

THE ROLE OF LEGUMINOUS COVER CROPS IN SOIL IMPROVEMENT WITH SPECIAL REFERENCE TO THE NITROGEN ECONOMY OF TROPICAL RUBBER SOILS

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The need to conserve the soil against erosion and maintain soil fertility, led to the traditional practice of introducing leguminous cover crops to several plantation crops in Sri Lanka, such as rubber, coconut and oil palm. Today, the use of leguminous covers is a standard practice in rubber plantations. The fast growing, perennial, creeping legumes are expected to quickly provide a dense vegetative growth covering the soil resulting in improvement of the biological, chemical and physical properties of the soil.

At present, five cover crops, viz *Pueraria phaseoloides* (Roxb.) Benth., *Desmodium ovalifolium* (Prain) Wall ex Ridley, *Mimosa invisa* (Mart ex.), *Calopogonium mucunoides* Desv., and *Centrosema pubescens* Benth. are grown commonly in rubber plantations. From these, the most popular and widely grown cover crop is *Pueraria phaseoloides*. It serves as a cover crop in about 90% of the new planting and replanting areas which are estimated to be more than 25,000 hectares. *Pueraria* grows well under direct sunlight and disappears with increased shade. The main shade tolerant cover crop is *Desmodium ovalifolium* which is the most common cover in mature plantations.

In Sri Lankan rubber and oil palm plantations, the most important requirement is to protect the soil from erosion as most of the land is undulating and receives high annual rain fall (around 4000 mm). Without this protection, direct sunlight and heavy precipitation break down the soil aggregates which seal the surface and reduce the infiltration of rain water. This causes soil erosion in sloping lands.

Cover crops shade the soil from direct sunlight reducing soil temperature and keeping down the rate of decomposition of organic matter. They also add organic matter to the soil which helps to improve the texture of soil, water infiltration and water holding capacity. Sanchez (1976) showed that organic matter enhances the cation exchange capacity in acidic, highlyweathered soil, and it reduces the erosion and compaction hazards in sandy top soils. Further, it has been demonstrated that organic matter is an important slow-release source of nitrogen, sulphur and phosphorus for pasture and crop plants.

Leguminous cover crops have a significant effect on biological activities of soils. They enhance the activity and numbers of soil microorganisms as well as macroorganisms like earthworms, termites and ants. These organisms improve the soil's physical conditions and increase the rate of nutrient cycling by breaking down the organic matter. But there is little information on their role in soil improvement in the tropics. Russel (1973) found that earthworms are more common under pasture than cropped soils in temperate ecosystems. Lee and Wood (1971) have discussed the agricultural significance of termites with special reference to the decomposition of organic matter.

Another advantage of the leguminous cover is the suppression of undesirable weed growth in plantation crops such as rubber, coconut and oil palm. This is particularly important during the first few years of the development of young plantations.

Most legumes possess the rare ability of fixing atmospheric nitrogen needed for their growth. This process occurs in root nodules through a symbiosis with the soil bacteria of the genera *Rhizobium* and *Bradyrhizobium*. A small part of the ultimate product of fixation is converted to bacterial protein in the nodules, but more significantly, most is available to the host plant.

Henzell (1968) showed that tropical pasture legumes with average growth can fix 20–180 kg of nitrogen $\text{ha}^{-1}\text{y}^{-1}$, and legumes with luxurious growth can fix around 290 kg N $\text{ha}^{-1}\text{y}^{-1}$. Slightly higher values were found in the humid tropics (Whitney *et al.*, 1967 Grof and Harding, 1970). Other fixation rates such as the following have been reported : 99 kg N $\text{ha}^{-1}\text{y}^{-1}$ (*P. phaseoloides*) 126–398 kg $\text{ha}^{-1}\text{y}^{-1}$ (*Centrosema pubescens*) and 34–220 kg N $\text{ha}^{-1}\text{y}^{-1}$ (*Stylosanthes* spp.) (Nutman, 1981 quoted as Anon, 1984).

When rubber plants were grown in sown legume (*Pueraria* and *Desmodium*) plots the growth of the trees, the dry weight of the leaves and nitrogen content of the leaves were significantly higher than those of rubber trees grown in plots with naturals (Yogaratnam, Sulaiman, Karunaratna and Peiris, 1977).

Further, decomposition products of those cover crops play a significant role in the nitrogen economy of the soils. The effect of litter decomposition of *p. phaseoloides* has received considerable attention during the last few decades and it is generally believed that *P. phaseoloides* has a greater potential in increasing the soil nitrogen compared to its counterparts. When 18 months' growth of *Pueraria* and other legumes were ploughed into the soil on the tropical coast of Queensland, the highest soil $\text{NO}_3\text{-N}$ values were found in plots with *P. Phaseoloides* (Schofield, 1945) After 32 days the $\text{NO}_3\text{-N}$ value in *P. phaseoloides* plots was 69 ppm, whereas *Calopogonium*, *Centrosema* and *Stylosanthes* gave 3.5, 5.3, and 2.0 ppm N respectively. However, $\text{NO}_3\text{-N}$ values reached a maximum of 395.6 ppm after 12 weeks with *Pueraria*, while *Centrosema* attained its peak at a figure of 219.5 ppm In the same experiment there was a high correlation between precipitation and leaching of nitrogen from the surface six inches to lower layers of soil Cultivation of *Pueraria* as an inter-row crop with sisal in Tanzania was reported to add 635 kg of nitrogen ha^{-1} to the soil, equivalent to the application of 1.4 tons of urea (Rijkebusch, 1967)

In Malaysia, legume cover crops grown in association with rubber have been found to impart a beneficial residual effect on plantation soils. It has been estimated that 300 - 350 kg of nitrogen ha⁻¹ could be added to the soil from the above ground litter (Ismail, Lock and Pushparajah, 1980). Further when *P. phaseoloides* is planted with *Calopogonium* in Malaysian rubber plantations they may provide a total of about 695 kg nitrogen ha⁻¹ to the soil through their litter from the third to eighth year after planting (Tan, Pushparajah, Shepherd and Teoh, 1976). When *Pueraria* was planted with *Centrosema* and *Calopogonium* they added 353 kg of N to one hectare through the deposition of litter over a five year period (Waston *et al.*, 1964). Later, results from a glass house experiment demonstrated that the application of either ammonium sulphate or *P. phaseoloides* leaf litter as a nitrogen source significantly increased the girth and total dry matter yield of rubber seedlings (Tan and Pushparajah, 1985).

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