Reusing Crop Residues for Enhanced Soil Function and Emission Reduction towards Climate Adaptive Agricultural Waste Management

Dipayan Dey[1], Tsering Gyeltshen, Purisima P Juico

Abstract

Reusing crop residues from sugarcane bagasse as biochar or raw application in the field in Purulia of India shows potential augmenting of soil organic carbon and carbon density and as well served in betterment of soil health, whereas reapplication of horticultural field residues from Hongtshu, Bhutan improved soil organic matter and nitrogen content of the soil enriching the soil microbial environment. This suggests that substituting the practice of agro-biomass burning for removal with prescribed reapplication in fields is a climate adaptive strategy for agricultural waste management.

Introduction

Recent references of residual biomass burning in North India and indicated air pollution in Delhi has prompted immediate reviewing the regime of agricultural waste management in the milieu of climate change in this ecoregion. Open burning of crop residues for removal or to yield biomass energy leads to emission, pollution and adversely affects soil function & nutrients (Mitchell et al. 2000). Additionally, it contributes to climate change by releasing GHGs, forming tropospheric ozone etc. and as well emission of dioxins owing to the chlorine content and presence of pesticides in agricultural waste (http://www3.cec.org/islandora/en/item/11405-la-quema-de-residuos-agr-colas-es-una-fuente-de-dioxinas-en.pdf). Nearly 500 million tons of crop residues are diverted for energy needs every year in the Indian eco-region that accounts for almost 7% of total agricultural emissions,whereas they reportedly perform positive functions like controlling surface erosion, retention of soil organic matter, restoring soil functions & soil bio-ecology (2-6). Present paper attempts to assess the practice of reusing crop residues for enhanced soil function and emission reduction towards climate adaptive agricultural waste management in sugarcane fields of Purulia district in India and horticultural fields in Hongtshu Block in Bhutan.

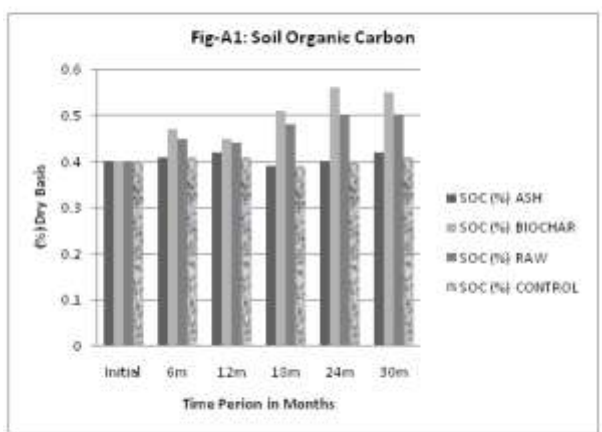
Methodology

Experimental Design: The treatments consisted of application of 75% of total crop residues generated per hectare as particulate BIOCHAR (<2mm), burnt ash (ASH) and raw agricultural wastes (RAW) laid in a Randomized Complete Block Design (RCBD)and replicated three times to form nine plots of size 3 m by 4 and 0.5m between plots and 1m between replicates. Soil data were collected from 9 soil samples at the

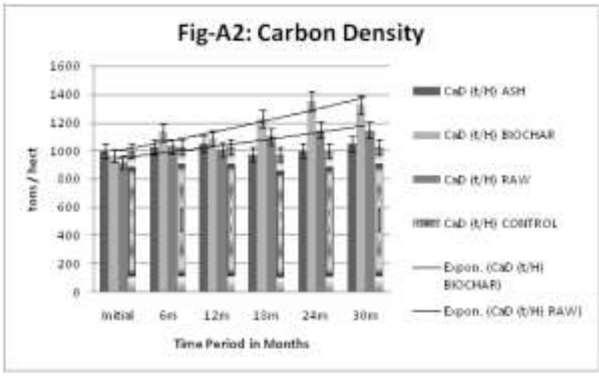
*Analytical methods***:** Standard laboratory procedure was used to determine physical properties of soil samples, Macro-Kjeldahl method was used to determine total nitrogen and soil organic carbon was determined using the Walkley-Black chromic acid titration method. The calculation of organic matter was done using the formula [Agbenin 1995] as Organic Matter (%) = Soil Organic Carbon (%) x 1.72; and carbon density (t/ha) per soil layer is calculated [CSE, Indonesia 2011] as CaD = % C x bulk density (cm3) x soil layer depth (m) x 10000(m2/ha). Biological health of soil environment was assessed with Calico-strip test and observational evidences (Latter & Walton 1988).

