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BYPASSING THE RESOURCE CURSE: CASE OF LEARNING, INNOVATION AND COMPETENCE BUILDING IN NATURAL RUBBER, KERALA, INDIA

K. J. Joseph, Namrata Thapa and Olav Wicken

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ABSTRACT

This paper challenges the often held view regarding the limits to growth set by natural resource intensity by taking the case of Kerala economy which despite being dominated by resource based sectors has experienced revival since the latter part of 1980s. Focusing on natural rubber - the largest resource based sector- wherein significant growth dynamics was observed, the study highlights the role of a vibrant innovation system which facilitated learning, innovation and competence building of different stakeholders especially the small holders and plantation labourers. In the earlier years, the innovation system appears to be more in tune with the narrow approach to innovation resulting in high yielding clones. However, in the context of new challenges under globalization, the system appears to have adapted itself not only by undertaking technological innovations (in the form of new clones) but going beyond the sphere of technology and clone development. This is manifested inter alia in the new organizational innovations like RPSs, labour banks along with other initiatives for interactive learning and competence building of different stakeholders. Sustaining the gains of the innovation system in natural rubber, however, would depend to a great extent on the presence of internationally competitive rubber-based industrial sector. But in the absence of a strong innovation and competence building system, the rubber based industrial sector is shown to be in distress in the event of heightened import competition under globalization. The study, therefore, makes the case for appropriate institutional innovations to facilitate the evolution of an innovative and knowledge driven rubber-based industrial sector.

Introduction

It has been argued that an abundance of natural resources can hurt economic growth by unleashing forces that hamper the development of the national economy. Ever since the pioneering work of Neary and Corden (1982) and the more recent seminal work of Sachs and Warner (1995) who have shown that economies with a high ratio of natural resource exports to GDP in 1970 (the base year) tended to grow slowly during the subsequent 20-year period (1970-1990) than their resource-poor counterparts, the issue has attracted significant scholastic attention. Case studies and historical examples also tend to confirm the negative impact of natural resource abundance on economic performances.

A number of both theoretical and empirical studies have tried to understand why natural resources are a "curse" rather than a "blessing" for economic development. Gylfason (2001) consider that natural capital crowds out other forms of capital (human, institutional, physical, foreign). Sachs and Warner (1995, 1997) have identified several pathways behind the observed negative relationship between natural resource intensity and growth. Ross (1999) distinguishes between political and economic explanations used in studies from political studies and economics. Here we start from economic models used by Sachs and Warner (1995, 1997) to analyse the resource curse. The argument is that economic rent from export of natural resources (NR) has effects on resource allocation in the overall economy. High income in NR increases

costs and wages in the economy, and moves labour and investments away from traded sector to non-traded sector. The assumption is that this is bad for the economy as there is less learning and knowledge intensity in the non-traded vs the traded sector. In this specific model the NR sector is regarded as a financial sector (like remittances, development aid) and not as a production sector. This is evident from the fact that Sachs and Warner operate with an assumption that there is no capital or labour in the NR sector.

Basically, the assumption underlying this model is that industrial structure matters for economic development. Manufacturing is more dynamic compared to natural resource sector (and non traded sector) because there is more learning and knowledge intensity. This is the point of departure for our paper. We analyse economic development in Kerala, India. There is a general acceptance among many scholars that Kerala – for a long time has had - a "backward industrial structure" characterized by absence of high-tech industries and focused on resource based manufacturing (Subrahmanian and Pillai 1986, Subrahmanian, 1990). It is argued that this structure in the long run will slow down growth and development. In spite of this Kerala has over the latest decades experienced growth above the Indian average; experienced relatively high GDP per capita among Indian states (ranked as number 4); and has the highest score in human development index. In the context wherein the revival of Kerala economy since the latter part of 1980s has not received the attention it deserves (plausible exception being Harilal and Joseph, 2003 and Kannan 2005)[1], we approach this 'structural paradox' by analysing the learning innovation and competence building process in one of the largest resource base sectors – natural rubber. This industry has experienced both rapid growth and increased productivity over a long period of time. Using an innovation system approach (section 2) we discuss how growth and productivity development has been linked to learning processes of various kinds in the industry (section 3). The development of the innovation system is

divided into two phases; phase one characterized by a protected national production system until the 1990s (section 4) and phase two characterized by globalization and increased international competition (section 5). In the conclusion (section 6) we present some of the challenges of the existing innovation system for natural rubber in Kerala.

2. Towards an analytical framework

Recent empirical evidence on the development dynamics of natural resource based economies (NRBE) and industries (NRBI) tend to challenge the argument that there is no or limited learning involved in NRBI (David and Wright 1997, Wright and Czelusta 2002, Ville and Wicken 2013). This holds both for extractive natural resources (especially minerals) and agricultural products. The findings using the Dutch disease model mainly involves the former, which tends to be very capital-intensive and only involves a small proportion of the population in the extraction of the resource. Consequently, the added income accrues to a few, while the appreciation of the country's currency affects the entire population. Agricultural exports generally involve larger segments of the population, and increased income usually accrues to all producers, diffusing the adverse consequences, if any, of currency appreciation (Jomo and Rock 1998).

Our paper is part of the recent development perspective to challenge the resource curse assumptions and findings by using alternative approaches influenced by innovation studies literature. The basic point is to open what is regarded as a 'black box' in the Dutch Disease model: *To what extent can we observe dynamic learning and innovation processes which is the base for long term growth in natural resource based industries.* We focus on small-scale production in agriculture, the case being natural rubber in Kerala. In general the study argues that the performance of natural rubber in Kerala in terms of conventional indicators like production and productivity has been head and shoulders above the competing countries. In addition, natural rubber

also experienced productivity and growth during a period where the agricultural sector has been under stagnation. This may be, to a great extent, attributed to the innovation system of the industry. We argue that there is – and has for a long time been - interactive learning between different actors along with the co-evolution of institutional and technological innovations. The learning process, in turn, has influenced competence building of organisations and individuals – the more relevant indicators of development like capabilities and freedoms as articulated by Amartya Sen.

We apply approaches from/related to innovation system literature. The underlying assumption is that industrial growth and social development is dependent on building of innovation systems. We describe the development of the industry in two phases. The first phase (c. up to 1990) of the system building process is characterized by *policy driven (top-down) and* science *based* processes within a protected economic framework. In this phase strong science based knowledge bases were developed and made available for the industry. With the globalization of the economy, marked by WTO and different regional trading agreements like the one with Sri Lanka and the ASEAN, the sector got exposed to international competition. The available evidence tends to suggest that in response to the changing environment there has been greater coevolution of technological and institutional innovations to facilitate higher level of interactive learning and competence building process. The paper however argues that the new phase demands a stronger *enabling sector* (i.e. knowledge intensive industries supporting innovation processes in the rubber industry) (Pol et al 2002, Ville and Wicken 2013). We discuss the demand for a transformation/expansion of the existing innovation system for the industry, and the on-going development towards a system more characterized by *bottom-up processes* which include a wider set of knowledge bases and actors than formerly have been the case.

