Print : ISSN 0970-7662
Online : ISSN 2455-7129

Journal of Tree Sciences
online available at www.ists.in

Volume 36 | No. 2 | December, 2017

Relationship of Socio-Economic Factors With Attributes of Homegarden Agroforestry Systems in Northern Part of West Bengal

Mohit Subba, Nazir A. Pala, Gopal Shukla, Kausik Pradhan* and Sumit Chakravarty

Department of Forestry, Uttar Banga Krishi Viswavidyalaya, Cooch Behar-736165 West Bengal, India;
***Department of Agril. Extension, UBKV, Cooch Behar-736165, West Bengal, India*
Email: gopalshukla12@gmail.com

DOI: 10.5958/2455-7129.2017.00029.2

ABSTRACT

The present study has explored the district-wise relational analysis between the total carbon stock in the home gardens and different socio-personal, socio-economic and socio-psychological and communication related attributes of home gardeners in Cooch Behar, Jalpaiguri and Siliguri sub-division of Darjeeling districts of West Bengal. Majority of the respondent belongs to medium utilization of resources category and in age category of 30-50 years with low education, medium level of family education, high educational aspiration, Moreover, the majority of the respondents represented medium risk orientation category. Finally the total C stock was distributed with mean of 101.27, standard deviation of 143.02 and coefficient of variation 141.22 indicating high consistency level of distribution with majority of homegardens had low level of total carbon stock. Pearson's co-efficient of correlation clearly shows that educational aspiration is positively and significantly associated with the total carbon stock at 5 % level of significance. The majority group of respondents are the most important stake holder in case of adopting strategies of climate change through managing home garden land use system.

Key Words:

adaptation, climate, culture, education, socio-personal

INTRODUCTION

Home gardens are essentially man made and reflect the wisdom of traditional culture and ecological knowledge that have evolved over the years. Such valuable traditional ecological knowledge systems are based on strong socio-cultural and traditional beliefs confounded by the economic status of the people (Okigbo 1990). The gardens are designed and managed appropriately based on indigenous knowledge harbors a wide diversity of local crops suited to social and traditional significance are most promising and ecologically feasible option for the community. Different agroecological and socio-economic conditions determine significant variations across agroecosystems in terms of its size (Galluzzi et al. 2010). Generally, home gardens representing a niche within larger farming systems, their size is to some degree proportional to the size of the overall farm (Guarino and Hoogendijk 2004). Gardens in cities having no immediate connection with larger fields are a more fragmented resource (Gaston et al. 2005) due to scarce land area available for it

(Vasey 1985; Linares 1996). These land-use systems contribute not only to production objectives but also to the objectives of biodiversity and environmental conservation (Panwar and Chakravarty 2010). Agroforestry has importance as a carbon sequestration strategy because of carbon storage potential in its multiple plant species and soil as well as its applicability in agricultural lands and in reforestation (Ruark et al. 2003; Nair et al. 2010).

By including trees in agricultural production systems, agroforestry can, arguably, increase the amount of carbon stored in lands devoted to agriculture, while still allowing for the growing of food crops (Kursten 2000). The basic premise of carbon sequestration potential of land-use systems, including agroforestry systems, is relatively simple. It revolves around the fundamental biological/ecological processes of photosynthesis, respiration, and decomposition (Nair and Nair 2003). Essentially, carbon sequestered is the difference between carbon 'gained' by photosynthesis and carbon 'lost' or 'released' by respiration of all components of the ecosystem, and this overall gain or loss of carbon is usually represented by net ecosystem productivity. Most carbon enters the ecosystem via photosynthesis in the leaves, and carbon accumulation is most obvious when it occurs in aboveground biomass. More than half of the assimilated carbon is eventually transported below ground via root growth and turnover, root exudates (of organic substances), and litter deposition, and therefore soils contain the major stock of carbon in the ecosystem.

Inevitably, practices that increase net primary productivity (NPP) and/or return a greater portion of plant materials to the soil have the potential to increase soil carbon stock. Unfortunately, literature on C sequestration in agroforestry systems is rather scanty (Montagnini and Nair 2004). Therefore, the schedule on home garden was mostly indirect, in the sense that any practice that contributes to higher productivity will indirectly lead to higher C sequestration. The present study was therefore undertaken to delineate the district-wise relational analysis between the total carbon stock in the home gardens and different socio-personal, socio-economic and socio-psychological and communication related attributes of home gardeners in Cooch Behar, Jalpaiguri and Siliguri sub-division of Darjeeling districts of West Bengal.

MATERIALS AND METHODS

Site Description

The study site is terai zone (foot hills plains area of Himalayas) in northern part of West Bengal which lies between 26° 30´ and 26° 56´ N latitude and 88° 7´ and 89° 53´ E longitude and spreading in the districts of Jalpaiguri, part of Cooch Behar and Siliguri sub-division of Darjeeling district. The region is sub-tropical receiving average annual rainfall of 250-300 cm from south-west monsoon of which 80 % is received from June to August. The summer and winter temperature are mild with 34C as the highest in the month of May while the lowest temperature is 7.5C in the month of January.

