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Plant Diversity in the Homegardens and their Significance in the Livelihoods of *War Khasi* Community of Meghalaya, North-east India

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ABSTRACT The study was conducted with an objective of investigating the plant species diversity in homegardens and their contribution towards livelihoods of *War Khasi* community of Meghalaya. In total, 197 plant species were recorded with an average of 89 plant species per homegarden. The average size of homegarden was 750 m^2 with the annual gross production of Rs.3514 per homegarden; this contributes about 7 % towards average annual gross income per household. Computing in terms of per unit area, the average annual gross income was found to be Rs.73,748/ha. The study revealed that 35% of the produce was used for self consumption and 65% was sold in the local markets. The important plant species which contributed to the household income were: *Piper betle* (24%), *Mangifera indica* (19%), *Litchi chinensis* (15%) and *Areca catechu* (11%). We conclude that although homegardens contribute only a small part of total income, they are particularly important because of low labour input for management and locational advantage.

INTRODUCTION

The cultivation of fruits, vegetables and ornamentals in homegardens has a long tradition in north-east India, especially among the hill tribes residing in the states of Assam, Manipur, Nagaland and Meghalaya. In general, homegardens are characterized by different vegetation strata composed of trees, shrubs and herbs in association with annual and perennial agricultural crops and small livestock within the house compounds. Homegarden may be defined as, 'a bounded piece of land cultivated with a diverse mixture of annual and perennial crops on which a house is built' (Karyono 1990). The major functions of homegardens particularly in rural areas are subsistence production and income generation (Kumar and Nair 2004). Because of high plant diversity in the homegardens, a wide spectrum of multiple-use plant products can be generated with relatively low labour, cash or other inputs. In seasons of scarcity homegardens with their diverse products available year round, contribute towards food security. They also fulfil many social, cultural and ecological needs. The multi-layered, forest-like vegetation structure of homegardens contributes substantially to the ecological sustainability of the village ecosystems (Kehlenbeck and Maass 2004). This vegetation structure prevents soil erosion, provides habitat to wild plants and soil microorganisms and promotes a favourable micro-climate for the household. Because of their richness in plant species, homegardens are regarded as an ideal production system for *in situ* conservation of plant species. The species composition of homegardens varies according to climatic and edaphic factors of the place and socio-economic condition of the people.

Homegarden systems provide an additional food supply and cash income for the people (Das and Das 2005). It is reported that in Indonesia and Nicaragua, homegardens contribute 21.1% and 35% of the total income respectively. Studies from south-west Bangladesh (Motiur et al. 2006) and north-eastern Bangladesh (Motiur et al. 2005) reported that on an average 15.9% and 11.8% of household income is derived from homegardens respectively. Many homegarden systems around the world have been studied for plant diversity and for their economic value (Motiur et al. 2005). However, researches on homegardens of India are very few (Kingston et al. 2006). The review of literatures clearly showed that there is a lack of research on plant diversity and economic value of homegardens in the north-eastern India where tradition of homegardens is very old (Das and Das 2005). This study aims at analyzing plant species richness in these homegardens and investigates the

contribution of the fruits, vegetables and spices grown in the homegardens towards cash income of the people.

STUDY AREA

The study was conducted in south Meghalaya, India (25° 7'-25° 18' N latitude and 91°-92° E longitude). Five surveyed villages were: Nongkwai (25°20' N, 91 °54' E); Mawriang (25° 12' N 91° 85' E); Umkrem (25° 14' N, 91° 55 E'); Nolikata (25° 15' N, 91° 13' E) and Ranikor (25° 15' N,91° 11' E) (Fig. 1). The altitude of the study area ranged from 450 m to 700 m above mean sea level. The mean annual maximum and minimum temperature was 23ºC and 13ºC respectively. The population is sparse and the people are predominantly employed in plantations and forestry related activities. Agriculture is limited to some small valleys where mainly tuber crops are grown. Arecanut, orange, betel leaf, jack fruit, bayleaf, honey and broom grass are the principal produce of the region. The region is inhabited by *War Khasi* people, a tribal community having long tradition of forest conservation (Tiwari 2005). The size of homegardens varies between 200 m^2 to 3500 m^2. The average size was about 750 m^2. The total number of household in the study area varied from 59 at Nolikata to 200 at Nongkwai. The average household consists of 8 members. The natural vegetation of the study area ranges from tropical evergreen to subtropical evergreen forests (Balakrishnan 1983).

METHODS

Field Sampling

Four complementary approaches were adopted, namely; (a) formal interview with the village headmen and secretary, (b) direct observation, (c) interaction with the head of the selected households through questionnaires and (d) phytosociological study in sample homegardens. The interview schedule comprised of a general introduction concerning management of homegardens, farming practices, domesticated and wild plants and their products found in the homegardens and the final section of discussion related to various socio-economic characteristics of the household. The discussion and interviews were conducted following the methods described by High and Shakleton (2000). The survey was administered to a random sample of 30 households in each village. Homegardens size was measured, excluding the area occupied by the house. In case of tree, shrub, climber and epiphytic plant species whole homegarden was used as sample plot while in the case of herb species a 1 x 1 m quadrat was used.

