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NATURAL RUBBER — PLANS FOR THE FUTURE

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This Conference commemorates the 100th year of the arrival of a few *Hevea* seedlings into Sri Lanka. It is from this nucleus material that the NR industry has developed in South East Asia. While the "conception" and "birth" of *Hevea* occurred in the Royal Botanical Gardens in Kew, the "cradle" in which these "infants" were nursed and nurtured into strength was Sri Lanka. In this respect, therefore, the catalytic growth of the NR industry in South East Asia into what it is today owes much to Sri Lanka. From the few seedlings originating in Sri Lanka through Singapore, Malaysia has become the world's largest exporter of NR, accounting for nearly 44% of the world's supply. It is, therefore, only appropriate on this Centenary occasion that I not only convey to you in Sri Lanka the felicitations and good wishes of Malaysia and the Malaysian NR industry but also extend to you our sincere thanks for that initiating act of generosity and co-operation you gave us one hundred years ago.

Dr. Peries in inviting me to speak to you was generous ; he intentionally did not specify the area I should cover. It is conventional, on an occasion like this, to review progress, highlight achievements and to generally reminisce on the "good or bad old days". I would like to depart from this tradition. The word "rubber" for our product derived, as it were, from its ability to "rub out" pencil marks, is symbolic of man's attitude to history ; it has been said that "we learn from history that we do not learn from history" — we "rub out" the lessons of the past. We have arrived at the NR situation today through many trials and tribulations, failures and achievements, oscillating attitudes and confidence, external pressures and internal doubts, economic turmoil and commodity market vagaries ; through this vicissitude over a hundred years of development history we have enriched our knowledge, experience and capacity. Do we repeat these or do we learn from these ? We are compelled now to look at the next hundred years with all this historical perspective, and it is imperative that we must strive forward with vision, dynamism and with confidence developed through our unique success, difficulty achieved against innumerable obstacles in the past. It is this requirement that has dictated the title of my talk today.

HISTORICAL PERSPECTIVE

Natural rubber today accounts for something like a third of the world's production of all rubbers and nearly 85% of the output comes from South East Asia. Technical and economic problems that have manifested themselves in the past in relation to production and marketing of natural rubber vary somewhat among producing countries but many main features are generally common. These are :—

(a) natural rubber is of immense socio-economic importance to the producing areas.

(b) the industry is a substantial source of employment and is basically worked by small men who own, in some cases, up to 95% of the total area under rubber.

(c) the produce continues to be sold through a commodity market in which producers have very little control on the price.

(d) the trees in all producing countries generate a single type of cis-polyisoprene.

The basic problems of the industry stem from the intensification of competitive market forces in the years immediately after the Second World War, resulting in an almost monotonic decline in the prices of natural rubber. What does this price decline mean overall to the producing countries ? If total natural rubber production were to have remained static from 1960 to 1970, this would have represented a loss in export income of some M$ 18,000 million. However, because of rising production efficiency, the actual loss amounted to M$ 12,000 million for all producing countries. What the situation portrays is one of continual erosion of the efforts of producing countries to increase production and productivity. Un-enlightened opinion for this unhappy state of affairs sometimes ascribes the price decline to over production of natural rubber. But this is hardly consistent with the pattern of total consumption *vis-a-vis* the production of both natural and synthetic rubbers over the past twenty years (Fig. 1).