Cooch Behar has a total area of 3, 31,566 ha. Vegetable, mustard, maize and potato cultivation are increasing. This district is familiar in vegetables and fruit production through the year. Total cultivated area is 264984 ha (79.92 % of the total area) and the forest area is 4256 ha (1.28 % of the total area) and the rest area is not under cultivation but excluding forest, i.e. 6232 ha (18.80 % of the total area). The total area of Darjeeling is 3,149 square kilometers, out of which the total forest area is 33957 hectares (www.darjeeling.gov.in). The net cropped area is 131063 hectares. Geographically, the district can be divided into two broad divisions, the hills and the plains. The main agriculture crops are rice, wheat, maize, millet, tea, chilies, ginger and other vegetables. The total geographical area of Jalpaiguri district is 6245 km^2, of which under tea garden is 1987 km^2 and under forest is 1790 km^2 (www.jalpaiguri.gov.in). The Terai region is inhabited by divergent communities with Indo-

Mongoloid tribes, majority of which is Raj Bangshis. Apart from them there are Mech, Ravas, Totos, Limbus, Lepchas, Bengalis and tea plantation labourers like Nageshias, Uraons and Mundas. The society of this region is mainly agrarian. All these various tribes have their distinct culture and beliefs.

Sampling Design

Purposive, multi-stage and random sampling procedures are followed in the present study. The districts Cooch Behar, Jalpaiguri and Darjeeling were purposively selected due to the availability of diversified ecosystem related to the theme of the present study wherein the terai and hill ecosystems were prevailing with a vast agricultural field and forest area coverage. From these selected villages the exhaustive lists of home gardeners was prepared and from the exhaustive list 100 diversified home gardens form terai region were selected for final data collection. The inter- and intra-level association exists among the socio-economic, socio-psychological, socio-personal and communication related determinants of the household with the total carbon stock. Total carbon stock was considered as the dependent variable for this study. The variables like socio-personal (age, education and family size); socio-economic (income, land holding and status) and socio-psychological (risk orientation, scientific orientation, innovation proneness) and communication (utilization of sources of information) are taken as independent variable and were obtained with a structured interview schedule. In the present study the number of years rounded in the nearest whole number the responded lived since birth at the time of interview is taken as a measure of age of the respondents. Education of the respondents was measured with the help of slightly modified scale developed by Supe (2007). The average score for education of family indicates the overall family education status of the respondents.

$$FESS = (E_1+E_2+...+En)/N$$

Where, FESS = Family education status score; $E_1+E_2+...+E_n$ = education score of all family members and N = total number of family member.

Land holding is measured by considering the total land owned by the respondents during the study in hectares. The economic status of the farmer was measured with the help of some components of the socio-economic status scale (rural) developed by Pareek and Trivedi (1963, 1964). The variable 'risk orientation' was measured with the help of slightly modified scale developed by Supe (2007) and scores allotted. Scientific orientation was operationalised as the characteristic of individual that made him to trust and rely on ideas and practices developed through scientific research. This variable was measured with the help of scale developed by Supe (1969). Innovation proneness was measured with the help of Moulik's (1965) self-rating scale. The sources of information of a respondent were determined by summing up the scores obtained from the cosmopolite and localite schedule developed by Singh and Roy (1993).

Field Data Collection

The data were collected with the help of the schedule constructed for the study through personal interview method. In each village, before starting the interview, a few days were devoted to establish rapport with the respondents. The schedule was administered to the respondent in local language and the responses were recorded in English on the schedule. The interview was carried out by the researcher himself.

Soil organic carbon (SOC) stocks were calculated by multiplying the organic carbon with weight of the soil for a particular depth and expressed as mega grams (Mg) ha^{-1} as given by Joao Carlos et al. (2001). Non-destructive method was adopted for biomass estimation. Tree biomass was estimated for each individual tree and then summed up. All dicot tree: Y = exp {-2.134 + 2.350 x In (D)} where Y = biomass per tree, exponential function, D = diameter at breast height in cm. This equation predict the trunk and canopy biomass of moist (1500-4000 mm rainfall) area with reasonable precision ($R^2 = 0.97$) and has become a standard approach (Anon. 2004). Coconut palms: Y = 5.5209x + 89.355, $R^2 = 0.89$, Y = biomass; x = tree age, year (Kumar 2011). All other palm trees (areca palm or *Areca catechu* L., palmyra palm or *Borassus flabellifer* L., *etc*,): Y = 4.5 + 7.7 H, where Y = biomass and H = stem height in meter (Brown 1997). Bamboo: In Y = 4.437 + 2.576 in (dbh) where Y is the biomass and dbh is clump diameter at breast height (Kumar et al. 2005).

Five shrubs were randomly selected from each home garden and uprooted to measure their average fresh weight separately for stems/branches, leaves and roots and then multiplied with the total number of shrubs in the quadrat. For herbs all the plants from three randomly selected 1 m x 1 m plots within the home garden were uprooted to measure their fresh weight separately for roots and above ground parts. Proper permission was taken from the owner of the home gardens to harvest the branch, shrub and herb samples. The total biomass in a home garden and the total herb, shrub &, total tree biomass was converted into carbon by multiplying with a factor of 0.45 (Woomer 1999).

