DIFFUSION OF INNOVATIONS IN NATURAL RUBBER: STUDY OF TAPPING PRACTICES AND RAIN GUARDING

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Report of the study “DIFFUSION OF INNOVATIONS IN NATURAL RUBBER: STUDY OF TAPPING PRACTICES AND RAIN GUARDING”. The study was conducted by Prof. K J Joseph and Dr. Kiran Kumar Kakarlapudi as part of the National Research Programme on Plantation Development.

Abstract

It has been argued that innovations like Low Frequency Tapping (LFT) rain guarding and Controlled Upward Tapping (CUT)significantly contribute towards increasing productivity, reducing cost of production, achieving longer tapping life and addressing diseases like Tapping Panel Dryness. Yet, the adoption of these innovations remains at a low level. There is also inter-regional variation in the extent of adoption with Trivandrum being the lowest. What accounts for the observed poor performance? Our enquiry suggests that there are serious information deficit along with knowledge gap notwithstanding the various efforts made by the Rubber Board. In the context of serious knowledge deficit, risk perception regarding innovation is highly prevalent that stood in the way of the adoption of innovations. A large proportion of growers especially from Trivandrum are unsure about the beneficial effects of the innovations under consideration. Labor factor also emerged as a major stumbling block. The apparent ineffectiveness of initiatives like labor bank needs to be seen against the fact that for seamless transfer of workers from one holding to another, there is the need for upgrading and standardizing the tappers skills to ensure that growers do not perceive any risk in assigning his holding to any tapper from the bank. To the extent that tappers bank is not significantly effective tend to suggest that success of tappers bank presupposes significant investment by the rubber board for training. Further, it was transpired that when the sector has been in crisis and the innovations not getting diffused calls for more effort to generate and diffuse information and knowledge. Evidently, there has not been any significant increase in the allocation for the Board concerned, instead a decline in real terms. Hence, the study point towards the need for more concerted and targeted measures from the diffusion agents towards more intensified extension efforts so that information and knowledge deficit of growers and workers with respect to these innovations are addressed sooner than later.To the extent that the labour factor is a crucial constraint in the diffusion innovations like LFT and CUT, the relevance further strengthening the organizational innovations like labour bank to address the labour related issues cannot be overemphasized.

1. The Context

Innovation studies have highlighted the role of technological diffusion in increasing production and productivity, irrespective of the sectors concerned. Several studies have emphasized the contribution of R&D and extension system towards improving the performance of natural rubber (Joseph and George 2010;Sethuraj and Jacob 2012; Mani and Santhakumar 2011; 11th Five Year Plan document 2007-12; NRPPD 2015). In this regard, the role of the Rubber Research Institute of India (RRII) under the Rubber Board is important since it is the main organization concerned with the generation and dissemination of technological innovations to the small growers. Over the years, a series of technological innovations have been generated at the instance of RRII with respect to cultivation, harvesting and processing of natural rubber. Notable among them are the high yielding varieties of clones, particularly RRII 105 which is the most widely adopted clone by the rubber farmers (Mani and Santhakumar 2011). Along with it, to enhance efficiency in production, optimal harvesting practices such as Low Frequency Tapping[1] (LFT) and Controlled Upward Tapping[2] (CUT), new practices[3] such as rainguarding of trees have been developed. Number of studies in other countries have highlighted the positive effect of such innovation like LFT as regards productivity, reduced cost of labor, longer tapping life on account of reduced bark consumption, addressing Tapping Panel Dryness (Kudaligama et al 2010, Rodrigo 2007, Rodrigo et al 2011, for Sri Lanka; Widyasari et al 2017 for Indonesia; Sainoi et al 2017 for Thailand). However, in the Indian context, there is hardly any detailed study on the diffusion of such innovations. Hence, this study attempts to analyse the adoption of these innovations by the small natural rubber growers. Further, among the cultural practices, rainguarding is considered as related to the system of tapping. Rainguarding is an important practice for ensuring regular tapping of trees even during rainy season. Further, with the introduction of low frequency tapping, rainguarding is essential to be followed even in the case of low

[1] Low frequency tapping refers to the system of tapping trees recommended by the Rubber Board that typically correspond to tapping once in three/four/five/six days/ once in a week rather than tapping the trees every day.

[2] Controlled upward tapping refers to cutting of the bark of the rubber trees by using ladder and a long handled knife modified gouge knife for upward tapping from the ground. This system of tapping is expected to minimize the bark consumption and ensure higher yield. http://rubberboard.org.in/ManageCultivation.asp?Id=119 (accessed on 11th November, 2017)

[3] Other cultural practices would include disease control, application of fertilizers, weed control etc.

rainfall.[4] This implies that low frequency tapping and rainguarding practice[5] are complementary to each other. Hence, along with the tapping practices, the study would consider the issue of diffusion of rainguarding practice by the rubber growers. In this context the focus of the present study is to examine the extent of diffusion of these innovations and the factors influencing observed pattern of diffusion/adoption.

