BIOMASS PRODUCTION AND ROOT DISTRIBUTION OF EIGHT TREES AND THEIR POTENTIAL FOR HEDGEROW INTERCROPPING ON AN ULTISOL IN SOUTHERN SUMATRA

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ABSTRACT

Long term productivity of upland soils for food crops may be improved by using a 'hedgerow intercropping' or 'alley cropping' system. However, information on trees suitable for hedgerow intercropping on acid soils is scarce. Suitability of trees for hedgerow cropping depends on a number of above and below ground characteristics of the trees, such as pruning tolerance, biomass production, N-content of the prunings, decomposition rate of prunings, rooting depth, presence of horizontal branch roots, nodulation, mycorrhizal infection. Desirable tree characteristics further include the production of useful products such as firewood, browse for goats and/or edible pods. Trees which provide a sufficiently dense cover, when left unpruned, to shade out weeds may help to save labor.

Pruning of trees affects their growth in many ways. Based on preliminary observations the hypothesis was formulated that a lower pruning height leads to more, but smaller branch roots originating from the stem base. In an experiment with five tree species this hypothesis was confirmed.

Eight trees were evaluated for the characteristics mentioned on an acid soil; six relatively well known agroforestry trees: *Leucaena leucocephala, Gliricidia sepium, Calliandra calothyrsus, Cassia siamea, Erythrina orientalis, Albizia falcataria*, and two local tree species: *Peronema canescens* and *Peltophorum pterocarpa*. Averaged over the first three years of pruning, the highest biomass production and N-yield was found for *Calliandra* (12 Mg/ha and 360 kg/ha, respectively). *Calliandra* requires regular pruning, however, to avoid excessive shading of intercropped food crops. Overall, the best results in hedgerow intercropping on this acid soil may be expected from the relatively deep-rooted *Peltophorum*, or from alternating hedgerows of *Gliricidia* and *Peltophorum*, with a biomass of around 8 Mg/ha and an N-yield of about 200 kg/ha. *Peltophorum* forms the densest canopy in a small hedge volume when pruned in a 3-months cycle.

INTRODUCTION

On acid infertile soils, such as ultisols, in the humid tropics the efficiency of nutrient use is generally low due to a combination of high leaching rates and shallow root development of annual food crops because of a high Al-saturation and low levels of Ca and P in the subsoil. Lack of weatherable minerals in the soil, nutritional constraints to N_2-fixation and probably poor mycorrhizal infection of roots may aggravate the problem. Under such conditions it is difficult to produce enough dead plant material as litter inputs to the soil ecosystem to maintain sufficiently high soil organic matter levels. According to an estimate by Young (1989) inputs of above ground biomass should be around 8.5 Mg/ha (dry weight) to maintain a desirable carbon content of 2 % in the top soil in the humid tropics. Agroforestry techniques, integrating trees and food crops, might help to improve soil fertility on such soils by providing sufficient organic inputs (Nair *et al.*, 1984).

Alley cropping or hedgerow intercropping is an agroforestry system in which food crops are planted in alleys in between hedgerows of regularly pruned trees or shrubs (Kang *et al.*, 1986; Nair, 1984; Young, 1989). The main functions of the trees, apart from any directly economic products, are to maintain soil fertility, by reducing erosion, by nutrient recycling from deeper soil layers and by providing organic matter. This system has been presented as a stable alternative to shifting cultivation, with the potential to improve or to maintain soil productivity without or with low fertilizer input (Kang *et al.*, 1986). Kang *et al.* (1981, 1985) and Duguma *et al.* (1988) have recommended *Leucaena leucocephala* and *Gliricidia sepium* as suitable hedgerow trees for humid and sub-humid areas. Kang *et al.* (1985), reported that the giant *L. leucocephala* var. K-28 grown on a sandy entisol, at 4 m spacing of hedgerows, produced between 15 - 20 Mg/ha of fresh prunings (excluded stakes) or 5- 6 Mg/ha of dry weight with 5 prunings per year. The prunings represented a substantial nutrient input to the soil: 160 kg N, 15 kg P, 150 kg K, 40 kg Ca and 15 kg Mg. Successes with the system appear to be restricted, however, to soils where a deep root development by the trees is possible. *L. leucocephala* the main tree species used, is not well adapted to acid soils (Szott, 1988). Hutton and de Sousa (1987) reported that *L. leucocephala* (Cunningham) performed poorly on an acid Oxisol in Brazil (pH 4.5-4.7) and that at lime applications up to 2 Mg/ha still large numbers of dead root tips indicated Al-toxicity. Although selection of acid soil tolerant strains of *L. leucocephala* has been attempted, no real improvement has been achieved. For the second tree, *G. sepium*, problems on acid soils are less pronounced, but still selection of a good tree for hedgerow intercropping on acid soils scores high on the research agenda (Kang *et al.*, 1986; Hairiah and Van Noordwijk, 1986).