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BIOMASS, CARBON STOCK AND CARBON SEQUESTRATION POTENTIAL IN *ACACIA NILOTICA*-PADDY BASED TRADITIONAL AGROFORESTRY SYSTEM.

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The traditional agroforestry system of growing a multipurpose tree *Acacia nilotica* with paddy is a very popular in the semi arid tracts of central India.The Chhattisgarh state is regarded as the “Rice bowl” of the central India. The present study was made to quantify the “biomass, carbon stock and carbon sequestration potential in *Acacia nilotica*-paddy based traditional agroforestry system” in tropical environment at Nara village PO Bhan Soj, Raipur district (Chhattisgarh), during the year 2015-2016. In the present study, the total crop biomass ranged between 3.10 and 4.93 t/ha. The total crop yield ranged between 0.82 and 1.58 t/ha. The carbon stock of the soil ranged between 4.92 and 5.8 t/ha. The total carbon stored in trees across the agroforestry system was found to be 6.15 t/ha. Total carbon sequestered by the system was at rate of 3.0 t/ha. Total net productivity of the tree was 2.61 t/ha/yr. The research suggests that *Acacia nilotica*-paddy based traditional agroforestry system have the potential to enhance carbon Stock through tree biomass and soil.

Key words: *Acacia nilotica,* carbon sequestration, carbon stock, biomass, traditional agroforestry, carbon storage

Trees are known to maintain soil organic matter and nutrient cycling through the addition of litter and root residues into the soil. Carbon dioxide is naturally captured from the atmosphere through biological, chemical, or physical processes. In the context of forests, carbon stock refers to the amount of carbon stored in the world's forest ecosystem, mainly in living biomass and soil. Tree based land used systems could sequester carbon in soil and vegetation and improve nitrogen cycling within the systems.

In view of set greenhouse gas reduction targets potential for agricultural systems to sequester atmospheric carbon dioxide (CO_2) through building levels of soil carbon has been an area of considerable interest in recent years. The goal of agricultural carbon removal is to use the crop and its relation to the carbon cycle to permanently sequester carbon within the soil. Agroforestry has the potential to increase the productivity by restoring and maintaining soil fertility. This improves the livelihoods of people in both developed and developing countries.

There is a growing interest in the role of different types of land use systems in stabilizing the atmospheric CO_2 concentration and reducing the CO_2 emissions or on increasing the carbon sink of forestry and agroforestry systems. Forestry has been recognized as a means to reduce CO_2 emissions as well as enhancing carbon sinks. There is considerable interest to increase the carbon storage capacity of terrestrial vegetation through land-use practices such as afforestation, reforestation, natural regeneration of forests, silvicultural systems and agroforestry. Agro forestry system is an important land-use system as far as their role in climatic mitigation is concerned and offer better alternative for livelihood to the farmers as compared to agriculture alone.

Thus, the importance of agro forestry as a land use system is receiving wider recognition not only in terms of agricultural sustainability but also in issues related to C sequestration or climate change (Verma *et al*. 2008).

STUDY AREA

The study sites were located in Nara village Bhan Soj in the Raipur district of the Chhatisgarh. *Acacia nilotica* grows naturally in the rice fields and also on the bunds at irregular spacings. The soil type of this region is silty loam locally known as matasi and irrigation is mainly rain fed. The climate is monsoonic sub humid tropical and is characterized by marked seasonality. The year is divisible into 3 seasons rainy (mid June-

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Sept), winter (Nov-Feb), summer (Feb-mid June)

MATERIALS AND METHODS

In the present study there were 6 plots which is bund based agroforestry system i.e. there is a presence of *Acacia nilotica* trees on the bund of field. Soil samples upto 20 cm depth were collected from 10 random location from each field. Soil samples for every field were mixed and composite samples were prepared and were further analyzed in the laboratory for organic carbon total nitrogen, phosphorus, potassium, pH, texture, bulk density and water holding capacity.

Carbon (C) and nitrogen (N) stock in plant were calculated by multiplying with carbon and nitrogen concentration and biomass of respective plant parts. Carbon & N stock in soil were calculated using: C & N concentration, bulk density and soil volume data. C & N concentration estimated earlier by Singh (2012) were used in the study. For estimating the biomass of tree allometric equation developed earlier by Singh & Mishra (1979) were used in the present study. At the peak biomass stage above ground crop biomass using 10 random quadrat of 0.25 square meter and belowground biomass upto 20 cm depth were measured.

RESULT AND DISCUSSION

The soil of the study area was silty loam in texture with considerably varying proportions of sand (23-28 %), silt (55-59 %) and clay (16-19%). The soil pH was in the range of 6.40-6.90 at the soil depth 0-10 cm and in the range of 6.10-6.50 at the soil depth 10-20 cm. Bulk density ranged from 1.31 to 1.36 gm^{-3}. The highest bulk density was observed in field no 4 of depth 10-20 cm (1.36g cm^{-3}) and the lowest was observed in field number 3 of depth 0-10 cm (1.29 g cm^{-3}). Increase in bulk density with increasing soil depth is also reported by Allen *et al.* (2004).

Total N and C were between 87 -112 kg/ha, and 0.30 - 0.45 %, respectively. Swamy and Puri (2005) reported that total nitrogen in the soil increased significantly and storage was high in the upper layer (0-20 cm) of depth and decreased with depth. Organic carbon was found in the range of 0.37% to 0.45% for soil depth 0-10 cm and in the range of 0.30% to 0.39% for soil depth 10-20 cm for different field under study. Swamy and Puri (2005) findings revealed that soil organic carbon from all studied sites generally decreased with the increased depth of soil. Similar observations were also observed in the present study. Samra and Singh (2000) observed an increase in soil organic carbon status of surface soil by 0.39 to 0.52% under *Acacia nilotica+Sacchram munja* and 0.44 to 0.55% under *Acacia nilotica+Eulaliopsis binata* after 5 years. The present finding is also comparable with the research.