This paper is divided into 5 sections. Section 2 deals with the analytical background of technological diffusion and discusses different perspectives therein. The sampling strategy and data is presented in section 3. Section 4 presents the findings from the field data analysis on reasons for low adoption of the innovations and the last section conclude with some lessons for policy.

2. On Analytics of Technological Diffusion

The theoretical literature on the process of technology diffusion could be traced to pioneering work of Schumpeter (1934), which emphasized the linear progression from invention to innovation followed by diffusion. In the process of technological change, where invention and innovation are considered as the pre-condition for the development of new technology, diffusion of technology is important in terms of bringing about technological dynamism of the economy as it determines productive uses of technological innovation. Diffusion of technology is the key to enhancement in productivity, which in turn drives economic growth and contributes to well being. However, observation made by Rosenberg (1972) still holds; "in the history of diffusion of many innovations, one cannot help being struck by two characteristics of the diffusion process: its apparent overall slowness on the one hand, and the wide variations in the rates of acceptance of different inventions, on the other." Hence the issue of diffusion has attracted much attention of innovation scholars giving rise to different perspective towards understanding the diffusion process. In what follows we shall briefly deal with different perspectives towards understanding technology diffusion/adoption.

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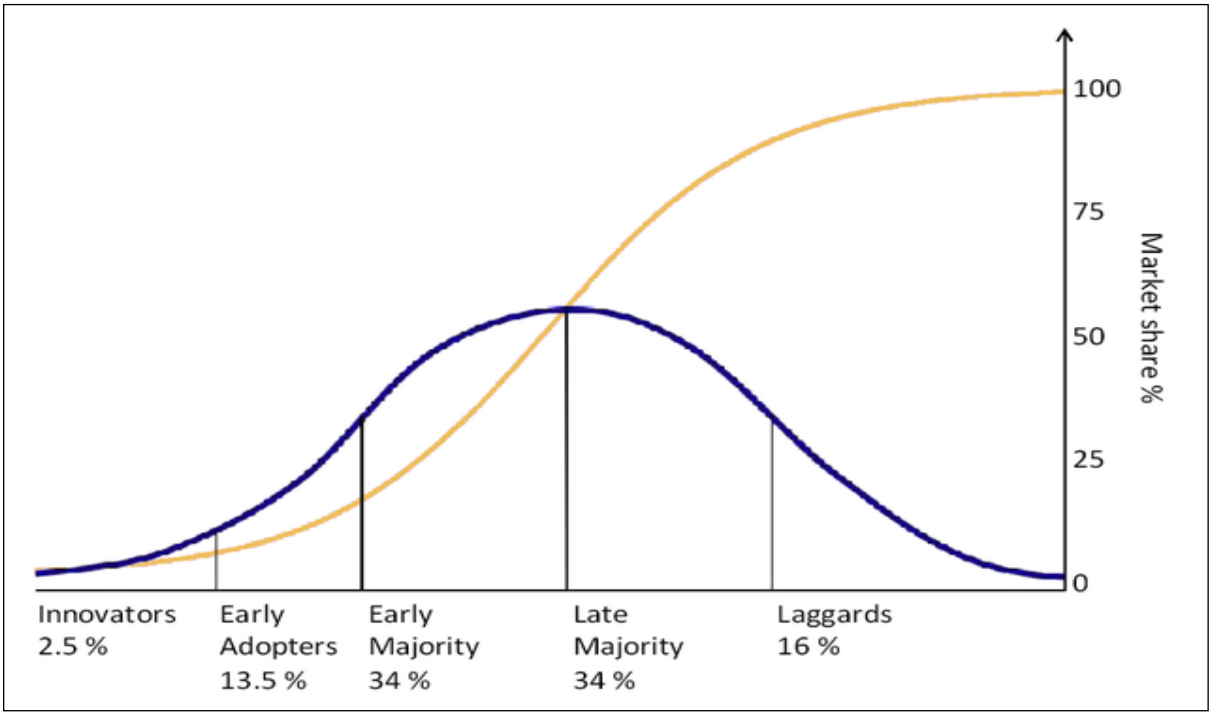
[4] http://rubberboard.org.in/ManageCultivation.asp?Id=120 (accessed on 11th December, 2017).

[5] Since the cost of rainguarding is Rs 40 per tree, this complementarity between the two practices could be expected to have implications on the adoption of the tapping system by the grower.