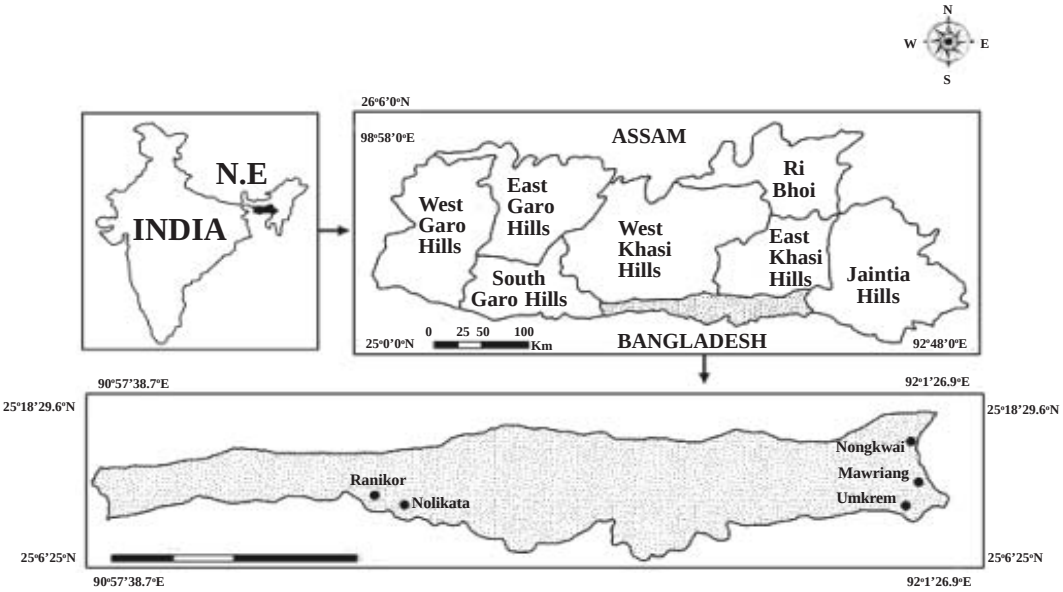

Fig. 1. Location of the study area

Plant Survey and Analysis

For tree, shrub, climber and epiphytes complete inventories were carried in 150 homegardens; where as in the case of herbs, 1 m^2 plots (1x1 m) for each homegardens was studied to assess plant diversity. The tree species diameter at breast height (dbh ≥5 cm) were individually measured and numbered and their density and frequency per plot were computed. The information on the uses and importance of plant species were collected by using questionnaires, focused group discussion, key informant interview, and Participatory Rural Appraisal (PRA) methods as described by Mukherjee (1993). The data and information about management of homegardens, plants, income and population were also collected using questionnaires and through discussions and interviews with elders of the sample household. Shannon and Wiener Index of diversity (Shannon and Wiener 1963) was calculated to analyze the diversity of homegardens for each village studied using the formula $H^1 = -\Sigma$ pi ln pi, where, pi = proportion number of ith species. The frequency, density and Importance Value Index (IVI) of the species were determined following the methods of Misra (1968) and Mueller-Dombois and Ellengberg (1974). The basal cover (m^2ha^{-1}) was calculated by using the formula: Basal Cover (BC) = density x average tree basal area (Khan et al. 1997). The species richness is the total number of all the species. Plant specimens were collected and identified with the help of Flora of Assam (Kanjilal et al. 1934-1940) and Flora of Jowai (Balakhrishnan 1981-1983). The identifications were confirmed by consulting the herbaria of Botanical Survey of India, North-eastern Circle, Shillong. The nomenclatures of the species are as per the regional flora.

Income

Household income from homegarden was calculated by asking the respondents the amount of homegarden products they sold and consumed how much income was earned from the previous year's sale of homegarden products and summing the sales and consumption values, allowed us to calculate the proportion of total income earned from the homegardens. Gross annual income of sampled households from agriculture, off-farm and other sources of income was also collected in order to compute the contribution of the homegardens towards peoples' gross income. Gross income was calculated by adding the amount of money earned from all the products collected from homegardens including those used for self consumption and sale. We converted other currencies at 1 US$ = 42.7 Indian Rupees, 1US$ = 7.47 South African Rands and 1US$ = 107.60 Sri Lanka Rupees as on July, 2008.