RESULTS AND DISCUSSION

Socio-economic Analysis

District Cooch Behar

Descriptive distribution of the selected predicted variable total carbon stock and 15 predictor variables is presented for Cooch Behar district in table 1. The analysis of mean standard deviation and coefficient of variation indicates medium to higher consistency of all the variables except annual income and utilization of resources by the respondent with lower consistency. Majority of the respondent belongs to medium utilization of resources category and in age category of 48-65 years with medium education, medium level of family education, high educational aspiration, small family and small land holding with small house, medium economic status, high farm power status, low amount of household materials and low annual income. Moreover, the majority of the respondents represented medium risk orientation category with high scientific orientation but had extremes of innovation proneness. Finally the total C stock was distributed with mean of 89.3, standard deviation of 23.59 and coefficient of variation 26.42 indicating high consistency level of distribution with majority of home gardens had medium level of total carbon. This group of respondents can be the most important stake holder in case of adopting strategies of climate change through managing home garden land use system and giving them priority in awareness building and skill development programme related to carbon sequestration, auditing and budgeting. Further they should be empowered through involving them in planning and implementation of climate change strategies. Pearson's co-efficient of correlation among the total carbon stock with fifteen causal variables in Cooch Behar district clearly shows that land holding, land status, house type and farm power are positively and significantly associated with the total carbon stock at 5 % and 1 % level of significance (Table 2).

Table 1. Descriptive distribution of the respondents with respect to their attributes and total carbon stock in the district of Cooch Behar

Sr. No.	Variable	Category	Score	F	%	Statistics			
						Range	Mean	SD	CV
		Young	30-47	15	37.5				
1	Age	Middle	48-65	21	52.5	30.0-80.0	52.02	11.76	22.61
		Old	66-83	4	10				
		Low	0-2.0	15	37.5				
2	Education	Medium	3.0-5.0	24	60	0.0-6.0	2.92	1.77	60.62
		High	6.0-8.0	1	2.5				
		Low	0.90-2.4	16	40				
3	Family Education status	Medium	2.5-4.0	21	52.5	0.90-5.30	2.6	0.91	35.00
		High	4.1-5.3	3	7.5				
		Low	3.0-6.3	27	67.5				
4	Family size	Medium	6.4-10	11	27.5	3.0-13.0	6.05	2.2	36.36
		High	11-13.1	2	5				
		Low	5.0-7.3	3	7.5				
5	Educational aspiration	Medium	7.4-9.7	16	40	5.0-12.0	9.37	1.47	15.69
		High	9.8-12.1	21	52.5				
		Low	11.15-237.93	38	95				
6	Annual income	Medium	238-476	1	2.5	11.15-691.5	125.78	120.3	95.64
		High	477-702	1	2.5				
		Small	0.6-1.46	37	92.5				
7	Land holding	Medium	1.47-2.33	2	5	.06-2.66	0.621	0.56	90.18
		Large	2.34-3.2	1	2.5				
		Low	0-1.0	19	47.5				
8	Economic status	Medium	1.1-2.0	20	50	.00-3.0	1.52	0.60	39.34
		High	2.1-3.0	1	2.5				

		Small	1-2.3	31	77.5				
9	House type	Medium	2.4-3.7	8	20	1.00-5.00	1.97	0.86	43.65
		Big	3.8-5.1	1	2.5				
		Low	0-1.3	19	47.5				
10	Farm power	Medium	1.4-2.7	0	0	0.0-4.00	1.9	1.39	73.16
		High	2.8-4.1	21	52.5				
		Low	2.0-9.7	30	75				
11	Material possession	Medium	9.8-17.5	9	22.5	2.0-25.00	7.45	4.1	55.03
		High	17.6-25.3	1	2.5				
		Low	24-28	17	42.5				
12	Risk orientation	Medium	29-33	19	47.5	24.0-36.0	29.32	3.22	10.98
		High	34-38	4	10				
		Low	23.0-27.3	16	40				
13	Scientific orientation	Medium	27.4-31.7	7	17.5	23.0-36.0	30.27	4.72	15.59
		High	31.8-36.1	17	42.5				
		Low	3.0-7.3	16	40				
14	Innovation Proneness	Medium	7.4-11.7	8	20	3.0-16.0	9.8	3.89	39.69
		High	11.8-16.1	16	40				
		Low	14.0-21.6	7	17.5				
15	Utilization of sources of information	Medium	21.7-29.3	27	67.5	14.037.0	25.45	4.98	19.57
		High	29.4-37.0	6	15				
		Low	48.91-80.22	18	45				
16	Total carbon	Medium	81.23-112.31	14	35	48.91-142.84	89.3	23.59	26.42
		High	113-144.30	8	20				

F- frequency

Table 2. Correlation co-efficient of Total carbon pool or stock with fifteen causal variables in Cooch Behar district of West Bengal

