The Contribution of Research to the Economic Development of the Rubber Industry in Sri Lanka

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The Rubber Research Institute of Sri Lanka (RRISL) is situated at Agalawatta, approximately 50 miles from Colombo, in the Kalutara District, one of the largest rubber growing districts in Sri Lanka. The work of the Institute can be conveniently divided into three main sections: biological research, chemical research and extension. In biological research, the scientists concerned try to improve the yield of the rubber tree by various methods, such as breeding new high yielding disease-resistant rubber trees, which will grow in the different soils and climatic zones where rubber is grown in our country. Improving the cultural practices, eg. developing better nursery management systems, breeding methods, tapping systems, soil and water conservation methods, improved yield stimulants, inter-row management and collection and transport of latex, also come under the purview of the biological scientist. The chemist on the other hand is concerned with the improvement of the product, either the raw rubber, in which case he is a rubber chemist or the finished goods where he would be a rubber technologist. The extension personnel are responsible for the rapid transfer of the new methods developed by the scientists to the rubber growers, both on the large estates and in smallholdings.

The recent developments established by the RRISL and some of the ongoing research work of the Institute will be described in this paper.

BIOLOGICAL RESEARCH

Plant Breeding

The Genetics and Plant Breeding Department of the Institute has developed several new high yielding clones by the method of hand pollination. Rubber (*Hevea brasiliensis*) flowers are normally pollinated by insects, but then the crosses are not controlled and the progeny are variable. Selected crosses between high yielding clones, with other desirable characters, such as resistance to diseases and wind damage, rapid bark renewal, good branching habits and ability to grow under various soil and climatic conditions, can be made by protecting the female flowers from natural pollination and transferring the pollen of selected clones on to the stigma of such flowers. The progeny of these selected crosses has a much higher probability of combining the essential character of high yield with other desirable characters than the crosses left purely to chance, as happens in nature with insect pollination.

The Institute has developed the RRIC 100 series clones in this manner and recommended the planting of RRIC 100, 102, 103, 104 and 105 recently. The main contribution in new clones in the last two years was the discovery of the South American Leaf Blight (SALB) resistant clones RRIC 121, RRIC 130 and 72 — 133. The yields of both RRIC 121 and RRIC 130 are very high and the growth of RRIC 121 is above average.

SALB is the most devastating disease of the rubber tree known anywhere in the world. At present it is confined to the South American region, the original home of *Hevea;* but there is no guarantee that this dreaded disease will not spread to the South East Asian rubber growing areas in the future, with the fast air traffic now linking various parts of the world. Although Hevea originated in Brazil and other South American countries, they have not been able to grow the crop on a commercial scale, entirely because of its susceptibility to SALB in those countries. Therefore, the value of the development of a SALB resistant, high yielding clone in Sri Lanka is a significant contribution to the industry, by our scientists.

Tapping Systems

The normal daily task of a tapper in Sri Lanka is about 250 trees, whereas the Malaysian tapper does up to 750 trees per day. Tapping and collection account for about 33 per cent of the cost of production of rubber. Therefore, any improvement in tapping systems can result in significant savings for the industry. The RRISL is studying methods of puncture tapping with yield stimulants, where vertical grooves made on the rubber tree are first treated with a yield stimulant and latex is extracted by piercing the bark at 2 to 3 points with a pointed instrument, rather than by the conventional method of shaving the bark with a tapping knife. These experiments are in their initial stages and indicate that the task size can be significantly increased by this method, while keeping the yields constant. However, further studies are necessary and an economic evaluation must be carried out before coming to any conclusions.

Yield Stimulants

These are materials that, when applied on the scraped bark of the rubber tree, either immediately above or below the tapping cut or on the cut itself, increase the yield of latex quite significantly. We have found that a material called Ethrel, which when applied to the tree releases ethylene, is the best yield stimulant available for rubber up to date. However, early studies showed that although Ethrel can increase the yield of latex by 100 per cent on first application, yields fell off gradually and, if the stimulant is used frequently, the yield can fall below that of control trees, which are untreated. This leads to further research, and it has now been established that Ethrel will give best results if used at low concentration 3 to 4 times per year. We are currently recommending the application of Ethrel at 5% concentration, on the tapping cut immediately after the South West Monsoon rains and twice thereafter. This has resulted in a steady yield increase of 15% to 25%, and there has been no adverse effects over several years.

Intercropping

Intercropping is an innovation recently introduced by the RRISL, which should be most attractive to smallholders; as it would give them an income in the first few years after replanting. Intercropping can be done for only about 4 years, from the time of replanting until the leaf canopy closes over. Very few plant will grow under the dense shade provided by mature rubber trees, planted on the normal spacing for rubber.

