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How Integrated Land Use Affects Seasonal and Spatial Soil Moisture in the Brazilian Cerrado Biome

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Abstract

The Cerrado biome, constituting the native Brazilian semi-arid savannah vegetation types, has been replaced to a large extent by crop and pastureland in the past decades with pronounced effects on key agro-ecosystem functions. With regard to sustainable intensification of agricultural production, integrated systems, such as crop-livestock systems (ICL) or crop-livestock-forestry systems (ICLF) are discussed to serve as an alternative land use to improve or maintain soil health and water related functions. As compared to conventional pasture or mono-cropping systems, especially the introduction of trees via an integrated land-use raises the question if these systems hold the potential to function more akin natural Cerrado with regard to soil moisture dynamics and water cycles.

Our study compares measured soil moisture up to 100 cm depth for natural Cerrado forest (cerradão), continuous pasture (COP), ICL, and ICLF systems for almost two years on a long term monitoring site with different land use plots and relict Cerrado vegetation. In both dry and rainy season, mean soil moisture (SM) in the upper 100 cm was highest in ICL followed by degraded continuous pasture and the land use types including trees, ICLF and Cerrado (CER). However, spatial analysis of SM showed differences between soil layers and land use systems. While in COP and in ICL water was mainly taken up from the upper 30 cm, in ICLF, strongest soil moisture depletion was observed between 40 and 100 cm depth with SM values close to permanent wilting point (PWP) being reached during the dry season. In CER, SM was lower than in the other land use types in the upper 40 cm, but water was conserved below 60 cm depth. Compared to COP in both integrated systems, soil properties such as bulk density and soil organic carbon were improved, and biomass productivity increased indicating the benefits of both ICL and ICLF over the traditional grazing system. However, in comparison to CER, all secondary land use systems studied represent a significant intervention, both in terms of changes in soil properties and in water availability in the observed soil layers.

Keywords: Agroforestry, Eucalyptus, land use change, pasture, Savannah, soil water dynamics, water cycle