Variables (X)	Coefficient of correlation (r)
Age (X_1)	-0.005
Education (X_2)	0.178
Family education status (X_3)	0.12
Family size (X_4)	0.086
Educational aspiration (X_5)	0.229
Annual income (X_6)	0.205
Land holding (X_7)	.786**
Land status (X_8)	.634**
House type (X_9)	.317*
Farm power (X_{10})	.340*
Material possession (X_{11})	0.183
Risk orientation (X_{12})	0.282
Scientific orientation (X_{13})	0.204
Innovation proneness (X_{14})	0.193
Utilization of sources of information (X_{15})	0.267

** **Significant at 1% level;** ***Significant at 5 % level**

Land holding was positively and significantly associated with total carbon stock of home gardeners. More the land holding higher is the total carbon stock in home gardens. The increased land size increased the soil coverage and population of plant species and thus increased the carbon stock. In other words, increased land holding increased the earnings, improving the socio-economic status of the home gardeners. The variable land holding is directly contributing 84.60 % in case of characterizing the total carbon stock of the home gardener. One unit change of the land holding is delineating the 35.11 unit change in the predicted variable, total carbon stock. The R^2 value being 0.724, it is to infer that the fifteen predictor variables put together have explained 72.40 % variation embedded with the predicted variable total carbon stock of the home gardener in Cooch Behar district. Still 27.60 % variations embedded with predicted variable are left unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the total carbon stock of the homemaker could have increased the level of explicability.

The increased level of risk orients the psyche of the home gardener to increase the biomass and to maintain the soil for increasing the carbon status of the whole system. That is why the variable house type is positively and significantly associated with the total carbon stock. The future intervention on climate change adaptation strategy through carbon stock and sequestration the individual with a good house type would be the key enabler of the system. In any social system possession of farm power is always treated as an important indicator of the social status. The person possesses a good number of sophisticated and traditional farm power is enjoying the better social status than any other person. They are the risk taker, venture some and innovative people and always keep them abreast with the new information and knowledge. Accordingly, the individual with good amount of farm power always be the owner of good amount of land. Due to the better amount of land holding the owner is always adopting proper and efficient land management that contributes towards his economic earning. Multiple regression analysis of the total carbon stock in the home gardens of Cooch Behar district with fifteen predictor variables indicate that land holding was positively and significantly contributing towards characterizing the total carbon stock in the home gardens (table 3).

Table 3. Multiple regression analysis of Total carbon stock with fifteen predictor variables in Cooch Behar district of West Bengal

Variables	B	b	S.E of 'b'	t-value
Age (X_1)	0.163	0.327	0.3	1.091
Education (X_2)	0.057	0.764	2.469	0.31
Family education status (X_3)	0.039	0.998	4.117	0.242
Family size (X_4)	0.044	0.473	1.514	0.312
Educational aspiration (X_5)	0.051	0.818	2.578	0.317
Annual income (X_6)	-0.113	-0.022	0.032	-0.695
Land holding (X_7)	0.846	35.107	7.486	4.69**
Land status (X_8)	0.023	0.904	7.705	0.117
House type (X_9)	0.230	6.292	4.293	1.466
Farm power (X_{10})	0.011	0.179	2.463	0.073
Material possession (X_{11})	0.018	0.104	0.895	0.116
Risk orientation (X_{12})	0.218	1.599	1.603	0.998
Scientific orientation (X_{13})	-0.384	-1.916	1.807	-1.06
Innovation proneness (X_{14})	-0.029	-0.175	1.579	-0.111
Utilization of sources of information (X_{15})	-0.073	-0.346	0.87	-0.398

R^2=0.724; ** Significant at 1% level

District Jalpaiguri

The analysis of mean standard deviation and coefficient of variation indicates higher consistency of all the variables (table 4). Majority of the respondent belongs to medium utilization of resources category and in age category of 30-50 years with low education, low level of family education, low educational aspiration, small family and small land holding with medium house type, low economic status, low farm power status, low amount of household materials and medium level of annual income. Moreover, the majority of the respondents represented medium risk orientation category with high scientific orientation and low level of innovation proneness. Finally the total C stock was distributed with mean of 91.2, standard deviation of 22.46 and coefficient of variation 28.1 indicating high consistency level of distribution with majority of respondent had medium level of total carbon. Pearson's co-efficient of correlation among the total carbon stock with fifteen variables in Jalpaiguri district indicates that family size is negatively and significantly associated with the total carbon stock at 5 % level of significance (table 5). The correlation analysis revealed that increased family members contributed negatively to the total carbon stock in the home gardens. The increased number of family members develops the situations of conflict during decision making process hindering to take a realistic and contextual decision regarding management of their homestead land.

