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Sustainable Management of Crop Residues through Biochar Production

*Dr. A. Nirmala
Assistant Professor, Agricultural Polytechnic, Jogipet, Sangareddy,
Professor Jayasankar Telangana State Agricultural University, India
*Corresponding Author's email: nirmala.puli@gmail.com

Huge quantities of unused and excess crop and agroforestry residues in India are becoming an issue of concern due to inefficient crop residue management practices. Biomass based energy generation is one of the major focus areas of renewable energy programs in India. The strength of India's biomass resources mostly lies in the agricultural sector. However, crop residue biomasses are distributed resources with variation in spatio-temporal availability and its characteristics. Overall, India produces 686 MT gross crop residue biomass on annual basis, of which 234 MT (34% of gross) are estimated as surplus for bioenergy generation. (Hiloidhari et al, 2014).

Direct incorporation of crop residues into agricultural soils can conserve soil nutrients and organic carbon content but causes considerable crop management problems due to delay in decomposition (Grace, 2008). Further, surplus crop residues when left unattended, often disrupt land preparation, crop establishment and early crop growth, and therefore is typically burnt on farm which causes environmental problems and substantial nutrient losses (IARI, 2012; Purakayastha et al., 2015).

Open field burning of crop residues is perceived as an age old practice to boost soil fertility in terms of P and K but often leads to a loss of other nutrients (e.g. N and S), organic matter and microbial activity required for maintaining better soil health (IARI, 2012). On the other hand, maintenance of a threshold level of organic matter in soil is crucial to sustain soil physical, chemical and biological activities to achieve optimum agricultural production and environmental functions (Grace, 2008).

Bhattacharya (2006) reported that 64% rural households in India rely on firewood for cooking and another 26% rely on crop residue or animal wastes. Further, in the urban sector almost 30% households rely on traditional energy for cooking. On a comparative study of household energy uses pattern in India and China, Pachauri and Jiang reported that at an aggregate level, solid fuels (traditional biomass and coal) comprise 80% of total residential energy use in both the countries. Large scale use of firewood as cooking fuel is reported in India. Annually about 220 MT of firewood is utilized for cooking in the rural sectors of India. Firewood contributes the major portion of final energy consumption with a variation between 65% and 80% depending on income level of households. Apart from household uses, biomass is also extensively used in various traditional and rural enterprises such as brick making, rice par-boiling, hotel, restaurants, bakeries, potteries and charcoal making.(Bhattacharya, 2006).
The modern uses of biomass take the advantages of modern biomass conversion technologies (combustion, pyrolysis, gasification, fermentation, and anaerobic digestion) for production of heat and electricity, liquid and gaseous transportation fuel, biogas for cooking *etc*. There is a huge potential for modern uses of biomass energy in rural India, especially in the cooking and lighting sectors.

Being an agricultural dominant nation, biomass energy programs in India are mostly associated with the crop yield in the fields. Worldwide India is holding first rank in the production of jute and also India stands second in rice, cotton, sugarcane, wheat and ground nut.

Huge quantities of unused and excess crop and agroforestry residue in India are becoming an issue of concern due to inefficient crop residue management practices. Annually 523 Mt crop residues are generated in India, out of which 127 Mt is surplus (S. Pachauri et al, 2008). These residues are either partially utilized or un-utilized due to various constraints.

Direct incorporation of crop residues into agricultural soils can conserve soil nutrients and organic carbon content but causes considerable crop management problems due to delay in decomposition. For more effective management and disposal of the crop residues, their conversion into biochar through thermo-chemical process (slow pyrolysis) is gaining importance as a novel and economically alternative way of managing unusable and excess crop residues, which are otherwise being used inefficiently (V.V.N. Kishore et al. 2004). Use of biochar in agricultural systems is one viable option that can enhance natural rates of carbon sequestration in the soil, reduce farm waste and improve the soil quality (Purakayastha et al,2015). Further, several studies across the world have established that biochar application increases conventional agricultural productivity and mitigate GHG emissions from agricultural soils. This has led to renewed interest of agricultural researchers particularly in India to produce biochar and its use as a soil amendment. The initial outcomes reveal that biochar application helps in improving soil health and crop productivity. However, to promote the application of biochar as a soil amendment and also as a climate change abatement option, research, development and demonstration on biochar production and application is very vital. It is necessary to develop low-cost biochar kiln to make the technology affordable to small and marginal farmers. The brief research in ICAR-CRIDA resulted in development of farmers' friendly portable biochar kiln strategy for effective utilization of castor, cotton and pigeonpea stalk residue for producing biochar. Presently, the low cost biochar kiln developed under this study has no mechanism to capture the exhaust gases released during the process of biochar preparation. Efforts are being made to modify the kiln with suitable mechanism to reduce the emission of exhaust gases. Data on biochar properties and amendment effects suggests for effective integration of carbon rich biochar in soils for sustainable improvement of soil health and crop productivity. (IARI. 2012).

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