In the traditional neoclassical approach towards technological change, which considers it as a linear process involving three linear stages, diffusion is the final stage, which is preceded by invention and innovation. Here diffusion is analyzed by drawing analogy with the spread of a contagious disease and it is often called adoption perspective (Griliches 1957; Rogers 1995; Evenson and Binswanger 1978among others). At the initial stage of the diffusion process, there exist a certain number of adopters of new technology. Over time, as the interaction of non-adopters develops with adopters, there is transfer of information among them and thus non-adopters get converted to adopters. As per this approach, the adopters were assumed to be homogenous. Further, following Rogers (1962) the rate of diffusion is said to follow a sigmoid (S-shaped) path (see fig 1) indicating that at the initial stage, the diffusion path first rises at slower rate, followed by an increase in the rate in the later stage and then it finally decreases (Stoneman, 2002).

Fig 1: Stages in the diffusion of innovations



Within this perspective, the processes of intra-firm and inter-firm diffusion in terms of probit models (also known as rank effects models) (Karshenas and Stoneman, 1993;

David, 1969; Davis, 1979) and game theoretic models (Reinganum, 1981; Fudenberg and Tirole, 1985; Mariotti, 1989). As per the probit models, the pattern of diffusion is determined by the difference in the characteristics of adopters, which results in earlier adoption by some. The game theoretic models emphasize the critical role played by strategic interaction among the potential adopters in determining the pattern of diffusion. Though, there exist differences in specifications of these Neo-classical equilibrium models, what is common across them is the assumption that adopters are infinitely rational in their decision making. This assumption implies that before any diffusion actually occurs, adopters are able to explore all of their strategies and determine the optimal strategy of whether to adopt a technology or not. Further, the diffusion process was considered as a continuous, quantitative and an equilibrium process. Undoubtedly,this approach has provided important insightson the diffusion process particularly in terms of highlighting 'the differences between the potential adopters, interactions between supply and demand for innovations and the pace of adoption; technological expectations of suppliers and adopters; different forms of strategic interactions among adopters and the role of market structure in adoption decision' (Sarkar, 1998: 140).

Considering the evolving nature of innovation adaption (Economic history) perspectiveanalyses adoption of technologies focusing on the process of change in the innovations (Brown, 1981; Rosenberg, 1972). Unlike, the neo-classical perspective and adoption perspective, which assumes that innovation is same over time, economic history perspective emphasizes on the continuity of innovation or technological characteristics.

The evolutionary approach argued that the decision-making agents, instead of being infinitely rational (as assumed by the Neo-classical models), are boundedly rational (Simon 1972). The decision of an individual to adopt an innovation or not will be restricted by their biological as well as cognitive limitations in terms of accurately interpreting and processing information on innovation and exploring the entire pay-off structure from its adoption (Silverberg, 1991). Their decision will be based on routines of behaviour i.e. habits and customs (Nelson, 1995), which would prevent them from

switching over to new technologies. Further, this approach considers the process of diffusion to be continuously evolving over time; hence there cannot be any adjustment to reach an equilibrium state. This helps to understand the historical patterns of technological change (Metcalfe, 1994). The diffusion process is also characterized as one, which may not be necessarily continuous. In this approach, technological diffusion is not viewed as a confrontation between old and new technology rather it is as an outcome of a process of competitive selection across the variety of technologies available at any point of time (Metcalfe, 1988). Along with the selection process, behavioral attributes of the individuals and economic and institutional environments determine the diffusion process over time.

Drawing from evolutionary economics and systems theory, the innovation system perspectiveon agricultural research and technological change has been developed. This perspectivehighlights the role of interactive learning between heterogeneous actors involved in the generation, dissemination and use of knowledge. The interactions are governed by the institutional context in which different actors operate and their interactions have a crucial bearing on innovation and diffusion (Spielman, 2005; Biggs and Clay, 1981; Hall and Clark, 1995).

It was understood from the discussion of the theoretical and empirical studies that though the different approaches and perspective provide useful insights in understanding the process of diffusion/adoption, they have limitations as well. Following one particular approach or perspective will not provide a deeper understanding of the process of technology diffusion among the potential adopters. It is reasonable to assume that diffusion would depend on subjective and objective factors along with socio-economic conditions or farm and farmer characteristics adoption perspective), changes in innovations in line with the changing contexts (economic history perspective/adaption perspective), as well as nature and extent of interaction between the research institutes and the rubber growers, the role of growers therein and institutional mechanisms related to the diffusion of technological innovation (innovation system perspective). Hence in order to study the adoption behaviour of the rubber growers by drawing insights from

different perspectives, the study attempts at developing a heuristic framework. Thus viewed we presume that in order to attain a comprehensive understanding on the adoption behavior of rubber growers, it is important to recognize the complementarities among the aforementioned four perspectives and draw key insights.

