Effects of an experimental drought on the functioning of a cacao agroforestry system, Sulawesi, Indonesia

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Abstract

Agroforestry systems may play a critical role in reducing the vulnerability of farmers' livelihood to droughts as tree-based systems provide several mechanisms that can mitigate the impacts from extreme weather events. Here, we use a replicated throughfall reduction experiment to study the drought response of a cacao/Gliricidia stand over a 13-month period. Soil water content was successfully reduced down to a soil depth of at least 2.5 m. Contrary to our expectations we measured only relatively small nonsignificant changes in cacao (−11%) and Gliricidia (−12%) sap flux densities, cacao leaf litterfall (+8%), Gliricidia leaf litterfall (−2%), soil carbon dioxide efflux (−14%), and cacao yield (−10%) during roof closure. However, cacao bean yield in roof plots was substantially lower (−45%) compared with control plots during the main harvest following the period when soil water content was lowest. This indicates that cacao bean yield was more sensitive to drought than other ecosystem functions. We found evidence in this agroforest that there is complementary use of soil water resources through vertical partitioning of

water uptake between cacao and Gliricidia. This, in combination with acclimation may have helped cacao trees to cope with the induced drought. Cacao agroforests may thus play an important role as a drought-tolerant land use in those (sub-) tropical regions where the frequency and severity of droughts is projected to increase.

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Keywords
cacao yield • CO_2 efflux • fine root biomass • leaf litterfall • plant water uptake • sap flux • shade trees • soil water • throughfall reduction