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CAN RUBBER BE GROWN SUCCESSFULLY IN MARGINAL DRY AREAS

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In Sri Lanka, rubber cultivation is traditionally confined to the low country wet zone. Most of the potential areas in the wet zone have already been brought under plantation and further expansion is therefore not feasible. The present extent under rubber in this traditional rubber growing areas in South-West region has shown a remarkable declining trend at a rate of nearly 2500 ha per annum since 1980, largely due to diversification of land for other alternative ventures. Moreover, the decline in the forest cover would have been much higher if not for the valuable contribution been made by the rubber sector in supplementing the increasing demand for wood products mainly timber and fuel wood. The domestic natural rubber consumption too has increased from 18,000 MT in 1980 to over 60,000 MT in 1996. With this increasing demand for both natural rubber and wood products, expansion of rubber cultivation to areas marginal with regard to rainfall has become essential than ever before.

The water requirement for plant growth is met from soil water stored in the plant root zone. In wet regions soil water is continuously replenished with rainfall and is therefore not a major constraint for agricultural production. But in the dry regions, prolonged dry periods resulting water scarcity is the major constraint to increased crop yields.

Like other crops rubber tree also needs water for growth and productivity. A uniform annual distribution of rainfall is regarded as favourable for the growth and productivity of rubber. Yet, in areas marginal with regard to rainfall, dry spells are usually common in some months of the year and prolonged drought periods also occur in some areas with distinct dry seasons. These lead to soil moisture stress of differential magnitude, adversely affecting the growth and productivity of rubber. It is therefore important to investigate the feasibility of expanding rubber cultivation into these relatively dry areas by identifying and devising appropriate agro-management practices such as drought resistance clones, field establishment practices, potassium fertilizer programme and ground cover management.

The rainfall and evaporation pattern of the two agro-climatic regions, wet and dry is illustrated in Fig 1. In the traditional rubber-growing areas in the south-west region, moisture deficits are relatively absent. However, in the marginal areas, moisture deficits are severe and prolong for a period of 4-5 months. In Table 1, the girthing pattern of rubber trees in the two regions indicates that the tappable age in the dry region is nearly two years longer than in the wet region.