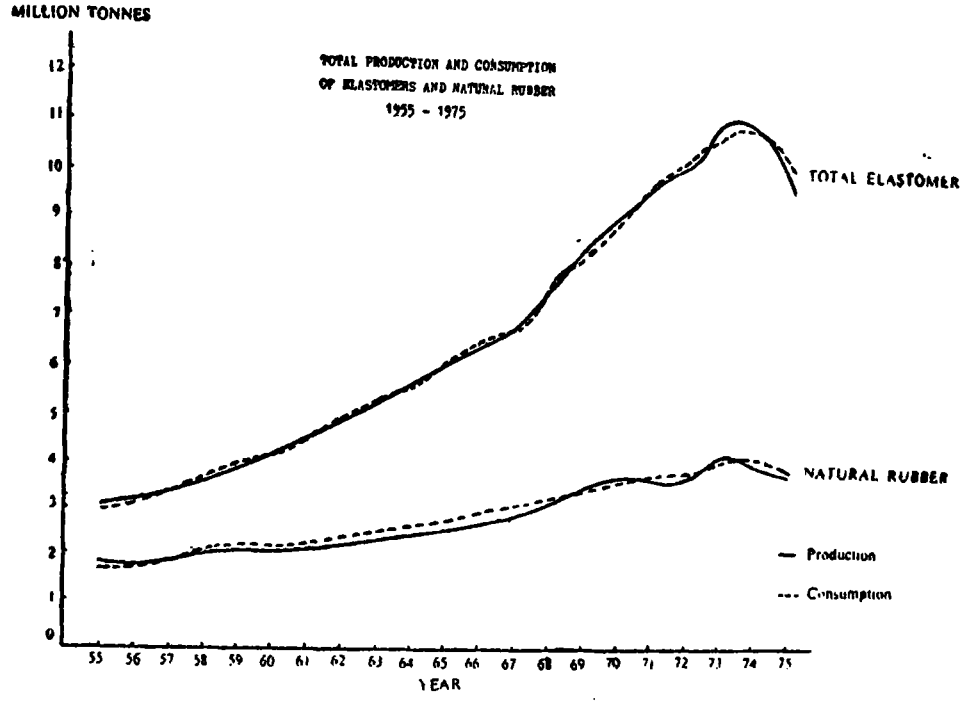

Fig. 1. Natural Rubber - Plans for the future — B. C. Sekhar

Impregnably, implicit in this Figure is that any attempt to restrict production of natural rubber to maintain prices would most certainly lead to further encroachment of synthetic rubber, *i.e.* a shrinkage in NR share of world market. Indeed the fact that total rubber consumption has been increasing at a considerably faster rate than natural rubber production has, for this reason alone, inevitably led to displacement of NR from uses for which it remains fully techno-economically satisfactory. The competitive forces thus called into play have led to serious market weaknesses of natural rubber. On the one hand, the synthetic rubber industry, " intoxicated " as it were with the availability of apparently abundant and cheap petro-chemicals from the petroleum industry, miscalculated their long-term capacity. On the other hand, the natural rubber industry, through lack of confidence and unappreciative of its own strength and uniqueness, has lagged behind in its investment policy. While the SR industry continued to expand in its production capacity, the natural rubber industry exerted only a weak effort.

In the inevitable fight for survival, the natural rubber industry was left with no alternative but to implement modernisation programmes in totality. These comprised :

(a) measures for improving productivity per unit land area,

(b) reduction in overall cost of production so as to produce rubber at economically low prices, and

(c) improvement in quality, presentation and grading.

The achievements of these programmes need no repetition here. Improvements in respect of production and productivity in the natural rubber industry have been substantial in the last ten years. A number of biological developments arising from research have already ensured the sound economic base of *Hevea* cultivation and production. I refer especially to :

(a) the development of high-yielding planting materials with yield capacities in excess of 2,500 kg/ha, including the efficacy of improved agronomic practices to bring planting materials into maturity in a period of four years and optimisation of yield through discriminatory fertilisation ;

(b) horticultural techniques combining the root, trunk, and crown systems to produce the "ideal" trees long dreamt of by plant breeders ;

(c) development of yield stimulation techniques enabling trees already planted and of different ages and varieties to express their full genetic potential, thereby effecting modernisation without resorting to premature replanting ;

(d) massive development of technically specified rubbers accounting for nearly 30% of South East Asia's export.

The fact that the natural rubber industry has not only withstood the competitive pressures exerted by a powerful oligopolistic industry, which is backed by the massive resources of multinationals and industrially advanced countries, but has also successfully and substantially carried out a radical face-lifting modernisation. This, I believe, speaks as nothing else can for the inherent soundness and strength of natural rubber. The NR industry has not only exploited the slogan of "replant or die" but has also assumed the need to "modernise or perish" as the key solution in the last decade.

PETROLEUM SITUATION

The OPEC countries' initiative in reviewing the petroleum situation, especially in respect of the cost and availability of this non-renewable resource, and the price-hike therefrom shocked the world into the realisation that there is need to review global attitudes towards resource conservation, energy requirements and environmental pollution. No doubt, the damaging effects of the increased petroleum prices to the economies of consuming countries, in its turn, had impinged on the market for natural rubber. However, with the more realistic price of feedstocks for synthetic rubber, the techno-economic strength of natural rubber has been placed completely outside the reach of any competing synthetic substitutes.

