EXTENT OF ADOPTION OF RECOMMENDED AGRONOMIC PRACTICES IN NATURAL RUBBER PLANTATIONS OF SOUTH INDIA

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A field survey was conducted to assess the extent of adoption of various agronomic practices in the rubber growing regions of Kerala, Kanyakumari, Karnataka, Goa and Maharashtra. Primary data was collected by a well-structured questionnaire with a series of questions related to the adoption of agronomic practices recommended by the Rubber Board of India by interviewing a total of 10760 farmers. In all the rubber growing regions of South India, majority of the growers used polybag plants of clone RRII 105 as the planting material and planting was done in pits of size 75 cm^3. Land preparation operations like digging pits and making terrace were done manually in the entire rubber growing regions of Goa, whereas it was 83, 76 and 92 per cent in Kerala, Karnataka and Kanyakumari, respectively and the use of earth movers becoming common in these regions. In Maharashtra, more than 90 per cent of the rubber growers followed mechanical mode for land preparation. More than 86 per cent of the rubber growers in South India adopted manual method of weed control both in immature and mature rubber plantations. Only less than 2.4 per cent of the growers applied herbicides in rubber plantations. Banana was the widely accepted intercrop in all states especially in Tamil Nadu (94%) and Goa (100%). In Maharashtra around 50 per cent of the farmers adopted pineapple intercropping where as in Kerala, Karnataka and Tamil Nadu, the percentage of adoption was 11, 9 and 3, respectively. Construction of terraces for conserving soil and water was the widely accepted conservation practice in all states and combination of conservation practices for controlling soil erosion was followed only in Kerala, which shows the need for concerted efforts to increase the adoption of integrated soil and water conservation practices in NR plantations particularly in the context of increasing drought and cost of cultivation. The observations from the present study will be useful in identifying areas where further institutional intervention is needed and also stress the importance of renewed extension efforts for diffusion of the recent technological innovations.

Key words: Agro-management practices, Extent of adoption, *Hevea brasiliensis*, Natural rubber

INTRODUCTION

Adoption of improved agronomic practices in natural rubber (NR) cultivation is important to ensure its commercial sustainability. Technologies are continuously evolved or modified to increase the productivity and efficiency and reduce cost. This will improve the income of the farmers and also help the long term sustainability of

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the system. But the level of adoption of different management components is varied among farmers and farmer's decision to adopt a new technology depends on their socio-economic circumstances and institutional effectiveness (Guo and Dadzie, 2012). In developing countries, an effective diffusion of appropriate technology is crucial for the successful implementation of the technology.

Natural rubber cultivation in India is traditionally concentrated in Kerala and to some extent in the adjoining state of Tamil Nadu. Karnataka, Goa and Maharashtra are the newly emerging NR growing regions in South India. Kerala holds a dominant position both in area and production since the introduction of NR cultivation in the country and accounts for 78 per cent of the total area and 90 per cent of total rubber production in India. Natural rubber occupies 26 per cent of the gross cropped area of Kerala (Joseph and Viswanathan, 2016) and is cultivated in all districts. Kottayam, Pathanamthitta and Ernakulam are the major NR producing districts of Kerala. Tamil Nadu is the second largest NR producing state in South India next to Kerala and contributes around three per cent of the total rubber production in India. In Tamil Nadu, Kanyakumari is the only NR growing district. Karnataka's contribution to the total rubber production in the country is around 1.5 per cent and the major NR growing districts are Dakshina Kannada, Udupi, Shimoga, Chikmagalur and Coorg.