Intercropping rubber planted at spacings of 2.5 m X 9.0 m with crops such as bananas, passion fruit, pineapples, cocoa and coffee has provided a good income and has had no adverse effects on the growth of rubber, when carried out according to the Institute's recommendations. Further experiments have to be carried out to establish whether coffee can be grown under mature rubber to yield an economic return.

One of the problems with intercropped pineapples is that of weed control. We have found that Diuron, a pre-emergent herbicide can be used successfully for weed control in this crop. Further studies are being carried out on this subject, as pineapple growing provides very attractive returns.

Various grasses have been grown with rubber to find out whether we can suggest a suitable farming system to the smallholder, where he can grow animals on his land. *Panicum* species have produced more dry matter than *Brachiaria* species tested both when grown alone or in combination with a legume. *B. brizantha* and *P. maximum* depressed growth of *Hevea* significantly when grown above or in combination with a legume when compared with *Pueraria* or natural covers. In terms of both dry matter and availability of nitrogen, a mixed pasture of grass and legumes appears to be best under our conditions.

Tissue culture

We have made considerable progress in tissue culture, having perfected methods of inducing root growth in callus cultures, and produced shoot growth at least on one occasion. Root differentiation was observed when *Hevea* calluses grown on a high auxin medium was transferred to low auxin media with kinetin. Low levels of cinnamic acid in the presence of kinetin also induce root differentiation. We are now developing a method that can be repeated for the production of shoots, and from there the production of plantlets would be relatively easy.

Disease control

There are five major diseases, caused by fungi, affecting the rubber tree in Sri Lanka. Three of these are leaf (*Oidium* and *Phytophthora*) and panel diseases (*Phytophthora*) and the other two root diseases (*Rigidoporus* and *Xylaria*). The RRISL has found that the majority of clones recommended for planting by the Institute at present are tolerant to *Oidium* leaf disease, so that control measures against it are not warranted in the wet low country districts, where rubber is grown. We have also found that the weather patterns in Sri Lanka are such that *Phytophthora* leaf disease does not occur on an epidemic scale regularly in this country, and according to our advice, no control measures are taken against this disease, too. *Phytophthora* infection of the bark, leading to Black Stripe or Bark Rot, occurs in exceptionally wet years, and control measures against it, as developed by the RRISL, are well known and adopted where necessary by estates. Therefore, the major disease problems on rubber are those caused by root infecting fungi.

We have studied the biology of the causal fungi and introduced several innovations in the control of the diseases caused by them. The size of the food base is important in the initiation and spread of both diseases. Only a few plants were infected, however, when quite large food bases were buried near plants; but even small pieces of inoculum caused infection when placed in contact with roots. Therefore, soil conditions, environment and placement of the inoculum are all closely linked with the spread of the diseases, and infected material has been found to be viable for more than 30 months in the soil. The introduction of sulphur to the soil, lowers its pH and helps in the suppression of the pathogen and encourages the growth of certain fungi antagonistic to it. Studies are now being carried out to use all this information to develop a method of biological control of these root diseases.

Soils and fertilizers

One of our main interests in the Soils and Plant Nutrition Department of the Institute is to study the response of the rubber tree to the supply of nutrients. We have shown that yield increases in the range of 5 to 32 per cent can be achieved by the proper fertilization of rubber trees. The requirements of various elements by different clones can be distinct, and differ according to the type of soil on which the crop is grown. Therefore, special fertilizer mixtures are recommended by us according to clone and soil type generally. This has been developed further, and the Institute now carries out soil and foliar analyses to recommend special fertilizers to different fields on each estate, according to the requirements of each area. Therefore, in certain cases, we may recommend the use of only one or two fertilizer elements, instead of the general fertilizer mixtures hitherto applied. The savings effected by this innovation are quite substantial.

Our studies have also shown that urea is as effective as sulphate of ammonia as a source of nitrogen for mature rubber, so that, with effect from 1981, the Institute has recommended the complete substitution of urea in place of ammonium sulphate for all mature rubber in Sri Lanka. Urea contains more nitrogen W/W, is cheaper than ammonium sulphate and is now manufactured in Sri Lanka, so that considerable economics will be effected by this substitution. Our studies have also shown that the local dolomite can replace imported Epsom salts and kieserite as a source of magnesium for rubber replantings. This has again resulted in significant savings in the fertilizer bills of rubber growers.

We have shown that certain cover management practices such as the establishment of legumes and fertilizing them with phosphate will give long term beneficial effects on growth and yield of mature rubber. Investigations in soil conservation methods have shown that, a good mulch should be maintained over the ground until a legume cover is established in replanted areas. The ground should never be left bare or clean weeded until the legumes have grown.

RUBBER CHEMISTRY AND TECHNOLOGY.