Obviously, the advent of such "energy/materials" crisis, coupled with the global concern for environmental pollution, adds force to the general proposition that the world is moving from a petro-chemical era to a " biological products era " ; or more specifically, in our context, the " natural rubber era ". The contrast between natural rubber, a renewable material produced by an essentially non-polluting industry, and the synthetic elastomers made from scarce and now exceedingly expensive feedstocks is therefore obvious. I will not elaborate on it. Suffice to point out that economic power has in fact tilted the situation well in favour of natural materials. In the 1950s and 1960s, synthetic rubbers had to fill the gap through volume production based on cheap feedstocks from oil because of the inability of natural rubber to satisfy world rubber demand ; advantage was also taken of economies of scale arising from bigger plants. The U-shaped cost function so often talked about by economists in the context of scale economies has finally bottomed ; the costs of plant have escalated and the excessive capital required has become inhibiting. Natural rubber, therefore, is no more faced with a one-sided competition. This may be gleaned from the 1967/1974 feedstock costs for synthetic rubbers shown in Table 1.

TABLE 1 : PRICES OF FEEDSTOCKS AND MONOMERS, 1967 AND 1974

Feedstock	US$ per tonne 1967	1974	% increase in price
Naphtha	20	130	550
Benzene	74	500	565
Butadiene	185	385	108
Styrene	180	800	344
Isoprene	275	660	140

This situation is not simply a feature of energy shortage or energy crisis. There is talk today of a further upward adjustment in petroleum prices in keeping with inflation. In spite of new discoveries and off-shore exploitation, petroleum in the different parts of the world is an exhaustible resource within any reasonable timescale. After all, it is sunlight energy absorbed through plants and mammals which then decay and end up as petroleum in a timespan of millions of years. This petroleum is the current source of petro-chemicals leading to the production of synthetic rubbers. In contrast, the *Hevea* tree photosynthetically converts sunlight energy into natural rubber everyday.

One fundamental requirement in today's context is the need for us, both from the NR and SR sectors, to move into a position of complementation. The key point that we must all appreciate is that while the world cannot do without natural rubber, neither can it do without synthetic rubber. This realisation has prompted the two industries to shift from bitter aggression of the 1950s to co-existence of the 1960s and, hopefully, to complementation in the 1970s. The energy crisis has dramatically introduced new dimensions into the role of natural rubber *vis-a-vis* synthetic rubber in satisfying the growing world demands for all elastomers. With an eye to the need of future generations, it is imperative that more careful, optimum use of resources is called for by way of effective conservation programmes. A new type of approach between the SR and NR is required for the welfare of man and the world. This approach will inevitably involve close collaboration between the two industries in its totality. There is no other practical alternative.

TOTAL ELASTOMER SITUATION

Very few industries have displayed the catalytic and explosive growth the elastomer industry has undergone. Historically, world demand for total elastomers has approximately doubled itself every decade, as can be seen from Table 2. As has been stated earlier, the inability of the natural rubber sector to expand supply in keeping with total demand has distorted the proportionate growth of the two industries. While the demand for total rubber has grown at an annual rate of 7% since 1945, the NR industry was only able to increase its supply by 2%. Among the root causes were the inherent inelasticity of supply of a perennial crop, the built-in conservation in planting policy or the excessive discounting of the future by investors, the massive pressure applied by the financially and technically supported SR sector and the vagaries of a commodity market. This has consequently reduced the market share of natural rubber from about 100% before the Second World War to the current level of 33%. Apart from the supply inhibition, the violent fluctuations in the commodity market of prices have tended to prevent the optimum utilisation of natural rubber. The industry has therefore suffered both as a result of decline and instability of prices.

TABLE 2 : CONSUMPTION AND MARKET SHARE OF NR, 1900 — 1970

Year	Total world rubber consumption ('000 tonnes)	NR consumption ('000 tonnes)	NR share of the market (%)
1900	53	53	100
1910	102	102	100
1920	302	302	100
1930	722	722	100
1940	1127	1127	100
1950	2339	1750	75
1960	4400*	2095	48
1970	8600*	2992	35

*FAO estimates, including ST consumed in centrally-planned countries.

Purely on techno-economic considerations, we have estimated that the world should logically use natural rubber to the extent of 43% of the total elastomer market, provided that adequate supplies are available at reasonably realistic and stable prices. In view of this, and on the basis of factors relating to petroleum and synthetic rubbers mentioned earlier, it would be feasible to look at the supply requirements of the future. This may be assessed through extrapolation of the past into the 1980s and 1990s, taking into account the optimistic outlook of growth in Asia and expected economic recovery of the West. Such an exercise has in fact been done by several international agencies. Although different figures have emerged, which is naturally expected, the projected consumption for the 1980s has been determined to range from 15 — 17 million tonnes. For the 1990s, the range would be 22 — 25 million tonnes, touching 35 — 40 million tonnes in the year 2000.

