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SPECIES DIVERSITY AND PRODUCTIVITY AT DIFFERENT MICROSITES OF HOMESTEAD IN THE TERRACE ECOSYSTEM OF BANGLADESH

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Abstract

An exploratory survey was carried out in Kapasia upazila of Gazipur district to investigate the distribution pattern of plant species and their relative performance in different microsites. Their contribution to homestead production and income along with constraints/prospects were also evaluated. A structured interview schedule was used for the survey with 110 randomly selected households. A total of 68 different plant species of diverse categories, namely fruit, timber, medicinal and ornamental species were identified from the surveyed homesteads. The species diversity was found the highest at the front yard (1.99) followed by that in the approach road (1.88). Among the trees, mango was the most dominant species in approach road, home yard and back yard followed by jackfruit, which was mostly dominant in the front yard and boundary. Most of the species performed better in the home yard and worse in boundary and approach road. Home yard contributed maximum to the total household annual production (32.24%) followed by back yard (21.34%) and front yard (23.5%). However, unavailability of land was the top-ranked problem, which could be solved by finding alternative bare land for planting trees and crops. Despite a number of problems associated with this production system, microsites have great prospect and potentiality in the annual household production, income and stability of the household. A well designed and properly managed homestead can ensure supply of products, such as food, fodder, fuel, timber; ecosystem services and resilience.

Keywords: Species diversity, species prevalence, homestead, microsite, income generation.

Introduction

Bangladesh is a densely populated developing country having nearly 161 million people with per capita annual income of US $ 1080, covering more than 1034 persons per square km (BBS, 2014; Rahman *et al.,* 2016; Rahman *et al.,* 2017). About 70% people live in rural areas in 15.4 million households and in about 85000 villages, where agriculture is the main occupation. Bangladesh possesses a total of 399585 hectares of homestead land with 0.03 hectares per household (BBS, 2014). Record of 70% of timber, 90% of fuelwood, 48% sawn, veneer logs and almost 90% of bamboo requirement are available from home gardens of Bangladesh (Uddin *et al.,* 2002). But state forest of Bangladesh covers 2.52 million hectares of land, representing 17% of the country's land area and supplying only 12% wood (Poffenberger, 2000). It is difficult to meet the country's huge demand for timber, fuel, fruit and fodder from the state forests. Villages of Bangladesh have a long heritage of growing timber and fruit trees along with other perennial shrubs and herbs in their homesteads (Rahman *et al.,* 2009).

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The homesteads of Bangladesh are a source of livelihood for many farmers and serve as safety net during the time of hardship and natural disaster (Islam *et al*., 2013). However, lack of appropriate development policy and inadequate investments on research have apparently caused poor productivity of homestead production system.

Homestead is the most complex multi-strata integrated production system that combines all farming components (tree, crop, livestock and occasionally fish) and provides household food security, employment and income generation opportunity to the millions of households (Miah and Ahmed, 2003). Even landless person has a homestead and his subsistence depends on the productivity of homestead (Nandy and Ahammad, 2012; Alam *et al.,* 2013). So if a homestead is designed and managed well, it would have immense value for the rural people. To harvest maximum benefits, it would be wise to divide it to various microsites as all areas are suitable for all purposes.

Homestead microsites represented the smallest production microsites having similar configuration of land and served specific purposes (Sarmin, 2008). Homestead microsites or homestead production sites serve to satisfy the dietary, economic and social needs of different cultures across the globe. It is suitable for resource poor situations and has economic advantages, such as low capital and labor costs, increased self-sufficiency, risk avoidance and even distribution of labor. The present study envisages assessing homestead microsites in Terrace ecosystem of Gazipur district. The study area is located in the central terrace ecosystem, which is an important region comprising about 8% of the total land area of Bangladesh (Ahmed, 2011). It is a region of complex relief comprising of level upland, closely or broadly dissected terraces associated with either shallow or broad, deep valleys. Here homestead production systems are well developed as this zone is almost free from flood.

Despite the fact that homesteads hold considerable promise as a developmental strategy, the extent of scientific studies on these systems has been disproportionately lower than what their economic value, ecological benefits or socio-cultural importance would warrant. Therefore, the aims of this study were to assess the species richness and diversity at different microsites of homestead in terrace ecosystem of Bangladesh in order to evaluate performance of tree species at different microsites and to determine the contribution of different microsites to the total homestead production and income.