Computation of Expenditures in Gardening

The expenditures in maintaining of the homegardens and marketing of plant products included management cost, sorting cost, harvesting cost, marketing cost, plantation cost, planting material and transport cost. These costs were calculated by multiplying wage rate by number of days spent. The plant products collected from homegardens which require sorting and processing before selling included betel leaf, betel nut and bayleaf. The money spent in arranging of betel leaf, processing of betel nut and packing of bayleaf was included in sorting cost. Sorting and arranging of the products was done by women and packing of bayleaf was done by men. Harvesting of plant products from homegardens was mostly done by men except for few species in which young boys and women were also involved. Harvesting of areca nut, bayleaf and betel leaf was done by skilled men. In the study area, marketing of forest product was exclusively the duty of women. Marketing cost was calculated by multiplying the period of time spent in selling the products by the daily wage of women. Majority of plants in the homegardens are cultivated by men. The plantation cost was calculated by multiplying the time spent in plantation of each species by daily wage of the cultivator. This was added to the amount of money spent in buying the seed or the propagules to be planted in the homegardens. The plant species in which the seed/propagules are to be purchased included black pepper @Rs.5/sapling, betel nut @Rs.5/sapling, litchi @Rs.10/sapling and maize @Rs.5/kg. In case of other plant species, people used their own seed saved or stored by them. Transport cost was the total amount of money spent in transporting the plant products from village to the market (by head load/vehicle/boat). In the study area, ordinarily the daily wage rate of workers during the study period was Rs.150 for skilled men, Rs.100 for unskilled men, Rs.45 for women

and Rs.30 for boys aged between 12-15 yr. The cost of materials was calculated from market rate.

RESULTS

Management of Homegardens

The management of homegardens includes fencing, weeding and tree lopping. In the fencing of gardens, *Bambusa vulgaris* is used as pole and *B. tulda* as spokes. Villagers use seeds, seedlings and vegetative propagules to regenerate homegarden plants. Soil fertility of homegardens is maintained naturally from leaf litter, faeces of reared animals and kitchen waste manure. In the day to day maintenance of homegardens, both men and women are involved.

Plant Diversity

We recorded a total of 197 plant species (70 trees, 41 shrubs, 50 herbs, 23 climbers and 13 epiphytes) belonging to 77 families comprising of 73 angiosperm, 1 gymnosperm and 3 pteridophytes. Moraceae was the dominant family with 20 species followed by Orchidaceae 12 species, Asteraceae 10 and Euphorbiaceae 9 species. The homegardens showed four distinct strata. Strata A or canopy layer was composed of big tree (>15 m height), sub-canopy or B strata was composed of middle sized tree (8 m to 15 m height), under-canopy or C strata was composed of small trees (<8 m height) and ground vegetation (≤ 2 m height) included shrub and herbs. The common tree species in the A strata were: *Artocarpus heterophyllus, Mangifera indica, Bombax ceiba* and *Duabanga grandiflora*. B strata was composed of *Areca catechu, Artocarpus lakoocha, Cinnamomum tamala* and *Baccaurea sapida* and C strata composed of *Averrhoa carambola, Psidium guajava* and *Zizyphus mauritiana*. The shrub layers were dominated by *Clerodendron colebrookianum, Hibiscus rosa-sinensis, Hibiscus sabdariffa, Manihot esculenta* and *Citrus limon.* The dominant plants of herb layers were: *Ageratum conyzoides*, *Houttuynia cordata, Drymaria cordata, Oplismenus compositus* and *Borreria pilosa*. The species name, frequency, density and IVI of ten most frequent trees, shrubs, herbs, climbers and epiphytes encountered during the study are given in table 1.

The homegardens appear to be assorted mixture of tree, shrub, herb, climber and epiphytes mainly ornamental orchids. However, the locations of most plants were found to be deliberate which could be distinguished into several management zones. The present study recorded six major management zones based on their purpose, location and species composition *viz.*, (a) arecanut (*Areca catechu*) grove, (b) banana grove, (c) vegetable garden, (d) fruit grove, (e) ornamental and (f) mixture of different plant species (Fig. 2). These zones fulfil specific objectives for household ranging from food, medicinal, cash, timber, fuelwood etc. Arecanut and fruit zones were the most important zones because of economic importance of the plants grown in these zones.

Expenditure and Cash income

The total amount of money spent by the people living in the five villages of study area in management of homegardens and other expenditures related to collection and processing of plant products from their homegardens was found to be Rs.8,66,438 (Table 3).

The gross production of homegardens of the five villages of south Meghalaya was worth Rs.19,69,671 per annum out of which Rs.6,88,442 (34.95%) was used for self-consumption, and Rs.12,81,229 (65.04%) was sold in local markets. The most important plant species found in the homegardens which contributed to the household income were: *Piper betle* (24.15%), *Mangifera indica* (19.30%), *Litchi chinensis* (15.16%) and *Areca catechu* (10.8%) (Table 4). The average annual gross income from homegardens was Rs.3,514.58 per household which accounted to Rs.73,748.39 per hectare (Table 5). Homegardens contributed 7% of the total household income.

