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NATURAL RUBBER RESEARCH IN INDIA: LOOKING AHEAD

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1. ABSTRACT

Rubber Research Institute of India (RRII) has made significant impact on the natural rubber plantation industry of the country during the past more than 50 years of its existence. This is a fact that is recognized and appreciated equally by the Indian rubber growing community and the rest of the natural rubber growing world. This article attempts to quantify the economic, social and ecological impacts of the major findings made by the Institute in the past. It also tries to identify some thrust areas that need focused attention and gives an outline of the R&D strategy for the immediate future, keeping in mind the fast changes taking place around the world in the socio-political scenarios and in the fields of science, t echnology, trade and commerce.

While the broader objectives of the Institute would remain the same – to develop products and services to cater to the natural rubber growing community and the downstream processing, trading and product manufacturing sectors in the country - we cannot and should not remain ignorant about the fast changes taking place around us, both domestically and globally. The great strides taking place in science and technology, the ever evolving market economy and international trade dynamics, domestic and international socio-political changes, the need to ensure sustainable productivity of the land, concerns about global climate change, pollution and ecological degradation and a host of other contemporary and newly evolving issues warrant us to review and reprioritize what kind of research we do and how we go about doing the same.

R & D strategy of the Institute is remoulded in such a way that more new clones would be evolved in a timely manner which will have not only more latex yield, but also other elite qualities such as more timber, tolerance to diseases and environmental stresses like drought and cold etc. A farmer-participatory mode of field research in which the grower also will be a partner in the field evaluation trials of new clones has already been I nitiated by the Institute.

Efforts to expand rubber cultivation to agro-climatically less congenial non-traditional regions of the country and the impact of climate change on natural rubber cultivation, and possible emergence of new diseases prominently figure in the research agenda of the Institute. Maintaining sustainable productivity of the rubber growing soils, both in terms of conservation of soil moisture and the organic matter status of the soil will receive importance in our immediate research agenda. Research in molecular biology and biotechnology has to move from the present exploratory to a more focused trajectory in order to deliver tangible results in a timely manner.

An important area that can make significant impact on the society is rubber technology and product manufacturing industry. Focused research to improve the performance and technical specifications of the rubber goods such as tyres will improve not only the quality of human life, but also the quality of our environment (e.g.

by reducing the greenhouse gas emission into atmosphere by improving the fuel use efficiency of automobiles). More than at any time in the past, there is a felt need today for complimenting applied field research with a strong and sound basic science, both in material and biological sciences which will be impossible without adequate capacity building of the scientific community and infra-structure development to meet the challenges of a fast changing world.

2. INTRODUCTION

Natural rubber is one of the most recently domesticated crop species. Although a native of the tropical Amazonian rain forests, natural rubber is commercially cultivated mostly in South and South East Asia which enjoy an equatorial climate. The major rubber producing countries are Indonesia, Thailand, Malaysia, India, China, Vietnam etc. Its commercial cultivation in India started a little more than 100 years ago. In the beginning, when unselected seedlings were used as planting materials, the productivity was hardly 200-300 kg/ ha/year for the first fifty years or so. Today India ranks first in the world with a productivity of approximately 1797 kg/ha/year. Establishment of Rubber Board during 1947 was a major milestone in the history of rubber cultivation in India. Natural rubber is an industrial raw material that has varied engineering applications affecting every aspect of modern life and it has a critical role to play in the economic development of our country.

Rubber Research Institute of India (RRII), the R&D wing of the Rubber Board under the Ministry of Commerce and Industry, Government of India was established in 1955. President Dr. Rajendra Prasad laid the foundation stone for the Institute in 1955 and President Dr. A.P.J. Abdul Kalam inaugurated its Golden Jubilee Celebrations in 2005. RRII has lived up to the expectations of its stakeholders by making significant impact on the natural rubber plantation sector of the country during the past more than 50 years of its existence. The Indian rubber growing community has immensely benefited from the fruits of its research findings. Enjoying the total confidence of the Indian rubber growing community, RRII is unique from other R&D institutions dealing with agricultural crops in the country.