Since the basic issue that we intend to address relates to the link between innovation in its broad sense and development, innovation systems approach appears to be an appropriate framework[2]. Innovation, broadly defined, relates to the various activities relating to production and exchange and involves the introduction of new or improved products, processes or ways of doing things and it is an aspect of all human activities, at all stages of development. While the historical roots of the concept could be traced back to the work of Friedrich List (1841), the modern version of this concept was introduced by Lundvall (1985) in a booklet on user-producer interaction and product innovation. Freeman (1987), while analyzing the economic performance of Japan, brought the concept to an international audience. He defined innovation system as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (p.1). The concept, as defined by Freeman, highlights the processes and outcomes of innovation. Since then there has been a burgeoning body of literature (Lundvall 1992, Nelson 1993, Freeman 1995 Edquist 1997) focusing on different dimensions of the innovation system[3]. Later, there has been conceptual advancements within National System of Innovation (NSI) framework in terms of *regional/local innovation systems* in which the boundary is the region; *technological systems,* in which the focus is on technologies and; and *sectoral systems of innovation* with focus on specific sectors which have further helped strengthening this bridge.

The studies using innovation system perspective consider knowledge as the most fundamental resource in the modern economy and its acquisition as an interactive learning process. The concept of innovation system got enriched by drawing insights from evolutionary economics, institutional economics, structuralists and theories on the economics of knowledge and appreciating the dangers of treating R&D on par with innovation *ala* GDP growth with development in traditional development economics. These studies deviated from the linear approach

to technological progress (invention-innovation-diffusion) and regarded innovation as an interactive and evolutionary process at micro, meso and macro level as key driver of growth and development. It provides a systemic perspective by linking the micro behaviour to the system level in a two-way direction. The changes at the system level is an outcome of the interactions at the micro level where as the system shapes the learning, innovation and competence building at the micro level. The evolutionary and the systemic perspective of innovation and development implicit in this framework is in contrast to the conventional economic perspectives that focus on optimisation of resource allocation for growth in a static context. Thus viewed, NSI approach goes beyond the narrow confines of product and process innovation and considered innovation as an interactive learning process involving different actors in an evolutionary manner wherein institutions playing the central role. The nature of innovation and its outcome in terms of development crucially depends on the extent of interactive learning within the given institutional context and the co-evolution of the system in response to changes within and outside the system.

There are two broad approaches in the innovation system perspective; NIS in *a narrow perspective* (or Science, Technology, Innovation mode), in tune with the earlier analyses of national science systems and national technology policies (Nelson, 1993, Mowery and Oxley 1995), aimed at mapping indicators of specialization and performance with respect to innovation, research and development efforts and science and technology organizations. The policy issues raised were almost exclusively in the realm of explicit S&T policy focusing on R&D. But the *broader approach to NSI*, which is of much relevance to developing countries, takes into account social institutions, macroeconomic regulations, financial systems, education and communication infrastructures and market conditions as far as they have impact on learning, innovation and competence building systems and process (Gu and Lundvall 2006). In this paper we use the distinction

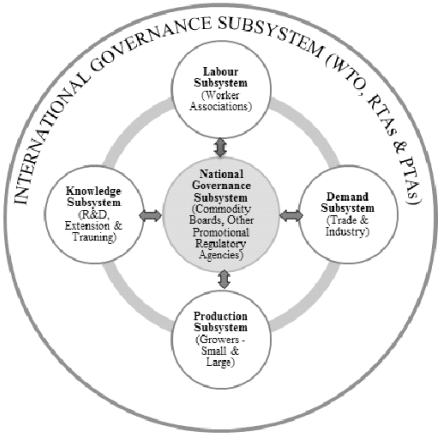
between narrow and broad approach to innovation as an analytical tool. We see the development of the first phase of the IS building as linked to the narrow approach and analyse to what extent the IS has been transformed into a broader perspective since the 1990s.

Drawing insights from the innovation system perspective, the system of innovation in natural rubber is presented in figure 1. The innovation system is conceived as having five subsystems with national governance subsystem comprising commodity boards at the centre, then the knowledge subsystem consisting of R&D, extension and training; the labour subsystem; the demand subsystem and the production subsystem. Each of these subsystems interacts intensively with the national governance subsystem which in turn facilitates socially embedded learning process. Further, their interaction as a whole is influenced by the international governance subsystem comprising WTO, RTAs & PTAs.

The institutions (laws, rules, policies) within and outside the system determine the nature and extent of interactions within the system. The system however cannot be treated as static. To appreciate the development implications there is the need to have a fair understanding on the changing nature of interaction between these sub systems and how they individually and collectively respond to challenges that arise from within and outside. For example, how the R&D system responded to need for ensuring enhanced supply of natural rubber in terms of their search for high yielding clones. To the extent that, the policy environment over time changed from one of protection to open competition, there is also the need to explore the response of the system to be competitive through innovations for reducing cost of production *inter alia* by reducing the gestation period and minimizing the use of inputs. Similarly each of the subsystems individually and/or collectively had to respond to institutional changes (like trade policies, licensing policies) at the national level, changes in labour market conditions, environmental concerns and also to demand conditions. Thus for understanding the

link between innovation and development there is the need to explore the extent of interactive and socially embedded learning process and the co evolution of the system, within the national-international context and in response to the exogenous and endogenous factors that influenced functioning of the system.

Figure 1: Innovation system of India's Natural Rubber



3. Empirical evidence

Production subsystem and performance

The existing production subsystem in natural rubber mainly comprises of growers[4], both large and small. Initially the large growers dominated the production subsystem, but since the mid-1950s, one of the most remarkable structural changes has been in terms of preponderance of small holdings (George et al., 1988; Joseph 2014). The growth rate of small holdings during 1955 to 2008 was as high as 5.42 per cent p.a as against that of estates (0.64 per cent p.a). Considering the size distribution of area among small holders and estate, in 2010, 1.20 million small holdings accounted for 90 per cent of area and contributed to 93 per cent of production. The average size of a small

holder is only 0.54 ha. Among the small holdings, around 78 per cent of the area under rubber was less than 2 hectares while, it was only 22 per cent in 1955 (see Table 1). These trends indicate that production is taking place on increasingly smaller holdings with less than 2 ha of land.

Table 1: Percentage share of area across different land holdings size

year	Less than 2 ha	Above 2 ha and upto 4 ha	Above 4 ha and upto 20 ha	Above 20 ha	Total area (ha)
1955-56	21.81	6.80	14.67	56.73	83867
1960-61	29.51	10.76	18.52	41.21	129905
1965-66	31.23	11.08	19.54	38.16	164713
1970-71	33.71	12.73	20.73	32.83	203098
1975-76	36.51	13.27	20.97	29.25	224428
1980-81	47.71	10.84	16.68	24.78	278057
1985-86	58.79	9.13	12.41	19.66	369348
1990-91	69.97	6.98	6.72	16.34	475083
1995-96	71.74	7.46	6.58	14.23	524075
2000-01	73.32	8.01	6.70	11.96	562670
2005-06	76.22	5.90	6.91	10.97	597610
2010-11	77.82	6.09	6.12	9.97	711560

Source: calculated from different volumes of Indian Rubber Statistics, Rubber Board of India.