Rubber Chemistry

The Rubber Chemistry Department of the Institute carries out studies on: rubber chemistry, rubber technology, specifications for dry rubber, chemical analyses of rubber and water samples, crepe rubber development, biochemistry of latex and non-rubber resources such as rubber seed oil and rubber seed meal.

We have found

(*a*) that storage hardening of liquid rubber can be reduced by incorporating a radical quencher,

(*b*) several applications for low temperature curing systems — an interesting and useful application is in the rubberising of bullock cart wheels,

(*c*) that low temperature curing systems based on natural rubber (NR) can be used to safeguard the tea bush against desiccation and borer attack, by effective sealing of pruning cuts,

(*d*) promising ebonite formulations for compression moulding of engineering components,

(*e*) a simple method of producing cyclised rubber — about 5 tons of this material is now manufactured every month in four estate factories, and replaces imported high styrene resins in various industrial processes eg. paints,

(*f*) that deproteinised NR prepared by papain/acid coagulation is satisfactory for cyclisation in the open mill using toluene sulphuric acid,

(*g*) that metal salts of higher fatty acids such as calcium stearate and the calcium salt of rubber seed oil fatty acid are very effective activities of sulphur vulcanization,

(*h*) that carboxy methyl cellulose can be used as a wetting agent in the manufacture of NR/carbon black masterbatch at the latex stage. The sheet form is the most suitable way to prepare the masterbatch for drying. Compounds made from this masterbatch have been tested out and found to be satisfactory,

(*i*) our studies leading to the development of a network bound antioxidant for NR have come to a temporary standstill due to the non-availability of the necessary chemical in commercial quantities, for exploitation of the process. Negotiations are now going on with a chemical manufacturing firm in the UIC to remedy this situation.

We are studying the possibilities of:

(*a*) introducing thermoplastic properties to NR, by both grafting and blending techniques,

(*b*) synthesising amine-based antioxidants and dual purpose accelerators.

Rubber technology

One of the main functions of the technology section is to give an adequate technical service to the rubber products manufacturing industry, especially with regard to quality control of locally manufactured rubber goods. In the processing of latex, we have made significant contributions in the methods of preservation, concentration and dialysis of NR latex.

The use of solar energy for drying crepe rubber is quite appropriate in the context of the energy crisis. Our own studies are being supplemented by factory scale trials at Padukka Estate, where a solar collector unit has been installed for a new drying tower.

An useful non-rubber resource is rubber seed oil (RSO) of the triglycerides available in Sri Lanka. RSO is the only one which has useful drying properties. Light coloured alkyd resins have been prepared by us in a purified form and this has distinct possibilities of further development. However, the free import of linseed oil may hinder the rapid development of this industry. It is important for the Government to give the necessary impetus to such useful industries, by suitable import restrictions.

EXTENSION SERVICES

Advice to Smallholders

The Advisory Services Department has officers resident in many of the larger villages where rubber is the main source of income of the residents. These officers visit rubber smallholders and assist them in lining and holing their land in preparation for replanting, and continue the visits at regular intervals thereafter to provide advice on all aspects of rubber planting and aftercare such as: soil conservation, fertilization, disease control, tapping, collection and processing of rubber. No charge is levied for this service, and it is an entirely voluntary service provided by the Institute.

A project was started in 1980, with World Bank financing, to replant 45,000 acres of rubber land in the Kalutara, Ratnapura and Kegalla Districts during the period 1980 to 1984. The RRISL is playing a vital role in this project.

Improvement of Smallholder's rubber

The Institute started a scheme in 1973 to improve the quality of the sheet rubber produced by smallholders. This scheme is supported by the Government, which provides the financial assistance for it. The scheme consists in grouping smallholders together, to bring their latex to group Processing Centres (GPC), where processing facilities and a smokehouse is constructed with Government funds: each GPC being provided with grants and loans totalling Rs. 30,000/-. The present census of GPCs is as follows:

GPCs in operation	...	103
GPCs under construction	...	04
Total	...	107

One-day seminars are organised at regular intervals for officials operating GPCs, a set of account books necessary for the proper maintenance of accounts are provided, and every effort is made by our field staff to make these viable, self financing units.

The GPCs have had a significant effect on the quality of sheet rubber produced by smallholders, and it has been shown that these centres can produce up to 96 per cent of No. 1 smoked sheet, whereas the normal average of small-holders is about 15 per cent, No. 1 sheet, a major part of their product falling into Nos. 3, 4 and 5. This shows the impact that proper advice can have on rubber production in the villages.

CONCLUSION

The RRISL carries out research on the biology of the crop, with a view to increasing rubber yields; and in rubber chemistry and technology, so as to increase the value of the product.

Therefore, it is seen that the Institute carries out research essentially to increase the total income of the country from the rubber industry. The success of the enterprise in recent years, can be judged from a careful assessment of the contents of this paper.