The Institute has 120 scientists and 340 supporting staff. It has a laboratory space of about 6000 sq. m and has approximately 750 ha of farm area. Head quartered at Kottayam in Kerala, RRII has a Central Experiment Station at Chethackal near Ranni in the nearby district of Pathanamthitta. It has Regional Research Stations at Padiyoor in Kannur District, Kerala, Dapchari in Maharashtra, Dhenkanal in Orissa, Nagrakatta in West Bengal, Guwahati in Assam, Tura in Meghalaya and Agartala in Tripura. In addition to these, it has two *Hevea* Breeding Substations in Thadikarankonam in Kanyakumari district of Tamil Nadu and Kadaba in South Canara district of Karnataka. With its large strength of scientific and supporting staff and presence in nine states of the country representing diverse agroclimatic regions, RRII is the largest natural rubber R&D organization in the world, and it enjoys a premier position among all the natural rubber growing countries in the world.

2.1 RRII Clones: Institute's pride and growers' preferred choice

Although natural rubber cultivation started in India during the turn of the 20th century, it got a boost with the establishment of Rubber Board in 1947. In the beginning, we were largely using imported Malaysian

clones such as RRIM 600; those days Malaysian R&D in natural rubber was the best in the world and their clones the most popular ones in all major rubber growing countries. With the release of the Indian flagship clone RRII 105 in 1980, which was developed by the Institute through a long and painstaking cycle of breeding and selection process by its committed breeders, the Indian rubber plantation industry took a dramatic change for the better which is still continuing. RRII 105 is perhaps the most highly productive clone released anywhere in the rubber growing world. The spectacular success of this "wonder clone" made it so popular that Indian rubber growers, particularly the smallholders wanted to cultivate only this clone since the 1980s. Today, this clone occupies more than 90 percentage of the cultivated area under rubber in the country. If there is one single reason behind how India achieved the number one position in rubber productivity in the world, it is the total acceptance of RRII 105 by the one million plus strong Indian rubber growers.

On a modest comparison, RRII 105 yields at least 350 kg dry rubber more than RRIM 600 per ha per year. RRIM 600 was popular in India until the release of RRII 105. The additional revenue generated as a result of the increased yield from RRII 105 (over RRIM 600) from the entire area under this clone in the country was to the tune of Rs. 1, 257 crores during 2007-08. This is the revenue realized by the one million strong rubber growers in the country.

2.2 Have the growers got the fullest possible economic returns from RRII 105?

The straight answer is no. The financial benefits from the increased yield performance of RRII 105 would have been better realized by our growers if the general cost of production (such as labour wages, input costs, land value etc.) had not increased and domestic price of rubber had not gone below the international price. A close analysis shows that the cost of cultivation of rubber has gone up significantly in the recent years. Also, since 2002 the domestic rubber price has remained consistently below the international price (except for small windows of time) and during 2006, by virtue of the price differential between the domestic and international price of rubber, there was a cumulative loss of about Rs. 600 crores to our growers (Fig. 1).

There are many holdings, even in the best traditional rubber growing tracts with RRII 105 that yield less than the national average due to various reasons, including tree senility, poor management of the holdings, unscientific latex harvesting practices etc. which beg the immediate attention of both the R&D and extension personnel alike. High incidence of TPD in RRII 105 is a major factor that has prevented the growers from maximizing the economic returns from their holdings. All high yielding clones are vulnerable to this malady, particularly those holdings that are over-exploited. Since there is no cure for this syndrome, scientific agronomic management, especially sound harvesting practices should be strictly adhered to, so that TPD can be contained within reasonable limits. Stimulants should be used with utmost care and discretion, because over-stimulation is a sure cause of large incidence of TPD irrespective of the clones.

The two new clones released by President Dr. A.P.J. Abdul Kalam during the golden jubilee year of the Institute, namely RRII 414 and RRII 430 are significantly superior to RII 105 in their rate of growth and rubber yield. On an average these clones show more than 20% increase in yield compared to RRII 105. The disease tolerance capacity of the new clones is better than or comparable with that of RRI I 105 which is one of the reasons for the fast growth of the new clones.

2.3 Future clones: The expectations

We have more than 140 experimental clones, both hybrids and ortets in the pipeline that have performed better than RRII 105 in the preliminary evaluation trials. These clones are being evaluated in large scale field trials for their growth and yield performance under different agro-climatic conditions through a farmer-participatory clone evaluation programme in association with willing growers. We hope and expect that a few clones from this pool will be released for large-scale cultivation by growers in the coming years. It is important that different clones are cultivated in the country for which we need to release good clones periodically; not an easy task, but this is imperative to ensure a better mix of clones in the field. A promising new clone is an excellent incentive for replanting old trees. Therefore, continued focus on classical breeding and selection will be crucial, while molecular breeding techniques also will be increasingly used in our crop improvement programmes.