Multiple regression analysis of total carbon stock with fifteen predictor variables in Jalpaiguri district of West Bengal indicates that the land holding was negatively and significantly contributing towards characterizing the total carbon stock in the home gardens, while age was contributing positively and significantly (table 6). The variable age is directly contributing 38.80 % i.e. one unit of change in age is delineating 6.496 unit change in total carbon stock. The respondents in the district were mostly poor land holders. The earnings from the land were a result of increased plant population of plant species in an optimum way within their stipulated land. The variable land holding was directly contributing 59.10 % in case of characterizing the total carbon stock in the home gardens. One unit change of the land holding is delineating 311.39 unit negative changes in the total carbon stock. The R^2 value being 0.493, it is to infer that the fifteen predictor variables put together have explained 49.30 % variation embedded with the total carbon stock in the gardens of Jalpaiguri district. Still 50.70 % variations embedded with the predicted variable are left unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the total carbon stock of the home gardener could have increased the level of explicability.

Table 4. Descriptive distribution of the respondents with respect to their attributes and total carbon stock in the district of Jalpaiguri

Sr. No.	Variable	Category	Score	F	%	Statistics			
						Range	Mean	SD	CV
		Young	30-50	24	60.0				
1	Age	Middle	51-71	13	32.5	30.0-90.0	51.72	13.4	25.91
		Old	72-92	3	7.5				
		Low	0.0-2	21	52.5				
2	Education	Medium	2.1-4.1	10	25.0	0.0-6.0	2.5	2.06	82.40
		High	4.2-6.2	9	22.5				
		Low	1.10-4.60	40	100.0				
3	Family Education status	Medium	4.61-8.11	0	0.0	1.10-4.6	2.61	0.96	36.97
		High	8.12-11.62	0	0.0				
		Low	3.0-5.0	22	55.0				
4	Family size	Medium	5.1-7.1	15	37.5	3.0-9.00	5.5	1.28	23.27
		High	7.2-9.2	3	7.5				
		Low	6.0-8.0	19	47.5				
5	Educational aspiration	Medium	8.1-10.1	12	30.0	6.0-12.0	9.07	1.7	18.74
		High	10.2-12.2	9	22.5				
		Low	22.50-23.1	1	2.5				
6	Annual income	Medium	23.2-440.5	38	95	22.5-648.0	1.22	110.6	9063.11
		High	441.5-650	1	2.5				
		Small	0.06-0.64	28	70.0				
7	Land holding	Medium	0.65-1.22	8	20.0	0.06-1.80	0.53	0.43	80.68
		Large	1.23-1.81	4	10.0				
		Low	1-1.33	21	52.5				
8	Economic status	Medium	1.34-1.67	0	0.0	1.0-2.0	1.47	0.50	34.35
		High	1.68-2.0	19	47.5				
		Small	1.0-1.67	14	35.0				
9	House type	Medium	1.68-2.35	17	42.5	1.0-3.0	1.87	0.76	40.48
		Big	2.36-3.03	9	22.5				
		Low	0-2.67	29	72.5				
10	Farm power	Medium	2.68-5.35	10	25.0	0.0-8.0	1.3	1.6	123.08
		High	5.36-8.03	1	2.5				
		Low	01.0-6.0	20	50.0				
11	Material possession	Medium	6.1-11.1	17	42.5	1.0-16.0	6.92	3.77	54.48
		High	11.2-16.2	3	7.5				
		Low	21.0-25.7	11	27.5				
12	Risk orientation	Medium	25.8-30.5	24	60.0	21.0-35.0	27.4	3.57	13.03
		High	30.6-35.3	5	12.5				
		Low	6.0-16.0	1	2.5				
13	Scientific orientation	Medium	16.1-26.1	16	40.0	6.0-36.0	27.05	5.35	19.78
		High	26.2-36.2	23	57.5				
		Low	3.0-8.33	19	47.5				
14	Innovation Proneness	Medium	8.34-13.67	10	25.0	3.0-19.0	9.97	4.25	42.63
		High	13.68-19.01	11	27.5				
		Low	12.0-19.7	8	20.0				
15	Utilization of sources of information	Medium	19.8-27.5	28	70.0	12.0-35.0	22.47	4.3	19.14
		High	27.8-35.5	4	10.0				
		Low	45.05-531.30	38	95.0				
16	Total C	Medium	532.3-1018.5	1	2.5	45.05-150.8	91.2	22.46	28.1
		High	1019.5-1506	1	2.5				

F- frequency

Table 5. Correlation co-efficient of Total carbon pull or stock with fifteen causal variables in Jalpaiguri district of West Bengal

Variables (X)	Coefficient of correlation (r)
Age (X_1)	0.169
Education (X_2)	0.201
Family education status (X_3)	0.277
Family size (X_4)	-0.307*
Educational aspiration (X_5)	0.300
Annual income (X_6)	0.22
Land holding (X_7)	-0.12
Land status (X_8)	-0.105
House type (X_9)	0.281
Farm power (X_{10})	-0.112
Material possession (X_{11})	0.064
Risk orientation (X_{12})	0.125
Scientific orientation (X_{13})	0.266
Innovation proneness (X_{14})	0.164
Utilization of sources of information (X_{15})	0.253

***Significant at 5 % level**

Table 6. Multiple regression analysis of Total carbon stock with fifteen predictor variables in Jalpaiguri district of West Bengal