DISCUSSION

Plant Diversity

Majority of the plant species recorded in the homegardens of south Meghalaya were typical plants found in homegardens throughout the tropics e.g., banana (sweet and plantains), coconut, jack fruit, guava, mango, papaya, citrus, the tuber, yam, cassava, taro, chilli, sugarcane etc. (Mendez et al. 2001; Nautiyal et al. 2008). These plants provide a broad basis for self-sufficiency in food for households. The total number of plant

Table 1: The frequency (%), density (plant ha^{-1}) and IVI of 10 most frequent tree, shrub, herb, climber and epiphyte species encountered in the homegardens of south Meghalaya

Plant species	*Nongkwai*			*Mawriang*			*Umkrem*			*Nolikata*			*Ranikor*		
	F	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*
Tree															
Areca catechu L.	33.33	41	13.89	27.00	155	26.64	90.00	189	60.60	63.33	287	53.28	90.00	280	51.46
Artocarpus heterophyllus Ham.	50.00	32	40.00	24.00	87	19.71	76.67	96	29.13	53.33	69	70.18	46.67	53	30.87
Baccaurea sapida (Roxb.) Müll. Arg.	13.33	9	3.98	4.00	9	3.28	6.00	12	11.53	6.67	5	2.06	3.33	2	0.81
Carica papaya L.	20.00	15	6.06	3.00	11	4.87	10.00	13	3.41	20.00	31	7.81	23.33	30	7.75
Citrus maxima S. Dutta & S.C.Bhattach.	56.67	45	19.88	16.00	55	10.24	53.33	65	18.69	10.00	13	4.06	10.00	7	2.58
Litchi chinensis Sonn.	20.00	19	10.87	22.00	94	16.10	73.33	111	36.56	10.00	5	2.82	3.33	1	0.69
Mangifera indica L.	63.33	60	39.39	25.00	96	17.50	83.33	113	60.10	40.00	34	19.64	63.33	59	23.00
Musa spp.	33.33	51	16.69	10.00	57	12.57	23.33	30	10.30	26.67	118	23.01	20.00	54	10.42
Prunus persica (L.) Batsch.	23.33	24	7.93	3.33	4	2.66	3.33	4	1.08	16.00	3	0.62	3.33	2	0.80
Psidium guajava L.	56.67	63	20.52	40.00	34	19.64	16.67	26	7.01	36.67	27	10.96	16.67	17	4.77
Shrub															
Allamanda cathartica L.	10.00	3	4.61	26.67	73	13.47	30.00	86	23.09	3.33	4	5.04	3.33	8	1.54
Capsicum frutescens L.	13.33	28	11.78	13.33	61	9.33	13.33	72	23.09	13.33	10	17.88	10.00	4	12.56
Citrus assamensis S. Dutta & S.C.Bhattach.	13.33	22	10.24	20.00	31	7.56	13.33	26	8.31	3.33	3	1.06	3.33	4	1.66
Citrus karna Raf.	20.00	22	12.81	3.33	2	0.95	3.33	3	1.45	3.33	4	5.04	3.33	4	5.67
Citrus limon Burn.	13.33	22	10.24	26.67	28	8.63	26.67	33	13.48	10.00	9	13.98	16.67	10	23.16
Clerodendron colebrookianum Walp.	36.67	45	24.84	33.33	34	10.75	33.33	40	16.80	3.33	4	5.67	20.00	31	7.56
Hibiscus rosa-sinensis L.	6.67	5	2.90	26.67	31	8.98	26.67	36	14.11	6.67	20	15.18	10.00	28	26.64
Hibiscus sabdariffa L.	3.33	3	2.05	3.33	3	1.06	6.67	5	2.90	3.33	14	9.58	13.33	5	4.96
Manihot esculenta Crantz.	6.67	2	3.08	43.33	108	20.79	40.00	127	32.88	16.67	36	32.57	16.67	46	44.64
Plogacanthus parviflorius T. Anders.	6.67	8	4.35	3.33	4	2.31	3.33	4	1.18	3.33	3	1.45	16.67	98	14.06
Herb															
Ageratum conyzoides L.	30.00	1621	16.31	43.33	1898	21.60	43.33	1798	26.80	63.33	3053	42.04	60.00	3164	45.46
Bidens pilosa (Blume.) Sherff.	10.00	522	5.34	10.00	522	5.48	16.67	733	10.63	10.00	133	3.74	10.00	244	5.10
Canna sp.	6.67	167	2.57	23.33	455	8.26	23.33	455	10.38	20.00	511	9.51	6.67	178	3.53
Centella asiatica (L.) Urban.	13.33	977	8.64	20.00	855	9.84	20.00	855	12.56	3.33	22	0.93	6.67	266	4.31
Drymaria cordata (L.) Roem. & Schult.	6.67	100	2.21	3.33	44	1.06	3.33	44	1.32	6.67	189	3.32	3.33	111	1.96

Table 1: Contd...

