2,340		2,300	2,990	
	1,800	2,340		2,400	3,120	
C	2,610			3,120		
	2,610	as in	as in	3,260	as in	as in
	2,610	I (a)	I (a)	3,620	II (a)	II (a)
	2,900			4,060		
	2,900			4,350		
D	2,755			4,060		
	2,755	as in	as in	4,060	as in	as in
	2,610	I (a)	I (a)	3,920	II (a)	II (a)
	2,610			3,920		
	2,465			3,770		
E	2,465			3,620		
	2,320	as in	as in	3,480	as in	as in
	2,175	I (a)	I (a)	3,330	II (a)	II (a)
	2,030			3,190		
	1,885			3,040		
F	1,740			2,750		
	1,670	as in	as in	2,460	as in	as in
	1,595	I (a)	I (a)	2,170	II (a)	II (a)
	1,525			1,880		
	1,450			1,590		

