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COST BENEFIT ANALYSIS OF NATURAL RUBBER CULTIVATION

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The R & D efforts of Rubber Research Institute of India led to development of region-specific high yielding clones, farm mechanization and new techniques for nursery, farm management and crop harvesting for enhancing cost competitiveness and addressing labour shortage. Based on these recommendations, a Benefit Cost Ratio (BCR) analysis was done to check whether natural rubber (NR) cultivation can be made sustainable under the current scenario of plunge in prices. Adopting technology-driven good agricultural practices to increase productivity and reduce cost of production in NR holdings is the key to improve the BCR and thus ensuring sustained supply of NR in the country. The BCRs of NR cultivation under different price and productivity scenarios in the traditional, North East and North Konkan regions were estimated. The present analyses show that adoption of technological innovations with cost-saving and income-enhancing measures can make NR cultivation moderately profitable even during the prevailing low price scenario. In the prevailing situation of low NR price and high labour/input costs, reducing cost of production has a greator impact on improving BCR than increasing productivity. Adopting technological innovations can still make NR harvesting from existing mature holdings profitable. Having invested in developing a rubber plantation, leaving it untapped, blaming low price and absence of any bailout schemes from the government is a lost economic opportunity for the grower and a national waste.

Key words: Benefit Cost Ratio, Cultivation practices, Natural rubber, North-East region, North Konkan region, Traditional region

INTRODUCTION

In the primary commodity market, liberalization of external trade coupled with de-protection policies in the domestic market often transform the stable and remunerative home market in to a volatile one characterized by heavy and frequent ups and downs, shattering the staying capacity of the farmers (Mohanakumar and Chandy, 2009). Until the 1990s Indian natural rubber (NR) plantation sector enjoyed the comforts of a protected economy and thus remained insulated from external shocks. In the protected economic regime, government used to intervene when NR prices crashed (George *et al*., 1988; George *et al*., 2002) which is not always feasible in the liberalized economy. Indian NR prices started to crash since 2012-13 (Rubber Board, 2015; 2017) along with international prices (Rubber Board, 2013) and a significant proportion of the Indian growers found it difficult to cope with the low price situation. NR price in India dropped to the extent of 46 per cent during 2015-16 compared to the high price achieved during 2011-12 and the

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tapped area dropped by 38 per cent from 5,04,040 ha during 2012-13 to 3,91,000 ha during 2015-16. Though, NR price and tapped area showed improvements later, even in 2016-17 more than 24 per cent of the mature area was left untapped owing to low price (Rubber Board, 2017). Prospects of an immediate marked improvement in NR price seem not bright as of now.

The value of output of Indian rubber industry is substantial (Rs. 74946 crores) (DGCI&S, 2018) and the value of output of manufacture of rubber products was 3.93 per cent of the manufacture GDP of India during 2014-15 (ASI, 2017; RBI, 2018). India is the sixth largest producer and second largest consumer of NR in the world. The country's share in global NR production is five per cent whereas, its share in global consumption is a little over eight per cent. Despite marked drop in domestic production in NR, its consumption increased in recent years, *albeit* at modest rates. The deficit was met by rising imports and the domestic rubber industry became increasingly dependent on large quantities of imported rubber. The share of imports in NR consumption increased from 10.02 per cent in 2007-08 to 46.09 during 2015-16 (Rubber Board, 2016).

Among the various factors influencing the export of rubber products, availability of raw materials play a significant role and hence, over-dependence on imported NR did not seem to sustain export of rubber products (Joseph and Jacob, 2018). As the economy continues to grow, India would require about 20 lakh tonnes of NR by 2030 (Joseph and Jacob, 2018). Currently India has the potential to produce close to 10 lakh tonnes of NR although the realized production today is much below this due to low rubber price. If the country does not produce sufficient quantities of NR to meet its rising industrial demand, it will hurt not just the rubber growers and the rubber products manufacturing industry but the economy at large, since rubber industry plays a significant catalytic role in Indian economy. There are large number of rubber products that find strategic applications in critical sectors such as defense, aerospace and communication and hence, in a fast growing economy like India the captive supply of this strategic raw material has to be ensured. Realising the crucial role of this raw material to Europe's industrial base and economy, European Commission included NR in its list of 27 critical raw materials and NR is the only agricultural produce in the list (European Commission, 2017).