Commercial cultivation of NR was started in India in 1902 at Thattekadu, Kerala and between 1970 and 2011-12, productivity of rubber in the state rose from 653 kg ha^{-1} to 1841 kg ha^{-1}, registering a nearly three times increase (Joseph and Kumar, 2016). The most important contributors behind the increase in productivity are the development of one of the most promising clones RRII 105 during 1980 and a series of innovations evolved to reduce gestation period, increase productivity, sustain soil health and reduce cost of cultivation (Punnoose and Lakshmanan, 2000). Adoption of technologies mainly depends on farmer's perception of the benefits that would arise from the use of the practices. Natural rubber plantation sector in India is dominated by small holders, accounting for 90 per cent of the total area and 94 per cent of the total production of rubber (Price stabilization fund trust-Annual report, 2013-14). Many of the small growers continue to follow their own accumulated traditional experiences in rubber farming of which some are adversely affecting the system and cost of production. Hence, adoption of improved technologies for increasing and sustaining NR productivity as well as increasing farmer's income is critical for overall growth of the NR industry. The information on the extent of adoption of improved technology by the NR growers is essential for identifying areas where further intervention is needed and appropriate policies can be evolved. Hence, a survey was undertaken to find out the extent of adoption of various agronomic practices in NR plantations in Kerala, Tamil Nadu, Karnataka, Goa and Maharashtra.

MATERIALS AND METHODS

A field survey was conducted in the NR growing tracts of South India during 2012-2013 to assess the extent / level of adoption of various agronomic practices in NR plantations. This was done as a part of a project on soil fertility mapping in the rubber growing states of South India. Primary data was collected by a well-structured questionnaire with a series of questions related to the adoption of agronomic practices recommended by the Rubber Board of India. A total of 10760 farmers were selected from the NR growing

regions of all districts of Kerala, Kanyakumari district of Tamil Nadu, Goa, Sindhudurg district of Maharashtra and five districts of Karnataka based on stratified sampling with Neyman allocation method (1934) and interviewed. In this large sample survey, the number of samples taken for each agro-management practice was different, so as to eliminate the effect of missing samples and to improve the accuracy. The study involved small, marginal and large NR growers and of the total surveyed area, 80 per cent area was under mature rubber and 20 per cent under immature rubber. The primary data were compiled using queries in Microsoft Access Data base and the level of adoption of each practices was expressed in percentage.

RESULTS AND DISCUSSION

Planting materials

In the beginning of NR cultivation, seeds were directly planted in the main field and subsequently, budded stumps and later poly bag plants and root trainer plants were used as the planting materials. It was observed that, 100 per cent of the farmers in Karnataka, Goa and Tamil Nadu and 97 per cent of the farmers in Kerala used polybag plants as the planting materials (Table 1). Budded stumps were widely used as the planting material during 1970's. The direct planting of budded stumps in the field has several disadvantages compared to poly bag planting and during 1980's Rubber Board started promoting planting of polybag plants. The root trainer plants recommended in 2009, reduce cost of planting considerably and are more environment friendly and gaining popularity among rubber growers (Soman *et al*., 2011). In this study more than 80 per cent of the plantations were established during 1990's and the growers preferred poly bag plants, the most popular planting material during that time.

High yielding clones

Planting with high yielding clones is one of the important strategies for increasing NR productivity. The Rubber Research Institute of India has evolved several high yielding clones that are suitable to agro-climatic conditions of our country (Mydin *et al*., 2017). The level of adoption of different clones in different rubber growing areas is given in Table 2. At the aggregate (all states) level, around 70 per cent of the respondents adopted RRII 105, 26 per cent multi clone planting, 17 per cent RRII 414, two per cent RRII 430 and one per cent PB 260. The introduction of RRII 105 virtually revolutionized the NR plantation industry in Kerala in terms of sustained increase in national average yield, production and area under cultivation (Jacob and Siju, 2017). During 1982, breeding and selection of RRII 400 series clones was initiated and two of the clones, RRII 414 and 430 were evolved and released during 2005 and RRII 417, RRII 422 and RRII 429 were released subsequently. During the post release period of RRII 400 series clones, the share of area under RRII 105 declined and area under RRII 400 series increased to 18.9 per cent and among the RRII 400 series, RRII 414 was the most popular clone followed by RRII 430 (Veeraputhran *et al*., 2013).