With the significant contribution of over a million small holders, India stands as the fourth largest producer of natural rubber in the world. It contributes to nine per cent share in the world production after Thailand, Indonesia and Malaysia. The production of natural rubber in the country in 2010-11 was 862 million kg. India occupies the top position in the world in productivity (1806 kg/ha during 2010-11) (Rubber Board, 2010-11). Traditionally, cultivation of natural rubber has concentrated in the southern state of Kerala. Kerala is said to have a near monopoly in

the production of natural rubber (George and Toms, 1992). It accounts for 78 per cent of the area under rubber in the country (Economic Review, 2010). Its share in total NR production in the country is around 91 per cent in 2010-11. Among other historic reasons, the dominant position of Kerala in terms of rubber cultivation is to a large extent on account of the favourable agro-climatic conditions compared to other states (Mani, 1984).

In what follows we are examining in some detail the trends in area, production and yield of natural rubber for India as a whole. This analysis is indeed reflective of the trends with regard to these indicators for Kerala as it occupies a dominant position both in area and production.

Trends in Area, Production and Yield

An increase in crop production can be derived from three main sources: expansion of arable land, increases in cropping intensity (the frequency with which crops are harvested from a given area) and improvements in yield[5] (FAO, 2002). Plantation crops are essentially perennial crops. Unlike annual crops, perennial crops are characterized by a long gestation period between initial input (planting) and first output (yielding), an extended period of output flows from the initial production and eventually a gradual deterioration of the productive capacity of the plants (French and Matthews, 2001). As such cropping intensity is not an important component of plantation crop production but yield growth and area growth comprises other important components.

With a view to analysing the performance in terms of area, production and production per hectare (yield) we have analysed the time series data on these variables since 1950. The observed trend breaks in the series and recorded growth rate during different phases are reported in Table 2 & 3. Table 2 shows that there were 4 break points in area,

production and yield giving rise to 5 distinct phases in terms of their observed growth. In general, the first phase lasting up to late 1950s was a period of low growth in all the indictors. This was followed by high growth phase lasting till early 1970s. The third phase (1970s) was a period of relative low growth rate followed by fourth phase (beginning with early 1980s and lasting till mid-1990s) wherein observed growth rate was remarkably high. The sector appears to be undergoing the final phase with deceleration in growth.

Table 3 shows that tapped area registered highest growth rate of 6.12 per cent during 1959-68. Large scale expansion of rubber cultivation during 1950s and 1960s is said to have taken place as a result of the move in Kerala towards imposition of a ceiling on land holdings from which rubber plantations along with other plantations were exempted. Further during that period there was the prevalence of steady and remunerative price for rubber and also the diversion of extensive areas under disease infected coconut plantations in Central Kerala to rubber plantations had taken place (Burger et al., 1995). These can be expected to have led to an increase in area under rubber during that period. However, from 1969 onwards, it has witnessed a sharp deceleration to 3.90 per cent during 1969-78. This trend can plausibly be linked to the fall in the growth rate of domestic consumption due to general industrial recession during 1970s. As such domestic supply was in excess of

Table 2: Estimated Break dates (1950 to 2010)

Crops	Variables	First break	Second break	Third break	Fourth break
Rubber	Tapped Area	1958	1968	1978	1990
	Production	1958	1972	1982	1995
	Yield	1963	1972	1981	1993

Table 3: Growth rates in Area, Production and Productivity during break period

Break Points	1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase
Area	1.27 (1950-58)	6.12* (1959-68)	3.90* (1969-78)	3.88* (1979-90)	2.72* (1991-2010)
Production	1.60 (1950-58)	11.53* (1959-72)	3.78* (1973-82)	8.76* (1983-95)	4.21* (1996-2010)
Yield	1.78* (1950-63)	7.35* (1964-72)	0.52* (1973-81)	4.16* (1982-93)	2.57* (1994-2010)

Source: Thapa, 2013

Note: "*" indicates significant at 1% level

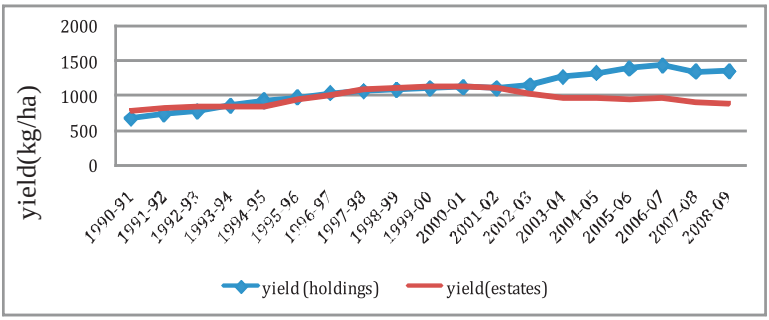
demand which resulted in a price crash. These uncertain market conditions during that period created pessimism among the growers which would have resulted in a fall in planting activities (Burger et al., 1995). From 1979 onwards too the same trend in the growth rate of area persisted, as such the growth rate stood at 2.72 per cent during 1991-2010.

The recorded growth of production increased from a mere 1.60 per cent during 1950-58 to as high as 11.53 per cent during 1959-1972 (see Table 3). This may have been due to the increase in area as has been explained above. Thereafter, there was a sharp deceleration with the growth rate being 3.78 per cent during 1973-82. Then it increased to 8.76 per cent during 1983-95 and fell to 4.21 per cent during 1996-2010.

Considering the yield across holdings size, for small holdings it increased from 675 kg per ha in 1990 to 1352 kg per ha in 2008 at the rate of 3.78 per cent while the yield of estates increased from 787 kg per ha in 1990 to 894 kg per ha in 2008 at the rate of a mere 0.80 per cent. Figure 2 shows that though the yield of the estates was slightly higher

than that of small holdings in the initial years (1990-92), thereafter the yield of both the land sizes were more or less the same; however, in recent years (2002-08), the yield of small holdings is higher than that of the estates.

Figure 2: Yield (kg/ha) of smallholdings and estates



Note: Yield is calculated by dividing total production by total planted area rather than tapped area as the data on tapped area was not available for holdings and estates. So the figures may be an underestimation.