3. Data and Method and approach to the study

This study is based on primary data collected from a representative sample of (441) of rubber growers from the 3 rubber growing regions in Kerala; Trivandrum, representing southern Kerala, Kottayam representing central Kerala and Thaliparampu representing Northern Kerala. The stratified random sample of rubber growers representing the three regions has been selected in consultation with the committee appointed by the Rubber Board to associate with NRPPD in undertaking this study. The primary data was canvassed with the help of the field staff of the Rubber Board under the supervision of the senior officials of Rubber Board and the NRPPD study team. The survey was undertaken during the period may-September 2018. The Survey started after the crop year 2017-18 to get a comprehensive picture of the one crop year. Three interim interactive sessions were organized with the field staff, the committee of Rubber Board and study team to ensure that the data has been properly collected from the field. With the support of the Committee concerned from the Rubber Board Focused Group Discussions (FGD) was organized with select growers from two regions.

4. Empirical Evidence

In understanding the diffusion of any technology/innovation, the common practice in the literature has been to begin with an examination of the extent of awareness among its potential users. Different perspectives on technology diffusion consider awareness as a pre-condition for adoption. This in turn is closely linked to the communication strategies used by the innovator or other actors like extension agents involved therein. Hence, awareness about technology has often been considered as an indicator of the effectiveness of the communication strategy adopted by the innovator or the extension agents. In the present study also we shall begin with the extent of awareness among the potential users regarding the innovations under study. From Table 1 it is evident that awareness about

rain guarding is all most 100 percent. However, when it comes to LFT also the awareness in general is not very high and there is high inter-regional variation. To be more specific when it comes to D5, D6 and D7, the extent of awareness is much lower in Trivandrum (even less than 50 percent in case of D5 and D6). Similarly, in case of CUT as well Trivandrum showed much lower level of awareness as compared to Kottayam, which is highest at 83 percent followed by Thaliparambu (67 percent). With respect to stimulant application also, Trivandrum lacks behind other regions though the extent of awareness is 68 per cent.

Table 1: Extent of awareness about the innovations

Awareness		**Trivandrum**	**Kottayam**	**Thaliparambu**	**Total**
Rain guarding		97.55	100	97.19	98.62
Low frequency tapping (LFT)	Once in three days tapping (d3)	91.54	94.71	94.53	93.95
	Once in four days tapping (d4)	78.61	88.91	88.28	86.43
	Once in five days tapping (d5)	47.26	84.84	88.28	77.42
	Once in six days tapping (d6)	44.12	84.28	88.28	76.31
	Once in seven days tapping (d7)	52.45	90.16	87.89	81.04
Controlled upward tapping(CUT)		50.49	83.48	67.58	71.51
Stimulant application		68	94.22	94.92	88.63

Source: Field Survey, (2018)

Having analysed the extent of awareness, we shall proceed with an analysis of extent of adoption of these innovations.

Rain guarding

It is widely known that uncertain raining patterns affect the tapping practices of rubber trees and therefore harvesting of latex. This is because the fungi which usually grow on leaves and pods enter the fresh cut along with water gushing along the trunk of the tree, causing bark rot. Around 140 days of tapping is lost each year as a result of rain

interference. Since one tapping block is recommended to be tapped once in two days, the loss of tapping days in a tapping block is around 70 per year. On an average a tapping block consists of around 300 trees and gives a yield of around 9kgs per tapping. Therefore, for 70 days the loss of crop is about 630kgs. This is a significant loss for both land owners and the tappers.

In this context, to prevent the loss of tapping days, the rain guarding technology was developed in the last century in order to minimize the adverse effects of rain interference on tapping. Initially, a polythene rain guard, similar to a plaited skirt in appearance, was fixed to the trunk of the rubber tree using a special adhesive that was not expected to melt or crack in any weather, although this had not been achieved fully. Rubber Rain Guards are fixed above the tapping panel all around the tree so as to divert stem flow of water protecting tapping panel and bark area. It provides sufficient aeration to the tapping panel so that the chance for fungal growth is negligible. It also protects the latex collection cup fixed under tapping panel. Given the proven benefits for plantation owners, they say, Rain Guards are being used in plantations across the world. Programs have been implemented in many countries including Ivory Coast, Nigeria, India, Indonesia, China and by some in Sri Lanka.

From table 2 it is evident that the extent of adoption of rain guarding is only about 38% for the whole sample with significant variation across different regions. While the extent of adoption is as high as over 56% in Kottayam it is found to be only less than 9% in Trivandrum.Exploring the reasons for non-adoption, it is found that major reason (43%) for non-adoption is the lack of detailed knowledge both at the state level and regional level. As one of the RPS representative remarked during the FGD "*there is lack of enough knowledge about the positive aspects of shading among growers and tappers which actually leads to increase the yield*". In the similar vein another grower remarked Rain guarding are of two types 1) polythene rain guarding. With this rain guarding technique, tapper needs to be very careful while tapping and it is time consuming as well. To encourage RG, grower should provide a little more wage to the tappers. 2) tapping shade. There is a technique required to adopt shading to the trees, otherwise it will

adversely affect the trees. *Proper awareness is required to the growers as tappers give false information to the growers for not adopting rain guarding*"

In the absence of detailed knowledge the farmers seem to perceive rain guarding as involving high risk, which in turn induce them to refrain from its adoption. The second important reason for non-adoption is found to be lack of finance and low price, which was more pronounced in case of Trivandrum (29.5%). From our Focused group discussion with framers and representatives of RPS it was transpired that rain guarding inconvenience the tappers while tapping and therefore they discourage the adoption of rain guarding. However, the labour related factors found to be considerable only in Kottayam (21%) where as labour is not found an important factor in non-adoption on other two regions.

