Allometric Relationships of Frequently Used Shade Tree Species in Cacao Agroforestry Systems in Sulawesi, Indonesia

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Introduction

Agroforestry systems carry great importance in the conservation of tropical rainforests, particularly of rainforest margins as they reduce pressure on natural forests. Shade trees play an important role within agroforestry systems by influencing radiation and wind regimes as well as nutrient and hydrological cycling. The aim of this study is to **provide basic information on tree structural parameters of frequently used shade tree species and develop allometric relationships** for the implementation in ecological investigations dealing with agroforestry ecosystem processes.

Methods

The investigation of the shade trees was conducted at two cacao agroforestry sites, Omu and Bulili, on Sulawesi, Indonesia. Measurements of the main structural parameters: diameter at breast height (DBH), tree height (H), trunk height (TH), crown length (CL) and crown radius (CR) were carried out for the shade tree species *Aleurites moluccana*, *Cocos nucifera* and *Gliricidia sepium* according to the National Forest Inventory Field Manual Template by FAO. Based on this information allometric functions were derived for the correspondent shade tree species. The transferability of the obtained allometric functions was examined using results of measurements performed in other sites in the region.

Results

The correlation matrices (Fig. 1) show the allometric relationships between different tree structural parameters. The best significant relationships (red framed in Fig. 1) were obtained for the **height-crown length relationship** of the dicotyledonous tree species' *Aleurites moluccana* (top) and *Gliricidia sepium* (bottom) with a coefficient of determination **r^2 = 0.925** and **r^2 = 0.738**, respectively and the **height-trunk height relationship** of the monocotyledonous palm *Cocos nucifera* with **r^2 = 0.807**. The crown form and equations of the allometric relationships for each species are given in Fig. 2. Fig. 3 illustrates the transferability of the derived allometric relationships to other regions on example of H – CL relation for *Gliricidia sepium*.

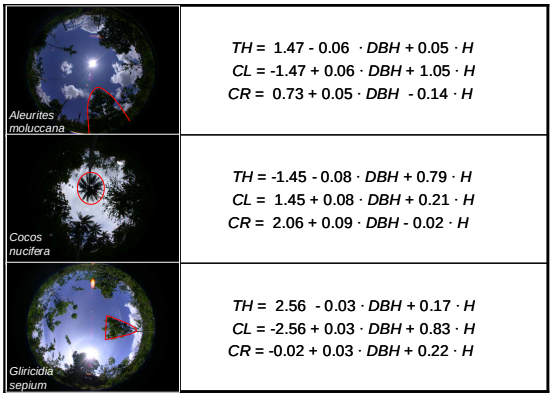

Fig. 2: Crown forms (l) and allometric relationships (r) that enable the derivation of difficulty measurable tree structural parameters (TH, CL, CR) from easily measurable ones (DBH, H) of *Aleurites moluccana*, *Cocos nucifera* and *Gliricidia sepium*

Conclusions

Revealing species-specific allometric relationships this study provides important basics for a descriptions of shade tree structure that are required in models simulating ecosystem processes in cacao agroforestry such as nutrient cycling, radiative transfer, wind regime and hydrological cycling. Furthermore, it shows that the derived allometric functiones are applicable to other cacao agroforestry systems of that region (Fig. 3).

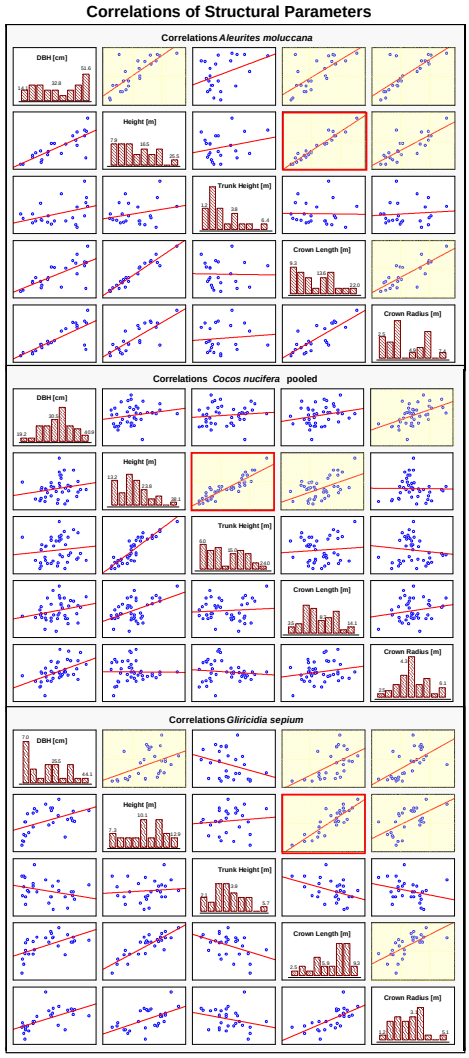

Fig. 1: Correlation matrices of tree structural parameters of Aleurites moluccana, *Cocos* nucifera and *Gliricidia sepium;* significant relationships are highlighted with yellow background

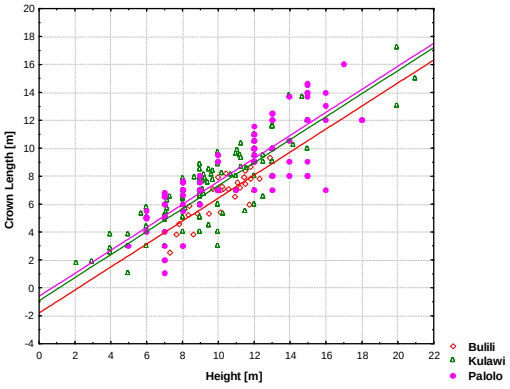

Fig. 3: Relationship between crown length and height for *Gliricidia sepium* measured at different sites

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