In all states, a sizable number of farmers adopted multi clone planting. From the very beginning, the small holder sector revealed a strong preference for RRII 105 and the trend finally culminated in the wide spread monoclonal planting of RRII 105 (Ipe and Haridasan, 1998). Realizing the potential risk

Table 1. **Level of adoption of different types of planting materials by growers in different rubber growing areas of South India (%)**

State	District	Planting materials		
		Budded stumps	Polybag plants	Root trainer plants
Goa	North Goa	-	100	-
	South Goa	-	100	-
	Average	-	100	-
Karnataka	Chikmagalur	-	100	-
	Coorg	-	100	-
	Dakshin Kannada	-	100	-
	North Canara	-	100	-
	Shimoga	-	100	-
	Udupi	-	100	-
	Average	-	100	-
Kerala	Alappuzha	3	92	5
	Ernakulam	2	95	3
	Idukki	7	93	-
	Kannur	4	96	-
	Kasaragod	1	99	-
	Kollam	-	99	1
	Kottayam	5	93	2
	Kozhikode	2	97	1
	Malappuram	-	99	-
	Palakkad	3	97	-
	Pathanamthitta	4	95	1
	Trissur	1	99	-
	Trivandrum	2	98	-
	Wayanad	-	100	-
	Average	2	97	1
Maharashtra	Sindhudurg	3	98	-
Tamil Nadu	Kanyakumari	-	100	-

n = 7902

involved in monoclonal planting, Rubber Board has been recommending the multi clone planting concept from 1991. The introduction of RRII 400 series has also opened a new window of opportunity to promote multi clone planting of RRII 105 with RRII 400 series in the small holding sector (Veeraputhran *et al.*, 2013).

Agronomic practices

Improved agronomic practices significantly increase the crop production in addition to improved hybrids (Eberhart, 1989). Land preparation, planting, soil and water conservation, intercropping, ground cover management, weed management and dry season management are the major

agronomic practices (Punnoose and Lakshmanan, 2000).

Land preparation

In earlier days the standard size of the planting pit recommended for rubber was 75 x 75 x 75 cm (75 cm^3). Around 60 per cent of the expenditure for land preparation is for pitting and filling of planting pits. To reduce the cost on pitting and refilling, planting in small pits (just sufficent to accommodate polybag plants) in soils with minimum one

Table 2. **Level of adoption of different clones by growers in major rubber growing areas of South India (%)**

State	District	Clone				
		RRII 105	RRII 414	RRII 430	PB 260	Multi clone
Goa	North Goa	71	-	-	-	29
	South Goa	75	-	8	-	17
	Average	73	-	4	-	23
Karnataka	Chikmagalur	79	5	-	-	16
	Coorg	58	-	-	-	42
	Dakshin Kannada	80	4	-	-	16
	North Canara	50	25	-	-	25
	Shimoga	89	-	-	-	11
	Udupi	71	6	-	-	23
	Average	71	7	-	-	22
Kerala	Alappuzha	82	13	-	-	5
	Ernakulam	86	4	1	1	8
	Idukki	78	5	3	2	12
	Kannur	90	3	1	0	5
	Kasaragod	91	4	-	0	5
	Kollam	81	8	1	1	9
	Kottayam	77	5	1	1	15
	Kozhikode	81	5	-	3	12
	Malappuram	87	3	-	-	10
	Palakkad	88	2	-	-	9
	Pathanamthitta	75	6	1	3	14
	Thrissur	90	7	2	1	1
	Trivandrum	89	1	-	-	9
	Wayanad	89	3	-	1	7
	Average	85	5	1	1	9
Maharashtra	Sindhudurg	61	2	2	-	35
Tamil Nadu	Kanyakumari	56	2	2	1	39

n = 10020

Table 3. **Level of adoption of land preparation operations by growers in different rubber growing areas of South India (%)**