Materials and Methods

The study was conducted in Kapasia upazila under Gazipur district, located in the central part of Bangladesh, with an area of 356.98 square km. There are 11 administrative units called unions in Kapasia upazila. Three villages (Barjuna, Nakasini and Korolia) were selected from Kapasia union because homestead farming was widely distributed in this area where a total of 365 households were found. In this study, 110 households were selected randomly, which covered one third of the active population.

Survey was conducted through pre-tested structured interview schedule taking one to one interview during June to September 2013. Focus Group Discussion was conducted in all study areas with different farm holders throughout the field study period to assess the problems and prospects of the homestead microsites.

To indicate the importance, species richness of different plant species in study areas and relative prevalence (RP) of species in per unit area was calculated as follows (Millat-e-Mustafa, 1997):

$RP = n_i/A^* f_i/F$

Where,

n_i = Number of specimen of species i on location/garden,

A = Area of locations per garden,

f_i = Number of locations/gardens on which i is found,

F = Total number of locations per garden.

To measure the abundance and diversity of different plant species, Shannon-Wiener Species Diversity Index (H) is commonly used, which is calculated by the formula (Magurran, 1988; Abebe *et al.,* 2013) shown below:

$H = - \Sigma(Pi \ln Pi)$

Where Pi is the proportional abundance of i^{th} species such that

Pi= n/N (n is the number of individuals in i^{th} species and N is the total number of the individuals of all species in the community).

Statistical analysis was done to analyze data using MS-Excel and Statistical Package for Social Science (SPSS) programs. Descriptive statistics, such as frequency and percentage distribution were used to process all collected information obtained from survey, monitoring and secondary sources. Responses of the completed interview schedules were numerically coded and analyzed. Mathematical analyses were used to determine the species diversity and relative prevalence of species.

Results and Discussion

Demographic characteristics of the respondents

The demographic characteristics, such as age, education level, family size, homestead area, farm area and occupation of the household heads are presented in Table 1. The distribution of respondents according to their age showed that 60.9% of the respondents belong to the middle age group followed by old age (24.5%) and young (14.5%) age group. It was found that 16.4% of the respondents had no formal education, while 40.9%, 24.5%, 11.8% and 6.4% had primary, secondary and higher secondary level of education, respectively. Thus, 83.6% of the respondents were educated in the study area. Family size of the respondents indicated that 41.8% of the respondents belonged to medium sized family followed by 40.9% to small family and 17.3% to large sized family. Previously, there was 62.2% medium sized family as reported by Ahmed (1999). These results indicate that medium sized families have been converted into small families possibly due to access of information and high rate of education.

It was found that the farm size of about one third of the respondents (31.8%) was small followed by that of medium (26.4%). Eleven point eight percent, 18.2% and 11.8% respondents belonged to landless, marginal and large farm categories, respectively. It indicated that majority of the families had possessed small amount of land. In a previous study, Habib (2006) reported that 31%, 27%, 22%, 7% and 13% respondents belonged to medium, small, marginal, landless and large farm category, respectively. In the study area, farm size was found to become small to marginal for various reasons mostly for fragmentation of holding and converting agricultural land to other purposes.

Table 1. Demographic characteristics of the respondents

Parameter	No. of respondents
Age (years)	
Young (Less than 30)	16 (14.5%)
Middle aged (30 – 50)	67 (60.9%)
Old aged (Above 50)	27 (24.5%)
Educational level	
No formal education	18 (16.4%)
Primary	45 (40.9%)
Secondary	27 (24.5%)
Higher secondary	13 (11.8%)
Above higher secondary	7 (6.4%)
Family size (no.)	
Small (1 – 4 members)	45 (40.9%)
Medium (5 – 7 members)	46 (41.8%)
Large (Above 7 members)	19 (17.3%)
Farmer's category (Farm size in ha)	
Landless <0.2	13 (11.8%)
Marginal 0.2 – 0.5	20 (18.2%)
Small 0.51 – 1.00	35 (31.8%)
Medium 1.01 – 3.00	29 (26.4%)
Large >3.00	13 (11.8%)
Primary occupation	
Farming	50 (45.5%)
Business	21 (19.1%)
Service	24 (21.8%)
Others	15 (13.6%)
Homestead size (decimal)	
Up to 10	56 (50.9%)
10.1 – 20.0	29 (26.4%)
20.1 – 30.0	16 (14.5%)
>30	9 (8.2%)

The main occupation of the respondents showed that 45.5% were intensively involved in farming, while 21.8% engaged in service, 19.1% in business and 13.6% respondents were in other occupations.