Source: Calculated from Rubber Board data, http://rubberboard.org.in/rubberstaticsdisplaypage.asp

The trend in yield is observed to follow more or less similar pattern as the trend in production (see Table 3). Growth rate of yield increased from 1.78 per cent during 1950-63 to 7.35 per cent during 1964-72. This may be the result of Replanting Subsidy Scheme introduced by the Rubber Board in 1957. In this scheme along with financial assistance, concrete plans were taken to replant the older plantation areas with high yielding planting materials (George et al., 1988). In the following years during 1973-81, the growth rate sharply decelerated to 0.52 per cent. However, as we move to the next phase (1982-93) the growth rate increased to 4.16 per cent followed by a phase of deceleration (2.57%)

during 1994-2010. Despite these phases of deceleration experienced by natural rubber, the Eleventh Five Year Plan document has clearly stated that "the rate of growth in production and productivity of natural rubber in the country, during the last five decades, rank among the highest for any agricultural or plantation crops". This is in conformity with our estimates of the growth in the yield of major crops in Kerala (see Table 4). Further estimates show that for Kerala, the agricultural GSDP exhibited a modest growth of 2.53 per cent during the nineties which further decelerated to 0.27 per cent during the decade after 2000. Earlier studies have highlighted the negligible or negative growth of the agricultural sector of Kerala during 1970s and 1980s (Kannan and Pushpangadan 1990). In general, the performance of natural rubber sector is significantly superior to that of agricultural sector in general and major crops in particular.

Table 4: Growth rate in the Yield of Major Crops in Kerala

year	NR	Tea	Coffee	Coconut
1960-70	8.91	0.28	-0.27	-1.49
1970-80	3.00	2.43	3.96	-1.80
1980-90	3.09	2.68	-2.85	1.27
1990-2000	4.33	0.27	5.78	1.33
2000-10	2.04	-1.59	1.85	-1.48

Source: Estimates based on the data obtained from different commodity boards

Thus, natural rubber until mid-1990s has been showing a remarkable performance. What makes this performance distinct is the fact that the recorded growth rate of the sector even during its phase of deceleration was much higher than the other plantation crops and agricultural sector as a whole. The five different phases of its performance that we have discussed could be divided into two broad phases. The first phase (up to 1990) was the period of protection wherein various

initiatives were undertaken at the instance of the national governance subsystem in a top-down manner. This was followed by the second phase of globalization marked by the withdrawal of the State and a weakening of national governance subsystem. In what follows, we shall discuss the role of various actors in the innovation system in bringing about the observed growth performance.

4. Innovation in a protected market

Drawing from the analytical framework, we shall attempt to explain two distinct phases of growth performance particularly focusing on the knowledge subsystem and its interaction with the national governance subsystem. In this section, we present the build up of the knowledge subsystem and some aspect of its relationship with the production subsystem in the framework of a protected market until the mid-1990s.

Knowledge subsystem- R&D and Extension & Training

While the emergence of the innovation system in India's plantation sector in general has been driven by the objective of export promotion (Joseph 2014), that of natural rubber, given the heavy dependence on imports, was driven by import substitution. This was manifested in the establishment of an institutional architecture for innovations in the sphere of promoting production, processing and marketing. This included, among other things, the setting up of the Rubber Board under the Rubber Act of 1947 and legislations, which empowered the Board to undertake various activities for plantation development. Agriculture is a State subject under the Indian constitution. However, on account of the role in fostering import substitution the Rubber Board was under the Ministry of Commerce of the Central Government and not under the Ministry of Agriculture. There have been series of innovations – technological, institutional and organisational – relating to all aspects of natural rubber mainly at the instance of the Rubber Board. In what follows we shall discuss these innovations especially how they have

coevolved in such a way as to make the natural rubber one of the most vibrant sectors in Kerala economy.

Given the heavy dependence on imported NR on account of the growing demand from the growing automotive and other rubber based industries increasing domestic availability through domestic production has been the prime agenda of the Rubber Board on its inception. Recognizing the primacy of R&D in the overall development of the NR sector, the Rubber Research Institute of India (RRII) was established in 1955 with the mandate of undertaking research on all aspects of natural rubber. Broadly RRII undertakes research on crop improvement, crop management, crop physiology, crop harvesting, crop protection, rubber technology and agricultural economics and of late greater focus is given to the development of rubber-based products. Perhaps the distinguishing characteristics of innovation system in rubber as compared to other planation crops is that, in case of rubber, RRII is the sole organization engaged in the R&D for rubber whereas in case of most other crops, there are multiple actors. For example in case of cardamom, in addition to the Indian Cardamom Research Institute (ICRI) under the Spices Board, other organizations include, Kerala Agricultural University, Directorate of Arecanut and Spices Development (DASD), Indian Institute of Spices Research, The Cardamom Research Station (Joseph and George 2010).

Though headquartered in Kottayam (in the state of Kerala) with the establishment of regional centers spread over different regions where rubber cultivation is undertaken RRII has been able to focus on region-specific issues. Table 5 shows the distribution of R&D manpower across different research stations located in different states and regions within. It is also to be noted that R&D manpower accounts for about 22 per cent of total manpower under the Rubber Board indicating the importance assigned to research[6].

Table 5: Distribution of R&D manpower across different regional centers in 2010

Station	R&D personnel	Share (%)
RRII HQ, Kottayam	269	63.4
Regional Labs	22	5.2
HBSS Nettana	8	1.9
HBSS Parliar	5	1.2
RRS Padiyoor	7	1.7
RRS Dapchari	10	2.4
RRS Orissa	5	1.2
RRS Agartala	28	6.6
RRS Guwahati	13	3.1
RRS Tura	8	1.9
RRS Nagrakatta	5	1.2
CES Chethackal	44	10.4
Total	424	100.0

Source: Indian Rubber Statistics, Rubber Board of India.

It is also to be noted that total R&D expenditure in natural rubber as well as the R&D intensity (measured as R&D expenditure per unit of area cultivated) has also shown an upward trend. It has been observed that R&D expenditure per hectare under natural rubber cultivation has increased over the years from Rs 107 per hectare in 2002-03 to the highest level of Rs 273 per hectare in 2008-09.

During the initial years the major challenge before the RRII was to come up with high yielding clones because of the low yield of the plant varieties imported from East Asia (Malaysia) and other parts of the world and cultivated in the major rubber growing areas- Kerala and some part of Tamil Nadu. To begin with RRII imported high yielding rubber clones and promoted the budding method instead of stumps and

seedlings. This was followed by the RRII's attempt at evolving a clone suited for Kerala. Of the number of varieties that were developed,[7] RRII 105 turned out to be the most successful with high yield level. With the adoption of this variety by the growers, India could overcome its heavy dependence on the imported natural rubber and attain near self-sufficiency and also emerge as the leader in natural rubber productivity.

Studies have basically attributed the increase in the growth rate of yield to sustained research and development activities being carried out by the Rubber Board coupled with extension and advisory services and transfer of technology to the fields (Rangachary, 2006 as cited in Varkey and Kumar, 2013). Particularly, the development of the high yielding variety (HYV) planting material RRII 105 in the 1970s and its official release by the Rubber Board in 1980 for commercial planting can be mentioned in this regard. There was a comparatively higher adoption of the new variety by the dominant small holding sector which has significantly transformed the viability of rubber cultivation.