State	District	Pit size (cm^3)			Digging pits		Construction of terrace		
		<75	75	>75	Manual	Earth movers	Hole digger	Manual	Earth movers
Goa	North Goa	-	100	-	100	-	-	100	-
	South Goa	-	100	-	100	-	-	100	-
	Average	-	100	-	100	-	-	100	-
Karnataka	Chikmagalur	-	100	-	44	56	-	44	56
	Coorg	-	96	4	97	3	-	97	3
	Dakshin Kannada	14	66	21	83	17	-	83	17
	North Canara	-	100	-	67	33	-	67	33
	Shimoga	3	85	12	100	-	-	100	-
	Udupi	-	86	14	62	38	-	62	38
	Average	3	89	8	76	25	-	76	24
Kerala	Alappuzha	3	84	14	91	9	-	91	9
	Ernakulam	2	90	8	69	16	15	81	19
	Idukki	1	99	-	89	6	4	93	7
	Kannur	10	88	2	96	4	-	96	4
	Kasaragod	1	99	-	97	3	-	97	3
	Kollam	3	91	7	86	12	2	88	12
	Kottayam	4	92	3	83	10	7	90	10
	Kozhikode	1	90	9	93	6	1	94	6
	Malappuram	1	89	10	71	27	1	72	28
	Palakkad	1	96	2	76	23	1	77	23
	Pathanamthitta	11	87	3	91	8	1	92	8
	Thrissur	-	100	-	44	26	31	63	37
	Trivandrum	15	81	4	80	20	-	80	20
	Wayanad	1	96	3	90	10	-	90	10
	Average	4	91	5	83	13	5	86	14
Maharashtra	Sindhudurg	6	92	2	9	91	-	9	91
Tamil Nadu -	Kanyakumari	7	86	7	92	8	-	92	8

n= 7883

meter depth was recommended by Rubber Research Institute of India during 2012, based on a series of experiments (Joseph *et al.*, 2012). Labour shortage is another problem faced by the rubber growers in the traditional rubber growing regions and recently this led to a large scale shift to mechanized land preparation using earth movers.

Different aspects of land preparation operations and the level of adoption are given in Table 3. With respect to size of the planting pits, majority of the farmers

Table 4. **Level of adoption of soil and water conservation practices by growers in different rubber growing areas (%)**

State	District	Soil conservation practices						
		Terrace	Silt pit	Edakkayala	Terrace + Silt pit	Terrace + Edakkayala	Silt pit + Edakkayala	Terrace + Silt pit + Edakkayala
Goa	North Goa	100	-	-	-	-	-	-
	South Goa	62	38	-	-	-	-	-
	Average	81	19	-	-	-	-	-
Karnataka	Chikmagalur	81	14	5	-	-	-	-
	Coorg	100	-	-	-	-	-	-
	Dakshin Kannada	95	4	-	1	-	-	-
	North Canara	100	-	-	-	-	-	-
	Shimoga	89	11	-	-	-	-	-
	Udupi	98	2	-	-	-	-	-
	Average	94	5	1	-	-	-	-
Kerala	Alappuzha	67	21	12	-	-	-	-
	Ernakulam	44	13	13	8	11	8	4
	Idukki	7	2	52	6	15	12	5
	Kannur	53	7	9	13	13	3	2
	Kasaragod	74	8	4	10	2	1	1
	Kollam	72	4	19	1	2	3	-
	Kottayam	64	7	12	2	6	7	1
	Kozhikode	72	2	6	5	14	1	1
	Malappuram	92	3	1	2	2	1	-
	Palakkad	87	7	4	1	1	-	-
	Pathanamthitta	70	7	9	2	3	7	1
	Thrissur	79	7	12	-	1	-	-
	Trivandrum	86	8	4	1	-	-	-
	Wayanad	71	20	6	-	-	2	-
	Average	67	8	12	4	5	3	1
Maharashtra	Sindhudurg	88	6	6	-	-	-	-
Tamil Nadu	Kanyakumari	94	4	2	-	-	-	-

n=6195

adopted pit size of 75 cm^3. All rubber growers in Goa adopted 75 cm^3 planting pits, whereas, the adoption per cent for 75 cm^3 planting pits in Kerala, Kanyakumari, Karnataka and Maharastra were 91, 86, 89 and 92, respectively. The per cent of adoption of small pit was very low because in this survey, 80 per cent of the plantations were established before 2006 and the growers adopted 75 cm^3 pit size which was prevailing during that period.