Table 2: Adoption of Rainguarding and underlying factors

	Trivandrum	Kottayam	Thaliparambu	Total
Adopted Rainguarding				
Yes	8.67	56.34	30.77	37.78
No	91.33	43.66	69.23	62.22
Total	100	100	100	100
Sources of Information				
Informal	50.79	30.86	51.72	38.68
Rubber board	46.03	51.03	39.08	47.58
RPS	1.59	16.87	5.75	11.96
Others	1.59	1.23	3.45	1.78
Total	100	100	100	100
Reasons for not adoption				
Lack of detailed knowledge	53.02	25	41.13	42.69
Labour	9.4	21.05	7.26	11.17
Price	29.53	18.42	21.77	24.36

Others	8.05	35.53	29.84	21.78
Total	100	100	100	100
Discontinued Rainguarding				
Yes	71.43	37.38	51.72	42.09
No	28.57	62.62	48.28	57.91
Total	100	100	100	100
Reasons for discontinuing				
	District	Code		
Lack of detailed knowledge	29.41	16.88	15.63	17.72
Labour	0	9.09	12.5	9.49
Price	17.65	42.86	18.75	30.38
Others	52.94	31.17	53.13	42.41
Total	100	100	100	100
Availed rainguarding subsidy				
Yes	8	1.12	6.78	3.04
No	92	98.88	93.22	96.96
Total	100	100	100	100

Source: Field Survey, (2018)

Examination of the source knowledge about the innovation revealed the important role that rubber board played through training, campaigns, extension visits etc (48%) (seeTable 2). At the same time, informal sources like other growers, friends and relatives also play import role (39%). The role of informal source is found to be as high as over 50% in Trivandrum and Taliparambu. Table 3 also indicate that subsidy has had only very limited role with only 3% reportedly received subsidy for rain guarding.

Data from the survey (Table 2) further revealed that a substantial number of growers have discontinued with rain guarding. For the whole sample while 42% discontinued the relevant proportion was as high as 71% in Trivandrum and the lowest being in Kottayam (38%).The major reason for discontinuation is found to be other reasons (53%) that include TPD, tappers unwillingness, perceived damage to the trees and lower yield. To

the extent that finical reasons were reported as factors responsible for non-adoption and discontinuation, the relevance of subsidy to induce the growers to adopt rain guarding along with training for the labour cannot be over emphasized.

Low Frequency Tapping

The natural rubber plantation sector is passing through difficult times mainly due to very low NR price and acute scarcity for skilled tappers. Evidence suggests that rubber price crashed from an all-time high of Rs 250 plus during 2011-12 to less than Rs 100 a kilogram in 2016.Along with the rise in NR price, all other costs also increased and the most striking was the increase in tapper wages which continues to stay at the increased level since the wages are flexible upwards and rigid downwards. In order to address the issue of high cost of cultivation on account of high labour costs, RRII introduced low frequency tapping and conducted two large-scale trials (in 30 ha at SFCK estate, Punalur, from 1988 & in 10 ha at Koney estate of M/s Harrisons Malayalam Ltd, from 2010) on Low Frequency Tapping (Thomas, 2017). On completion of long-term evaluation, RRII has recommended lower frequencies of once in three days (d3), once in four days (d4) and once a week (d7) tapping with clone and frequency-specific yield stimulation schedule. The compiled annual mean yield from Koney estate under all systems except for d3 frequency without yield stimulation is on a par with d2 frequency.

There is ample scientific evidence from elsewhere also highlighting the positive contribution of LFT not only towards increasing productivity and reducing labour cost but also for addressing widespread TDP and ensuring higher tapping life on account of reduced bark consumption. Hence, rubber board has been propagating LFT from the early years of 2000 in place of erstwhile practices like daily tapping and S2 D2. Though it is too early, unlike rain guarding, to assess the diffusion process, if evidence presented in Table 3 is any indication, the adoption of LFT for the whole sample is only 19 percent with Trivandrum recording very negligible adoption at 1.6 percent. During the FDG a grower from Trivandrum said that " 25 per cent practice daily tapping. Some growers in his region who practiced daily tapping have changed to once in 4 days tapping method while some others have changed to once in two days tapping". Here again

Kottayamrecorded the highest level of adoption at 27 percent. It is also evident that rubber board played a significant role in the achievement so far made with respect to its adoption. 70 percent of the growers reported that their source of information has been rubber board and its various initiatives. Here again one finds a significant difference across districts. Kottayam wherein the rubber board's is located 80 percent of the growers reported rubber board as the major source of information whereas the corresponding share was lower at 57 percent in Trivandrum. It is also of relevance to note that nearly 27 percent of the growers in Trivandrum and Thaliparambureceived required information from informal sources like friends, relatives and other growers.