It was noted that more than half (50.9%) of the homesteads were up to 10 decimal area, 26.4% were between 10.1 and 20.0 decimal, 14.5% were between 20.1 and 30.0 decimal and 8.2% were above 30 decimal area, which indicated that most of the homesteads were small sized may be due to population explosion and land fragmentation.

Homestead microsites

Homestead microsites i.e., approach road, front yard, home yard, back yard and boundary differ from each other without following a significant pattern. The comparative area coverage, canopy layer, spatial arrangement and species changing nature of each of the microsites are discussed below:

Area coverage of microsites

All homesteads are not comprised of all five microsites or units. Therefore, area of each microsite compared to total homestead area vary with homesteads. It was observed that majority of approach roads covered (90.9%) up to 33% of total household area. Thirty four -66% households had 7.3% approach roads, while 67–100% had about 1.8% approach roads.

Similarly, most of the front yards (84.5%) were found 33% area coverage of total household area. About 14.5% front yards were within 34–66% household area followed by 0.9% front yards within 67–100% area. Majority of the home yards (48.2%) covered up to 33% of total household area. About 47.3% home yards were within 34–66% household area followed by 4.5% home yards within 67– 100% area.

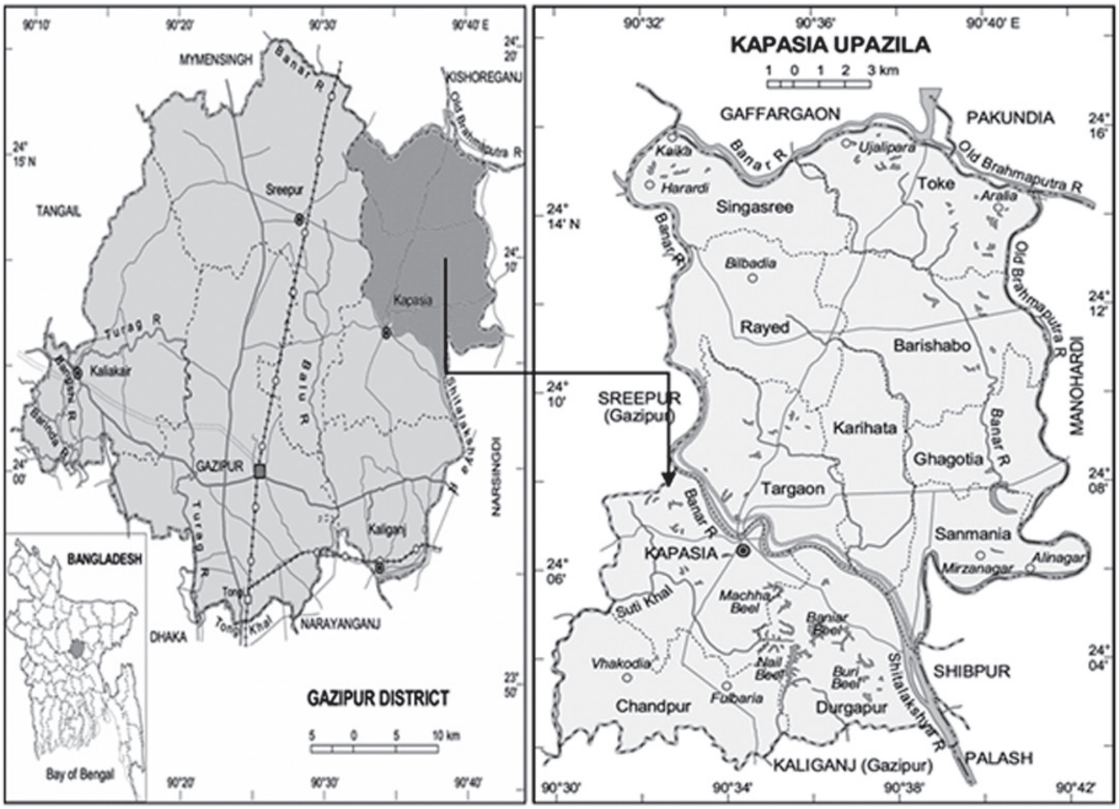

Fig. 1. Map of Gazipur district and Kapasia upazila showing the study area.