The consequence of this assessment is that, taking into consideration the techno-economic norm, the natural rubber requirements would be 6·5 — 7·0 million tonnes in the 1980s, 9·5 — 11·0 million tonnes in the 1990s and 15 — 17 million tonnes in the year 2000. The natural rubber industry has been subjected to various predictions

in the past by innumerous international agencies. Among the latest is the World Bank's estimate of a shortage of one million tonnes of natural rubber in the 1980s. Another cogent consideration in this regard is the sudden decision by the GSA of USA to review their stockpile from its present level of 130,000 tonnes to a new required level of over 530,000 tonnes.

Equally important are the considerations now being given to alternatives of natural rubber. While industrialised consuming countries have come to firmly accept the imperative need of a sole cis-polyisoprenic rubber, they are circumspect on the capacity of NR producing countries to meet projected requirements. As a consequence, the USSR plans to have a capacity of over one million tonnes of synthetic cis-polyisoprene in the 1980s. The USA and Mexico are earnestly reviewing the economic and technical viability of deriving cis-polyisoprene from other rubber-bearing plants, such as Guayule and Goldenrod. As there are more than a hundred different varieties of rubber-bearing species, we can no doubt expect to hear more names of rubber-bearing plants. What does all this portray ? A single feature is manifest, *i.e.* the world requires a substantially larger supply of cis-polyisoprene. Unless this is forthcoming from the most advanced and techno-economically attractive industry, *i.e. Hevea*, the world must look for alternatives. In other words, the natural rubber industry is moving into an exciting and challenging era which demands optimistic dynamism in production.

POTENTIALS OF NATURAL RUBBER

The potentials of natural rubber have been adequately exhibited by the innovations already available through biological and technological research. Let me briefly survey some of these.

Biological innovations

1. Compared with the current annual average yields in the producing countries, which range from 500 — 1000 kg/ha, proven planting materials yielding more than 2500 kg/ha are available for commercial exploitation.

2. The traditional immaturity period of 5 to 6 years can now be significantly reduced to 3 to 4 years by the use of advanced planting materials and modern agronomic practices.

3. Yield stimulation using ethylene gas in the form of Ethrel, or as a gas in molecular sieves, has given a procedure through which mature trees already on the ground can be modernised. By stimulating rubber trees of ten years of age or more in tapping, the production of most planting materials can be increased by 60 — 100%. Even old trees upward tapped with stimulation on the virgin panel can provide a substantial increase in yield levels.

4. The concept of utilising *Hevea* plants as a composite source of raw materials is now possible. With precocious high-yielding materials and efficient use of stimulants to enchance flow, a replanting cycle of 20 years is manifestly attractive. At the end of this period, the rubber timber after proper chemical treatment can be successfully used for furniture, panelling, flooring and numerous other applications including pulp and paper. Techniques are also available for inducing *Hevea* trees to flower as and when required. The rubber seed so produced can constitute a commercial source for semi-drying oils and fatty acids, while the debris can become a supplement to cattle feed. In the research pipeline are developments of great promise such as tissue culture, horticultural manipulation, dwarfing and discriminatory fertiliser usage.

5. The utilisation of latex as a soil conditioner in sandy soils and other poor soil structures, together with encapsulation of fertilisers have shown immediate and distinct benefits.

Technological innovations

1. Introduction of technically specified rubbers using new processing methods had small beginnings in 1965. Today, nearly 30% of the South East Asian rubber is represented in one or another form of technically specified grades, all of which are designed to retian the native excellence of the natural rubber molecule.

2. Tyre rubber, which has been developed as a general purpose grade attuned to the tyre market, combines a balance of requirements. It meets the volume demand, economics and technological properties and energy conservation for the tyre industry. Saving expensive mixing operations, avoiding complex inventories, assuring benefits of higher dispersibility and providing low temperature crystallisation resistance, this rubber has indeed aroused the enthusiasm of consumers.

3. A series of special purpose natural rubbers, ranging from constant viscosity, superior processing rubbers and carbon black masterbatches to enzyme deproteinised rubbers, have been developed ; these developments are now assuming greater importance in consumer factories. Perhaps at an earlier stage of development is the situation regarding rubber powder in free-flowing form and reversible latex paste. The former is in pilot plant production while the latter has been produced in the laboratories.