Plant species	*Nongkwai*			*Mawriang*			*Umkrem*			*Nolikata*			*Ranikor*		
	F	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*	*F*	*D*	*IVI*
Houttuynia cordata Thunb.	56.67	3541	33.42	56.67	3541	34.54	20.00	1099	14.49	13.33	278	5.82	6.67	178	3.53
Oplismenus compositus P. Beauv.	26.67	1077	12.52	26.67	877	11.56	33.33	1832	24.15	3.33	100	1.38	16.67	722	11.25
Oxalis corniculata L.	20.00	733	8.98	3.33	233	2.18	3.33	233	2.81	6.67	144	2.44	13.33	488	8.23
Sansevieria trifasiata Hort. ex Prain.	6.67	300	3.30	6.67	366	3.76	6.67	366	4.83	20.00	311	6.61	3.33	122	2.06
Tagetes erecta L.	3.33	44	1.07	3.33	44	1.06	3.33	44	1.06	13.33	311	6.09	23.33	733	13.33
Climber															
Dioscorea hispida Dennst.	13.33	4	6.22	13.33	13	7.13	16.67	16	9.26	36.67	54	24.76	3.33	4	7.58
Dolichos lablab L.	20.00	37	14.84	36.67	55	23.04	3.33	4	5.59	6.67	4	12.13	3.33	4	5.59
Elaeagnus latifolia L.	20.00	12	10.86	16.67	11	7.90	16.67	13	8.87	6.67	6	14.15	10.00	4	13.59
Hemidesmus indicus (L.) R.Br.	20.00	33	13.98	20.00	34	13.32	3.33	4	1.97	10.00	7	4.74	6.67	11	12.77
Hodgsonia hetiroclita Kh.f.&T.	10.00	13	6.64	3.33	2	1.58	3.33	3	1.77	16.67	51	15.18	16.67	27	10.99
Merremia hedereaca (Burm.f.) Hallier.f.	6.67	9	4.73	10.00	7	4.74	10.00	16	26.77	3.33	4	5.59	6.67	6	3.85
Mikania micrantha Kunth.	16.67	49	16.4	16.67	51	15.18	16.67	27	10.99	10.00	28	35.86	30.00	133	92.10
Passiflora edulis Sim.	6.67	10	4.81	6.67	10	4.17	16.67	24	10.33	3.33	3	6.57	43.33	29	42.14
Piper betle L.	40.00	97	33.77	70.00	200	61.48	70.00	237	64.23	16.67	30	46.98	10.00	19	19.94
Piper nigrum L.	10.00	28	76	30.00	88	26.75	46.67	166	44.11	13.33	33	62.15	10.00	46	31.58
Epiphyte															
Aerides multiflorum Roxb.	10.00	13	46.73	-	-	-	6.67	16	31.79	-	-	-	-	-	-
Aerides odoratum Lour.	-	-	-	-	-	-	10.00	12	35.65	-	-	-	-	-	-
Coelogyne corymbosa Lindl.	-	-	-	-	-	-	-	-	-	-	-	-	10.00	24	78.54
Cymbidium elegans Lindl.	-	-	-	-	-	-	-	-	-	-	-	-	10.00	14	59.42
Cymbidium mastersii Griff. Ex Lindl.	-	-	-	10.00	28	76	13.33	33	62.15	-	-	-	-	-	-
Dendrobium chrysanthum Wall. Ex Lindl.	-	-	-	-	-	-	-	-	-	-	-	-	3.33	4	17.15
Dendrobium longicornu Lindl.	-	-	-	-	-	-	3.33	21	28.32	3.33	-	-	-	-	-
Dendrobium ochreatum Wall. Ex Lindl.	6.67	8	29.92	3.33	4	44.76	-	-	-	-	5	94.7	-	-	-
Eria paniculata Lindl.	10.00	12	44.91	-	-	-	-	-	-	-	-	-	-	-	-
Vanda cristata Wall. Ex Lindl.	10.00	14	48.52	-	-	-	-	-	-	-	6	105.31	-	-	-