We want the new clones being developed by RRII to be "smart clones" that produced not only for more rubber and timber yields, but they will also have faster growth and better tolerance to diseases and environmental stresses such as drought and cold. Concerted research focusing on the basic science of plant biology is needed to achieve this objective.

RRII has about 4000 odd wild accessions of *Hevea* collected from the Amazon region. They are a repository of agronomically important genes such as those responsible for tolerance to biotic and abiotic stresses, genes associated with efficient rubber biosynthesis or carbon partitioning between rubber and wood, etc. These wild accessions are being evaluated and assessed for their useful traits with the objective of exploiting them in our crop improvement programme, both through classical breeding and molecular techniques.

2.4 Rising demand for natural rubber

International agencies such as the Singapore based International Rubber Study Group (IRSG) have predicted that global demand for elastomers, including natural rubber will increase in future. In fact, the strong positive correlation existing between world consumption and GDP (Fig. 2) indicates that an economically buoyant future world will demand increased quantities of natural rubber. It is true that the high price of natural rubber will prompt many rubber growing countries to increase their rubber output. Also, rubber cultivation may expand to hitherto non-traditional regions in many rubber growing countries, or new low cost countries such as Laos and Myanmar may come into the scene. Increased dependence on synthetic polymers may become less attractive in future because of the uncertainties in the crude oil market and also due to environmental concerns. In general, NR prices showed significantly positive correlation with crude oil price (Fig. 3), although a host of other regional and global factors can significantly alter this cause-effect relationship. (During the pre-liberalized era when there was "market protection" of the domestic price of natural rubber by the government, this correlation was very weak for obvious reasons).

Increasing productivity of the existing plantations and expanding rubber cultivation to newer areas are the two ways by which we can increase the supply of natural rubber. There are practical and technological

difficulties in increasing the productivity of existing plantations. If the trees are too old or have poor growth or if they were harvested indiscriminately in the past, it is difficult to bring them back to good health in the short term. Productivity of old trees is bound to decline, irrespective of whatever agronomic or management practices are put in place. Controlled upward tapping with discrete use of stimulant is perhaps the only possible measure that can be adopted to increase the productivity on existing older plantations in the short term. In the case of young plantations, especially immature ones, adoption of right agronomic practices such as timely and appropriate fertilizer application, disease control measures etc. assume crucial importance. Scientific protocols for all the above have been already developed by the Institute.

Climatic stresses (eg. drought, high temperature and high light in the North Konkan region or severe cold in the North East) pose a threat to successful rubber cultivation in many parts of the country. Evolving clones that can tolerate these stresses better and developing agronomic techniques for diverse agro climatic conditions, therefore assume importance.

Climatic uncertainty as a result of global warming is increasingly becoming a matter of serious concern in some parts of the traditional and non traditional rubber growing regions. Climatic vaugeries can cause not only environmental stress on the rubber plants, but also can trigger various diseases in rubber trees. International agencies such as International Rubber Study Group (IRSG), Association of Natural Rubber Producing Countries (ANRPC) and International Rubber Research and Development Board (IRRDB) have taken cognizance of this fact.

At least one new disease has recently started to emerge in the rubber growing tracks of India, namely Corynespora leaf fall disease caused by *Corynespora cassiicola*. Although this was originally reported from Karnataka and the disease control measures are in place, this disease has appeared in some isolated pockets in the traditional regions as well. It is not clear if changing climate is responsible for the appearance of this disease in India. While Corynespora can be controlled, there is no practical remedy for the South American Leaf Blight (SALB) caused by *Micorcyclus ulei*. This disease is now prevalent only in Latin America. Our plantations will have a devastating effect if this fungus reaches our shores and if the climatic conditions favor its survival here. None of the oriental clones, including the RRII clones are tolerant to SALB. There is a need to define the association between climate change and diseases of rubber plants and develop scientific protocols to control them if they become a significant threat in the future.

Increasing rubber production to meet its increasing demand in the future would mean doing so under more and more adverse agro-climatic conditions, and hence our focus on developing clones and farm techniques suitable for different stressful environmental conditions. The Kerala model of rubber cultivation, as being practiced now may not be entirely applicable to North Konkan or the North East with vastly different agro-climatic conditions, and certainly not in a significantly altered future climate.