NR cultivation is not only a means of sustainable livelihood to more than a million small rubber growers but also provides employment to rural masses but also leads to recurring income generation over a long period. The contribution of rubber in the social upliftment of socially and economically deprived communities in Tripura and Odisha are worth mentioning (Joseph *et al*., 2010; Siju *et al*., 2018). The income generated from rubber cultivation has transformed the tribal communities in Tripura and has helped in eradicating decades of insurgency in the state (Joseph *et al*., 2010). In the Left Wing Extremism affected areas, NR cultivation has proved to be a powerful tool for socio-economic development of the marginalized peasant communities and integrating them with the mainstream society. Rubber cultivation results in restoration of denuded ecosystem *(eg*. *Jhummed* lands in North East) (Joseph *et al*., 2010) and sequesters large amounts of carbon dioxide from the atmosphere (Ambily *et al*., 2012; Kosei *et al*., 2014). Rubber plantations are also a source of renewable timber saving forests.

Unhindered access to this strategic raw material is too important to be left to the vagaries of the free market and hence, there is the need to ensure adequate domestic production of NR which is possible only if its cultivation is profitable to the grower which is not the case for the past several years in holdings that follow traditional cultivation practices and large extent of such plantations have remained untapped. With price staying low and the production costs remaining high, tapping the rubber trees has become less profitable today and rubber holdings with poor yields are the worst affected. Our estimate shows that this was as much as 30, 24 and 22 per cent of the total mature area in the country during 2015-16, 2016-17 and 2017-18, respectively. This has led to marked reduction in domestic NR production and steep rise in imports (Rubber Board, 2018). The root cause of the crisis experienced by the Indian NR plantation sector can be traced to its near total inability to face the challenges posed by the free market economy. For its very survival, it is crucial for the NR plantation sector to adapt to the realities of free market economy sooner than later. Cost competitiveness is central to this and technology has a major role in improving the cost competitiveness. It is in this larger context of challenges posed by the globalized economy to the Indian rubber industry and the commercial, socio-economic and social imperative to produce NR in the country, a BCR analysis was made to check whether NR cultivation is economically sustainable. The paper describes the BCR of NR cultivation under different productivity scenarios in different rubber growing regions of India and evaluates the change in BCR of NR cultivation when cost reducing and income enhancing technologies are adopted. The study also estimated the minimum productivity required for breakeven BCR, and the BCR based on operational cost in mature plantations.

MATERIALS AND METHODS

The present study makes cost benefit analysis of NR cultivation for different rubber growing regions under different cost and yield scenarios. The BCRs for different regions were estimated using the formula: BCR = sum of discounted revenue/sum of discounted costs. Discounting was done using the discount factor: 1/(1+r)^n and in the present analysis n=30 which is the economic lifecycle considered for NR plantation. Revenue considered for the analysis was the amount received (price* productivity) from the sale of the crop (rubber) which included sheet rubber (both RSS 4 and 5) and field coagulum. Cost used was the rates prevailing in the different regions which included all labour and material costs involved in the production of NR.

Profit of NR cultivation depends on productivity, cost of production and price of NR and all the three vary among the different rubber growing regions of India. Hence, BCRs were worked out for three different regions of India, *viz*. (i) Traditional region, (ii) North Konkan region and (iii) North eastern region.