F-frequency, D-density, IVI-important value index

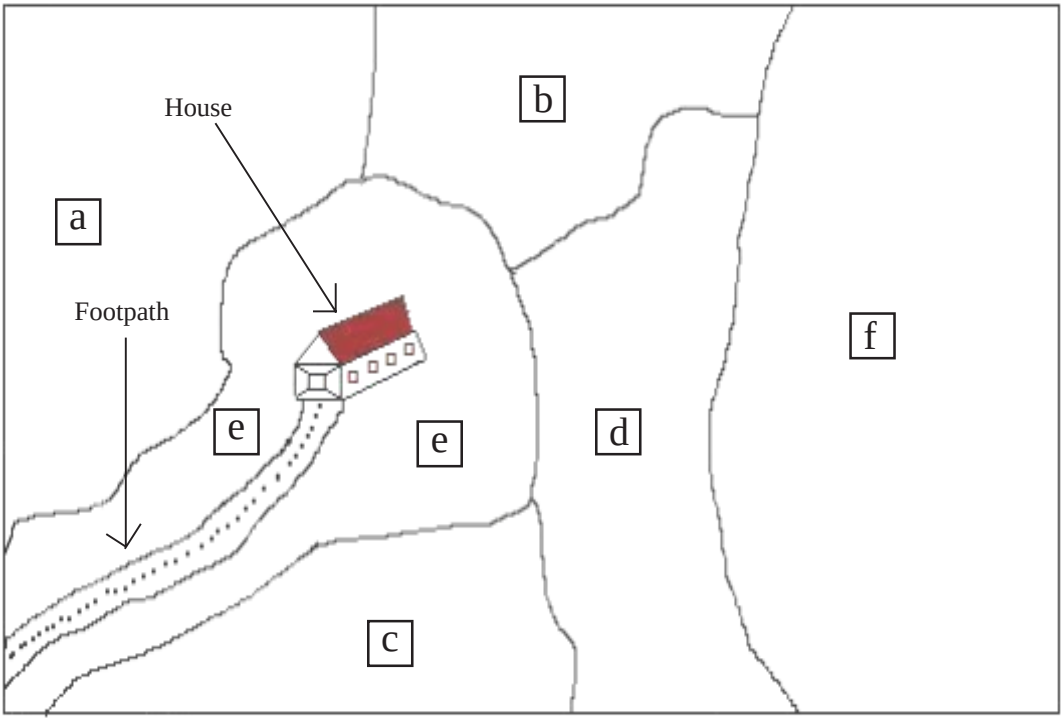

Fig. 2. Different management zones: a-arecanut grove, b-banana grove, c-vegetable garden, d-fruit grove, e-ornamental and f-mixture of different plant species
(*Illustration:* H.Tynsong, drawn at Umkrem village on 18th Dec. 2009)

Table 2: Diversity and community characteristics of homegardens at Nongkwai, Mawriang, Umkrem, Nolikata and Ranikor villages of south Meghalaya

Plant component	*Village*	*F*	*G*	*S*	*D*	*BC*	*PE*	*SD*	*SI*
Tree	Nongkwai	27	31	41	588	12.96	0.56	3.14	0.06
	Mawriang	26	36	46	867	8.15	0.88	4.01	0.06
	Umkrem	17	24	28	823	31.02	0.74	2.51	0.12
	Nolikata	20	28	31	852	45.01	0.78	2.70	0.11
	Ranikor	25	34	41	861	39.80	0.75	2.81	0.10
Shrub	Nongkwai	20	27	32	420	-	0.89	3.08	0.06
	Mawriang	22	31	36	932	-	0.86	3.11	0.06
	Umkrem	11	16	22	621	-	0.85	2.89	0.08
	Nolikata	10	13	15	229	-	0.95	2.52	0.09
	Ranikor	8	10	12	169	-	0.66	1.66	0.13
Herb	Nongkwai	20	25	32	18393	-	0.87	3.03	0.07
	Mawriang	23	33	34	16828	-	0.85	3.00	0.07
	Umkrem	22	28	29	12687	-	0.86	2.89	0.08
	Nolikata	14	19	23	12032	-	0.95	2.52	0.09
	Ranikor	22	27	28	11444	-	0.86	2.84	0.09
Climber	Nongkwai	8	8	20	578	-	0.85	2.49	0.11
	Mawriang	10	16	18	545	-	0.80	2.34	0.15
	Umkrem	1	7	10	512	-	0.78	1.49	0.16
	Nolikata	8	10	11	124	-	0.91	2.19	0.13
	Ranikor	8	8	10	236	-	0.76	1.76	0.26
Epiphyte	Nongkwai	1	5	5	55	-	0.83	1.59	0.21
	Mawriang	2	3	4	56	-	1.15	1.27	0.30
	Umkrem	2	3	5	100	-	0.96	1.56	0.22
	Nolikata	2	2	2	11	-	0.99	0.69	0.50
	Ranikor	2	4	4	54	-	0.92	1.28	0.30

F-families, G-genera, S-species, D-density (ha^{-1}), BC-basal cover (m^2ha^{-1}),PE- Pielou's eveness index, SD- Shannon's diversity index, SI- Simpson's dominance index, '-' indicates absent

species as well as the average number of plant species per homegarden in south Meghalaya was rather high and comparable to plant diversity of homegardens in Assam, India (Das and Das 2005) but lower than the number of plant species reported in Nicaragua (Mendez et al. 2001) and South Africa (High and Shakleton 2000). The average number of plant species per homegarden was very high (89 plant species) and much higher than the number of plant species found in Cuba (22 plant species). The mean Shannon indices of plant species (2.37) was also considerably higher as compared to Cuba (1.79) (Wezel and Bender 2003) and central Sulawesi, Indonesia (2.32) (Kehlenbeck and Maass 2004) but comparatively much lesser than the mean Shannon indices of arecanut agroforests (3.04) of south Meghalaya (Tynsong 2009). Mean Shannon indices vary widely in tropical homegardens and are reported to range from 0.93 to 3.00 (Karyono 1990). The high plant species richness in the homegardens of south Meghalaya may be due to its location in the lower altitude as also observed elsewhere (Quiroz et al. 2002).