Variables	B	b	S.E of 'b'	t-value
Age (X_1)	0.388	6.50	3.059	2.123*
Education (X_2)	-0.173	-18.88	31.327	-0.603
Family education status (X_3)	0.047	10.91	60.114	0.181
Family size (X_4)	-0.010	-1.71	35.17	-0.049
Educational aspiration (X_5)	0.341	45.06	30.598	1.473
Annual income (X_6)	0.124	0.25	0.443	0.568
Land holding (X_7)	-0.591	-311.39	148.008	-2.104*
Land status (X_8)	0.036	15.85	115.435	0.137
House type (X_9)	0.405	120.05	68.925	1.742
Farm power (X_{10})	-0.081	-11.33	26.066	-0.435
Material possession (X_{11})	-0.066	-3.94	12.408	-0.317
Risk orientation (X_{12})	0.091	5.70	10.942	0.521
Scientific orientation (X_{13})	0.206	8.65	9.456	0.915
Innovation proneness (X_{14})	0.138	7.30	11.179	0.653
Utilization of sources of information (X_{15})	0.167	8.71	11.154	0.781

R^2 = 0.493, ** Significant at 5% level

Siliguri sub-division of Darjeeling

The analysis of mean standard deviation and coefficient of variation indicates higher consistency of all the variables (Table 7). Majority of the respondent belongs to medium utilization of resources category and in age category of 38-53 years with high education, extreme levels of family education, high educational aspiration, small family and small land holding with big house, low economic status, low farm power status, medium possession of household materials and low annual income. Moreover, the majority of the respondents represented low risk orientation category with low scientific orientation and high and medium level of innovation proneness. Finally the total C stock was distributed with mean of 82.41, standard deviation of 14.70 and coefficient of variation 17.8 indicating high consistency level of distribution with majority of respondent had medium level of total carbon stock. Pearson's co-efficient of correlation among the total carbon stock with fifteen causal variables in Siliguri sub-division of Darjeeling district indicates that land holding and land status are positively and significantly associated with the total carbon stock at 1 % and 5 % level of significance (table 8).

Land holding of the respondents ranged between 0.6-0.44 ha. As a result the poor home gardeners increased the population of plant species in an optimum way within their stipulated land. It may be concluded that the increased level of land holding increased the amount of total carbon stock. The increased land size increased that soil coverage and population of plant species. Ultimately the increased area of soil coverage and plant population contributed to the total carbon stock. Multiple regression analysis of total carbon stock with fifteen predictor variables indicates that land holding and innovation proneness are positively and significantly contributing while family size is negatively and significantly contributing towards characterizing the total carbon stock in the home gardens of Siliguri sub-division of Darjeeling district (table 9). The increased family members develop the situations of conflict during decision making process hindering a realistic and contextual decision regarding home garden management. In other words the improper management of home garden makes the owner resource poor. Family size is directly contributing 55.0 % in case of characterizing the total carbon stock in the home garden. One unit change of the family size is delineating the 8.50 unit negative change in the total carbon stock. Land holding is directly contributing 112 % in characterizing the total carbon stock of the home garden. One unit change of the land holding is delineating 58.58 unit positive changes in the total carbon stock. Land holding increases the soil coverage and thus increases the biomass.

Innovation proneness was directly contributing 58.10 % in characterizing the total carbon stock of the home gardens. One unit change of innovation proneness was delineating 2.5 unit positive changes in total carbon stock. The estimated R^2 value of 0.978 signifies that when fifteen predictor variables put together had explained 97.8 % variations embedded with total carbon stock in the home gardens. However, 2.2 % variations embedded with predicted variable are left unexplained. Innovation proneness reflects the innovative capability of an individual and it measures the ability to go along with the innovation. So the innovative people always try to innovate for maximizing the profit of their whole system.

Table 7. Descriptive distribution of the respondents with respect to their attributes and total carbon stock in the district of Darjeeling