The cost-saving technologies considered for the analysis for all the regions are mechanization for land preparation during planting (terracing and pitting), intercropping (saving in weeding *etc*.), use of root trainer plants, adoption of weekly tapping, selective weeding only on platforms (except for NE) with weed cutter and fertilizer skipping in mature holdings (application limited to once in 3 years) (Annexure I). The income enhancing technologies considered for traditional and North Konkan region are pineapple cultivation for the first four years

and cocoa cultivation from 10th year onwards (Annexure IIa). For north-eastern region the income enhancing technology considered was cultivation of banana + amorphophallus + coffee from first year onwards (Annexure II b). The cost and price considered were for the year 2016-17. For the three regions, the BCRs were worked out for two different cost scenarios based on two cultivation practices, *viz*. (i) using standard agricultural practices (without using cost-saving and income enhancing technologies) and (ii) latest good agricultural practices (GAPs) which included cost-saving and income enhancing measures.

RESULTS AND DISCUSSION

BCR under different productivity and cost scenarios

BCR analyses of rubber cultivation in different parts of the country under different productivity and cost-saving and auxiliary income scenarios are presented in Table 1. Increasing productivity and reducing costs is the key to improving BCR. Present analyses show that by following traditional standard cultivation practices, NR cultivation is not profitable under the present productivity and price scenarios. But by adopting latest technology-driven innovations aimed at saving cost of production and increasing auxiliary farm income, it is seen that NR tapping is still profitable.

Several key findings emerge from the BCR models for profitable rubber cultivation presented in Table 1. One significant finding is that for a given productivity and price, BCR is relatively higher in the North East than in the traditional regions; thanks to the low cost of cultivation in the north-eastern region. But realized yields remain high in traditional region compared to the North East making rubber cultivation more attractive in the traditional region. The potential and prospects for further rise in

Table 1. **BCR of NR cultivation in different regions of India under different productivity and cost scenarios**

(i) Traditional region

Cost scenario according to cultivation practices	Yield scenario (kg $ha^{-1}yr^{-1}$)		
	1629[a]	1931[b]	2500[c]
Using standard agricultural practices	0.71	0.85	1.10
Using cost saving and income enhancing GAPs	1.44	1.63	1.98

[a]Annual average productivity in traditional region during 2016-17. [b]Highest annual average productivity obtained in traditional region. [c]Highest productivity obtained in well maintained select holdings in traditional region.

(ii) North eastern region

Cost scenario according to cultivation practices	Yield scenario (kg $ha^{-1}yr^{-1}$)				
	1257[d]	1270[e]	1750[f]	1931[g]	2500[h]
Using standard agricultural practices	0.75	0.76	1.05	1.16	1.50
Using cost saving and income enhancing GAPs	1.40	1.42	1.85	2.01	2.51

[d]Annual average productivity in North eastern region during 2016-17. [e]Highest average productivity in North eastern region. [f] Highest productivity achieved by well maintained select holdings in North eastern region. [g]Highest annual average productivity achieved in traditional region. [h] Highest annual average productivity obtained in well maintained select holdings in traditional region.

(iii) North Konkan region

Cost scenario according to cultivation practices	Yield scenario (kg ha^{-1} yr^{-1})				
	1000[i]	1016[j]	1500[k]	1931[l]	2500[m]
Using standard agricultural practices	0.53	0.54	0.79	1.02	1.32
Using cost saving and income enhancing GAPs	1.02	1.08	1.38	1.65	2.01

[i]*Annual average productivity obtained in North Konkan region during 2016-17.* [j]*Highest annual average productivity obtained in north Konkan region.* [k]*Highest annual average productivity achieved by select holdings in north Konkan region.* [l] *Highest average productivity achieved in traditional region.* [m]*Highest annual average productivity obtained in well maintained select holdings in traditional region.*

productivity are higher in the North East because the yield is still low compared to traditional region and this is on the rising phase in the North East.

A close analysis of the BCR data presented in Table 1 also revealed that for the various cost and productivity scenarios examined here, cost reduction and auxiliary income enhancing measures has a much bigger impact on increasing BCR in the current low price scenario in all regions, compared to increase in productivity. This is because the relative impact of cost is much larger than that of productivity today (and the cost component will most likely remain high in future as well) and rubber price is at a low (which could go up in future). Adopting latest technologies for reducing the costs/ increasing auxiliary income and increasing productivity should be a top priority irrespective of rubber price for improved profits, but during the current times of low NR price, the former assumes greater relevance.

