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Reciprocal Effects of Soil Moisture Dynamics and Land-Use Systems with Cocoa in Alto Beni, Bolivia

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Abstract

Soil moisture is a function of topography, soil texture, vegetation and meteorological conditions and therefore highly spatial and temporal variable. Vegetation reduces evaporation from the soil but takes up water for production and transpiration. *Vice versa*, vegetation is affected by water availability. In many agricultural systems, especially in the (sub-)tropics with distinct dry seasons, water availability limits production. Cocoa production relies on a stable humid and warm climate. Drought causes a reduction in yield and long-term drought affects the vitality of the trees. Land-use systems with cocoa range from monocultures to highly diverse agroforestry systems. Agroforestry systems have higher water needs for the dense vegetation than monocultures, but little information is available on belowground complementarity or competition for water.

We measured soil moisture dynamics in four depths over a 30-months period in six different land-use systems, comprising cocoa monocultures, cocoa agroforestry systems and a fallow without cocoa in a long-term trial in Bolivia. By excluding the influence of topography and soil texture, we could relate the spatial variability to the land-use system. In monocultures, soil moisture was reduced in the upper 30 cm, while agroforestry systems exploited water deeper along the profile, indicating a complementarity in water use between the cocoa and the shade trees. On the other hand, soil texture and water retention capacity influenced the plant available water. In our case, the cocoa yield of the same type of production system was not affected by the soil heterogeneity.

Finally, we assessed the possibility of planting cocoa trees in a natural regrowth to maintain local biodiversity while producing cocoa. As long as the regrowth is dominated by fast growing pioneer tree species, the water use of these trees is very high and may oppress the development of the cocoa. However, in secondary forests the light will be more limiting and an adequate tree pruning and thinning would be necessary beside the water management.

Keywords: Agroforestry, complementarity, monoculture, spatio-temporal dynamics