Sl. No.	Variable	Category	Score	F	%	Statistics			
						Range	Mean	SD	CV
1	Age	Young	38-53	15	37.5	38.0-83.0	49.05	10.36	21.1
		Middle	53.1-68.1	4	10				
		Old	68.2-83.2	1	2.5				
2	Education	Low	0.0-2	3	7.5	0.0-6.0	4.1	1.55	37.8
		Medium	2.1-4.1	7	17.5				
		High	4.2-6.2	10	25				
3	Family Education status	Low	.60-2.17	10	25	0.6-5.3	3.04	1.15	37.8
		Medium	2.18-3.75	6	15				
		High	3.76-5.33	4	10				
4	family size	Low	3.0-4.4	4	10	3.0-7.0	5.2	0.951	18.3
		Medium	4.5-5.9	8	20				
		High	6.0-7.4	8	20				
5	Educational aspiration	Low	7.0-8.7	4	10	7.0-12.0	10.3	1.65	16.0
		Medium	8.8-10.5	6	15				
		High	10.6-12.3	10	25				
6	Annual income	Low	33.80-202.7	14	35	33.8-540.0	2.06	158	7669.4
		Medium	202.8-371.7	2	5				
		High	371.8-540.7	4	10				
7	Land holding	Small	0.06-0.44	17	42.5	0.06-1.2	0.27	0.28	105.5
		Medium	0.45-0.89	2	5				
		Large	0.90-1.28	1	2.5				
8	Economic status	Low	1-1.33	16	40	1.0-2.0	1.2	0.41	34.2
		Medium	1.34-1.67	0	0				
		High	1.68-2.0	4	10				
9	House type	Small	1.0-1.67	2	5	1.0-3.0	2.45	0.69	28.0
		Medium	1.68-2.35	7	17.5				
		Big	2.36-3.03	11	27.5				
10	Farm power	Low	.0-1	19	47.5	0.0-3.0	0.3	0.73	244.0
		Medium	1.1-2.1	0	0				
		High	2.2-3.2	1	2.5				
11	Material possession	Low	2.0-6.7	3	7.5	2.0-16.0	10.25	3.97	38.7
		Medium	6.8-11.5	12	30				
		High	11.6-16.3	5	12.5				
12	Risk orientation	Low	21.0-26.33	9	22.5	21.0-37.0	28.65	4.36	15.2
		Medium	26.34-31.67	5	12.5				
		High	31.68-37.01	6	15				
13	Scientific orientation	Low	22-28	14	35	22.0-40.0	27.65	4.24	15.3
		Medium	28.1-34.1	4	10				
		High	34.2-40.2	2	5				
14	Innovation Proneness	Low	4.0-7.33	10	25	4.0-14.0	7.7	3.41	44.3
		Medium	7.34-10.67	5	12.5				
		High	10.68-14.01	5	12.5				
15	Utilization of sources of information	Low	15-18.7	6	15	15.0-26.0	20.8	3.7	17.8
		Medium	18.8-22.5	7	17.5				
		High	22.6-26.3	7	17.5				
16	Total carbon	Low	53.52-75.2	6	15	53.5-118.6	82.4	14.7	17.8
		Medium	75.3-96.98	11	27.5				
		High	96.99-118.67	3	7.5				

F- frequency

Table 8. Correlation co-efficient of Total carbon pull or stock with fifteen causal variables in Darjeeling district of West Bengal

Variables (X)	Coefficient of correlation (r)
Age (X_1)	0.071
Education (X_2)	0.022
Family education status (X_3)	-0.035
Family size (X_4)	-0.109
Educational aspiration (X_5)	0.018
Annual income (X_6)	-0.124
Land holding (X_7)	0.758**
Land status (X_8)	0.435*
House type (X_9)	0.167
Farm power (X_{10})	0.312
Material possession (X_{11})	0.204
Risk orientation (X_{12})	-0.087
Scientific orientation (X_{13})	-0.153
Innovation proneness (X_{14})	0.123
Utilization of sources of information (X_{15})	0.164

** **Significant at 1% level;** * **Significant at 5% level**

Table 9. Multiple regression analysis of Total carbon stock with fifteen predictor variables in Darjeeling district of West Bengal

Variables	B	B	S.E of 'b'	t-value
Age (X_1)	0.274	0.389	0.331	1.175
Education (X_2)	0.432	4.091	11.45	0.357
Family education status (X_3)	0.068	0.861	9.493	0.091
Family size (X_4)	-0.550	-8.504	3.739	-2.275*
Educational aspiration (X_5)	-0.660	-5.855	7.263	-0.806
Annual income (X_6)	-0.099	-0.009	0.026	-0.359
Land holding (X_7)	1.123	58.582	14.97	3.913*
Land status (X_8)	0.036	1.304	23.305	0.056
House type (X_9)	0.502	10.752	21.526	0.499
Farm power (X_{10})	-0.291	-5.833	5.524	-1.056
Material possession (X_{11})	-0.323	-1.197	0.784	-1.526
Risk orientation (X_{12})	-0.202	-0.682	1.093	-0.624
Scientific orientation (X_{13})	-0.133	-0.462	0.838	-0.552
Innovation proneness (X_{14})	0.581	2.5	1.01	2.476*
Utilization of sources of information (X_{15})	-212.0	-0.839	0.617	-1.361

R^2 = 0.978 ** **Significant at 5 % level**

Crop diversity in home gardens was attributed to a broad range of known factors and usually as a fruit of ecological conditions, economic context and demands, tastes, knowledge, ethnicity, culture and special experiments of home garden owner (Khoshbakht *et al*., 2006; Schadegan *et al*., 2013). Thus to fully understand how home gardens function and what benefits they provide to their users, it was necessary to integrate and then analyze both socio-economic and biophysical aspects of these systems (Mendez *et al*., 2001). Different performed studies on home gardens throughout the world has resulted in clarifying different realities in the interactions among different characteristics of home gardens e.g. household characteristics, literacy, age of household, labour inputs, times devoted to home gardening, agrobiodiversity indices, etc. (Schadegan et al. 2013).

