International Scholars Journals

International Journal of Agroforestry and Silviculture ISSN 2375-1096 Vol. 5 (5), pp. 311-314, May, 2017. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Carbon stock present in dominant tree species of coffee based agroforestry system

[1]M Manjunatha, [1]AS Devakumar, [2]Nivedita M and [2]CG Kushalappa

[1]Associate Professor, Department of Forestry and Environmental Sciences, UAS.GKVK, Bangaluru, India. [2]Professor, Department of Forest Biology and Tree Improvement, College of Forestry, Ponnampet, India.

Accepted 09 March, 2016

The biomass accumulation of standing trees and the carbon stored in it varied considerably by different shade tree species grown in the coffee plantations under two vegetation types. The contribution of *Tabernaemontana heyniana, Syzygium cumini* and *Acrocarpus fraxinifolius* was as high as 8.7, 8.5 and 7.2 per cent of the carbon stocked in the total above ground biomass by the shade trees respectively, while it was as low as 1.2 per cent in *Erythrina suberosa*. Though the number of trees per unit of land area was more in case of *Gravillea robusta*, the contribution in terms of carbon stocked in it was only 1.8 per cent. The contribution of all the ten dominant tree species to the total above ground biomass of shade trees was found to be 43.3 per cent but in case of coffee plantations of moist deciduous type of vegetation, *Acrocarpus fraxinifolius* and *Gravillea robusta* recorded 88 and 49 number of individuals per hectare which was highest, while it was as low as 9 and 12 in case of *Acrocarpus fraxinifolius* and *Holigarna nigra* respectively. The maximum per cent contribution of carbon stocking was seen in *Terminalia bellarica* and *Ficus racemosa* to the extent of 21.5 and 11.7 respectively, while it was least in case of *Mangifera indica* 2.1 per cent.

Keywords: Carbon stock, agroforestry, coffee plantation, biodiversity, shade tree.

INTRODUCTION

Climate change is one of the greatest challenges now facing humanity and will likely remain so for generations to come. An increasingly large body of evidence suggests that the Earth is getting warmer and if it continues warming will have negative effects on human affairs, the natural environment and biodiversity. An increase in the concentration of greenhouse gases (GHGs) in the atmosphere released primarily through the burning of fossil fuels, deforestation and agricultural and industrial processes is generally accepted to be the primary contributor to global warming (Pfaff et al., 2000). Agroforestry has been demonstrated to be a promising mechanism of carbon sequestration in India (Singh and Lal., 2000) Therefore, agro ecosystems have the potential to act as carbon sinks and carbon storage pools while contributing to increased farm production, environmental conservation and poverty alleviation (Pandey, 2002). Agroforestry systems are believed to have a higher potential to sequester C than pastures or field crops (Sanchez, 2000; Roshetko et al., 2002; Sharrow and Ismail, 2004; Kirby and Potvin, 2007). This conjecture is based on the notion that tree incorporation in croplands and pastures would result in greater net aboveground as well as belowground C sequestration (Palm et al., 2004; Haile et al., 2008). In this context, the coffee agro ecosystem is ideal for investigation, as it is one of the leading production systems.

The trees are not only raised for providing shade to coffee plants but are also seen as a subsidiary source of income especially under distress. Therefore, in a coffee plantation high population of different tree species are raised. These shade trees play important role in accumulating atmospheric carbon dioxide into the tree biomass.

*Corresponding author E-mail: manjumunsar@gmail.com Tel.: 08943623285

MATERIALS AND METHODS

Kodagu district, located in Central Western Ghats (Western Ghats is chain of mountains 1600 Km long and 5-150 Km wide along the west cost of India.

The study was carried out in the coffee plantations distributed in the Cauvery watershed area under two vegetation types namely Evergreen and Moist deciduous type. These two vegetation types receive distinctly high and low rainfall. Further, in these two major vegetation types, coffee plantations are having the shade trees of different types of native tree species and the plantations with *Grevillea robusta* as one of the dominant tree were selected for the study. Coffee plantations with only native tree species are termed as native plantation and plantations with Grevillea *robusta* is considered as Exotic plantations along the Cauvery watershed area 28 different villages were selected and of which 14 under the evergreen vegetation type and another 14 villages under the moist deciduous vegetation type. Altogether there were 56 plantations in that 52 plantations are robusta plantations and only four plantations are arabica plantations where were studied in both the areas of vegetation type.

Importance Value Index

This index is used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance are summed up together and this value is designated as the

a) Relative density.

Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$Relative\ Density = \frac{Number\ of\ individual\ of\ the\ species}{Number\ of\ individual\ of all\ the\ species} X\ 100$$

b) Relative frequency.