The homegardens of all the five villages possessed a multi-layered vegetation structure which could offer advantages in controlling of soil erosion and efficient use of resources *viz.*, light and space. Hochegger (1998) also observed similar multi-layered homegardens in Sri Lanka, which are very old and larger in size. Presence of large number of medicinal plants in the homegardens clearly showed that medicinal plants still play an important role in healing of people's ailments. Medicinal plants were found in larger numbers in the homegardens of herbal practitioners. Most medicinal plants were collected from the wild and domesticated in the homegardens. These included: *Calamus floribundus, Centella asiatica, Fagopyrum cymosum, Hemidesmus indicus, Kaempferia rotunda, Mussaenda roxburghii, Merremia hedereaca, Piper peepuloides, Smilax* sp. and *Trichosanthes palmata.* This corroborates with the finding of Kingston et al. (2006) and Das and Das (2005) who also reported that homegardens preserve large number of plant species having medicinal properties. During interviews it was noted that herbal practitioners have a sound knowledge of medicinal plant uses and techniques to grow them in their homegardens. For herbal practitioners, majority of plant species found in the homegardens such as fruit trees, tubers, vegetables, spices etc., have potential medicinal use. Large numbers of ornamental plants are also grown in the homegardens. Some of them were collected from the wild and domesticated in the homegardens *viz., Cassia tora, Dracaena fragrans, Luculia pinceana, Morinda angustifolia, Raphidophora calophyllum* and a variety of orchids. The study also revealed that *War Khasi* community were concerned in the cleaning, beautifying and maintaining the surroundings of their settlements.

The homegardens contribute a great deal to food supply especially for the people living in the rural areas because of high production and diversity of cultivated edible species. Although the extent of household dependency on homegardens varies considerably, its contribution is quite significant towards livelihood of the people because of low investment and easy accessibility. Homegardens function as *ex situ* as well as *in situ* conservation plots for plant genetic resources of the region. In the villages studied, 103 wild plant species were recorded from the homegardens which showed that homegardens are also a home to many wild plant species, thus they serve as a repository of wild plants.

Table 3: Annual expenditure (Rs.) incurred in management of homegardens and marketing of the products collected from homegardens of five villages of south Meghalaya

Activities	*Nongkwai*	*Mawriang*	*Umkrem*	*Nolikata*	*Ranikor*	*Total*
Management cost	184333	78342	120738	54378	105583	543375
Sorting cost	2784	1567	7132	7187	1069	19739
Harvesting cost	16607	14528	32461	28396	35080	127072
Marketing cost	2818	1800	3516	1806	10029	19969
Plantation cost	29180	14056	15291	12245	3357	74130
Planting material (seed, vegetative etc.)	1967	14558	6928	3733	9927	37113
Transport cost	1825	5777	5974	12707	18757	45040
Grand Total	239514	130628	192040	120453	183803	8,66,438

Standard daily wages of workers during the survey period was Rs.150 for Men (skilled labourers) and Rs.100 (unskilled labourers), Rs. 45 for women and Rs.30 for boys.

Table 4: Production and percentage contribution of various plant species found in homegardens towards annual income of households of Nongkwai, Mawriang, Umkrem, Nolikata and Ranikor villages of south Meghalaya

Plant species	*Production (kg)/year*		*Rate(Rs. /kg)*	*Amount (Rs.)*		*Gross Production (Rs.)*	*%*
	Self consumption	*Sale*		*Self consumption*	*Sale*		
Ananas comosus	2315	248	10	23150	2480	25630	1.30
Areca catechu	772	3197	50	38600	159850	198450	10.08
Artocarpus heterophyllus	30938	36397	0.83	25678.54	30209.51	55888.05	2.84
Averrhoa carambola	192	1029	15	2880	15435	18315	0.93
Baccaurea sapida	614	904	17	10438	15368	25806	1.31
Bambusa vulgaris	825	1925	0.5	412.5	962.5	1375	0.07
Calamus floribundus	96	80	50	4800	4000	8800	0.45
Carica papaya	274	716	30	8220	21480	29700	1.51
Cinnamomum tamala	12	2016	8	96	16128	16224	0.82
Citrus assamensis	47	57	60	2820	3420	6240	0.32
Citrus karna	214	680	37.5	8025	25500	33525	1.70
Citrus limon	101	21	30	3030	630	3660	0.19
Citrus maxima	6917	2627	10	69170	26270	95440	4.85
Citrus reticulata	300	168	30	9000	5040	14040	0.71
Cocos nucifera	488	758	10	4880	7580	12460	0.63
Cucurbita pepo	31	57	10	310	570	880	0.04
Elaeagnus latifolia	130	2560	20	2600	51200	53800	2.73
Emblica officinalis	38	144	15	570	2160	2730	0.14
Garcinia cowa	20	200	30	600	6000	6600	0.34
Litchi chinensis	2001	9946	25	50025	248650	298675	15.16
Mangifera indica	18069	7271	15	271035	109065	380100	19.30
Musa sp.	1304	2443	15	19560	36645	56205	2.85
Piper betle	3199	10393	35	111965	363755	475720	24.15
Piper longum	3	17	60	180	1020	1200	0.06
Piper nigrum	102	915	90	9180	82350	91530	4.65
Tamarindus indica	320	1141	15	4800	17115	21915	1.11
Thysanolaena maxima	48	328	20	960	6560	7520	0.38
Zea mays	59	197	3	177	591	768	0.04
Ziziphus mauritiana	352	1413	15	5280	21195	26475	1.34
Total			-	6,88,442	12,81,229	19,69,671	100.00