4. The whole area of natural rubber modification chemistry has undergone review. The underlying philosophy is whether natural rubber can be used as a feedstock for new polymers. The reaction and extent of modification can be controlled and, therefore, can be directed specifically to improve properties such as ageing, bonding, abrasion resistance, adhesion, etc. Modifications can also be successfully used to impart special properties such as gas impermeability, solvent resistance and thermoplasticity. Modifications are now available which can tailor hardness, resilience, and glass transition temperature to specific engineering uses.

5. Consumer-oriented developments such as network bound anti-oxidants, efficient and semi-efficient vulcanising systems, and the more revolutionary development of di-urethane crosslinking are ensuring that natural rubber is keeping pace with changes in the consumer factories.

INDUSTRY OF THE SMALL MAN

The rubber industry in South East Asia is characterised by the preponderance of the small farmers who own and cultivate some 67% of the total planted area in Malaysia, 78% in Indonesia, 95% in Thailand and 55% in Sri Lanka. Most of the smallholdings are less than 10 acres apiece and are widely scattered. It is because natural rubber is capable of growing in very diverse conditions, difficult terrain and is not overly sensitive to management standards that the confidence of the small man has been generated in the cultivation of *Hevea*. Flexibility in the demand for agro-management inputs and flexibility in the scale of production and processing have made natural rubber an almost ideal crop for smallholders. To increase the supply for the 1980s and beyond, it is necessary that the confidence of the small man in the rural sectors of South East Asia be sustained and enhanced. There is, therefore, a compelling need to modernise these operations. To realise this, it poses a tremendous problem of resource allocation by producing countries who are hard pressed by priorities to tackle this task even modestly. However, as a crop

which can generate the highest form of benefits from the socio-economic viewpoint, *Hevea* has very little competition. This entails an obligation on the part of planners and decision-makers in the producing countries of the world to ensure situations which are conducive to smallholders' enthusiasm and enlarged participation in industry.

Low productivity of the smallholders stems from their inability or the slow rate to absorb the known technologies available in the industry. Clearly, this must be overcome. We have the technologies to do this ; the transfer to the smallholders must be given a new dimensional motivation. It must be pursued with vision with a missionary zeal.

In the new found strength of natural rubber in the world market, its " Achilles ' heel " remains to be the price instability. The vagaries of a commodity market has to be controlled. While a dynamic production policy for natural rubber is essential, the dilemma faced by the producers of natural rubber is transient imbalances causing these price fluctuations, which are further complicated by speculation and other subjective market forces. It is in this context that the ANRPC countries have come together and agreed to launch an international price stabilisation scheme. This aims primarily at effecting a measure of price stability through open market operation and dynamic production processes. It has not been conceived as indicative of a weak NR position. The mechanism is now, therefore, available to ensure that the producing countries can adopt a dynamic production policy as a long-term strategy to equilibrate supply and demand.

In most producing regions, the countries have exported raw rubber and imported manufactured goods. There are, however, few exceptions. In Malaysia, only 30,000 tonnes of the 1·6 million tonnes produced are being fabricated into manufactured items. The pattern is largely similar in other producing countries. In the wake of the energy crisis and the ability of producing regions to optimise the use of energy in manufacture, it is becoming imperative that at least some of the manufacturing operations should logically be transferred to the producing countries. Towards this end, a new Technology Centre has been established in Malaysia at a cost of $10 million to provide the technological and infrastructual support towards the expansion of rubber-based industries. But this is just the beginning. Regional and international co-operation is absolutely essential to achieving a healthy growth of a manufacturing base in South East Asia.

PLANNED SCENE OF THE FUTURE

The title of my talk is " Natural Rubber — Plans for the Future ". It is not my intention to take on the role of a planner for all producing countries. What I would like to do, with the background that I have, with an element of intuition if you like and certainly with a knowledge and involvement in the activities of producing countries, is to describe to you what in fact should be the planned shape of things for the NR producing scene. The basic factors that must be catered for are :

(a) a dynamic and vigorous production policy in all producing countries,

(b) the multiplicity of grades of natural rubber must disappear and instead there should be one general purpose grade, *i.e.* Standard Natural Rubber (SNR) from the producing regions of the world,

(c) the consumption for natural rubber must be diversified into (1) special purpose uses employing the elastomeric properties, and (2) non-elastomeric uses by modification of the natural rubber molecule,

(d) natural rubber should be considered as a composite material with its latex, its timber and its seeds providing sources of raw materials of the future,

(e) natural rubber in producing regions should be processed to a stage as near the fabricated product as possible to optimise on the use of energy.