Along with a vibrant R&D system, an elaborate system of extension network has also been established at the instance of the Rubber Board for facilitating the diffusion of R&D outcomes among the growers. The extension network consists of 37 regional and 172 field offices spread all over India. A Regional office is headed by a deputy rubber production commissioner/ a development officer and has a senior extension officer.

The extension system undertakes a wide range of activities dealing with varied concerns of different stakeholders like the growers, workers, nursery operators, rubber processors and traders. The extension schemes of rubber board are classified into three board categories; rubber plantation development scheme, productivity enhancement scheme and farmer group formation and empowerment schemes. Under these broad schemes activities undertaken under by the extension system include

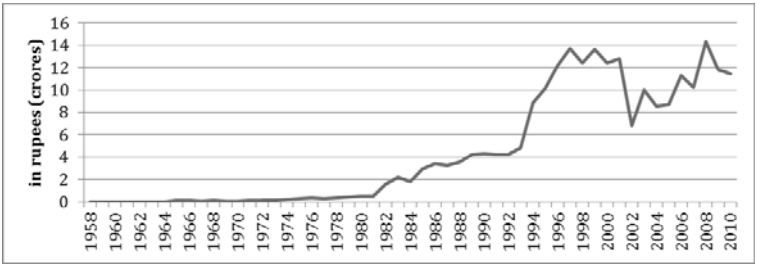
- Free advisory service to the growers,
- Financial assistance as a performance incentive for adoption of technology,
- Assisting the grower's organisations in setting up environment friendly group processing and technology transfer centres.
- Training for small growers and workers,
- Supply of agro inputs and generation and supply of planting materials,
- Periodic impact assessment studies, collection of statistics

The yield profile of the crop have experienced a vertical shift on account of a relatively higher realized and potential level of yield of the clone and incentives for the adoption of the clone contained in the integrated Rubber Plantation Development Scheme (RPDS) since 1980 (Kumar and Sharma, 2006). The rubber plantation development schemes are grouped under three major components namely, plantation development, productivity enhancement; and farmer group formation and empowerment. Under the productivity enhancement component, the various schemes undertaken are related to distribution of rubber plantation inputs offering price concessions. The other is related to the setting up of rubber agro-management units which would promote the adoption of four vital cultural practices such as manuring, plant protection, rain-guarding and scientific tapping. Another scheme for providing financial assistance for soil protection and water harvesting was in operation since 2007-08. The Rubber Board also has been maintaining one central nursery and 5 regional nurseries in different parts of the traditional rubber growing regions which provided quality planting material and thus ensured quality control and check unscrupulous trading practices by the private nursery owners. The farmer group formation and empowerment component is a strategy to promote interactive learning and also to cater to the extension requirements of over 1.2 million small holders with the available minimum strength of

extension officials. Farmer groups such as Rubber Producers' Societies and the Self Help Groups are formed and the Board supports RPSs and SHGs through special projects aimed at the socio-economic development of the resource poor farmers and their families. Technical and financial support is extended in the form of various schemes such as purchase of low volume sprayers and dusters, weed cutters, computers and peripherals (Rubber Board, Annual Report, 2010-11). Thus it can be said that the Rubber Board has been providing both capital and input subsidies as well in order to offset the large capital investments and the long gestation period of seven years in the growing of NR (Mani and Santhakumar, 2011).

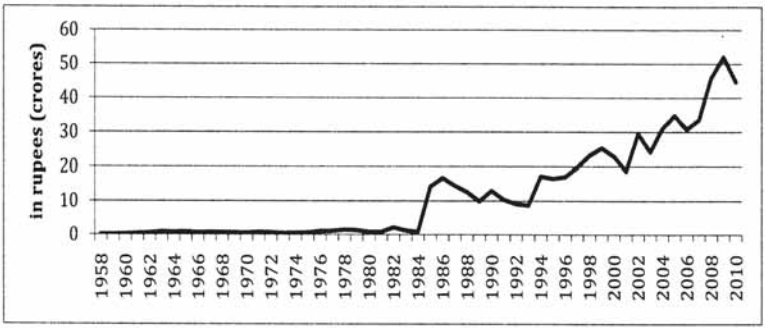
The importance assigned to extension is evident from the fact that nearly 60 percent of the budget of the rubber board is allocated for the extension and training subsystem. Considering the scheme wise expenditure of the Rubber Board, the highest share of total expenditure is allocated to the scheme "Rubber Plantation Development" which accounted for around 45 per cent in 2010. It was followed by the scheme "Rubber Development in the North East Region" which accounted for 29 per cent of the total expenditure and then by the scheme Rubber

Figure 3: Real Expenditure in R&D



Source: calculated from various volumes of Indian Rubber Statistics

Figure 4: Real Expenditure under Rubber Plantation Development Scheme



Source: calculated from various volumes of Indian Rubber Statistics

Research and Development (12 per cent). The real expenditure[8] on Research and Development and subsidy under the Rubber Plantation Development Scheme is observed to have increased from the early 1980s after experiencing almost stagnant trend prior to that (see Figure 3 and Figure 4)

Though an increase in real expenditure on R&D and Rubber Plantation Development schemes is observed, studies have highlighted that area under high yielding planting materials (mainly RRII 105) taken as a proportion of total area had stagnated from 1990s onwards. This indicates that the diffusion of the most widely adopted clone RRII 105 has reached a saturation point (Mani and Santhakumar, 2011). Thus it can be argued that though the yield of NR is the highest amongst the NR producing countries[9], in recent time particularly since 1990s, the trend in diffusion of HYV planting material have stagnated thus having a decelerating effect on growth rate of yield. However, in order to overcome this issue, the Rubber Board has released new varieties namely RRII 414 & 430 in 2005 and RRII 417 & 422 in 2009 but these varieties

are yet to be fully adopted by the growers. Such a trend brings up the question as to how well the innovation system in natural rubber has been able to coevolve in response to the emerging challenges since 1990s.

5 The New Challenges and responses

As already noted the innovations as manifested in the development of new clones were instrumental in addressing the growing domestic demand for NR from the industrial sector in a period when the domestic market was protected from external market. But in tune with the changes in national policy environment, the protected regime gave way to open competition, very often with countries with substantial production and very limited domestic market. Moreover, with the formation of WTO and the Regional Trading Agreements (RTAs) like the one with ASEAN and Sri Lanka, hither to protected small holders were exposed to open competition.[10] Further, in a context of growing concern for environment, the mono crop culture promoted by the Rubber board with a view to enhance productivity, began to be considered as environmentally hostile. It has also been argued that mono crop culture is inimical to the smallholder's concern for reducing market risk associated with the fluctuations in the price of agricultural commodities. The most recent challenge has been of acute labour shortage in the planation sector in general and rubber plantations in particular (Viswanathan et al., 2003; Parliamentary Standing Committee Report, 2012).[11] With respect to labour shortage in natural rubber, Viswanathan (2013) has shown that during the 10 years following 1998-99, average wage rate of tapping labour in Kerala recorded an annual increase of over 17 per cent. Hence in a context of heightened competition, labour shortage and growing concern for environment, the prime concern of the innovation system turned to become internationally competitive and environmentally friendly in contrast to attaining self-sufficiency at any cost in the earlier regime.