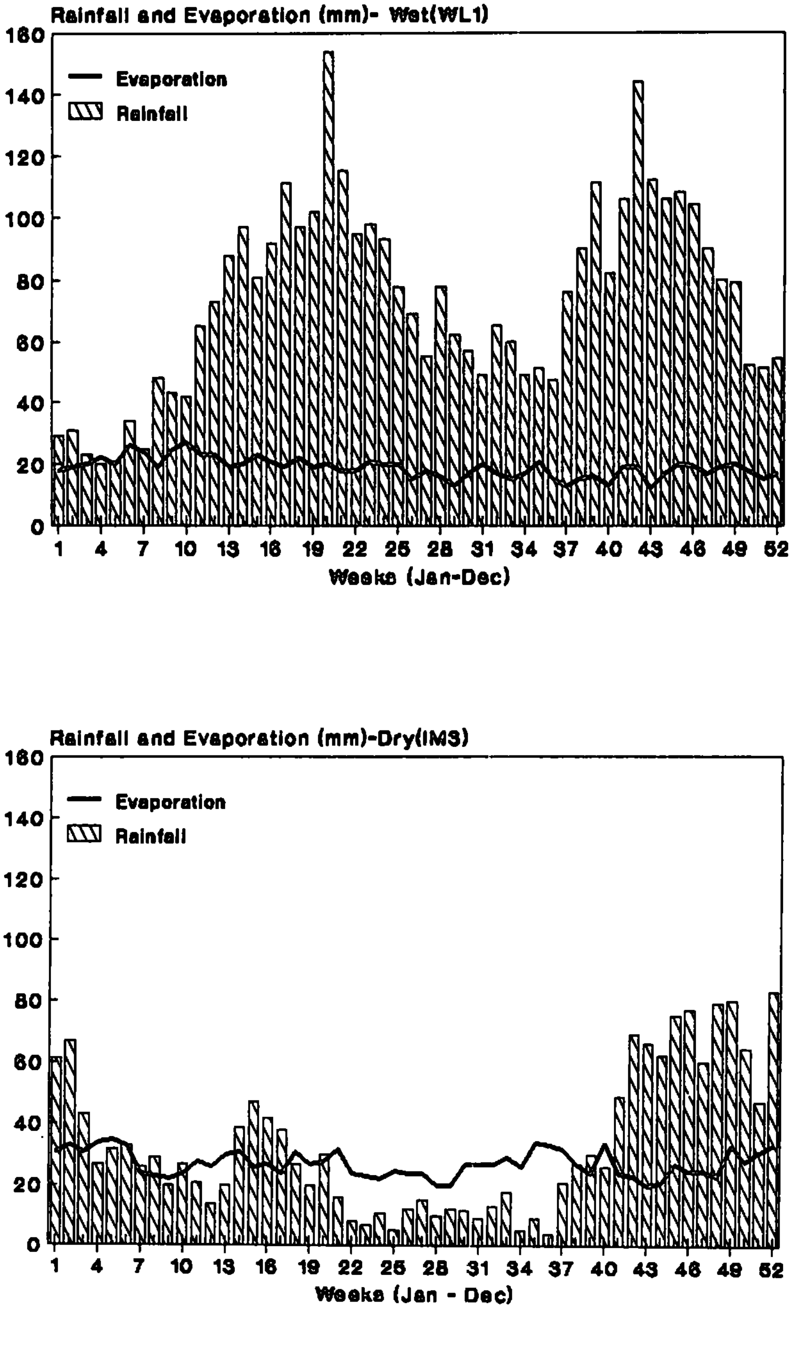


Fig. 1. Rainfall and evaporation pattern of wet and dry regions

Table 1. *The girthing pattern of rubber trees in dry and wet regions*

Region	Girth (cm)						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Wet	9.5	22.5	30.3	40.6	48.3	54.6	-
Dry	7.2	15.5	20.8	27.2	33.1	39.3	45.1

Drought resistance clones

Frequent dry spells and prolonged drought periods which lead to soil moisture deficit appear to be a major limiting factor for growth and tappability of rubber trees (Samarappuli, 1992a). It has shown that the growth of RRIC 121 and RRIC 102 were superior to other clones tested even at the very low soil moisture level of 10% available water. As would be expected, better growth resulted in higher total dry weights in clones RRIC 121 and RRIC 102 even under low soil moisture conditions (Samarappuli *et al*, 1992a). It was further noted that the soil water deficit caused a reduction in root growth which is expected to decrease the efficiency of plants ability to absorb soil water and nutrients. Moreover, there were significant differences in feeder root development between various clones of *Hevea brasiliensis* (Samarappuli *et al*, 1996). Clone RRIC 102 had the highest root density and furthermore, this particular clone exhibited better growth performance under moisture stress conditions. It is likely that if a clone has the ability to produce a vigorous root system, which is available for absorption of moisture, it would be suited for planting under dry climatic conditions.

It was evident that most of growth data are consistent with measured physiological parameters. The results of leaf water potential (LWP), Relative Water Content (RWC) and Transpiration Rate (TR) for all clones subjected to water stress indicated that all the above parameters decreased with the increasing levels of moisture stress. It was further noted that the LWP was highest in clone RRIC 102 indicating a higher water holding capacity. Moreover, RWC was significantly higher in the clone RRIC 102 confirming again the ability of this clone in maintaining a higher water holding capacity. The performance of young RRIC 102 plants may have been improved as a result of the better plant water status (Samarappuli, 1992). It has also been reported earlier (Samarappuli, 1992) that cultivars believed to be more drought resistant usually maintained higher relative water content as well as higher leaf water potential. Moreover, leaf diffusive resistance data indicated that clone RRIC 102 had the highest leaf diffusive resistance which could result in a comparatively higher water use efficiency value. It seems, therefore, possible that clone RRIC 102 may perform better compared to other clones *i.e.* RRIC 100, RRIC 110, RRIC 121 and PB 86, under low soil moisture conditions.