A third significant finding from the analysis presented in Table 1 is that by adopting cost reduction and additional income generation measures, BCR will increase in all regions, and the increase is the highest in the traditional region than in the North East and the North Konkan regions. It is evident that under the prevailing low productivity and price scenario, NR harvesting is not profitable in any region unless latest technologies are implemented to save costs and increase auxiliary farm income. The North Konkan region may be only barely profitable even after adopting latest innovations as long as NR prices stay low.

If productivity goes up, NR cultivation will become more economical in the north-eastern region. Total area under NR cultivation also should expand in the North East if it's perceived BCR advantage should get translated into more NR production from the region which is achievable. Satellite-based remote sensing analyses have been successfully employed in collaboration with ISRO to locate and map wastelands in the North East where NR can be newly cultivated without entering forests or food cropped areas (RRSC & RRII, 2012). Studies conducted by RRII in collaboration with IIT, Kharagpur have shown that regional climate warming will benefit rubber cultivation in the North East (Satheesh and Jacob, 2011). Thus the north-eastern region presents excellent opportunities for profitable NR cultivation. But it is important that NR production continues in the traditional region as more than 75 per cent of the national production still comes from this region. This situation will not change quickly because of the long gestation period and life cycle of this tree crop.

Table 2. **Minimum productivity needed for breakeven BCR**

Cost scenario according to cultivation practices	Minimum productivity (kg $ha^{-1}yr^{-1}$) needed for BCR = 1		
	Traditional region	North-East region	North Konkan region
Using standard agricultural practices	1920	1400	1600
Using cost saving and income enhancing GAPs	790	665	750

Break-even BCR

The minimum productivity that is needed to get a break-even BCR in the traditional region (at the 2016-17 costs and NR price) is 1920 kg ha^{-1} yr^{-1} based on old cultivation practices (Table 2). The break-even productivity is way above what is realized today in all regions and therefore adopting old practices is not profitable. If latest technology driven practices are adopted, the break-even productivity (at the current costs and price) goes down markedly (Table 2). This clearly shows that NR harvesting is still profitable even under the current productivity levels and low price scenario, provided cost-saving/auxiliary income enhancing technologies are adopted in full earnest. Profitable NR cultivation will have to harp on the twin agendas of reducing the costs and increasing revenue. During periods of low rubber price as is the case now, adopting technologies aimed at saving costs and increasing auxiliary income from the farm are more relevant than productivity to make NR cultivation profitable.

BCR based on current operational costs in a mature holding (Operational profit)

A quarter of the tappable area which is currently remaining untapped is almost entirely in the traditional region. This is because the current low revenue from NR is not satisfactory for the growers. Analysis based on annual operational costs only showed that tapping the rubber trees even during the low price and productivity scenario of 2016-17 is marginally profitable in the traditional (BCR=1.20) and North East (BCR=1.29) regions, even with old cultivation practices and by adopting cost reducing and income enhancing technologies, the operational profit improves considerably in both the regions (Table 3). Having invested in developing a NR plantation, leaving it untapped blaming low NR price is therefore not an intelligent economic decision on the part of the grower.

CONCLUSION

In a liberalized economy, NR growers are more vulnerable to price volatilities and

Table 3. **Comparison of operational profit from an yielding NR plantation in three different regions**

Cost scenario according to cultivation practices	Operating BCR		
	Traditional region	North-East region	North Konkan region
Old cultivation practices	1.20	1.29	0.84
Latest technology-driven practices	1.64	1.99	0.95

BCR calculated on the basis of 2016-17 cost and productivity

market shocks. NR being an industrial raw material (and not an agricultural produce) restrictions imposed by various international trade agreements limit the scope of government interventions in the domestic market. The BCR analyses show that adopting technological innovations can make NR harvesting from mature holdings profitable and sustainable and thus empower them to face challenges posed by economic liberalization, in the present instance, sharp decline in rubber price.