2.5 Manpower crisis

Manpower crisis in agriculture sector, especially agricultural laborers is an issue that is going to become more and more serious in the immediate years ahead. There is already a severe shortage of skilled tappers which reflects the general situation in the agricultural labor market in many developing countries. Malaysian rubber plantation industry has already has gone through such a difficult phase and the consequences have been

far reaching for that country. Many rubber plantations were either abandoned or converted into other land uses, mostly oil palm cultivation which is less labor intensive or into industrial areas in Malaysia. Shortage of work force in the Indian rubber plantation sector can not be seen in isolation, but this should be viewed as a general consequence of economic growth and a clear shift away from an agrarian to a non-agrarian lifestyle, not only for the labor force, but also for the grower community as well. Immediate and serious attention is needed in this aspect.

Possible automation of tapping (even partially), reducing the frequency of tapping without compromising the productivity of the trees, discrete use of yield stimulants etc. are possible ways of reducing manpower requirement in a rubber plantation. Rubber growing countries such as Malaysia have done excessive research in the past on developing automatic tapping tools, but there has been no success. Due to acute shortage of skilled tappers, mechanization of tapping is receiving renewed interest. Since tapping has to be done without injuring the cambium, substituting the human skill with mechanical device can prove to be expensive as well as injurious to the tree. Left with no choice, the question is how best cost and injury can be minimized. There is a growing concern of the likelihood of rubber holdings in the traditional rubber growing regions of India will be left untapped due to lack of availability of skilled tappers in future.

3. NEW TECHNOLOGIES FROM RRII

In the last 1-2 years, RRII has successfully transferred a few technologies to the field. Root trainer plants (Fig. 4) have become quite popular with our growers and commercial nurseries during the first year of its recommendation by RRII. These planting materials have several advantages; the most important one being the excellent root growth which gives them an edge in tiding over dry periods. Another technology that we have successfully transferred to the field is an integrated effluent treatment system to treat the waste water from RSS processing at the group processing centres. The main components of this system are the high rate anaerobic digester and the diffused aeration system. The biogas generated during the treatment process is collected in gas holders and used for the drying of the sheets in the smoke house and thus reduces the use of firewood.

The Institute has also developed two sheet washing devices that can successfully remove mould growth from dry sheets and thus improve the quality of sheets fetching more profit to the growers. A device for fast and efficient determination of dry rubber content of latex is now at an advanced stage of evaluation in the field after completing the laboratory trials successfully.

4. PRIORITY AREAS

The Institute has identified the following areas of research that require immediate consideration on a priority basis. They include, research in rubber technology and product manufacturing, molecular biology and biotechnology of *Hevea*, and climate change and sustainable rubber cultivation.

Our achievements in the area of rubber agriculture have been quite remarkable and it is important that this momentum is maintained for which better clones and farm technologies are to be evolved from time to time. But this will not be possible unless we make break-through research in the areas of molecular biology and biotechnology. Adequate capacity building of scientists and development of infrastructure are needed in this area.

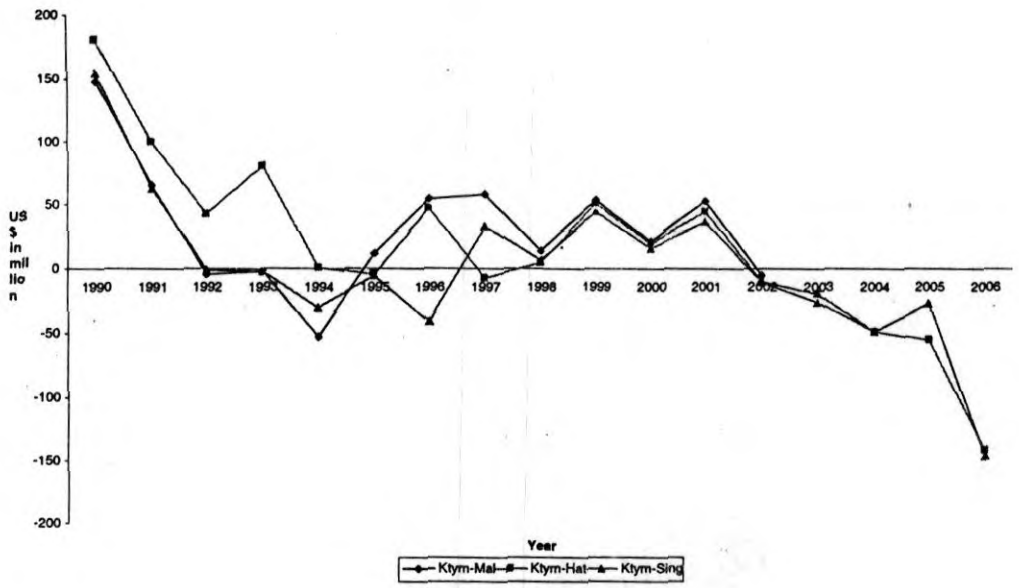
It is unlikely that we will have any break-through in this area unless they are addressed properly. We seriously contemplate embarking upon an ambitious *Hevea* genome programme.