The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$Relative\ frequency = \frac{Number\ of\ occurence\ of\ the\ species}{Number\ of\ occurence\ of all\ the\ species} X\ 100$$

c) Relative dominance.

Dominance of a species is determined by the value of the basal cover. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$Relative\ dominance = \frac{Total\ basal\ area\ of\ the\ species}{Total\ basal\ area\ of all\ the\ species} X\ 100$$

The total basal area was calculated from the sum of the total diameter of immerging stems. In trees, poles and saplings, the basal area was measured at breast height (1.37m)

Species richness, diversity and dominance indices

The species richness of the vascular plants was calculated by using the method

'Margalef's index of richness' (Dmg)

Dmg = (S-1)/ In N

Where, S = Total number of species.

N = Total number of individuals.

Species diversity and dominance were evaluated by using the following methods. Shannon's diversity index and Simpson's index of dominance were calculated using important value index (IVI) of species.

Shannon–Weaver (1963) index of diversity: The formula for calculating the Shannon diversity index is

H' = – ∑ *p*i In*p*i

Where, H' = Shannon index of diversity

pi= the proportion of important value of the i^{th}species (pi = species n_i/ N, $n_i$is the IVI of i^{th} species and N is the IVI of all the species).

RESULTS AND DISCUSSION

The ten dominant species (it is based on IVI) found under evergreen vegetation are presented in Table 1. The (Important Value Index) IVI values are the indicators of the most preferred tree species in the coffee plantations of a region. The IVI values were found to vary considerably. The values ranged between 20.7 and 7.2 in evergreen vegetation type, while it varied between 35.55 and 8.40 in moist deciduous vegetation. The density and frequency of species such as *Syzygium cumini, Acrocarpus fraxinifolius, Grevillea robusta,* and *Aporosa lindleyana* was found to be very high among the various tree species used for providing shade in coffee plantations in evergreen vegetation whereas it was *Erythrina suberosa, Dalbergia latifolia, Ficus racemosa, Grevillea robusta*, species that had higher frequency and density in moist deciduous vegetation type coffee plantation. It was interesting to note that, there was six species found common to both the vegetation type among the ten dominant species which includes *Grevillea robusta*.

Contribution of dominant tree species to total carbon

The biomass accumulation in the standing trees and the carbon stored in it varied considerably by different shade tree species grown in the coffee plantations under two vegetation types (Table 2 and Table 3). In coffee plantations of evergreen type of vegetation the number of individuals of different species varied from as high as 71 in *Grevillea robusta* to as low as 15 in *Ficus mysurensis.* The carbon accumulated in

The above ground biomass of individual tree species showed lot of variation. The contribution of *Tabernaemontana heyniana, Syzygium cumini* and

Table 1. Ten dominant shade tree species of both the vegetation types of coffee plantations.

Sl. No	Evergreen Vegetation		Moist Deciduous Vegetation	
	Dominant species	IVI	Dominant species	IVI
1	*Syzygiumcumini*	20.74	*Erythrinasuberosa*	35.55
2	*Acrocarpusfraxinifolius*	19.03	*Dalbergialatifoila*	25.06
3	*Grevillearobusta*	17.90	*Ficusracemosa*	22.49
4	*Aporusalindleyana*	16.24	*Grevillearobusta*	22.48
5	*Erythrinasuberosa*	15.57	*Syzygiumcumini*	16.03
6	*Tabernaemontanaheyneana*	5.43	*Acrocarpusfraxinifolius*	14.47
7	*Artocarpusheterophyllus*	11.34	*Artocarpusheterophyllus*	13.23
8	*Oleadioica*	8.36	*Terminaliabellirica*	12.23
9	*Mangiferaindica*	7.60	*Mangiferaindica*	11.13
10	*Ficus species*	7.26	*Holigarnanigra*	8.40

Table 2. Contribution of ten dominant tree species to the Carbon Stock in the above ground biomass ofshade trees under evergreen vegetation type.

Sl.No	*Species*	No. of Individuals	Per cent of carbon contribution
1	*Syzygiumcumini*	50	8.5
2	*Acrocarpusfraxinifolius*	66	7.2
3	*Grevillearobusta*	71	1.8
4	*Aporusalindleyana*	50	2.6
5	*Erythrinasuberosa*	69	1.2
6	*Tabernaemontanaheyneana*	18	8.7
7	*Artocarpusheterophyllus*	26	3.3
8	*Oleadioica*	22	1.5
9	*Mangiferaindica*	17	2.4
10	*Ficusmysorensis*	15	6.3
	Total	404	43.4
	Others	380	56.6

Table 3. Contribution of ten dominant tree species to the Carbon Stock in the above ground biomass of shade trees under moist deciduous Vegetation type.