Table 5: Gross income, total expenditure and net income (Rs.) generated by homegardens of Nongkwai, Mawriang, Umkrem, Nolikata and Ranikor villages of south Meghalaya

Village	*Gross income (Revenue)*		*Net income*	
	Household $^{-1}$	*Hectare^{-1}*	*Household $^{-1}$*	*Hectare^{-1}*
Nongkwai	2851.83	45997.17	855.88	26037.67
Mawriang	3232.76	53356.27	1055.63	34695.13
Umkrem	4519.17	128698.00	2385.39	96691.33
Nolikata	4590.90	98495.62	2181.84	58344.62
Ranikor	2378.26	42194.89	1207.54	5434.29
Average	3,514.58	73,748.39	1,537.26	44,240.61

Economic Value

Homegardens are a vital source of income for subsistence economy and contribute to the self-sufficiency of many rural households perched in remote places often secluded from markets and modern production centres. This is also true for the homegardens in other tropical countries (Kumar and Nair 2004; Peyre et al. 2006). The people usually work in the homegardens during leisure time or after coming back from agriculture fields or early in the morning before going to the field. During summer season, farmers of the hill areas of the region prefer to work in their homegardens if the rain is heavy. This is because they have to walk on foot, for a minimum of 1-3 hours to reach to their agricultural fields. The undulated terrain of the land with narrow footpaths are not convenient to walk during heavy rains.

The average annual gross production of homegardens in south Meghalaya was worth Rs.3514 per household, which was higher than the Kandyan Gardens of Sri Lanka (Rs.237) (Jacob and Alles 1987) but lesser as compared to homegardens in south west Bangladesh (Rs.11435) (Motiur et al. 2006), north-eastern Bangladesh (Rs.97441) (Motiur et al. 2005) and South Africa (Rs.6661) (High and Shakleton 2000). In terms of per hectare area the average annual gross income in south Meghalaya was Rs. 44,241 which was much higher than the Kandyan Gardens in Sri Lanka (Rs.1621) (Jacob and Alles

1987) and also the homegardens of South Africa (Rs.16520) (High and Shakleton 2000). The percentage contribution of homegardens towards peoples' average annual gross income was 7%, which was lesser than the contribution of homegardens in Indonesia (21.1%) (Soemarwoto 1987), Nicaragua (35%) (Mendez et al. 2001), south west and north-east Bangladesh (15.9% and 11.8%, respectively). With 7% contribution of homegardens towards average gross annual household income, it compares well with those from south and south-east Asia, where it varies between 6-54% (Kabir and Webb 2008).

CONCLUSION

Homegardens of south Meghalaya enhance the livelihood of the people by providing food, construction materials, medicines and by contributing significantly to the gross annual income of the household. The income from homegardens depends on their size, number of marketable crops and management regime. Homegardens also ensure availability of products within the homestead which is particularly important in hill areas where agricultural fields are generally far off and travel to the fields is difficult and time consuming. The study brings to fore the biodiversity value of the homegardens. It is revealed that they are rich repository of wild as well as domesticated plants. Homegardens harbour species found in the wild and also provide habitat for cultivation of economically useful plants. Thus these predominantly man made ecosystems can be placed between forest and agriculture ecosystems in the forest-agriculture continuum, that provide food security to the people and act as safety net in cases of exigency.

RECOMMENDATIONS

Homegardens are an important element of rural landscape of many tropical countries particularly in south and south east Asia and they play a vital role in the predominantly bioresource based economy of the region. However, they have not received due attention in the policies and programmes of government, the reason being they neither fall in agriculture nor in forestry sectors. Based on the study it is recommended that promotion of homegardens be included in the projects aiming to enhance the livelihoods of rural poor on sustainable basis.

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