Available P and K were between 7.23-17.56 kg ha^{-1} and 294.56 -404.32 kg ha^{-1}respectively. The electro-conductivity of the soil ranges from 0.19-0.33 Ds/m. The water holding capacity of the soil was ranged between 26 and 42% with maximum (42%) water holding capacity in field no 5 upto 10 cm depth and the lowest (26%) was observed in field no 3 at 10-20 cm depth. Hence, it was found that the water holding capacity decreases with increasing in the depth. The t-test assuming equal variances indicates that the variation in water holding capacity of the soil was due to variation in soil depth and it is statistically significant ($p<0.05$). It was observed that with increase in depth, the pH decreases in all the studied fields. The t-test, assuming equal variances, indicated significant variation in pH of the soil for different depths in all the studied fields at $p<0.05$. In all the field, it is clearly observed that electro conductivity is higher in the surface, 0-10 cm depth and lower in 10-20 cm depth The electro conductivity was lowest in field no 6 at the depth of 10-20 cm (0.21 S/m) and highest in field number 1 at the depth of 0-10 cm (0.33 S/m). Hence, it is concluded that the surface soil has more electro conductivity. The t-test assuming equal variances indicates that the water holding capacity of the soil was due to variation in soil depth and it is

Table 1: Total crop biomass,Crop yield biomass and Crop residue biomass.

Biomass	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Average Biomass
Crop Residue Biomass	3.35±0.49 (68)	2.18±0.53 (68)	2.50±0.4 (66)	2.52±0.53 (68)	2.38±0.38 (66)	2.28±0.20 (74)	3.71±0.35 (68)
Crop yield biomass	1.58±0.35 (32)	1.01±0.27 (32)	1.27±0.21 (34)	1.17±0.23 (32)	1.24±0.21 (34)	0.82±0.11 (26)	1.18±0.42 (32)
Total crop biomass	4.93±0.84	3.20±0.80	3.77±0.64	3.69±0.76	3.62±0.59	3.10±0.31	2.53±0.38

Note: Values in parenthesis are % value

statistically significant ($p<0.05$).

In the present study, the total crop biomass ranged between 3.10 and 4.93 t/ha. Crop biomass (above+ below ground biomass) reported by Bergalli *et al* (2009) was 2.42 tons/ha hence the crop biomass in present study is more which may be attributed to the good nutrient status of the soil and also the farmers used to pruned the tree regularly. It was maximum in field no 1 and minimum in field no 6. The total crop yield ranged between 0.82 and 1.58 tons/ha given in table 1. It is in contrast with that of the reports given by Singh *et al*. (2008) paddy grain yield range between 3.26 to 4.30. It is due to the difference in sites nutrient status, soil texture and climatic factor

The carbon stock of the soil ranged between 4.92 and 5.8 tons/ha. It was found to be maximum in field no 3 and minimum in field no 6. Carbon stock in tree component was 2.32 tons/ha. The total carbon stored in trees across the agroforestry system was found to be 6.15 tons/ha. Total carbon sequestered by the system was at rate of 3.0 tons/ha. Total net productivity of the tree was 2.61 tons/ha/yr

CONCLUSION

The research concluded that *Acacia nilotica*-paddy based traditional agroforestry system have the potential to enhance carbon stock through tree biomass and soil. The magnitude and quality of carbon stock depends on the complex interaction between climate, soil, density, age of plantation, and management practices.

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REFERENCES

Allen S C, Jose S, Nair P K R, Brecke B J, Nkedi-Kizza P and Ramsey C L 2004 Safety-net role of tree roots: evidence from a pecan (*Carya illinoensis* K. Koch)- cotton (*Gossypium hirsutum L*.) alley cropping system in the southern United States. *For Ecol Manag* **192,** 395-407.

Bargali S S, Bargali K, Singh L, Ghosh L, and Lakhera M L 2009 *Acacia nilotica*-based traditional agroforestry system: effect on paddy crop and management. Current Science: **96(4)** 581-587.

Samra J S, Singh S C, 2000 Silvopasture systems for soil,water and nutrient conservation on degraded land of Shiwalik foothills (Sub tropical northern India). *Indian Journal of Soil Conservation* **28**:35-42.

Singh K P and Mishra R 1979 Structure and Functioning of Natural, Modified and Silvicultural Ecosystems of Eastern Uttar Pradesh. Final Technical Report (1975-1978). MAB Research Project. Banaras Hindu University, India.

Singh L 2012 Impact of Land Use on Vegetation and Soil Carbon, Net Primary Productivity and Nitrogen Budget in Tropical Dry Deciduous Forest of Barnawapara Sanctuary.A Final Technical Report (2006-2010), Submitted to Ministry of Environment Forest and Climate Change, Government of India. Indira Gandhi Krshi Vishwa Vidyalaya,Raipur, India.

Singh L, Ghosh L, Bargali S S, Saxena R R, 2008 Influence of naturally occuring trees on bunds and their impacts on yield parameters of Paddy Crops. *Range Management and Agroforestry* **29 (2)** :134-137

Swamy S L and Puri S 2005 Biomass production and C-sequestration of *Gmelina arborea* in plantation and agroforestry system in India**.** *Agroforestry Systems*, **64:** 181–195.

Verma K S, Kumar S and Bhardwaj D R 2008 Soil organic carbon stocks and carbon sequestration potential of agroforestry systems in H.P. Himalaya Region of India. *Journal of Tree Sciences,* **27 (1):** 14-27.