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BIOMASS PRODUCTION AND CARBON STOCK IN A SILVI-HORTI BASED AGROFORESTRY SYSTEM IN ARID REGION OF RAJASTHAN

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ABSTRACT

A study was conducted to compare carbon accumulation in both tree biomass and soil (0-30 cm in depth) in a six year old agri-silvi-horti system grown on a farmer field in arid region of Rajasthan. Silvicultural species were *Prosopis cineraria* (PC), *Ailanthus excelsa* (AE) and *Colophospermum mopane* (CM) along with *Zizyphus mauritiana* (ZM), *Cordia myxa* (COM) and *Emblica officinalis* (EO) horticultural species planted alternate plant to each other. These were intercropped with wheat (*Triticum aestivum*). In addition, there were controls for each tree species as well as crop alone. Biomass production of horticultural and silvicultural species was higher in agroforestry plots as compared to respective control plot. *P. cineraria* showed the highest biomass (14.02 kg per tree) and *Z. mauritiana* tree (2.07 kg per tree) lowest biomass in agroforestry system, whereas biomass was one and half time low in sole tree plot (control). Maximum reduction was in *A. excelsa* tree. Carbon content (%) was highest in leaf and lowest in roots. The highest carbon content was 45.84% in *C. mopane* and lowest was 43.61% in *A. excelsa* trees. Both biomass and soil carbon stock varied ($P<0.05$) among the horti-silvi combinations. Average carbon stock was highest in *P. cineraria* based agroforestry than other two silviculture species. It was more in agroforestry than in sole horti- and silvi- species as well as agriculture plots. Our results show that the main carbon sink in horti-silvi is the wooden parts of trees which increased with stand age, whereas the soil carbon pool remained stable.

Key words: Agroforestry, Arid region, Soil carbon stock, Tree carbon content.

Introduction

Changing land use pattern is one of the factors causing the global increase in the atmospheric carbon dioxide (CO_2). Atmospheric concentrations of CO_2 has increased from 310 ppm in 1950, to above 400 ppm in 2014 (IPCC, 2014). Tropical deforestation and forest degradation are considered to be an important source of GHG contributing to 17.4% of the global emissions (IPPC, 2007). Land use practices such as afforestration, reforestation, natural regeneration of forests and agroforestry help reduce CO_2 concentration (Canadell and Raupach, 2008). The role of forestry and agroforestry in reducing atmospheric CO_2 concentration and lowering the emissions rate of greenhouse gases (GHG) has led this system more functional (Mutuo *et al.*, 2005).

Tree-based intercropping system is one of the best options to sink carbon and nourish the people who depends on land for livelihoods, by way of integrating food production with environmental services (Soto-Pinto *et al.*, 2010). By working as carbon sink both in soil and biomass, agroforestry systems contribute to mitigate climate change (IPCC, 2007; Takimoto *et al.*, 2009; Goswami *et al.*, 2014). The amount of carbon stored in biomass and soils can be increased further by avoiding carbon releasing practices, such as deforestation, or by adopting land management practices that increase the amount of carbon stored in plant and soil (Janzen, 2005). The increasing carbon storage in agroforestry systems are expected to increase carbon accumulation in the biomass of planted trees, and provide inputs of lignin-rich litter that decomposes slowly to stabilize soil organic carbon (Montagnini and Nair, 2004).

Prosopis cineraria, Tecomella undulata, Acacia nilotica, A. senegal, A. tortilis, Zizyphus mauritiana etc. species are widely promoted in traditional agroforestry systems in the Desert regions of Rajasthan, where rainfall is low and erratic, temperature is high and occurrence of drought is frequent. These systems provide perceived economic and environmental benefits including fodder and food, shelter, arrest desertification, improve soil fertility, check soil and water erosion and improve biodiversity (Roy and Tewari, 2011). Most of the studies reflect measurement of soil organic carbon (SOC) as compared to the total carbon stored in the cropping systems (Singh, 2010). Though these specific agroforestry practices enhance soil carbon as compared to the treeless land use systems but carbon accumulation also depends upon climate, system age, soil conditions, structure and function, silvicultural management, and land use history (Murthy *et al.*, 2013).

Present study is an attempt to compare the carbon storage both in biomass and soil in different agroforestry,

The main carbon sink in horti-silvi agroforestry system is the wooden parts of trees which increased with stand age, where as the soil carbon remained stable.