Kerala's rubber revolution

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THARIAN GEORGE K

THE Rubber Research Institute of India (RRII), which is celebrating its golden jubilee this year, has a number of achievements to its credit.

Most significant is the development and popularisation of the high yielding clone RRII 105 since 1980. The introduction of RRII 105 virtually revolutionised the cultivation of natural rubber (NR) in Kerala in terms of sustained increases in national average yield, production and expansion of area.

Beyond these achievements, has there been an intangible contribution by the RRII to the small-holder sector?

In order to answer that, it is necessary to comprehend the unique regional and historical contexts in which NR cultivation has been nurtured in Kerala, the policy regimes and socio-economic milieu which ensured surplus generation in the small-holder sector.

First, unlike in the case of other major NR producing countries, the introduction of its cultivation in Kerala was characterised by the active participation of the peasantry. Despite its colonial heritage, Indians controlled about 73 per cent of the area under rubber even as early as in 1946. This was contrary to the dominant foreign ownership and control of NR production in Malaysia and Indonesia during the colonial period. This unique feature of Kerala's rubber sector, which has accounted for more than 90 per cent of the country's NR production during the last one century, had important policy implications.

The introduction of commercial cultivation of NR in the State in the early 20th century coincided with a phase of remarkable commercialisation of agriculture, growth in trading and banking, and other conducive factors such as access to general education and development of the transport infrastructure.

The introduction of NR cultivation by the British opened up a new vista of enterprise for the peasantry in the State to channel the surplus generated from the commercial cultivation of traditional crops and those from trading and banking. Three important developments during the pre-Independence phase, namely:

- Growth of an indigenous rubber products manufacturing industry since the 1920s;
- bypassing of two International Rubber Regulation Agreements (IRRAs); and
- statutory price regulations of NR since 1942,

proved pivotal in the dynamic growth of the NR sector. The cumulative impact of these developments ensured a comparatively remunerative price.

The policy regime on NR, post-Independence, has been characterised by proactive government interventions under the national economic policy for achieving the twin objectives of self-sufficiency and import substitution. The two-pronged strategy that was adopted to attain the objectives were: Increasing yield in the traditional belt, and expansion of NR cultivation in the non-traditional areas. A major breakthrough in the former was achieved with the development and popularisation of the clone RRII 105. The resultant boom in planting, especially the rate of new planting during 1980-90 was unprecedented in the history of rubber planting in the country since 1950.

However, the critical factor that sustained the tempo of growth has been a protected price policy regime which ensured remunerative prices as in the pre-Independence phase.

The popular adoption of RRII 105, with its higher yield, and protected prices led to higher surplus generation. As the small-holder sector had been more enthusiastic to adopt the new clone compared to the large estate sector, the potential benefits of the higher yield and the protected price primarily accrued to the former.

At the other end of the spectrum, this success story has been confronted by three major challenges:

- Growing sub-division and fragmentation of holdings leading to limited options for reinvestment in the dominant small-holder sector with an average size of less than 0.50 hectare;
- Limited scope for new planting in Kerala in the absence of adequate area under favourable agro-climate; and
- Growing market uncertainty in NR prices since 1997 casting a shadow on the hitherto observed momentum in the expansion of area under the crop.

The cumulative impact of the surplus generation and the problems arising from the three major challenges led to the channelling of the surplus generated to non-rubber sources of income, especially investments in the formal education of children. The pattern of investment in a new and sustainable source of income by the dominant small-holder sector in Kerala has been evident from various field surveys done during the past one decade.

The choice of disciplines for professional education ranged from para-medical courses to information technology and business management. Despite the regional variations in the proportion of persons with professional qualifications and employment within the small-holder sector, the growing trend towards multiple sources of non-farm income vary from employment in the country and abroad as well as self-employment in a wide array of activities in the service sector.

To a large extent, the diversified sources of income must have enabled the small-holder sector withstand crises during the past one decade. Interestingly, not a single farmer suicide has been reported in the rubber sector even during its worst period of the crisis, in 1997-2001.