Table 3: Adoption of LFT and underlying factors

	Trivandrum	Kottayam	Thaliparambu	Total
Adoption of LFT				
Yes	1.65	26.7	19.3	18.81
No	98.35	73.3	80.7	81.19
Total	100	100	100	100
Sources of Information				
_new	1	2	3	Total
Informal	26.79	11.86	26.79	17.65
Rubber board	57.14	80.23	66.07	73.01
RPS	10.71	7.91	7.14	8.3
Others	5.36	0	0	1.04
Total	100	100	100	100
Reasons for not adoption				
Lack of detailed knowledge	65.41	36.78	56.67	52.38
Labour	26.42	44.25	21.33	31.26
Price	5.03	6.9	0.67	4.35
Others	3.14	12.07	21.33	12.01
Total	100	100	100	100

Thought of upgrading to D7				
		2	3	Total
Yes	0	13.13	20.45	15.38
No	0	86.87	79.55	84.62
Total	0	100	100	100
Reasons not upgrading to D7				
Lack of detailed knowledge	100	35.05	68.97	45.45
Labour	0	43.3	17.24	35.61
Price	0	2.06	0	1.52
Others	0	19.59	13.79	17.42
Total	100	100	100	100
Discontinued LFT				
Yes	0	9.23	23.53	14.14
No	0	90.77	76.47	85.86
Total	0	100	100	100
Reasons for discontinuing				
Did not find it usefyl	0	42.86	40	41.67
Others	0	57.14	60	58.33
Total	0	100	100	100

Source: Field Survey, (2018)

Coming to the reasons for not adoption, as expected, in Trivandrum over 65 percent of the growers reported that lack of detailed knowledge about the innovation is the factors that stood in their way of adoption. As one of the growers remarked during the *FGD "Many of the current growers and tappers lack enough knowledge on rubber cultivation practices. Say for instance, If I have two daughters and two acres of rubber area, I distribute one acre each to them. They don't know anything about rubber cultivation. They rely on tappers for the cultivation who also does not have enough knowledge about rubber cultivation. This in turn adversely affects the rubber sector*". In Thaliparambu also knowledge barrier and associated risk perception appeared to have played its role in non-adoption Here it is important to note that despite significant role of the rubber board for

the state as a whole, over 52 percent of the growers are reported to have considered lack of detailed knowledge as the key factor behind not adoption.The next important factor related tolabour especially the case in Kottayam. It appears that with the adoption of LFT, farmers find it difficult to retain their tapping labor, which could have long-term adverse impact.

In the light of the rubber board's advocacy for D7 backed by the scientific evidence of its positive outcomes, we have enquired whether the farmers have considered the option of upgrading to D7. Table 3 shows that while 15 percent have thought of upgrading for the sample as a whole none in Trivandrum had any thought in this direction with the corresponding share being highest in Thaliparambu (20.4 percent). Table 3 also indicate that labour appears to be an important reason that prevent them considering D7 as an option. On the whole LFT adoption appears to be severely constrained by the labor related factors. Here it needs to be noted that though rubber board had taken initiatives like formation of labourbank, labour related factors still remain as a major constraint hindering the adoption of LFT. The apparent ineffectiveness of initiatives like labor bank needs to be seen against the fact that for seamless transfer of workers from one holding to another, there is the need for upgrading tappers skills to ensure that growers do not perceive any risk in assigning his holding to any tapper from the bank. To the extent that tappers bank is not significantly effective tend to suggest that success of tappers bank presupposes significant investment by the rubber board.

Controlled Upward Tapping (CUT)

It is observed that the adoption of controlled upward taping is very negligible with 2.8% with none adopting in Trivandrum and the highest being in Kottayam (6.3%) (see Table 4). The major reason for non-adoption reported is the lack of adequate knowledge in all the regions. Along with lack of adequate knowledge, labour related issues also appears to matter because CUP involves much more effort on the part of the labor and the tapping knife is too difficult to handle and carry around. Further during the focusedgroup discussion it was argued that CUT takes much more time than conventional tapping and

that the laborers need to be adequately compensated to induce them to adopt CUT. With respect to CUT also the available evidence