In a context of heightened competition and the need to enhance efficiency, the RRII has come with a number of innovations along with

new clones to enhance efficiency in production, bring about reduction in cost of cultivation and enhanced income for the growers. In response to the growing concern for environment RRII introduced an innovation called triangular planting wherein three trees are planted forming a triangle This provides enough space to practice intercropping which ensured maintenance of soil quality while enabling the farmers to insure from the risk associated with price fluctuations. Further, intercropping and programmes were also encouraged to facilitate the utilization of space between the rows in rubber plantations to grow other crops (like pineapple) that would ensure a flow of income during the premature period. With a view to addressing the issue of shortage of skilled tapping labour, RRI introduced the Low Frequency Tapping (LFT) wherein the rubber trees are tapped once in three days or even seven days instead of the conventional practice of daily tapping without any reduction in output. This innovation is shown to have helped addressing the wide spread incidence of the tapping panel dryness of the rubber plantation while addressing the issue of labour shortage. The research system is also working towards developing tapping machines.

Building farmers' competence and capacity

Even before the liberalization period, the Rubber Board started programmes to enhance knowledge and competences among growers, traders and other actors involved in the natural rubber industry. This became a core activity in building an active innovation system which was able to relate to the challenges from a more global and competitive economic framework from the 1990s.

Organizational innovations for effective extension

Rubber Board from the very beginning has been instrumental in organizational innovations like the formation of Rubber Marketing Co-operative (RMC). In 1986 the Rubber Board initiated the formation of separate groups of small voluntary associations of small growers

called Rubber Producer's Societies (RPS). These societies play a major role in providing all the extension activities at the farm level. The RPS is instrumental for bringing the Board and growers together for two way technical and development communication and most of the extension activities are now channelled through RPS. These were viewed as some attempts from the part of rubber board to enhance and empower the growers through these societies in the wake of lack of enough field staff. As of October 2011, there are 2592 RPSs and 1770 SHGs undertaking varied activities. 35 Model RPS functioning as centres for transfer of technology, have proved to be very effective not only in processing highest quality sheets but also in imparting training on various technical topics as well as on group management and leadership to other RPS. RPSs have collaborated with rubber board to establish processing and trading companies. Presently there are 18 such companies (6 processing companies and 12 trading companies) who are actively involved in providing services to the farmers. These companies are formed based on public private partnership with RPSs and rubber board.

To empower these small holders, particularly the resource poor and weaker groups, women self-help groups were formed and assistance were provided for income generation activities, hygiene and sanitation etc. and these groups were linked to RPSs. Women were supported for establishing handicrafts units and biogas plants which ensures environment friendly processing of rubber.

The extension system has been keeping a constant interaction with the grower community. The Board launches a campaign every year on a theme of topical importance and campaign group meetings are organized in association with the RPSs and held simultaneously in different centres every day continuously for about a month. The meetings in the field are followed by demonstrations and distribution of literature and inputs. Such campaigns help creating a widespread awareness of the subject matter dealt with and quick extensive adoption of the

innovations sought to be popularized. Mass media such as newspapers, own publication, radio and television are being extensively utilized for educating growers on all aspects of rubber cultivation and production and the other extension programmes.

Rubber plantations are characterized with a higher gestation period contrary to other crops. Therefore providing subsidy to growers remains an important component of extension activity by the board (as has already been mentioned earlier). Financial assistance disbursed (subsidies for new planting and replanting) to the growers are aimed for scientific planting and maintenance of rubber holdings, generation and distribution of good quality planting materials. Till 1980s subsidy was provided only for replanting. George et al (1988) shows that there was a steady increase in area under HYV planting materials and in 1985-86 its share was 88.55 per cent in the small holding sector and 99.24 per cent in the estate sector respectively. It has also been argued that the diffusion of HYV variety and the consequent rise is yield was facilitated by replanting subsidy scheme introduced in 1957. Rubber Board started giving equal importance to replanting and new planting and promoted both alike under common integrated schemes from 1980 as part of extending the area of rubber plantations to meet the growing industrial demand for rubber. The scheme came to be known as the Rubber Plantation Development schemes. Most of the subsidies to growers are now channelled through RPSs in an attempt to strengthen the RPSs. Labour saving and productivity increasing techniques are campaigned by rubber board through RPSs and field officers. Innovative tapping practices like low frequency tapping i.e. tapping once in three days is also being encouraged through campaigns and seminars conducted to farmers and RPSs. The practice enables the growers to maintain the same yield and thereby reduce the labour cost. Introduction of new clones is also communicated through campaigns, mass media, multimedia, RPSs and field offices/extension officers.

The extension system evolved over time has been successful in terms of effectively transferring knowledge from lab to field and bring rich dividends to the farmers and other stakeholders. Subsidy based promotion system has been effectively used in the past towards inducing farmers to adopt new innovations. Over time there appears to be greater focus on capacity building and promoting interactive learning among the actors. The emergence of *RPSs* as major actors indicates the responsiveness of the system to the challenges confronted especially by the small holders that dominate the system. An effective training system has also been evolved wherein hardly any stakeholder has been left out of the capacity building process.

Competence building through Training

Recognising the relevance of capacity building of stakeholders, training programmes have been in existence from the early days of the establishment of the innovation system in rubber. These training programmes were oriented inter alia to address the issues like quality of latex, rubber sheet, unscientific plantations, poor tapping practices, overuse of fertilizers and so on. The training programmes in general aimed at increasing the production through increasing the cropped area, productivity, improve the quality of produce, educate about the new practices in farming etc. Increase in industrial demand for rubber and the plea from manufacturing sector for quality rubber sheet and latex paved the way for imparting of training to these communities.

From 1980 onwards, rubber board has introduced various new schemes to ensure more effective extension activities at the farm level. The training programmes and campaigns are essentially imparted to small rubber growers, tappers, RPSs, rubber marketing societies, rubber dealers, rubber processors, rubber and rubber products exporters, rubber products manufacturers entrepreneurs from rubber based industry, production managers, quality control managers.

The board has started using farmer resource person in the campaigns and training programmes. These farmer resource persons are selected from among experienced farmer members and they are first trained and later their services are utilized for training programmes of the board. About 200 farmer resource persons have been selected and their services are utilized regularly. Campaigns and seminars are designed mainly to address the problem of low yield through creating awareness about the new clone varieties, new farming practices, newly launched policies and programmes at the grass root level. Annual Mass contact programmes have been conducted every year to disseminate modern techniques on rubber cultivation, maintenance, harvesting, crop processing, marketing and additional income generation. Campaign meetings are usually conducted by extension officers and other officials of rubber board for the farmers and other stakeholders. Table 6 provides data on group interaction in terms of meetings, seminars by the extension division in the rubber board.

