

Spatial and temporal data for assessing layout and sustainability of perennial polycultures – consequences of growth heterogeneity

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The comparison of nutrient accumulation of trees with the time course of fertilizer application is a valuable tool for developing a sustainable nutrient management for plantation systems: the fertilization can be adjusted to the species' nutrient requirement. The canopy structure of trees in polyculture systems provide data for the quantitative investigation and improvement of the system's spatial layout: planting distances can be corrected. Such integrated system information is presented for a 4-year-old perennial polyculture in central Amazônia (*terra firme*, Oxisol). It is strengthened, that the often observed heterogeneity of tree growth has to be considered when using these spatial and temporal data as tools for system improvement: the trees have to be treated as individuals, not just as the respective species.

The heterogeneity of biomass among individual trees of the same species has various adverse effects even in an early stage of plantations: small individuals can not make full use of the fertilizer applied, what results in unproductive nutrient losses through leaching. Large individuals, in contrast, would require more nutrients for optimum growth. Also when calculating the system's nutrient balance, hence the specific contribution of the single trees must be known and included in the calculations. Using average data for each species will result in erroneous balances.

If the trees show highly different size, also the period of time for cropping annual crops between the rows of the perennial species in agroforestry systems will be reduced: large trees disturb a systematic cropping pattern, while the free space surrounding the smaller trees remains unused. When the trees increase in size and begin to interact, the existing differences are amplified, neighboring trees overlap and compete in an undesired way for the above- and belowground resources. In many parts of the plantation the system does not "function" in the planned way for a prolonged period of time.

This heterogeneity requires a more flexible layout and management of the plantation system to optimize the use of space (e.g. delayed planting and/or a flexible inclusion of annual crops; pruning). The fertilizer application scheme could be adjusted to the single tree's relative size (e.g. by grouping the trees of each species into differently fertilized „big“, „medium“, and „small“ individuals). The practicability and economy of such measures still has to be tested.

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