Land preparation operations like digging pits and making terrace were done manually in majority of the NR growing regions of Kerala (more than 83%), Karnataka (76%) and Kanyakumari (92%). The use of earth movers for land preparation was not observed in Goa and all operations were done manually. In Maharashtra, more than 90 per cent of the NR growers followed mechanical method of land preparation and in Karnataka the per cent was around 24. The use of tractor mounted hole digger for making pit was followed in Kerala and in other regions it was not common. Mechanised land preparation in NR was

Table 5. **Level of adoption of inter row management practices by growers in different rubber growing areas (%)**

State	District	Inter row management		
		Cover crop	Intercrop	Natural cover
Goa	North Goa	57	29	14
	South Goa	92	-	8
	Average	80	10	10
Karnataka	Chikmagalur	-	33	67
	Coorg	38	-	62
	Dakshin Kannada	36	4	60
	North Canara	-	25	75
	Shimoga	14	23	63
	Udupi	36	9	55
	Average	21	15	64
Kerala	Alappuzha	6	65	29
	Ernakulam	14	68	18
	Idukki	13	32	55
	Kannur	26	38	36
	Kasaragod	13	9	78
	Kollam	6	42	53
	Kottayam	25	40	36
	Kozhikode	28	47	24
	Malappuram	33	23	44
	Palakkad	44	24	31
	Pathanamthitta	16	41	44
	Thrissur	40	26	34
	Trivandrum	7	28	65
	Wayanad	-	40	60
	Average	19	38	43
Maharashtra	Sindhudurg	51	4	45
Tamil Nadu	Kanyakumari	10	22	68

n = 9623

popularized from 2010 onwards and is gaining acceptance.

Soil and water conservation

In India, most of the NR growing regions have sloppy / undulating terrain and farmers are adopting various soil and water conservation measures depending on the degree of steepness, rain fall intensity and size of the holdings. Construction of contour terraces, stone pitched contour bunds (*Edakayala*) and silt pits are the common mechanical measures recommended for NR (Punnoose and Lakshmanan, 2000). The level

Table 6. **Level of adoption of different inter crops and cover crops by growers in different rubber growing areas (%)**

State	District	Inter crops					Cover crop	
		Banana alone	Pineapple alone	Tapioca alone	Tuber crop alone	Mixed & others	*Pueraria*	*Mucuna*
Goa	North Goa	100	-	-	-	-	25	75
	South Goa	-	-	-	-	-	17	83
	Average	100	-	-	-	-	21	79
Karnataka	Chikmagalur	43	-	-	43	14	-	-
	Coorg	-	-	-	-	-	-	100
	Dakshin Kannada	45	18	-	27	9	7	93
	North Canara	-	-	-	100	-	-	-
	Shimoga	38	38	-	-	25	-	100
	Udupi	75	-	-	-	25	-	100
	Average	50	9	-	29	12	2	98
Kerala	Alappuzha	35	3	-	11	50	33	67
	Ernakulam	37	43	-	2	18	72	28
	Idukki	36	43	-	3	17	67	33
	Kannur	48	4	13	6	29	43	57
	Kasaragod	29	-	29	-	42	35	65
	Kollam	59	4	4	4	30	48	52
	Kottayam	64	13	3	2	19	75	25
	Kozhikode	46	15	1	14	24	25	75
	Malappuram	76	7	1	5	11	79	21
	Palakkad	82	4	-	1	13	78	22
	Pathanamthitta	56	10	1	2	31	34	66
	Thrissur	75	8	4	-	13	91	9
	Trivandrum	59	5	20	-	15	56	44
	Wayanad	25	-	-	42	33	-	-
	Average	52	11	5	7	25	53	47
Maharashtra	Sindhudurg	50	50	-	-	-	56	44
Tamil Nadu	Kanyakumari	94	3	-	1	1	69	31

of adoption of various soil and water conservation measures is given in Table 4.