Results and Discussion:

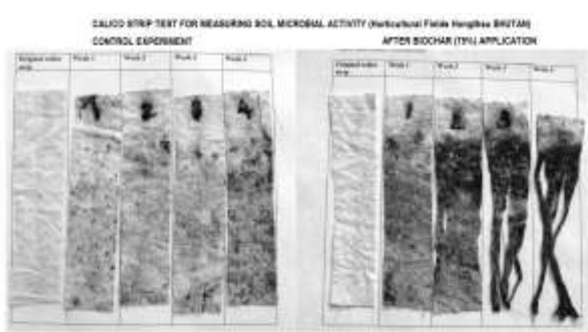
Perusal of results from Purulia district of India shows that application of raw agro-waste and biochar augmented soil organic carbon by 25% to 30%, whereas the application of ash has no similar impact (Fig-A1).



The applications also increased organic matter, bulk density of soil and its porosity thereby making it more conducive to support biological growth. This has a concurrence with the reporting of Ndor et al 2015 from Nigeria. Another major benefit associated with the use of biochar and raw crop residues as a soil amendment is its ability to sequester carbon in the soil thereby mitigating climate change [Lehmann et al 2006]. The increasing Carbon Density after the application of Biochar and crop residues is evident from the results (Fig-A2).



The sequestration potential for biochar in this study is highly significant; which is in agreement with report of [Gaunt et al 2008]. The present observation is also in parity with the inferences of Chen et al. (2010), that the bagasse charcoal increased soil moisture and as well the residence time of nitrate in the crop root zone providing greater opportunity to absorb nitrate (Kameyama et al 2012). It is noteworthy, that carbon content in raw bagasse to charcoal, reduced from 43.89 ± 9.56 % to 33.27 ± 18.30 %, whereas in the ash, it reduced to only 1.92 ± 0.89. This data, suggests that if raw bagasse mulch can be used in the agricultural field, instead of burning as fuel, it can reduce emission of ~ 42 %. Results from Hongtshu, Bhutan shows that application of raw crop residues in horticultural fields and hand crushed biochar augmented the soil organic matter and nitrogen content of the soil depicting a positive correlation. This hints about a better soil health, which was further substantiated with positive tests on Calico strips (Fig-B2) showing enhanced microbial activities in soil.



References:

(a) Agbenin JO. (1995) Laboratory Manual for Soil and Plant Analysis (Selected methods and data analysis). Published by the Author. Zaria.; pp24-44.

(b) Chen, Y, Shinogi ,Y&Taira, M (2010), 'Influence of biochar use on sugarcane growth, soil parameters and groundwaterquality', Soil Research, vol. 48(7) pp.526–530.

(c) CSE (2011) Measurement and calculation of carbon stocks – Field measurement for estimating forest carbon stocks (ground based forest carbon accounting). Document of Centre for Standardization and Environment Ministry of Forestry, Indonesia; 2011

(d) E. Ndor, S. M. Amana and C. L. A. Asadu (2015) Effect of Biochar on Soil Properties and Organic Carbon Sink in Degraded Soil of Southern Guinea Savanna Zone, Nigeria. International Journal of Plant & Soil Science. 4(3): 252-258, (Article no.IJPSS.2015.025 ISSN: 2320-7035)

(e) Gaunt J, Lehmann J. (2008) Energy balance and emissions associated with biochar sequestration and pyrolysis bioenergy production. Environmental Science and Technology; **42**:4152–4158.

(f) Kameyama, K, Miyamoto, T, Shiono, T &Shinogi, Y (2012), 'Influence of sugarcane bagasse-derived biochar application on nitrate leaching in calcaric dark red soil', Journal of Environmental quality, doi: 10.2134/jeq2010.0453.

(g) Lehmann J, Gaunt J, Rondon M. (2006) Bio-char sequestration in terrestrial ecosystems a review', Mitigation and Adaptation Strategies for Global Change; **11**:403–427

(h) Mitchell, RDJ, Thorburn, PJ & Larsen, P (2000), 'Quantifying the loss of nutrients from the immediate area when sugarcane residues are burnt', Proceedings of Australian Society of Sugarcane Technology, vol.22, pp.206-211.

(i) Wood, AW (1991), 'Management of crop residues following green harvesting of sugarcane in north Queensland', Soil and Tillage Research, vol. 20 (1), pp. 69-85.