Benefits of technological innovations should reach the grower and this is central to making NR cultivation profitable and internationally competitive. Some of these recent innovations are based on cutting-edge areas of modern science and technology such as satellite-based remote sensing, application of geospatial technology and Information and Communications Technology (ICT) for soil health management, internet based grower advisory services, gene technologies for developing high yielding, climate-resilient rubber clones adapted to different rubber growing regions, location-specific farm practices *etc*. (Meti *et al*., 2016; Mydin *et al*., 2017) Principles of ecological sustainability are successfully combined with crop husbandry in developing GAPs aimed at improving crop diversification for higher farm income, biodiversity, soil and water conservation *etc*. (Jessy *et al*., 2015).

Poor diffusion and adoption of technological innovations by the grower community has adversely affected their competitive fitness in a liberalized/ globalized economy. This accentuates the

Annexure I. **Cost-saving technologies considered in the present analyses**

Technologies	Possible cost saving in different regions		
	Traditional	North East	North Konkan
Mechanization for land preparation during planting (terracing and pitting) for first year only	Rs. 80,000/-	Rs. 37,620/-	Rs. 40,000/-
Intercropping (saving in weeding *etc*.)	Rs. 1,12,100/- (Rs. 28,025/- for first four years)	Rs. 72,240/- (Rs. 18,060/- for first four years)	Rs. 54,180/- (Rs. 13,545/- for first four years)
Root trainer plants	Rs. 3,850/-	Rs. 3,850/-	Rs. 3,850/-
Weekly tapping	Rs. 26,445/-yr^{-1} during mature phase	Rs. 26,445/-yr^{-1} during mature phase	Rs. 26,445/- yr^{-1} during mature phase
Selective weeding only on platforms with weed cutter	Rs. 16,000/- yr^{-1} during 23 years in mature phase	Rs. 10,150/- yr^{-1} during 23 years in mature phase	Rs. 7,840/- yr^{-1} during 23 years in mature phase
Fertilizer skipping in mature holdings (application limited to once in 3 years)	Rs. 3,333/- yr^{-1} during 23 years in mature phase	Nil	Rs. 2,500/- yr^{-1} during 23 years in mature phase

Annexure II a. **Auxiliary income enhancement: Traditional and North Konkan region**

Option	Income enhanced	
	Traditional	North Konkan
Pineapple cultivation for first 4 years and cocoa from 10th year onwards	Rs. 6,19,430/- during the entire life cycle	Rs. 6,19,430/- during the entire life cycle

Annexure II b. **Auxiliary income enhancement: North-East region**

Option	Income enhanced
Banana + amorphophallus + coffee from first year onwards	Rs. 3,43,555/- during the entire life cycle

present crisis in the rubber plantation sector in the country caused by low NR price. Creating awareness among growers about the latest technological developments and nudging them into adopting the technologies alone can make the growers successfully compete globally and make NR cultivation profitable.

The analyses here show that at the current level of productivity, price and cost of production, harvesting latex from mature NR holdings can still be profitable by adopting the latest cost saving technologies and measures for increasing auxiliary income. Admittedly, growers' profits have come down due to steep decline in NR price, but its cultivation is still a profitable venture in India even at today's low price; thanks to the innovations made by Rubber Research Institute of India. Therefore, non-adoption of these innovations and leaving mature NR holdings untapped as is the case now in large extents of plantations is a lost economic opportunity for growers and a national waste.

REFERENCES

Ambily, K.K., Meenakumari, T., Jessy, M.D, Ulaganathan, A. and Nair, N.U. (2012). Carbon sequestration potential of RRII 400 series clones of *Hevea brasiliensis*. *Rubber Science*, **25**(2): 233-240.

ASI (2017). Estimate of selected characteristics of factory sector by 3 digit industry group (NIC 2008) for each state/UT, Annual Survey of Industries 2014-15, Ministry of Statistics and Programme Implementation, Government of India, Vol. 1: P. 174.