Although this highlights the intangible contribution of RRII 105 in terms of the feasibility of survival strategies adopted by the small-holders, the changes also had seeds of potential agro-management issues. The three specific issues posing challenges to the small-holder sector are:

- Steady increase in the share of part-time farmers;
- Growing trend towards homestead farms with inter-planting of timber species; and
- Increasing dependence on hired labour.

While the phenomenon of increasing number of part-time farmers is *the outcome of the inherent dynamics* built upon the diversification of the sources of income in the small-holder households, the logical premise of the transmutation process leading to the emergence of homestead farms has to be located in the sub-division and fragmentation of the holdings.

The disengagement from authentic peasant selfhood by the new generation of small-holders led to increasing dependence on hired labour in spite of the smaller size of the holdings. In sum, while it is commendable to surmise that the evolutionary dynamics of the small-holder sector in Kerala has been unparalleled in the realm of natural rubber cultivation, the challenges sin the era of market integration pose serious questions on the compatibility of the prescribed agro-management systems.

(The author is Deputy Director, Rubber Research Institute of India, Kottayam.)

Solution to Crossword No. 287

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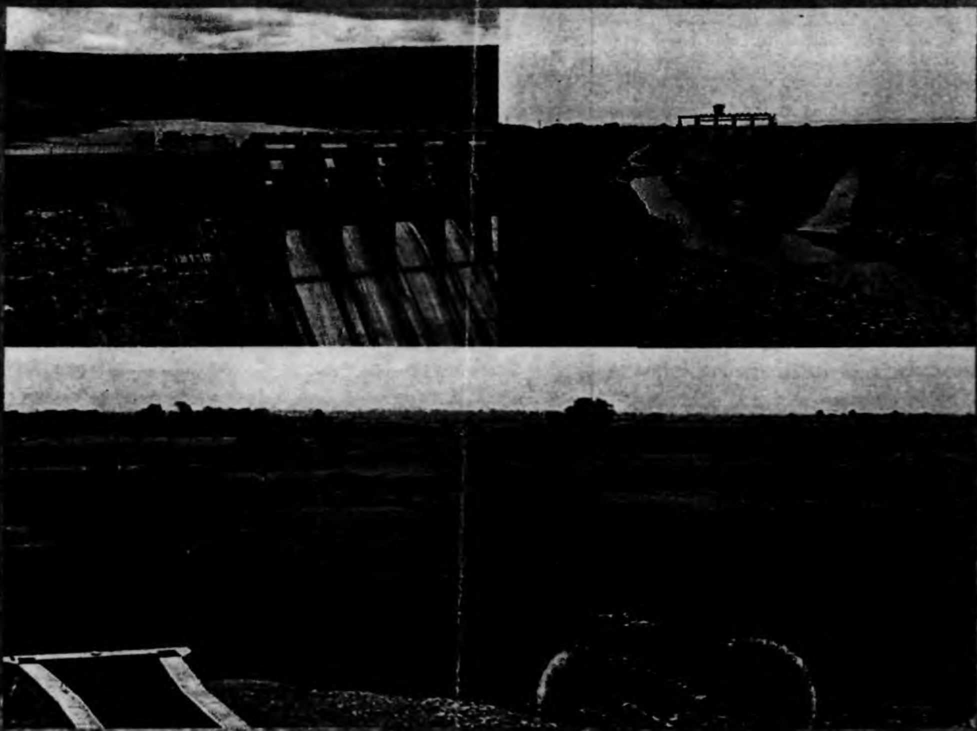

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Conservation Pits : A Viable Soil Conservation and Water Harvesting Technology for Rubber Plantations