Table 4: Adoption of CUT and underlying factors				
	Trivandrum	Kottayam	Thaliparambu	Total
Adoption of CUT				
Yes	0	6.3	0.49	2.88
No	100	93.7	99.51	97.12
Total	100	100	100	100
Reasons for not adoption				
Lack of detailed knowledge	78.63	42.13	69.4	59.93
Labour	6.11	24.68	8.74	14.94
Price	0.76	1.28	0	0.73
Others	14.5	31.91	21.86	24.41
Total	100	100	100	100

Source: Field Survey, (2018)

Growers' perceptions on innovations

The grower's perceptions on different innovations especially on their usefulness is presented in Table 5. The evidence presented in the table highlights some interesting insights. With respect to rain guarding vast majority of the growers were aware of its usefulness for preventing the loss of tapping days and increasing production. Here again one exception is Trivandrum wherein a little over 25 percent of the respondents were unsure about its usefulness in enhancing production.

Table 5: Users opinion on Rainguarding				
Prevents loss of tapping days				
	Trivandrum	Kottayam	Thaliparambu	Total
Yes	90.87	87.05	97.67	90.92
No	1.92	2.46	0	1.64

Unsure	7.21	10.49	2.33	7.44
Total	100	100	100	100
Increases production				
Yes	71.84	77.28	93.02	80.5
No	2.91	10.24	0	5.7
Unsure	25.24	12.47	6.98	13.8
Total	100	100	100	100

Source: Field Survey, (2018)

When it comes to low frequency tapping, only 45 percent considered it as useful in enhancing yield (Table 6). Trivandrum turned out to be different with over 52 percent of the growers were unsure of its usefulness in enhancing yield. Coming to the role of LFT in increasing economic life of the trees, 67 percent were in the affirmative. But here again there were stark inter-regional differences with Trivandrum being the lowest (54%) and Thaliparambu being the highest (87 %)(Table 6). Nearly 74 % of the respondents perceived LFT as useful in reducingtapping cost with relatively very low inter-regional difference. The smallest proportion of growers perceived the positive contribution of LFT to address TPD and addressing labour shortage. Here again, Trivandrum presented a different picture wherein 64 percent of the growers were unsure about the advantages of LFT with respect to addressing TPD and its usefulness in overcoming labour shortage.

Table 6: Users opinion on LFT

	Trivandrum	Kottayam	Thaliparambu	Total
Increases yield				
Yes	35.9	39.2	63.14	45.43
No	11.79	10.56	7.06	9.82
Unsure	52.31	50.23	29.8	44.75
Total	100	100	100	100
Increases economic life of tree				
Yes	53.77	61.28	86.67	66.97
No	7.04	3.09	1.57	3.54

Unsure	39.2	35.63	11.76	29.49
Total	100	100	100	100
Reduces tapping cost				
Yes	66.15	68.41	87.45	73.48
No	5.13	1.19	0.39	1.84
Unsure	28.72	30.4	12.16	24.68
Total	100	100	100	100
Helps overcome tapping panel dryness				
Yes	21.88	51.55	82.75	54.16
No	14.06	3.58	0	4.85
Unsure	64.06	44.87	17.25	40.99
Total	100	100	100	100
helps overcome shortage of skilled labor				
Yes	27.03	47.39	74.9	51.25
No	21.08	4.47	1.18	7.12
Unsure	51.89	48.14	23.92	41.64
Total	100	100	100	100

Source: Field Survey, (2018)

When it comes to advantages of CUT in terms of reduced bark consumption, higher yield from the renewed bark usefulness in overcoming TPD, the respondents in general indicated that they are unsure of the above advantages (Table 7).

Table 7: Users opinion on CUT

	Trivandrum	Kottayam	Thaliparambu	Total
Minimises bark consumption				
Yes	34.64	19.17	59.11	34.25
No	10.06	9.22	1.21	7.04
Unsure	55.31	71.6	39.68	58.71
Total	100	100	100	100
Higher yield from renewed bark				
Yes	23.63	14.9	58.2	29.68
No	8.79	10.1	1.23	7.18
Unsure	67.58	73.74	40.57	62.53
Total	100	100	100	100

Higher yield for several years				
Yes	21.23	17.8	60.73	31.22
No	5.59	9.51	2.02	6.46
Unsure	73.18	72.68	37.25	62.32
Total	100	100	100	100
Helps overcome tapping panel dryness				
Yes	24.26	12.56	60.82	29.39
No	7.1	9.61	1.22	6.59
Unsure	68.64	77.83	37.96	64.02
Total	100	100	100	100

Source: Field Survey, (2018)

Based on the discussion thus far on the growers perception it may be inferred that less remarkable performance in the adoption of innovations like rain guarding, LFT and CUT needs to be seen in the context of substantial cut back in the rubber boards efforts towards extension efforts To quote from the statements made by growers and RPS office bearers during the FGD

"there is lack of financial resources with the RPS to undertake various activities. The rubber board has stopped providing transport subsidy (50 paisa per kg) and rent subsidy to RPS. Initially Rubber board used to incur 50 per cent of the RPS building rent, but now it has stopped. There is no training for RPS".