CONCLUSION

The present study was delineated to explore the carbon stock and the relationship of carbon stock with socio-economic, socio-psychological and communication attributes of home garden owners with help of structured research methodology adopted for the purpose of operationalising and developing a conceptual framework. Carbon sequestration is a relatively new issue and it is not widely discussed among agricultural extension officers, who usually bring new ideas to farmers, in West Bengal and in many areas throughout the world. Therefore, the schedule on home garden was mostly indirect, in the sense that any practice that contributes to higher productivity will indirectly lead to higher C sequestration. The adaptive strategy of climatic change may be treated as innovation. In the present study the home gardener with high level of innovation proneness makes them able to acquaint with the adaptation strategy of climate change through the improvement of total carbon stock within their homesteads and cultivated land.

REFERENCES

Anonymous 2004. Assessing carbon stocks and modelling win-win scenarios of carbon sequestration through land use changes. FAO, Rome. 156p.

Brown S 1997. *Estimating biomass and biomass change of tropical forests: a primer*. A forest resources assessment publication, FAO Forestry Paper 134. FAO, Rome.

Galluzzi G, Eyzaguirre P and Negri V 2010. Home gardens: neglected hotspots of agro-biodiversity and cultural diversity. Biodiversity Conservation 19: 3635-3654.

Gaston KJ, Warren PH, Thompson K and Smith RM 2005. Urban domestic gardens (IV): the extent of the resource and its associated features. Biodiversity Conservation 14: 3327-3349.

Guarino L and Hoogendijk M 2004. Micro environments. In: Home gardens and agro-biodiversity, eds. Eyzaguirre, P. and Linares, O. Smithsonian Books, Washington. Pp 31-40.

Khoshbakht K, Hammer K and Amini S 2006. Interdisciplinary analysis of homegardens in Savadkouh/Iran: plant uses and socioeconomic aspects. Food and Agriculture Environment 4: 277-282.

Kumar BM 2005. Land use in Kerala: changing scenarios and shifting paradigms. Journal of Tropical Agriculture 43**:** 1-12.

Kumar BM 2011. Species richness and above ground carbon stocks in the home gardens of central Kerala, India. Agricultural Ecosystem and Environment 140**:** 430-440.

Kursten E 2000. Fuelwood production in agroforestry systems for sustainable land use and CO_2 mitigation. Ecological Engineering 16**:** S69–S72.

Linares OF 1996. Cultivating biological and cultural diversity: urban farming in Casamance, Senegal. Africa 66: 104-121.

Mendez VEL, Lok R and Somarriba E 2001. Interdisciplinary analysis of home gardens in Nicaragua: micro-zonation, plant use and socioeconomic importance. Agroforestry Systems 51: 85-96.

Montagnini F and Nair PKR 2004. Carbon sequestration: an underexploited environmental benefit of agroforestry systems. Agroforestry Systems 61: 281-295.

Moulik TK 1965. A study of predictive values some factors of adoption of nitrogenous fertilizers and the influence of sources of information on adoption behaviour. Ph. D. Thesis. Indian Agricultural Research Institute, New Delhi. Unpubl.

Nair PKR and Nair VD 2003. Carbon Storage in North American Agroforestry Systems. In: The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect, eds. Kimble, J.; Heath, L. S.; Birdsey, R. A. and Lal, R.. CRC Press, Boca Raton, FL, USA. Pp. 333-346.

Nair PKR, Nair VD, Kumar BM and Showalter JM 2010. Carbon sequestration in agroforestry systems. Advances in Agronomy 108: 237-307.

Okigbo BN 1990 Home gardens in Tropical Africa. In: Tropical Homegardens, eds. Landauer, K. and Brazil, M. United Nations University Press, Tokyo, Japan. Pp. 41-65.

Panwar P and Chakravarty S 2010. Floristic structure and ecological function of homegardens in humid tropics of West Bengal, India. Indian Journal of Agroforestry 12: 69-78.

Ruark GA, Schoeneberger MM and Nair PKR 2003. Agroforestry-Helping to Achieve Sustainable Forest Management. UNFF (United Nations Forum for Forests) Intersessional Experts Meeting on the Role of Planted Forests in Sustainable Forest Management, 24-30 March 2003, New Zealand. www.maf.govt.nz/unff-planted-forestry-meeting.

Schadegan FH, Khoshbakht K, Damghani AM, Liaghati HVH and Kambouzia J 2013. A Multidisciplinary Study of Rural Homegardens in Basht, Southwestern Iran. Middle-East Journal of Scientific Research 13: 1431-1437.

Singh RP and Roy NK 1993. Adoption behaviour of tribal farmers with respect to high yielding varieties of rice. Journal of Research. 5: 17-22.

Supe SV 1969. Factors related to differential degrees of rationality decision making among farmers. Ph. D. Thesis. Indian Agricultural Research Institute, New Delhi. Unpubl.

Supe SV 2007. Measurement techniques in Social Sciences. Agrotech Publishing Academy, Udaipur.

Vasey DE 1985. Household gardens and their niche in Port Moresby, Papua New Guinea. Food Nutrition Bulletin **7:** 37-47.

Woomer PL 1999. Impact of cultivation of carbon fluxes in woody savannas of Southern Africa. Water, Air and Soil Pollution 70: 403-412.