Table 6: Group Interaction held by Extension Division

Type of Meeting	2010-2011		2011-2012	
	No. of meetings	No. of Partici-pants	No. of meetings	No. of Partici-pants
Campaign meetings	2734	87061	2704	84562
Full day seminars	75	5433	63	6337
Half day seminars	233	8965	137	4945
Group meetings	1088	21492	1591	15474
RPS meetings	3569	41856	2863	29471
Other meetings	1146	9222	1163	4976
Use of Audio Visual Equipment	254	9561	344	9522
Training in RPS	795	14741	889	19730

Source: Annual Report-2011-12, Rubber Board, Govt of Kerala,

Labour Subsystem: Institutional innovations for welfare and capability building

The major institutional innovation in the labour market evolved at the instance Plantation Labour Act (PLA) of 1951 that provided for the welfare of plantation labour and regulated the conditions of work in plantations. The Act is administered by the State Governments and is applied to any land used as plantations, which measures 5 hectares or more in which 15 or more persons are working. The State Governments are, however, free to declare any plantation land less than 5 hectares or less than 15 persons to be covered by the Act. It was applicable to all the plantation workers whose monthly wages does not exceed Rs.750/- per month.

The Act stipulates that in every plantations covered under the Act shall provide medical facilities for the workers and their families as may be prescribed by the State Government. The Act also provides for setting up of canteens, crèches, recreational facilities suitable accommodation and educational facilities for the benefit of plantation workers in and around the work places in the plantation estate. Also there is provision for woolen cloths in those plantations located in cold climate. The Act provides that no adult workers and adolescent or child shall be employed for more than 48 hours and 27 hours respectively a week, and every worker is entitled for a day of rest in every period of 7 days[12].

As we have already seen, cultivation of natural rubber is mostly by the small holders who do not come under the purview of PLA. In order to attract labour to the industry and address the labour shortage, the Rubber Board has devised different welfare schemes for the workers. The schemes by the Board consist of stipend for higher education for the children of rubber tappers and other rubber workers. In addition there is provision for merit awards for children of rubber plantation workers, who are able to obtain the prescribed level of marks in school examinations. Rubber plantation workers receive health and medical reimbursement and a reasonable housing subsidy. These apart, there are

subsidy schemes for backward communities like scheduled caste and scheduled tribe. Thus in effect, the Rubber Board has taken up the role of welfare provider in the rubber plantation sector. This has probably become necessary in the wake of the fact that nearly 95 percent of the growers are small growers who will not come under the ambit of the Plantation Labour Act. Also the small planters, who are tappers themselves, may require these welfare schemes for decent living as much as the workers require.

For the development of rubber industry, the quality and quantity of manpower available for rubber cultivation, processing, manufacture of rubber goods, marketing is very important. Tappers training school has been started to improve the quality of tappers in tapping and also to provide training for scientific harvesting under the supervision of Rubber Tapping Demonstrators / Rubber Tapping Instructors. Other training programmes include rain guarding, application of rubber stimulant and panel protectants, processing of latex.

In 2000, a short duration training programme for tappers was started by the board. The duration of the course is 8 days. The practical as well as theoretical aspects are covered during the training period. The trainees are paid a stipend as an incentive for attending the training programme, as compensation against their wages, on days engaged. Table 7 provides a detailed picture of the number of tappers who underwent training.

Table 7: Short Duration Intensive Tappers Scientific and Processing Training

Region	2010-2011			2011-2012		
	No. of Batches	No. of Beneficiaries	Assistance Rs in Lakh	No. of Batches	No. of Beneficiaries	Assistance Rs in Lakh
Traditional & Non-Traditional (other than North East)	307	4714#	35.07	322	4965*	37.42

Source: Annual Report-2011-12, Rubber Board.

Note: # General-4552,SC/ST-162; * General-4748, SC/ST-117

Yet another organisational innovation to address labour shortage is the setting up of labour banks through RPS. Workers registered in the labour banks are provided with free training in all the aspects of operations in rubber plantations. To encourage the functioning of labour banks, rubber board has come up with various welfare programmes and services for the labourers which includes dress allowance, weather protective materials, medical allowance, educational stipend scheme and merit award scheme for children's of tappers. Other schemes includes housing subsidy schemes for tappers in small plantations, housing and sanitary subsidy scheme for the SC/ST rubber tappers, sanitary subsidy scheme, medical attendance scheme and group insurance-cum-deposit scheme are also there for improving the conditions of the labourers.

Demand Subsystem

One of the distinguishing features of Natural Rubber sector is the presence of vast and diversified rubber goods manufacturing sector large enough to consume the domestically produced Natural Rubber. India is the fourth largest consumer of Natural Rubber after China, USA and Japan (Economic Review, Government of Kerala, 2007). Around 50.2 per cent of Natural Rubber in India is consumed by the automotive tyre sector. The total consumption of Natural Rubber in the country was 19.85 thousand tonnes in 1950 which increased to 9.47 lakh tonnes in 2010 registering a growth rate of 6.63 per cent from 1950 to 2010. Due to the presence of a relatively well developed manufacturing sector, the domestic consumption of Natural Rubber exceeds total production.

Table 8 shows that compared to other states, Kerala has experienced increase in the share of natural rubber consumption over the years. Its share has remained the highest among the major natural rubber consuming states in India from 1990 onwards. With hardly any large tyre manufacturing units in the state, the observed increase in the natural rubber consumption, is mostly accounted for by the large number of small-scale units operating in the non-tyre manufacturing sector. The future of natural rubber to a great extent depend on the growth and

Table 8: Relative share in Natural Rubber consumption by states

State	1970-71	1975-76	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2007-08
Andhra Pradesh	0	0	1.28	1.91	2.44	3.62	3.15	4.64	6.09
Bihar	0	0	0	0	0	0.22	0.21	0	0
Delhi	2.24	3.32	3.63	4.3	4.29	3.77	2.91	0.86	1.89
Goa & Daman	0	2.77	1.39	1.76	1.71	2.22	3.73	4.39	2.08
Gujarat	1.37	1.7	1.75	2.09	1.89	4.61	5.56	7.12	7.74
Haryana	5.13	8.84	8.62	7.91	6.24	5.94	6.12	4.81	5.77
Jharkhand	0	0	0	0	0	0	0	0.15	0
Karnataka	0.72	1.53	3.32	4.91	4.66	4.62	4.95	6.92	7.48
Kerala	7.72	7.37	11.11	11.94	15.2	14.31	13.97	14.43	16.51
Madhya Pradesh	0	0	0	0.39	1.13	3.65	4.39	3.83	3.87
Maharashtra	22.58	22.59	19.07	15.73	12.96	11.96	10.82	13.24	12.29
Orissa	0	0	0	0	0	3.21	3.81	3.95	4.65
Pondicherry	0	0	0	0	0	0.58	0.4	0.34	0
Punjab	2.61	4.57	7.62	11.44	12.67	11.8	13.12	8.35	9.7
Rajasthan	0	0	3.16	5.16	4.92	4.23	5.68	6.74	6.71
Tamil Nadu	20.12	16.63	9.82	8.04	5.82	4.92	5.16	6.18	9.45
Uttar Pradesh	1.33	7.7	13	12.41	12.84	12.4	8.82	4.05	4.56
West Bengal	35.52	21.72	15.79	11.6	11.61	7.59	6.85	3.88	2.59
Others	0.66	1.26	0.43	0.41	1.61	0.33	0.35	5.36	0.4
Total	100	100	100	100	100	100	100	100	100