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Abstract

Soil erosion caused by runoff is a major problem of land degradation in the traditional rubber growing regions in India as the landscape features and high rainfall received predispose soil to erosion hazards. Effective runoff and erosion management is therefore a vital part of the quest for sustainable agricultural production. The effect of conservation pits on growth and yield of rubber and soil moisture storage were evaluated in two field experiments, one in immature rubber and another in mature rubber in the central region of the traditional rubber growing tract in India. The treatments for immature rubber include conservation pits taken at the rate of 250 per ha and a control without pits. The treatments for mature rubber comprised combinations of conservation pits taken at the rate of 150, and 250 per hectare and two methods of fertilizer application viz., placement in pits and broadcasting. Plots without pits and fertilizer served as control. The experimental fields were well drained. The average slope of immature and mature fields were 12 and 14 per cent respectively. All growth parameters of immature rubber were positively and significantly influenced by taking pits. There was a significant increase in the plant height, diameter and number of whorls of immature rubber in the plots where pits were taken. Higher soil moisture content was retained by the plots with pits. The leaf water potential and the relative leaf water content were also favourably influenced by opening of pits. Dry rubber yield enhanced by 15 per cent by taking pits at the rate of 250 per hectare. Soil moisture storage estimated up to a depth of one meter was substantially higher, when pits were taken at the rate of 250 per ha indicating the contribution of pits towards ground water recharge. The quantity of soil conserved in the pits and thus prevented from being lost through erosion ranged from 5.1 to 9.6 t/ha as the no. of pits increased from 150 to 250. The results of the experiments indicated that excavation of conservation pits is a viable soil conservation and water harvesting technology for the traditional rubber growing regions in India.

Introduction

Hevea brasiliensis, the single viable source of natural rubber is a perennial tree crop that has economic and social importance in many tropical and subtropical countries like Indonesia, Sri Lanka, Thailand and Malaysia, India, China, Vietnam and Philippines. India is the fourth largest producer of natural rubber accounting for 9.2 per cent of global output. The entire state of Kerala together with parts of Kanyakumari district of Tamilnadu and South Kannada and Kudaku Districts of Karnataka forms the traditional rubber growing belt of India. The state, Kerala accounts for about 85 per cent of the national area and 94 per cent of natural rubber production (Rubber Board, 2004) where it is grown traditionally on laterite and lateritic soils under suitable agro ecological conditions. It is estimated that 60 per cent of the rubber plantations in India are slope lands with a gradient of 16-33 %, experiencing more than three months dry period (NBSS & LUP, 1999). The average annual rainfall in this region ranges from 2000 mm to nearly 5000 mm with about 67 per cent received during the South - West monsoon. The rainfall intensity during this season far exceeds the infiltration rate resulting in runoff. unoff wherever it occurs, results in washing away of the top fertile soil and nutrients, loss of soil moisture and recharge capacity. The consequence of water runoff and soil erosion not only affects crop production, but results in serious problems of water stress, soil degradation and ecological imbalance (Troeh *et al.*, 1991). Therefore, water retention and erosion control are major concerns in the traditional rubber growing tracts. The conservation practices commonly adopted in rubber plantations are contour terracing, construction of stone-pitched retaining walls (edakayyalas), cover cropping and digging of conservation pits (Punnoose and Lakshmanan, 2000). This paper collates information on the effect of conservation pits on growth and yield of rubber and discusses their effectiveness in soil moisture conservation and soil erosion control.

Materials and Methods

Two field experiment were conducted, one in mature rubber at the Manickal division of TR&T estate, Mundakayam, Kottayam District, Kerala, and the other in immature rubber in a small holding at Kanjirappally, Kottayam District, Kerala both representing the central region of the traditional rubber growing tract in India. The sites are located in tropical humid zone with a mean annual temperature of 28^{0}C. The mean annual rainfall (2000- 4000mm) has a bimodal distribution pattern with major peaks in June- July and September-October. The period December through February / March constitutes the dry season. Soils were classified as Ustic Haplohumult (USDA classification).