"Now RPS has to take care of all the expenses for training such as seminar expenses, building rent, etc. Initially RPS used to get Rs.30 per person for training, but now RPS is not getting any amount. Though RPS is an extension arm of the board, they are not given much support".

"The rubber officials are incorrupt, committed and well behaving. But there is only one development officer in Nedumangad. In Trivandrum, there are only 4 field officers, which was 20 in earlier period."

"They (Rubber Board) have dropped the post of Joint RPC and there are no new appointments happening to fill the existing vacancies and RPS has to take care of all the activities."

"Rubber board is not providing the expense in connection RPIS (Rs. 36 for document uploading and other expenses) which RPS spent for each new membership."

"For latex testing, there is only one laboratory for four districts from Kanyakumari to Kollam. There is lack of enough staffs to do it as well. Initially we used to get the result within three days but now we need to wait for at least a month to get it"

Let as one of the participants in FGD remarked "….". Hence, any further increase in the adoption could not be accomplished without complementary investments towards general awareness building regarding their advantages among the growers concerned.

5. Concluding observations and implications for policy

There is significant evidence to suggest that innovation like Low Frequency Tapping (LFT) rain guarding (RG) and Controlled Upward Tapping (CUT) could be helpful not only in increasing productivity, reducing cost of production especially cost of labor, achieving longer tapping life on account of reduced bark consumption but also in addressing diseases like Tapping Panel Dryness. Hence, the rubber board has been taking a number of initiatives to facilitate greater adoption of these innovations by the growers. However, in the absence detailed field based explorations, our understanding on the extent of adoption their adoption by the growers at best remains rudimentary. In this context, the present study explored the extent of adoption of these innovations by the growers and the factors that influence the adoption pattern. The study dealt with rain guarding, LFT, and CUT.

At the outset it may be noted that unlike rain guarding LEFT and CUT are recent innovations and there is some merit in the argument that it is too early to assess their diffusion. Keeping this caveat in mind, itmay be noted that only 38% of the sample growers have adopted rain guarding with significant inter-regional variation wherein the adoption was only 9% in Trivandrum.In case of LFT adoption for the whole sample is only 19 percent with Trivandrum again recording very negligible adoption at 1.6 percent.

Finally in case of controlled upward taping (CUT), the overall adoption was very negligible (2.8%) with none adopting in Trivandrum. In all the three innovations Kottayam recorded highest rate of adoption with 56% for rain guarding 27 % for LFT and 6.3% for CUT. The observed difference across regions tends to support the adoption perspective that highlights the bearing of farmer characteristics in influencing the diffusion process.

What accounts for the observed poor performance? A pre-condition for the adoption of any innovation is the availability of information and deep knowledge about the innovation concerned such that perceived risk regarding the adoption of innovation is minimized. This essentially depends on the institutional arrangements along with availability of complimentary factors. Our enquiry based on the data from the field survey tends to suggest that in sync with the evolutionary perspective and unnovation system perspective there are serious information deficit along with knowledge gap notwithstanding the various efforts made by the Rubber Board. In the context of serious knowledge deficit risk perception regarding innovation is highly prevalent that stood in the way of the adoption of innovations. Here it is important to note that a large number of growers especially from Trivandrum are unsure about the beneficial effects of the innovations under consideration.

When it comes to the complementary factors in case of LFT and CUT,labour emerged as an important limiting factor. Thus it appears that for successful diffusion of technological innovation like LFT and CUT, there is the need for appropriate organizational innovations to address the labour related issues. Although the rubber board had taken initiatives like formation of labour bank, labour related factors still remain as a major constraint. The apparent ineffectiveness of initiatives like labor bank needs to be seen against the fact that for seamless transfer of workers from one holding to another, there is the need for upgrading and standardizing the tappers skills to ensure that growers do not perceive any risk in assigning his holding to any tapper from the bank. To the extent that tappers bank is not significantly effective, tend to suggest that success of tappers bank presupposes significant investment by the rubber board. From the field

survey as well as the FGD, it was transpired that when the sector has been in crisis and the innovations not getting diffused that calls for more effort to generate and diffuse information and knowledge, there is an apparent withdrawal of the state. This is evident from the fact that there has not been any significant increase in the allocation for the Board concerned, instead a decline in real terms. Hence available evidence point towards more concerted and targeted measures from the diffusion agents towards more intensified extension efforts so that information and knowledge deficit of growers and workers with respect to these innovations are addressed sooner than later. To the extent that the labour factors is a crucial constraint in the diffusion innovations like LFT and CUT, the relevance further strengthening the organizational innovations like labour bank to address the labour related issues cannot be overemphasized.

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