Source: Mohanakumar, 2014

economic viability of these small and medium enterprises. Studies however, has shown that with heightened import competition under globalization along with increasing price of raw materials, the non-tyre manufacturing units in the state are in distress (Mohankumar, 2014). The available evidence also tends to suggest that a vibrant learning, innovation and competence building system for the non-tyre manufacturing sector is yet to emerge. The Rubber Research Institute of India, notwithstanding its long experience in rubber research is yet to play a significant role in evolving such an innovation system because its mandate is confined only to natural rubber. Needless to say, in the event of new challenges being confronted by the sector there is the need for appropriate institutional innovations such that the Rubber Board in general and the RRII in particular is placed to play a critical role in the evolution of a knowledge driven rubber-based industrial sector. If the experience of natural rubber is any indication, a vibrant learning, innovation and competence building system in tune with what we have observed in case of natural rubber is an imperative for the rubber-based industries in Kerala.

6. Concluding observations

The paper attempts to challenge the often held view that there exists a negative relationship between natural resource intensity and growth. At the same time, the study contributes towards our understanding on the revival of Kerala economy since the latter part of 1980s. The study observed that while the Kerala economy in general and the commodity producing sectors (dominated by resource based industries) in particular have been under stagnation, the natural rubber sector has shown significant growth dynamics. To be more specific, the performance of natural rubber in Kerala in terms of conventional indicators like production and productivity has been above the other plantation crops and agriculture sector as a whole. This has been attributed to the presence of a vibrant system of innovation which facilitated learning, innovation and competence building of different

stakeholders especially the small holders and plantation labourers. More importantly, the study noted the coevolution of technological and organizational/institutional innovations in tune with the changing environment. Thus viewed an economy need not be poor because it is primary commodity producing but because of the weak learning and innovation system. In the earlier years, the innovation system appears to be more in tune with the STI (Science, Technology and Innovation) mode resulting in high yielding clones. However, in the context of new challenges under globalization, the system appears to have adapted itself by bringing along with technological innovations (in the form of new clones), new innovations that go beyond the sphere of technology and clone development. This is manifested inter alia in the new organizational innovations like RPSs, labour banks along with initiatives for interactive learning and competence building of different stakeholders.

Along with the remarkable performance in the natural rubber sector, the state has also emerged as one of the leading sites for small-scale dominated non-tyre manufacturing industry in the country. However, with the opening up of the economy leading to unprecedented import competition along with increasing cost of raw material and devoid of a strong competence building system, this sector is shown to be in distress. Sustaining the gains of the innovation system in natural rubber would depend to a great extent on the presence of internationally competitive rubber-based industrial sector in the state. Initiatives towards evolving a vibrant learning, innovation and competence building system in the rubber-based industrial sector are yet to be made. However, it is beyond the mandate of the Rubber Research Institute of India, notwithstanding its long experience in rubber research. The study, therefore, makes the case for appropriate institutional innovations such that the Rubber Board in general and the RRII in particular is placed to play a critical role in the evolution of an innovative and knowledge driven rubber-based industrial sector.

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Notes

1 While Kannan (2005) highlighted the role of human development in the revival of Kerala economy, Harilal and Joseph (2003) called for greater role of science, technology and knowledge intensive sectors in sustaining Kerala's development trajectory.

2 Using bibliomertic evidence Fagerberg and Sapprasert (2011) have shown that by now NSI literature has emerged as the most important work on innovation published during the last two decades which coincided with an upturn in the scholastic interest in innovation and development.

3 Here the readers are referred to the large number of papers presented in the GLOBELICS conferences available at www.globelics.com

4 It needs to be noted that earlier the categorisation was below 20 hectares for small holders. In very recent years, small holdings are considered as those with area below 10 hectares while estates are those with area above 10 hectares. It needs to be noted that earlier the categorisation was below 20 hectares for small holders.

5 It needs to be noted that in case of perennial crops such as rubber, even the age profile of existing stock of trees affects yield per hectare and thus total output in any given period (Bateman, 1965). The yield cycle of rubber involves broadly four phases. There is an initial pre-bearing phase of about seven years, followed by an early harvesting phase of about one to three years wherein yield is positive and increasing with high variability. Then comes the third phase which can be termed as peak bearing phase and it lasts for about four to 13 years wherein the yield reaches the highest level. In the last phase, there is a decline in yield. Since the age of the plant, *interalia*, has a crucial bearing on the yield, timely replanting of the plants is required (Joseph and George, 2010).

6 It comes second to the manpower engaged in the department of rubber production (56 per cent) under the Rubber Board (calculated from the Annual Report of Rubber Board, 2010-11)

7 RRII has indeed introduced several high yielding clones. All together fifteen clone varieties have been evolved and released till date such as RRII 105, RRII 414, RRII 417, RRII 422, RRII 430, RRII 5, RRII 203, RRII 50, RRII 51, RRII 52, RRII 118, RRII 176, RRII 208, RRII 300, RRII 429. The most popular of them all is RRII 105 released in 1970s. RRII 414 & 430 was released in 2005 and RRII 417 & 422 in 2009.

8 The real expenditure in R&D and in Rubber Plantation Development Scheme is calculated by deflating the respective expenditures by WPI (base 2004-05).

9 The Natural Rubber producing countries are Thailand, Indonesia, Malaysia, Vietnam, China, Sri Lanka, Philippines, Cambodia.

10 The tariff rate prevailed prior to the WTO agreement was 70% and supplemented with non-tariff restrictions. As India became a signatory of WTO in April 1994, non-tariff measures have been removed and the tariff rate has significantly been curtailed – with MFN, tariff rate being only 20%.

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12 The amended Act of 1960 also empowers the State Government to extend all or any of the provisions of the Act to Plantations, measuring even less than 5 hectares and employing less than 15 persons. The Plantations Labour (Amendment) Act, 1960 is also applicable to offices, hospitals, dispensaries, schools and any other premises used for any purpose connected with the plantations, but does not apply to any factory or the premises to which the provisions of the Factories Act, 1948 apply.

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