Experiment

The design of the experiment on mature rubber was randomised complete block with six replications The treatments comprised of combinations of conservation pits taken at the rate of 150, and 250 per hectare in combination with two methods of fertilizer application viz., placement in pits and broadcasting. There were two control treatments viz., plots without pits and with fertilizer and plots without pits and fertilizer. The gross plot size was 24 plants and the net plot size was 8 plants. The treatments were allocated to each plot on area basis. Experiment on immature rubber comprised of two treatments viz., conservation pits taken at the rate of 250 per hectare and a control without pits. The gross plot size was 100 plants and net 30.

Soil Management

Pits of size 120cm × 45cm × 75 cm were excavated in each plot in a staggered manner along the contour at regular intervals with sufficient space in between. The soil from the pit was deposited on the lower side of the pit and compacted well.

Data Collection

Monthly plot wise latex yield was recorded. Annual growth measurement in mature rubber was done by recording the girth of the plants at a height of 150 cm above the bud union. Observations on growth parameters like plant diameter, number of whorls and height were recorded from the experiment on immature rubber. The soil deposited in the conservation pits in mature rubber was quantified. Computation was made based on a visual rating of the percentage of pit portion filled as 25, 50,75 and 100. After scoring, the fresh weight of the deposited silt was recorded from two pits in each replication. The dry weight was determined based on moisture content of samples pooled over replications for which soil samples were drawn from each replication. Access tubes were installed in the plots and moisture content was measured with Profile probe (Delta-T, UK} attached to a soil moisture meter at depths 10, 20,30,40,60 and 100 cm. The mid day leaf water potential was measured during the summer months using C-52 sample chamber psychrometer (Wescor Inc.,Logan, Utah, USA) connected to HR 33 T Dew Point Microvolt meter. The data were subjected to statistical analysis.

Results and Discussion

Effect on Soil Moisture Status

The data on soil moisture content at depths 0, 10, 20, 30, 40, 60,100 cm recorded from immature rubber plantation with and without pits during the summer of 2006 indicated that the plot with pits retained a higher soil moisture content compared to that without pit. (Table 1). The difference in moisture content was more distinct at the lower depths and at one meter depth, the moisture content in the plot with pits was 4 .32 per cent higher compared to control (without pits). A similar trend was observed in the case of mature rubber. The soil moisture content increased with increase in the number of pits. A notable difference was observed in the soil moisture content among treatments especially at the lower depths. Fig.1.

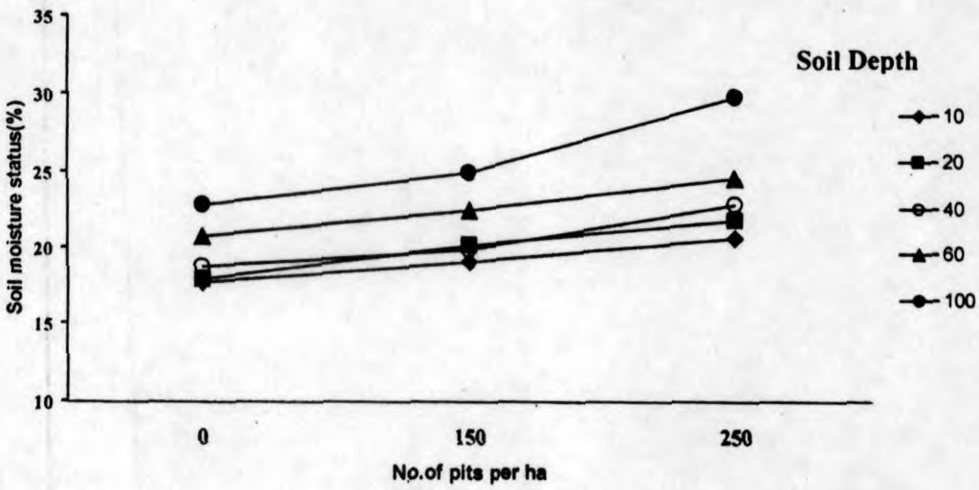


Fig. 1 Effect of Conservation Pits on Soil Moisture Status in Mature Rubber.