DGCI & S (2018).Export Import Data Bank, Directorate General of Commercial Intelligence and Statistics, Department of Commerce, Ministry of Commerce and Industry, Government of India, Available at: www. commerce.nic.in.

European Commission (2017). Critical raw materials. Available at:http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical-en.

George, K.T., Haridasan, V. and Sreekumar, B. (1988). Role of Government and structural changes in rubber plantation industry. *Economic and Political Weekly,* **23**(48): 158-166.

George, K.T., Joseph, T. and Joseph, J. (2002). Natural rubber in the post-QRs regime. *Economic and Ploitical Weekly*, **37**(32): 3319-3321.

Jessy, M.D., Joseph, P. and George, S. (2015). Establishing perennial intercrops in rubber plantaions after removal of pineapple: Effect on growth and yield of rubber, soil moisture and nutrient status. *Rubber Science*, **28**(2): 138-146.

Joseph, J. and Jacob, J. (2018). Over-dependence of Indian Rubber Industry on imported natural rubber: The question of long term sustainability. *Rubber Science*, **31**(1): 1-9.

Joseph, J., George, K.T. and Dey, S.K. (2010). Report on the impact of Natural Rubber cultivation under the block planting scheme in Tripura. Working Paper ER/4, Rubber Research Institute of India, Kerala, India. 39p.

Kosei, S., Watanabe, N., Takase, M., Hosako, T. and Gyokusen, K. (2014). Carbon sequestration, tree biomass growth and rubber yield of PB 260 clone of rubber tree *(Hevea brasiliensis)* in North Sumatra, *Journal of Rubber Research*, **17**(2): 115-127.

Meti, S., Pradeep, B., Jacob, J., Shebin, S.M. and Jessy, M.D. (2016). Application of remote sensing and GIS for estimating area under natural rubber cultivation in India. Rubber Science, **29**(1): 7-19.

Mohanakumar, S. and Chandy, B. (2009). Farm price volatility and its impact on rural labour market under neo-liberal regime: a study of rubber tapping labourers in Kerala. *Journal of Rural Development*, National Institute of Rural Development, **28**(2): 169-183.

Mydin, K.K., Meenakumari, T., Narayanan, C., Thomas, V., Gireesh, T., Suryakumar, M., Antony, D., Idiculla, S.P., Joseph, A., Mandal, D., Dey, S.K., Das, G., Krishan, B., Singh, M. and Jacob, J. (2017). Region-specific advisory on *Hevea* clones suited to traditional and non-traditional rubber growing areas of India. Rubber Science, **30**(2): 95-110.

RBI (2018). Database on Indian Economy, Reserve Bank of India, Available at: http://nma.org.WP-content/uploads/2016/09/NMA-Berland-Handout-FINAL.pdf.

RRSC and RRII. (2012). Geospatial technology for acreage estimation of natural rubber and identification of potential areas for its cultivation in Tripura state. Collaborative project report of Regional Remote Sensing Centre (RRSC), ISRO, Bengaluru and RRII, Rubber Board, Kottayam.

Rubber Board (2013). *Indian Rubber Statistics,* Volume 36. Rubber Board, Kottayam, India, 69p.

Rubber Board (2015). *Rubber Grower's Companion,* 2015. Rubber Board, Kottayam, India. 85p.

Rubber Board (2016). *Indian Rubber Statistics,* 2015. Rubber Board, Kottayam, India. 37p.

Rubber Board (2017). *Indian Rubber Statistics,* Volume 38. Rubber Board, Kottayam, India. 37p.

Rubber Board (2018). Personal communication, Statistics and Planning Department, Rubber Board, Kottayam.

Satheesh, P.R. and Jacob, J. (2011). Impact of climate warming on natural rubber productivity in different agro-climatic regions of India. *Natural Rubber Research,* **24**(1): 1-9.

Siju, T., Chandy, B. and Jacob, J. (2018). Rubber cultivation driven socio-economic development of tribal communities in Odisha. *Rubber Science*, **31**(2): 140-151.