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Biomass and Nutrient Addition in a Cycle of Rubber Plantation

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INTRODUCTION

Rubber (*Hevea brasiliensis*), the important commercial source of natural rubber, is a quick growing sturdy tree with tall trunk and thick canopy. Rubber plants take four to five years for canopy closure and attain full growth in 15 to 20 years. Natural rubber, having a perennial tree crop ecosystem, covers about 5.5 lakhs ha area in Kerala and parts of Kanyakumari. Rubber belonging to the family Euphorbiacea is deciduous in nature, having annual leaf litter fall during December–January. Cultivation practices in rubber include the establishment of cover crop in the immature phase (1–4 years) and systematic manuring by inorganic fertilizers during immature and mature phases. There is a regular biomass addition through annual litter fall and also at the time of felling of trees for replanting. Quantification of biomass recycling and nutrient addition through natural sources and inorganic fertilizers in one cycle of cultivation is important to assess the sustainability of the rubber ecosystem.

The earlier studies conducted at RRII and elsewhere have been used to quantify the biomass and nutrient addition through cover crop (*Mucuna bractiata*), litter fall and rain fall (Philip *et al.*, 2005); Karthikakuttyamma *et al,* (2000); Shorroks (1965) and Meti *et al.* (2008). Regarding nitrogen fixation by the cover crop, a conservative estimate of 300 kg N per hectare (Watson 1964) was adopted for the present study.

The biomass and nutrient addition at the time of tree felling was recorded by uprooting four trees of RRII clones of *Hevea* at an age of 30 years from the experimental field at

Central Experiment Station, Chethackal, Ranni of Rubber Research Institute of India. The uprooted trees were partitioned into different morphological units viz. trunk, branches, leaf and roots, and total weight of the plant parts were recorded. During felling the top portion of the tree including leaves, twigs and associated very small branches are left in the field and it undergoes decomposition. Therefore, these portions were also included in the leaf biomass. Estimation of leaf and root biomass and nutrient addition were carried out by recording total biomass and fresh weight and dry weight of the sub sample. Sub-samples were analysed for nutrient content and the nutrient addition to soil from the decomposition of leaf and root residue at the end of the planting cycle was calculated. It is reported that nutrients from the leaf and root residues will be completely decomposed within 2 years (Kheong 2001).

In rubber, legume cover is established during the immature phase as a soil cover and to reduce soil erosion in addition to nitrogen fixation. Rubber tree sheds its leaves during December - January resulting in recycling of nutrients. Another source of nutrient addition in rubber plantation is through rainfall. The estimated biomass addition in one cycle of rubber plantation is given in Table 27.1.

Table 27.1. Biomass addition in one cycle of rubber plantation (t/ha)

Source of biomass	*Quantity added to soil (t/ha)*
Cover Crop	4-6 *
Leaf Litter	6 **
Leaf, twig and very small branches tree felling- Root	1740

* Philip *et al.* (2005) **Karthikakuttyamma *et al.* (2000) and Shorrok(1965)

Apart from these, there is biomass addition during replanting to the extent of 17 t/ha through leaves and twigs as well as 40 t/ha through root residues. Usually during every replanting time, the top portion of the tree including canopy with petiole, twigs and very small branches are left in the field for decomposition. Therefore, leaf biomass at the time of felling includes these portions also. This is different from the annual leaf fall wherein the leaf fall occurs during December – January.

During immature phase there is addition of 236 kg N, 15kg P and 85kg K /ha through the cover crop residues (Philip *et al.,* 2005). About 300 kg nitrogen is added by the cover crop through nitrogen fixation process (Watson, 1964). Nutrient addition through the annual leaf fall is to the extent of 88kg N, 2.5kg P and 45 kg K/ha (Philip *et al.,* 2003). Through leaf fall there is recycling of nutrients annually. Hence, for calculating nutrient addition through leaf fall, it was accounted only once and not every year. From the present study, the nutrient release through decomposition of leaves, twigs and root residues after felling trees was estimated as 2,16 kg N, 250 kg P and 1,354 kg K per ha.

Comparison of annual nutrient addition through natural sources and by the inorganic fertilizer indicated that about 133.2 kg N, 2.5 kg P and 58.2 kg K per ha were added through leaf fall and rain fall (Philip *et al.*, 2003; Meti *et al.*,2008)). The corresponding nutrient addition through inorganic fertilizer is 30 kg each of N, P and K. This clearly shows that the nitrogen and potassium addition through leaf fall and rainfall are much higher than the inorganic fertilizer addition every year. However, the major portion of P addition was from fertilizers and it is higher than the P addition through leaf fall.

The percentage of annual addition of nutrients by natural sources and inorganic fertilizers shows that 82% N, 8% P and 66% K are added through leaf fall and rain fall. In the case of P, the application through external fertilizers is to the extent of 92% followed by 34% for K and 18% for N. From this it is clear that N and K addition through leaf fall and rain fall in rubber plantation is more than addition through inorganic form through external fertilizers.

The estimated total addition of nutrients through natural sources and inorganic form through external fertilizer in one cycle of rubber plantation is presented in Table 27.2. About 2,744 kg N, 268 kg P and 1,748 kg K per ha is added to the soil through organic form whereas, 840 kg N, 840 kg P and 754 kg K per ha only is added as inorganic form in one cycle of rubber cultivation.

Table 27.2. Total addition of nutrients in one cycle of rubber cultivation (30 years) kg/ha

Nutrients	*Natural sources* *	*Inorganic fertilizers*
N	2744	840
P	268	840
K	1748	754

*(cover crop + Nitrogen fixation by cover crop + Rain fall + leaf fall + leaf and root at tree felling).

The analysis of nutrient addition through natural sources and inorganic fertilizers in one cycle of rubber cultivation indicates that organic form accounts for 77, 24 and 70 percentage of total N, P and K whereas, it is only 23, 76 and 30 percentage through inorganic form (Table 27.3).

Table 27.3. Percentage of total nutrient addition in one cycle of rubber cultivation

Nutrients	*Natural sources*	*Inorganic form(chemical fertilizers)*
N	77	23
P	24	76
K	70	30

This also clearly indicated that in one cycle of rubber cultivation the total nutrient addition through organic form is more than the inorganic form except for P.

From this study it is clear that substantial quantities of nutrients are added annually through leaf litter and rain fall in rubber ecosystem. Annual addition of N and K through leaf litter and rainfall are more than that through chemical fertilizers. In the case of P, addition is more through chemical fertilizers. The rubber ecosystem is more dependent on natural sources for nutrients compared to external sources like chemical fertilizers and also higher biomass addition and nutrient recycling is recorded in one cycle of rubber cultivation.

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