Table1 Effect of Conservation Pits on Soil Moisture Status in Immature Rubber.

Mean soil moisture content (%)						
Soil Depth (cm)						
	10	20	30	40	60	100
With pits	12.8	16.4	20.8	21.9	26.37	32.12
Without pits	13.1	15.6	18.3	20.1	23.22	27.8

Excavation of pits is an efficient run off management technique wherein a part of the run off is conserved and reused for crop production in a sustainable manner. Haridas *et.al.*, 1987 reported that silt pits act as a series of storage tanks trapping water from surface runoff and through fall resulting in an increased soil moisture status. Infiltration pits have demonstrated to improve the soil moisture storage, prolong ,the period of moisture availability and enhance the growth of agricultural crops (Mugabe,2004)). Rubber being grown in the red and lateritic soils, all water inside these pits gets drained down to the lower layers of the soil finally contributing to ground water. Therefore it is possible to mitigate the moisture stress experienced during summer months to a certain extent by taking conservation pits.

Effect on Leaf Water Potential

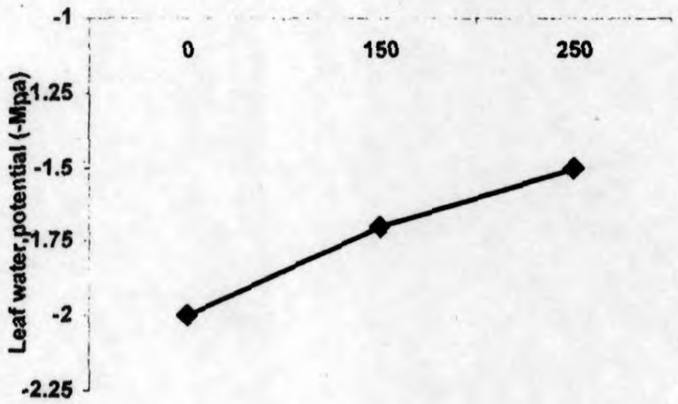
Indicators of plant water status like leaf water potential and relative leaf water content in immature rubber were relatively higher in the plots with pits (Table2). Leaf water potential was relatively low in the control plots.. The leaf water potential was directly proportional to the number of pits in mature rubber also(Fig 2). A higher leaf water potential was maintained by the plots with pits. The leaf water potential was comparatively low the control plots. Maintenance of higher plant water status in the plots with pits is associated with the higher moisture availability under this situation as evidenced by the soil moisture status (Table1,Fig.1). Water stress affects several aspects of plant physiology such as gas exchange, hormonal relations and mainly water relations (Gomez *et al.*, 2004). An experiment on seasonal effects of water relations on yield in *Hevea*, revealed that all the clones maintained a higher leaf water potential during wet season compared to dry season (Devakumar *et al.*, 1998). A relatively low leaf water potential associated with the control plots is indicative of the soil water stress which might have occurred in these plots in the absence of pits.

Effect on Quantity of Soil Deposited in the Pits

Conservation pits had a significant influence on the quantity of soil deposited in the pits. The quantity of soil conserved in the pits and thus prevented from being lost through erosion was directly proportional to the number of pits and ranged from 5.1t/ha to 9.6 t/ha in 2005 (Fig.3). Soil and water are earth's finite resources whose conservation is of great importance. There is a conscious need to efficiently manage and conserve these natural resources in a manner that will allow maximum productivity on a sustainable basis. The average soil loss in India is estimated to be over 16 tonnes per ha per year which translates to approximately 1 mm each year or 1 cm every decade (Singh *et al.*,1992). Natural processes such as formation of soil occur at an alarmingly slower rate than the soil can be lost. The rate of new soil formation for tropics was estimated to be about 2.5 cm in 300 to 1000 years(Lal,1984). In most of the tropical soils, the nutrient reserves are often concentrated in the thin surface horizon. Erosion is a selective process of preferential removal of the top soil(Lal,1984). Experiments have shown organic matter content of the eroded soil to be five times as high as that in the original top soil. Comparable figures for phosphorous and potassium were three and two respectively (Larson et al., 1983). Opening of pits is an efficient runoff management technique where in the runoff along with the top soil is captured in the pits, the run off infiltrates into the surrounding soils increasing the ground water recharge, retaining precious soil and nutrients in the subsurface level which accumulates over years and is recycled inside the plantation.