Field establishment practices

Effects of soil moisture on establishment success and early growth of rubber plants were studied as adequate availability of soil moisture during field establishment is important for establishment success of plants raised under different establishment practices. The growth of one whorled brown budded poly bag plants was found to be superior to other establishment practices such as one whorled poly bagged green buddings and young buddings, brown budded bare roots and green budded bare roots at the very low soil moisture level of 10% available water (Samarappuli *et al*, 1993a). In general, the plants raised in polythene bags appear to have an initial advantage over the use of bare root budded stumps. Nevertheless, as the root density of young buddings are higher, it is possible that the young buddings will eventually perform better under field conditions. Data on the influence of soil moisture on root growth of differently budded plants indicates that young budded polybag plants had significantly higher root density compared to other establishment practices (Samarappuli *et al*, 1996). It appears that root growth in relation to density may have had greater effect in the performance of rubber plants in the first 12 months of its growth. Young plants are less likely to survive in soils with inadequate supply of moisture at the surface; this is particularly so during the dry periods. Young budded polybag plants with more efficient root system would enable the young plants to tap on a larger reservoir of moisture beneath the surface, thereby increasing the soil water and nutrients absorbtion efficiency of the plants. Moreover, the deeper penetration of tap root in young budded poly bag plants is obviously advantageous in providing sufficient anchorage, where wind is considered a problem.

Potassium fertilizer programme

It is known that K plays a specific role in most plant species in opening and closing of stomata - a role which cannot be played by any other cation and an adequate supply of K is known to play an important role in water relation of plants. According to the results available, with the increase in soil moisture stress, stomatal conductance and transpiration rate of K sufficient rubber plants were decreased. However, in the absence of potassium, stomatal conductance was greater at 10% field capacity loosing more water from the plant (Samarappuli *et al*, 1993b). It seems to suggest that K sufficient rubber plants appear to close stomata and reduce transpiration more readily than the K deficient plants. It is possible that water stress in plants low in K, develops due to the sluggish opening and closing of stomates and to their low capacity to respond to rapidly changing transpirational conditions. It is well documented that stomatal opening is affected by accumulation of potassium ions in the guard cells (Outlaw, 1983). It may be assumed that K deficient plants had neither exhausted their soil water intensively nor regulated their stomata efficiently.

Measurement of relative water content of leaves under the influence of decreasing water availability in the soil revealed significantly higher values *i.e.* a better water status of the leaf tissues for K sufficient plants. These results seem to suggest that plants receive K_2 level of potassium under water stress maintain a higher turgor potential than K deficient plants (Samarappuli *et al*, 1992b).

Root growth measurements made, indicated that the root penetration was improved with added potassium. It has been suggested that efficient water uptake from the soil and its' transport upwards are more important than stomatal conductance in determining drought resistance of plants.

It was also noted that the plant diameter and height at 50% field capacity with recommended level of potassium were almost similar to the diameter and height at 10% field capacity in combination with double the recommended level of potassium. Moreover, this is further confirmed by the higher girth and tappability recorded with the increase in the level of K, under field condition, in the marginal dry area.