Sl. No	Species	No. of individuals	Per cent of carbon contribution
1	*Erythrinasuberosa*	88	4.0
2	*Dalbergialatifoila*	46	10.5
3	*Ficusracemosa*	21	11.7
4	*Grevillearobusta*	49	2.8
5	*Syzygiumcumini*	21	6.1
6	*Acrocarpusfraxinifolius*	27	4.8
7	*Artocarpusheterophyllus*	18	6.1
8	*Terminaliabellirica*	9	21.5
9	*Mangiferaindica*	20	2.1
10	*Holigarnanigra*	12	7.2
	Total	308	76.68
	Others	486	23.13

Acrocarpus fraxinifolius was as high as 8.7, 8.5 and 7.2 per cent of the carbon stocked in the total above ground biomass by the shade trees respectively, while it was as low as 1.2 per cent in *Erythrina suberosa*.

Though the number of trees per unit land area was more in case of *Grevillea robusta*, the contribution in terms of carbon stocked in it was only 1.8 per cent. The contribution of all the ten dominant tree species to the total above ground biomass of shade trees was found to be 43.3 per cent.

In case of coffee plantations of moist deciduous type of vegetation, *Acrocarpus fraxinifolius* and *Grevillea robusta* recorded 88 and 49 number of individuals per hectare which was highest, while it was as low as 9 and 12 in case of *Acrocarpus fraxinifolius* and *Holigarna nigra* respectively. The maximum per cent contribution of carbon stocking was seen in *Terminalia bellarica* and *Ficus racemosa* to the extent of 21.5 and 11.7 respectively, while it was least in case of *Mangifera indica* (2.1 per cent).

Though the number of trees per unit land area was second highest in case of *Grevillea robusta* the carbon stocked in its biomass was only to an extent of 2.8 per cent. The contribution of ten dominant tree species towards the total carbon stocked in the above ground biomass was found to be as high as 76.68 per cent. When we tried to delineate the contribution of individual species, it was found that in evergreen vegetation type about 43 per cent of the total carbon has come from 10 dominant tree species while under deciduous vegetation type about 76 percent came from 10 dominant tree species. This further reiterate the fact that the tree diversity is substantially higher in coffee plantations under evergreen area compared to deciduous vegetation type, therefore coffee plantations provide two important ecosystem services such as carbon sequestration and biodiversity conservation. Though the other ecosystem services were not quantified in this study, the coffee plantation would certainly help in conserving soil by reducing the soil erosion and retaining higher moisture in the soil.

REFERENCES

Haile S. G, Nair P K R., Nair VD (2008). Carbon storage ofdifferent soil-size fractions in Florida silvopastoral systems. J. Environ. Qual. 37:1789–1797.

Kirby K. R, Potvin C.(2007). Variation in carbon storage amongtree species: Implications for the management of a small-scalecarbon sink project. For. Ecol. Manage. 246:208–221.

Palm C. A. Tomich T, van Noordwijk M, Vosti S, Alegre J, Gockowski J, Verchot L (2004). Mitigating GHG emissions in thehumid tropics: Case studies from the Alternatives to Slash-and Burn Program (ASB). Environ. Dev. Sust. 6:145–162.

Pandey DN (2002) Carbon sequestration in agroforestry systems. Climate Change Policy.:2: 367-377.

Pfaff A, Kerr S, Hughes F, Liu S, SanchÈz-Azofeifa A, Schimel D, Tosi J, and Watson V. (2003). The Kyoto Protocol and payments for tropical forests: an interdisciplinary method for estimating carbon-offset supply and increasing the feasibility of a carbon market under the CDM. Ecological Economics.:5: 203-221.

Roshetko M, Delaney M, Hairiah K, Purnomosidhi P. (2002) Carbon stocks in Indonesian homegarden systems: Can smallholder systems be targeted for increased carbon storage? Am. J. Alt. Agr. 17: 125–137.

Sanchez, P. A.(2000). Linking climate change research with foodsecurity and poverty reduction in the tropics. Agric. Ecosyst.Environ.82: 371–383.

Sharrow SH, Ismail S. (2004). Carbon and nitrogen storage in agroforests, tree plantations, and pastures in western Oregon, USA. Agroforest. Syst. 60:123–130.

Singh TP, Lal M (2000). Carbon sequestration through farm forestry: a case from India. Indian Forester.126: 1257-1264.