Construction of terraces for conserving soil and water was the widely accepted conservation practice in all states. In Tamil Nadu and Karnataka 94 per cent of the farmers planted rubber on terraces while in Kerala, Goa and Maharashtra it was 67, 81 and 89 per cent, respectively. Digging of silt pits had only less than 10 per cent adoption in all states except Goa and regional differences in adoption was observed within the states. Chikmangalur and Shimoga districts in Karnataka and Alappuzha, Ernakulam and Wayanad districts in Kerala had more adoption compared to other districts in the respective states. In steep areas, for further reducing the soil erosion, construction of *edakayalas* and silt pits is very effective. The per cent adoption of silt pit and *edakayalas* was less than to contour terraces in all states where as in Idukki, the high range district of Kerala, 52 per cent of the NR growers constructed *edakayalas* in NR plantations. Adoption of combination of conservation practices for controlling soil erosion was observed only in Kerala. Construction of mechanical structures is very effective for soil and water conservation but this will need high initial investment and subsequent maintenance. The data shows the need for generating awareness about effective soil and water conservation strategies particularly in new areas where NR cultivation is expanding.

Inter row management

Establishment of intercrops, cover crops and maintaining natural covers are the inter row management practices followed in NR plantations (Punnoose and Lakshmanan, 2000). The level of adoption of different inter row management practices adopted by NR growers is given in Table 5.

Majority of the farmers in Kerala (43 %), Kanyakumari (68 %) and Karnataka (64 %) maintained natural cover in NR plantations. In the traditional NR growing tracts of South India, maintenance of natural cover in the inter rows of NR was the earlier practice and this was slowly replaced by inter crops and cover crops. In the newly NR growing states of Goa and Maharashtra, more than 50 per cent of the farmers established cover crops in the immature phase of NR (Table 6). *Pueraria phaseoloides* and *Mucuna bracteata* are the two common cover crops grown in India. Seventy nine per cent of the growers in Goa and 98 per cent of the growers in Karnataka established *Mucuna* in NR plantations, whereas, more than 50 per cent of the NR growers in Kerala, Kanyakumari and Maharastra established *Pueraria* in rubber plantations. *Pueraria* was the widely used cover crop during the initial years of establishment of NR plantations in the traditional NR growing regions and *Mucuna* was introduced in these tracts during 1980's only, hence the rate of adoption of Mucuna was less than to *Puraria* in the traditional NR growing tracts. *Mucuna* grows well under shade and drought conditions.

In the traditional NR growing tracts, 38 per cent of growers in Kerala and 22 per cent of growers in Kanyakumari were engaged in intercropping (Table 6). The choice of intercrops depends on the age of NR plantations, climate, market preference and geography. Intercropping provides additional income in NR plantations during the cash trap period of immature phase and is an insurance against price fluctuations in the mature phase (Siju *et al.*, 2012) and mitigated

drought and sustained soil fertility (Jessy *et al*., 2016). More over intercropping offers employment opportunities for local labours and promotes ecological diversity as well as economic diversity, which can help to protect farmers against volatility in both climatic and market terms (Carlisle, 2016).

Banana and pineapple are the popular intercrops cultivated in NR plantations and tapioca, tuber crops and combination of intercrops are also being grown on level or near level lands depending on regional suitability. It was observed that in all states majority of the intercropped area were planted with banana, especially in Tamil Nadu (94%) and Goa (100%). Kerala was the only state where tapioca was cultivated as intercrop in NR and only five per cent of the farmers cultivated tapioca as intercrop. In southern Goa, intercropping was not observed in the surveyed NR plantations but in northern Goa 29 per cent of the growers adopted intercropping and banana was the only intercrop cultivated. Pineapple intercropping was observed in all states except Goa. In Maharashtra around 50 per of the farmers adopted pineapple intercropping where as in Kerala, Karnataka and Tamil Nadu the percentage of adoption was 11, 9 and 3, respectively. The trend of cultivating pineapple as an intercrop in rubber plantations began a decade back and contract farming of pineapple intercropping is more profitable in large estates. In Kerala, 93 percent of the NR growers are small holders (Joseph and Viswanathan, 2016) and most of them preferred banana compared to pineapple. In central Kerala, pineapple was the most popular intercrop in NR where Vazhakkulam, the largest pineapple market of the country is located (Siju *et al*., 2015). Ernakulam, Idukki and Kottayam are major pineapple producing districts in the central region and constitute 80 per cent of total area and 85 per cent of total production of pineapple in the state (Padmini, 2002). The adoption of pineapple intercropping in Ernakulam, Idukki and Kottayam district was 43, 43 and 13 per cent, respectively.