Table 2 Effect of Conservation Pits on Leaf Water Potential and Relative Leaf Water Content in Immature Rubber.

	With pits	Without pits
Leaf water potential (-bars)	23.97	29.31
Relative leaf water content (percent)	95.19	86.94



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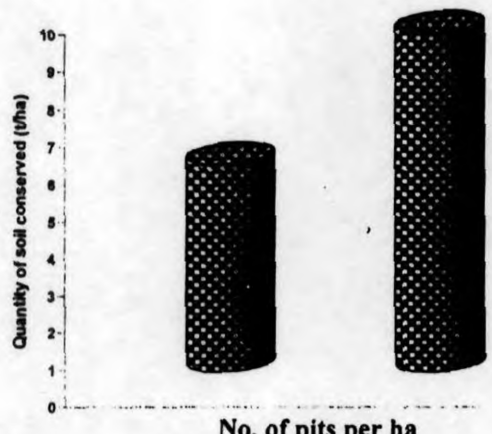

Fig. 3 Effect of Conservation Pits on Quantity of Soil Conserved.

Effect on Growth and Yield

All growth parameters of immature rubber were positively and significantly influenced by taking pits. There was a significant increase in the plant height, diameter and number of whorls of immature rubber in the plots where pits were taken (Table3).

Table 3 Effect of Conservation Pits on Diameter, Height and no. of Whorls of Immature Rubber.

	MEAN	
	With pits	Without pits
Diameter(cm)	1.34**	1.09
Plant height(cm)	133.29*	117.11
No. of whorls	2.49**	2.11

Presence of pits positively influenced the growth and yield of mature rubber. Significant positive response was obtained for yield of rubber (Table 4). Yield showed increasing trend with increase in the number of pits. The mean yield (2004-05) was significantly higher for the treatment with 250 pits per ha compared to control without pits. Yield enhanced by 18 percent in the plots with 250 pits per hectare compared to those without pits. The cumulative girth increment (2001-06) didn't vary significantly with respect to different treatments (Table 4). However, the girth increment also showed a positive trend and the highest girth increment was recorded in the plots with 250 pits. Control plots without pit and fertilizer recorded the minimum girth increment.

Table 4 Effect of Conservation Pits on Growth and Yield of Rubber.

No. of pits / ha	Girth increment 2001-2006 (cm)	Yield (g/tree/tap)
150 (S)	7.43	54.40
150 (P)	6.74	55.80
250 (S)	7.66	59.34
250 (P)	8.06	61.19
No pit & standard practice	6.68	50.16
No pit & no fertilizer	6.27	52.11
SE	**0.66**	**2.28**
CD	**NS**	**6.74**

Dry periods with water deficit frequently occur in humid and sub-humid regions where there is a theoretical need to dispose the excess water and positive responses to moisture conservation techniques are frequently obtained. According to NBSS and LUP(1999) about 60 per cent of the rubber plantations in India experiences more than three months dry period. Haridas *et al.*, 1987 reported an enhancement in yield of rubber to the tune of 10- 15 per cent in Malaysia in a field where pits were dug compared to an adjacent field without pits. Studies on seasonal effects on water relations and yield in Hevea indicated that the low rubber yield during dry season is associated with low moisture status and

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Conclusion

Conservation pits have a significant role in the conservation of soil, water and nutrients in rubber plantation which is reflected in the growth and yield of rubber. Therefore, opening of conservation pit is a viable water harvesting and soil conservation technology for the traditional rubber growing regions.

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