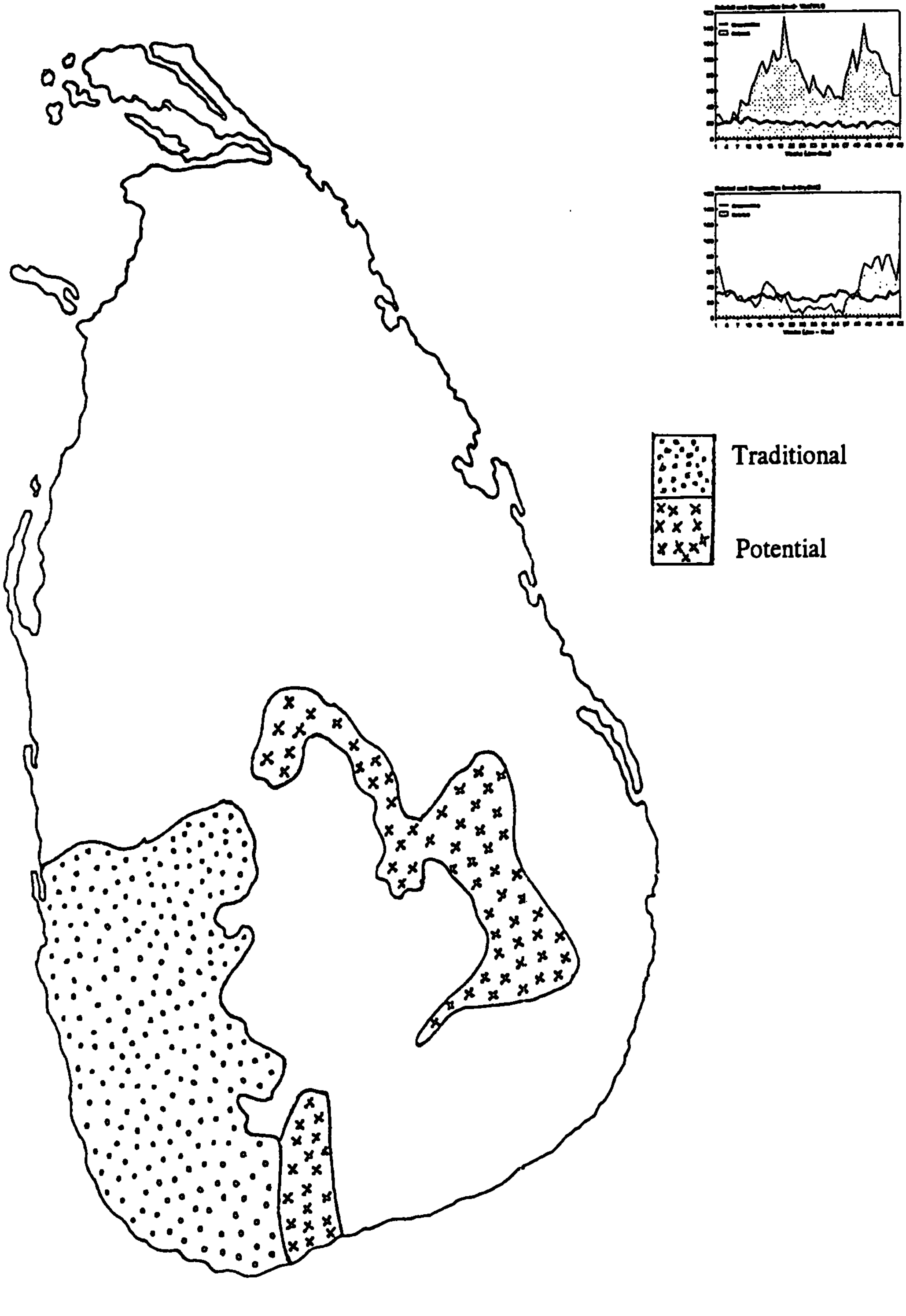
Ground cover management

Among the different soil management practices, dead mulch exhibited the highest soil moisture storage capacity (Samarappuli, 1992b). Application of straw as a mulch reduces the rate of evaporation of soil moisture thus allowing moisture to remain in the soil for a longer period. Mulches would also influence the moisture content of the soil by their effect on water intake through the immediate surface layer and due to improved soil structure by higher organic matter content, thereby increasing the water holding capacity. Any reduction in evaporation of soil moisture would be beneficial to crop growth in the same manner as additional water intake by the soil. Therefore it appears possible to eliminate or at least minimize the adverse effects of moisture stress by mulching. Moreover, root density were higher under mulching than under legume cover or natural cover. Such differences in feeder root development of *Hevea* under different soil management practices could be attributed to the higher organic matter content of the soil under mulching. At the same time it also seems to suggest that the higher soil moisture content and higher root density increases the water uptake and along with the water, nutrients are also taken up thereby increasing the growth of rubber plants under dry climatic conditions.

CONCLUSION

The study suggests that rubber cultivation can be extended to areas marginal with regard to rainfall as shown in Fig. 2. The recommendations made in this regard are; selecting drought resistance clones such as RRIC 102, choosing young budded poly bag plants as planting material, use of dead mulch preferably paddy straw as a mulching material and application of higher levels of potassium during the early

Traditional and Potential Rubber Growing Areas in Sri Lanka



stages of growth. Adopting a combination of above recommendations would eventually help to expand the existing rubber growing area of the country by approximately 70,000 ha. and thereby to increase the total production approximately by 65,000 MT/yr.

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