How are these factors to be met ? In what way could this become manifest as the ideal producing scene of the future ? Let me now describe to you the natural rubber scene of tomorrow.

The growing of natural rubber will be in economically viable smallholdings consolidated together into a plantation-type operation. Each unit of the composite plantation will be operated by shareholder workers. Management of each composite plantation will be in the hands of fully qualified technical personnel.

Planting materials will be supplied from a central unit with decentralised nurseries of a few selected high-yielding materials. Such materials would have undergone genetic improvements not only through breeding in the conventional sense but modification at the cell level through tissue culture. All high-yielding planting material supplies would have guaranteed average yield levels in excess of 3000 kg/ha/yr during its mature period. Discriminatory manuring and effective intercropping programmes would be exercised. Rubber seeds generated through induced flowering will provide adequate material for centralised processing into semi-drying oils and fatty acids. Replanting programmes will be based on a 20-year cycle. At the end of 20 years, the trees will generate adequate timber as a continuous and constant source for furniture, panelling, flooring and pulp for the paper and packaging industry.

Exploitation systems would be based on those applicable to the new variety of *Hevea* which would respond to millimeter cuts. This would entail a revolutionary tapping system allowing a worker to tap more than a thousand trees. Stimulation would be carried out soon after maturity. Collection of latex will be in polythene bags at intervals of a month. Liquid latex will only be collected for special purposes for reversible paste manufacture and for latex compounding. All agricultural operations will cease with tapping, after which industrial operations will commence with collection of polybags of latex. Such operations will be in modern central factories, processing more than a hundred tonnes a day. Only one general purpose grade of natural rubber, *i.e.* SNR, will be produced and this will be cleaner and technologically superior to RSS 1, while all other rubbers will be tailor-modified ones. These central factories will have facilities not only for processing latex and rubber for export but also for custom-compounding and manufacture of selected rubber items. Special-purpose synthetic polymers having plastic and elastomeric properties will also be manufactured in these factories for blending with natural rubber to impart certain special properties for new areas of application.

Marketing operations will be centralised into large units with technical service being provided both before and after sales to all consumers. An international buffer stock of adequate capacity will be in operation to ensure price stability at equitable levels.

As the dynamic production policy gets fully into train, modification chemistry will become manifest. Natural rubber will not only enter a wider area of engineering applications but will appear in the market in forms other than those with elastomeric properties. The product may become gas impermeable, thermoplastic and even in liquid form. As NR becomes modified and admixed with special polymers having elastic, fibrous, plastic and resinous properties, it will fully integrate with polymeric materials *per se*. It may even lose its identity, although it would certainly retain its native, techno-economic excellence.

This scene is not overly optimistic, nor is it a figment of my imagination. Nor can it be relegated to science fiction. The scene depicts exciting possibilities which must be achieved as we progress into the next hundred years. However, a pragmatic approach is required for the immediate ten years ahead. In this vein, the ANRPC is at present in the process of evolving an " agro-economic norm ", which aims at specifying the production potential of natural rubber in the ANRPC region. The initial assessments have not produced the real optimism envisaged. The world today has only a production potential of some 3·3 million tonnes. If we move into the next ten years without an aggressive promotional effort, *i.e.* massive new and re-investments followed by dynamic production, we as producing countries will be unable to take advantage of the exciting situation now open for the biologically-based polymers, especially natural rubber.

With renewed confidence and acceptance of the challenge to meet the material shortage of the future, research innovations available are clearly indicative that the world's requirements of isoprenic rubber in the 1980s and 1990s can be met. Through the international price stabilisation effort, the ANRPC countries have established initiative in a co-operative approach. Similar co-operation in research is manifest among the IRRDB producing countries. In the IRSG and other world forums, natural rubber producers have started coming to terms with synthetic producers and consumers. As we step into the next decade of the next hundred years for this country, areas of co-operation will expand among natural rubber producing countries and between natural and synthetic rubber industries. We must, therefore, become receptive to these requirements. Demands on scientific research and development and implementation of innovations in the producing scene are bound to become more sophisticated, more massive and more compelling than have been witnessed in the past.

In an interdependent world, which is beset with energy/material problems, environmental hazards and the population explosion, it is essential that natural rubber producers from developing countries and synthetic rubber producers from the industrialised consuming countries must move closer together in furthering their mutual interests affecting both the present and future generations. Decisions must be made. The preferences of present individuals, if I may borrow the terms of welfare economic theory on social time preference, must be allowed to determine the preferences and welfare of future generations.