During the 11th Plan, Government of India have approved setting up the Advanced Centre for Molecular Biology and Biotechnology in RRII to consolidate all our activities in this area of research and streamline our activities for the future. There are various international agencies that are also contemplating such a project at the moment.

Continuous cultivation of same crop on the same land for longer periods of time is known to reduce soil productivity. RRII has already initiated some studies to evaluate the long-term impact of rubber cultivation on the sustainable productivity of rubber soils. Monitoring soil health, especially in terms of organic matter content and moisture holding capacity of soil are important areas of our current research activities.

The agroclimatic conditions, even in the traditional rubber growing regions are not the best for rubber cultivation in our country as compared to South East Asian countries where rubber is cultivated. Global climate change may lead to frequent or unpredictable extreme climatic events such as droughts and storms, risking growth and productivity of rubber. In general, there has been a reduction in the amount of rainfall received in the Central Travancore Region of Kerala in the recent years as compared to the long-term average (Fig. 5). The impact of climate change on rubber cultivation is, therefore, one of our key areas of research.

Compared to agriculture research, there is perhaps a greater possibility to come up with research findings that can have profound impact on the society in the field of rubber technology and industrial research. The Advanced Centre for Rubber Technology set up under RRII is aimed at strengthening this important area which will be realized only with better interaction and integration between our technology research with the rubber industry at large. RRII hopes to focus more in this area of research without shifting its attention away from research in rubber agriculture which has been its traditional area of strength and that has paid rich dividends.


200
150
100
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US $ in millio n
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Fig. 1

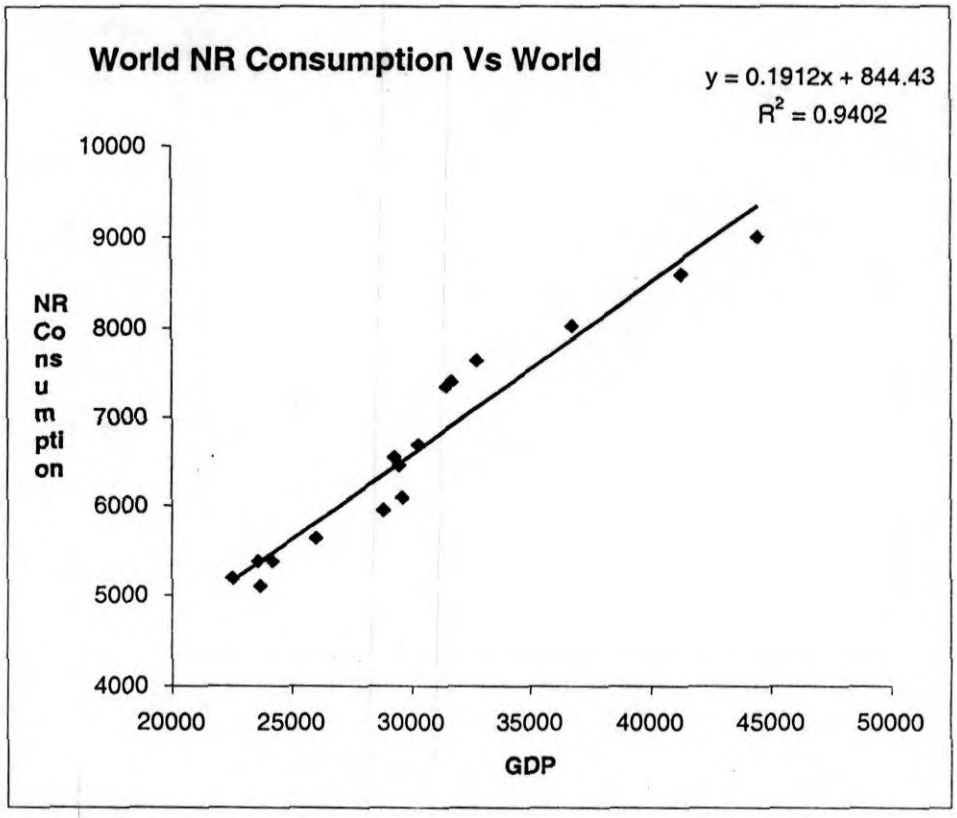
World NR Consumption Vs World
y = 0.1912x + 844.43
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Fig. 2