Weed management

The choice of a particular weed management practice depends on age of rubber, size of the holding, type of weed and its distribution (Yogaratnam, 1991). In NR plantations, the common methods adopted for weed control include slashing by sickle (manual), herbicide spray (chemical) and mechanical weed control by weed cutters. The adoption of different weed control measures by NR growers in different states is given in Table 7.

The study revealed that more than 86 per cent of the NR growers in South India adopted manual method of weed control in immature and mature rubber plantations. The use of weedicides/herbicides for weed management was observed in all states other than Goa and the adoption was only less than 2.4 per cent. In these regions growers followed an integrated approach for weed management. *i.e.* herbicide application and manual weeding. Kerala is the only state where herbicide alone was used for weed control and the rate of adoption was less than two per cent. The manual method of weed control along with weed cutter was adopted by the growers of Karnataka in immature (18%) and mature (16%) plantations. The NR growers in Kerala adopted all types of weed control methods including integrated weed management. More than 50 per cent of the respondents in Trissur district of Kerala followed mechanical method of weed control in immature and mature NR plantations.

Table 7. **Level of adoption of weed management practices by growers in different rubber growing areas of South India (%)**

State	District	Immature rubber						Mature rubber					
		Manual (M)	Weed cutter (W)	Herbicide (H)	M+H	M+W	H+W	Manual (M)	Weed cutter (W)	Herbicide (H)	M+H	M+W	H+W
Goa	North Goa	100	-	-	-	-	-	100	-	-	-	-	-
	South Goa	100	-	-	-	-	-	100	-	-	-	-	-
	Average	100	-	-	-	-	-	100	-	-	-	-	-
Karnataka	Chikmagalur	67	-	-	-	33	-	67	-	-	-	33	-
	Coorg	100	-	-	-	-	-	100	-	-	-	-	-
	Dakshin Kannada	83	5	-	-	12	-	85	4	-	-	11	-
	North Canara	75	-	-	-	25	-	75	-	-	-	25	-
	Shimoga	60	-	-	20	20	-	57	-	-	29	14	-
	Udupi	83	-	-	-	17	-	88	-	-	-	13	-
	Average	78	1	-	3	18	-	79	1	-	5	16	-
Kerala	Alappuzha	100	-	-	-	-	-	100	-	-	-	-	-
	Ernakulam	79	6	4	10	1	-	79	8	4	8	1	-
	Idukki	93	2	1	1	2	-	94	2	1	-	3	-
	Kannur	86	4	-	-	10	-	85	4	-	-	10	-
	Kasaragod	88	-	-	1	11	-	88	-	-	1	11	-
	Kollam	94	-	-	5	2	-	95	-	-	4	1	-
	Kottayam	82	3	6	4	5	1	82	4	5	3	6	1
	Kozhikode	87	-	-	2	11	-	80	-	-	7	13	-
	Malappuram	52	-	1	2	45	1	53	-	1	3	44	1
	Palakkad	81	-	2	-	17	-	45	45	1	-	9	-
	Pathanamthitta	95	2	1	-	1	-	96	2	1	-	2	-
	Trissur	38	50	6	-	6	-	24	72	4	-	-	-
	Trivandrum	93	-	2	-	5	-	98	-	-	-	2	1
	Wayanad	96	4	-	-	-	-	86	4	8	-	-	2
	Average	83	5	2	2	8	-	77	11	2	2	8	-
Maharashtra	Sindhudurg	97	-	-	3	-	-	97	-	-	3	-	-
Tamil Nadu	Kanyakumari	88	9	-	3	-	-	77	9	-	2	11	-

n= 8265

Table 8. **Level of adoption of dry season management practices by growers in different rubber growing areas (%)**