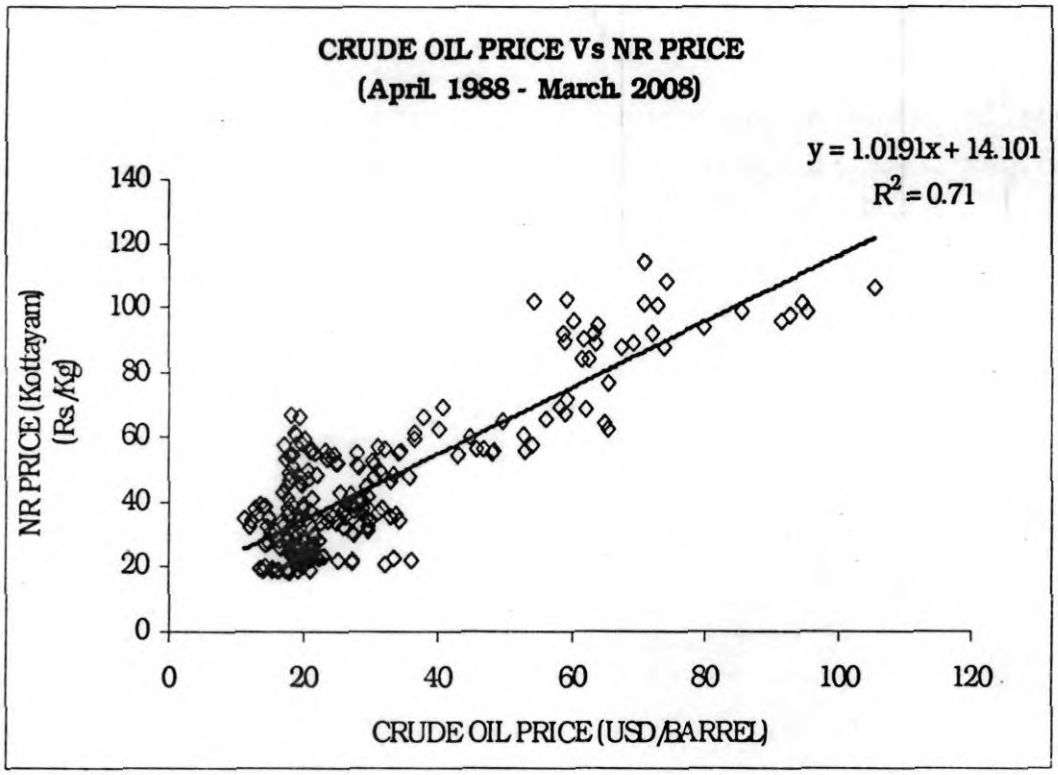
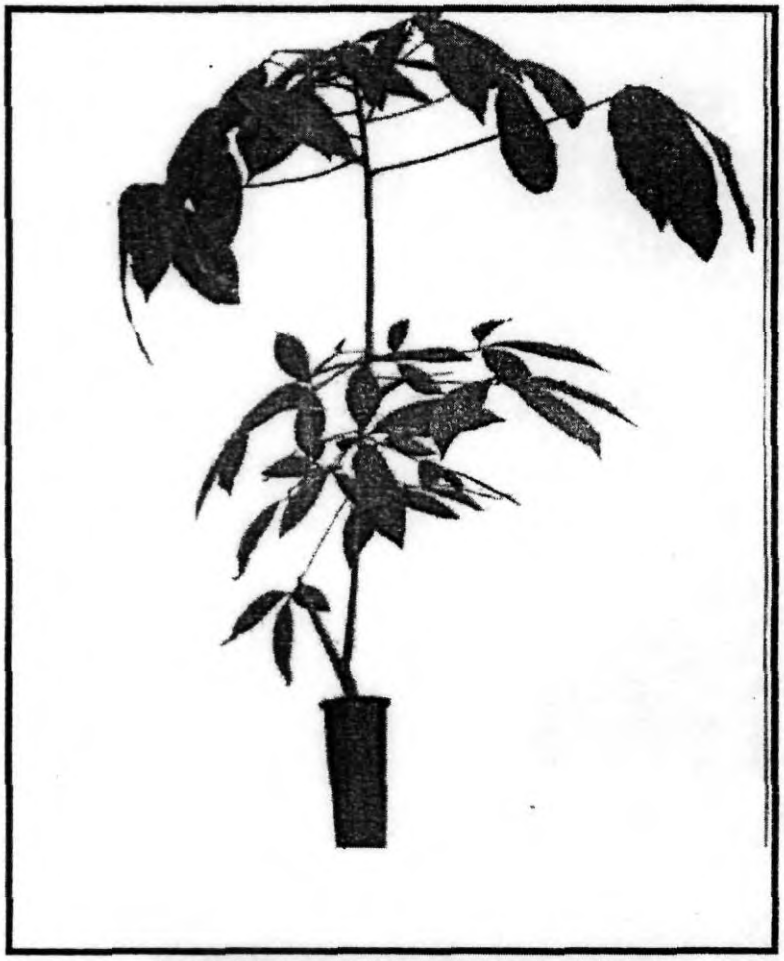
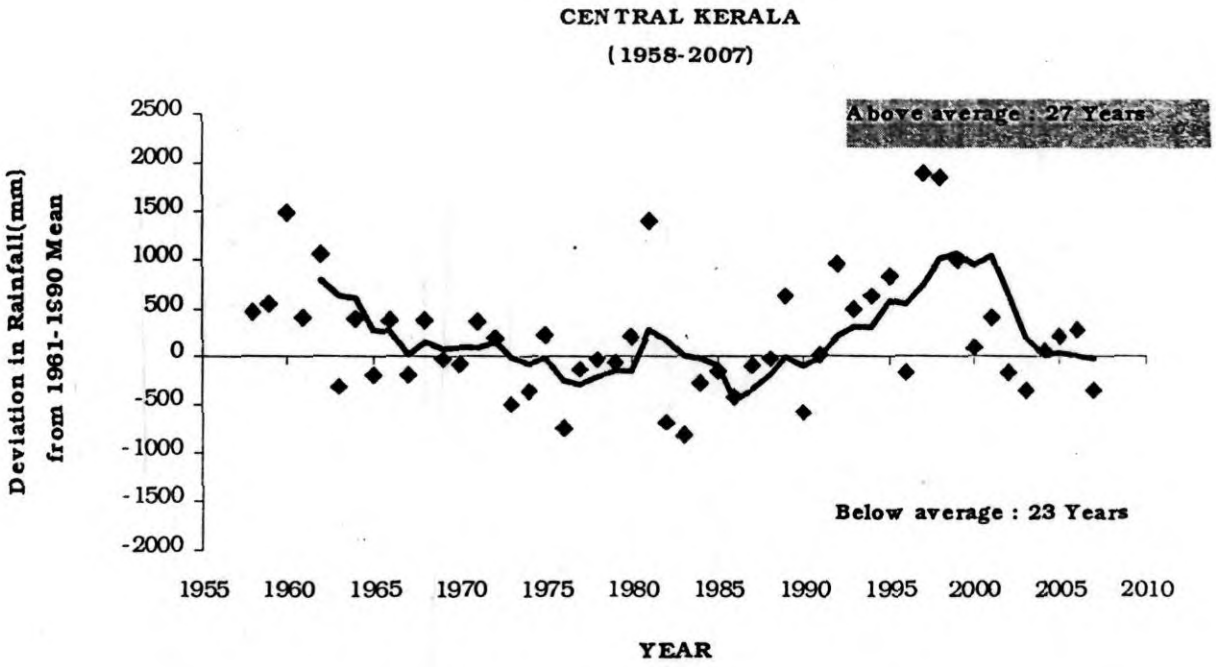


Fig. 3



ROOT TRAINER PLANT

Fig. 4



The number of years with sufficient rainfall is more than the number of years with deficient rainfall, for the last 50 years

Fig. 5

This paper was presented at the International Conference on Natural Rubber Extension and Development held at Cochin on 8th and 9th May 2008 in connection with golden jubilee celebration of Rubber Plantation Extension.