State	District	Dry season management practices			
		Shading	Irrigation	White washing	Tilling
Goa	North Goa	-	100	-	-
	South Goa	-	100	-	-
	Average	-	100	-	-
Karnataka	Chikmagalur	-	17	83	-
	Coorg	-	-	100	-
	Dakshin Kannada	2	-	98	-
	North Canara	25	50	25	-
	Shimoga	13	4	83	-
	Udupi	8	8	85	-
	Average	8	13	79	-
Kerala	Alappuzha	-	4	96	-
	Ernakulam	1	3	96	-
	Idukki	5	16	75	5
	Kannur	-	2	96	2
	Kasaragod	11	-	86	3
	Kollam	-	-	100	-
	Kottayam	2	1	94	3
	Kozhikode	-	-	100	-
	Malappuram	4	3	93	-
	Palakkad	1	4	94	1
	Pathanamthitta	3	3	94	1
	Trissur	-	-	100	-
	Trivandrum	-	-	98	2
	Wayanad	-	-	100	-
	Average	2	3	94	1
Maharashtra	Sindhudurg	14	76	3	7
Tamil Nadu	Kanyakumari	-	4	90	6

n= 8021

Traditionally, weed control in NR plantations has been largely dependent on manual weeding. Due to the increasing cost of labour and wide spread apprehension about the environmental impact of herbicides, the usage of mechanical weeders like brush cutters / weed cutters are becoming more popular among NR growers. By adopting mechanical method of weed control, 75 per cent of weeding cost can be

reduced compared to manual method (Joseph and Jessy, 2013). The survey shows the need for identifying the constraint for large scale adoption of weed cutters and appropriate interventions to increase the use of weed cutters.

Dry / summer season management

Rubber plantations are usually grown under rain fed condition and a moderate water stress is experienced during summer season. During the initial years of establishment of NR plantation, adoption of suitable dry season management strategies are important. Mulching around the plants, white washing of brown bark, providing shade and lifesaving irrigation and tilling of plant basins are the recommended dry season management strategies in young NR plantations. Mulching is a common dry season management practice adopted by the NR growers during the initial years of establishment of NR in all states except in Goa where due to the high probability of occurrence of forest fire, mulching was not common.

Table 8 shows the information on the level of adoption of various dry season management practices by NR growers of different states. It was observed that in Goa, life saving irrigation was the only dry season management practice followed by all the NR growers for young plants during summer months. In Maharashtra, 76 per cent of the growers adopted irrigation in their plantations. The climatic conditions are less congenial for growth of NR in Goa and Maharashtra where prolonged dry season is a constraint, and irrigation is essential in the initial years for the establishment and early growth of plants.

In Kerala, Tamil Nadu and Karnataka white washing of main stem was the widely accepted practice and the rate of adoption was 94, 90 and 79 per cent, respectively. The proportion of farmers who implemented conservation tillage for dry season management was very less, and was observed one per cent in Kerala, six per cent in Tamil Nadu and seven per cent in Maharashtra. Tamil Nadu and Maharashtra experience more recurrent drought incidents than Kerala and conventional tillage is a common farming practice in the drought prone areas in several crops. Tillage reduced evaporation and capillary rise in the soil by creating discontinuity in the capillary system (Jessy *et al*., 2011).

CONCLUSION

The survey conducted for assessing the extent of adoption of agro management techniques revealed that in the NR growing regions of South India, majority of the NR growers adopted most of the recommended practices, though regional differences were observed. Extent of adoption of integrated approach for soil and water conservation was less indicating the need for renewed effort to generate awareness. In recent years, labour shortage and increasing labour wages in the plantation industry resulted in the wide acceptance of the use of earth movers or tractor mounted hole diggers for land preparation and brush cutters / weed cutters for weeding operations. Hence, more attention should be given to fabricate / manufacture implements or machinery that can replace manual labour in NR plantations to reduce cost of cultivation and address labour shortage. Many of the recommendations of the Rubber Board like root trainer planting materials, small pits for planting, intercropping with perennial crops *etc.* were issued during the end of last decade or first half of this decade and are yet to be

adopted by farmers on large scale and extension activities should be strengthened for the effective dissemination of these technologies among farmers.

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