Similarly, most of the back yards (66.4%) covered up to 33% of total household area. About 30.9% back yards were within 34–66% household area followed by 2.7% back yards within 67–100% area. Majority of the boundaries (76.4%) lied within 0 – 33% area coverage of total household area. Near about one fourth (23.6%) boundaries were within 34 – 66% household area. No boundary was found within 67–100% household area.

Fig. 2 indicates that mostly each of the microsites possess one third area coverage of a homestead. Due to high fragmentation of land, rarely all microsites can be found in a single household. Rather land allocation for each of the microsites is also getting lower day by day.

Canopy layer of different microsites Comparative analysis among each of the microsites were done according to three canopy layers, namely ground layer, mid layer and top layer (Fig. 3). It was observed that majority of approach roads had top layer plant species (41.8%) followed by 16.4% ground layer species and 12.7% mid layer species. Majority of front yards had top layer plant species (39.1%) followed by 30.0% mid layer species and 18.2% ground layer species. Home yards were also dominated by the top layer species (41.8%) followed by 38.2% mid layer species and 19.1% ground layer species. Ground layer species were mostly occupied in home yard as most of them were annual vegetables. Similarly most of the back yards

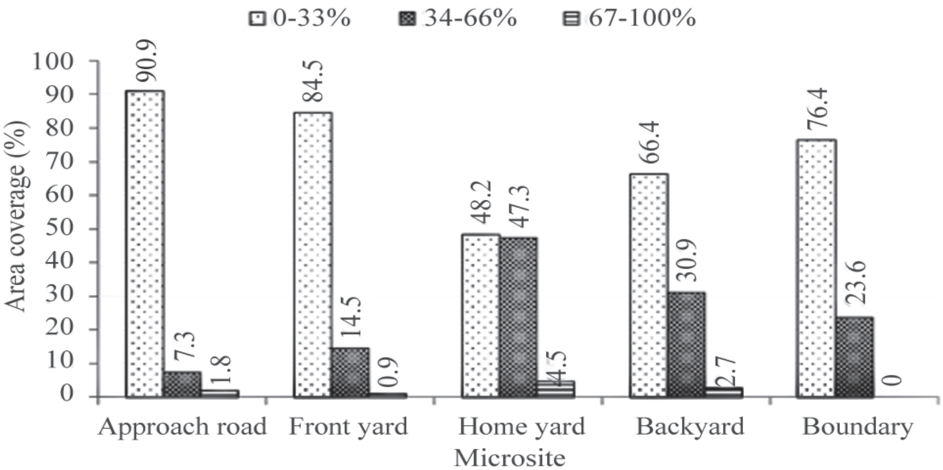

Fig. 2. Distribution of area coverage of different microsites in total homestead area.

were also dominated by the top layer species (57.3%) followed by 19.1% mid layer species and 2.7% ground layer species. Majority of boundaries were dominated by top layer species (47.3%) followed by 19.1% mid layer species and 3.6% ground layer species.

Spatial arrangement of different microsites

Fig. 4 represents spatial arrangements of different microsites by categorizing into over-crowded, crowded, optimum, thin and deserted. It showed that majority of the approach roads were over-crowded (20%) and crowded (20%) followed by optimum (17.3%), thin (10%) and deserted (3.65%), while front yards had optimum (29.9%) spatial arrangement followed by thin (25.5%), crowded (20%), over-crowded (10.1%) and deserted (6.4%). Most of the home yards had optimum (35.5%) spatial arrangement followed by thin (28.2%), crowded (20%), over-crowded (14.5%) and deserted (0.9%). On the other hand, the back yards had thin (24.5%) spatial arrangement followed by optimum (20.9%), crowded (19.1%), over-crowded (14.5%) and deserted (7.3%), while most of the boundaries had optimum (25.5%) spatial arrangement followed by thin (20.9%), crowded (14.5%), over-crowded (8.2%) and deserted (4.5%).

Nature of species change during last 10 years

Each of the microsites was compared according to their species changing nature during last 10 years. It implied that approach roads had about 34.5% increasing trend, 34.5% decreasing trend and 30.9% unchanged nature of species change during last 10 years. Front yards had about 44.5% decreasing trend, 30.9% increasing trend and 24.5% unchanged nature of species change. Home yards (40%) had most increasing percent of species than all other microsites followed by 30.9% unchanged nature of species and 29.1% decreased nature of species change during last 10 years. Increasing trend of home yard species is likely due to higher production of annual vegetables there. Back yards had mostly unchanged (37.3%) nature of species change followed by 36.4% increasing and

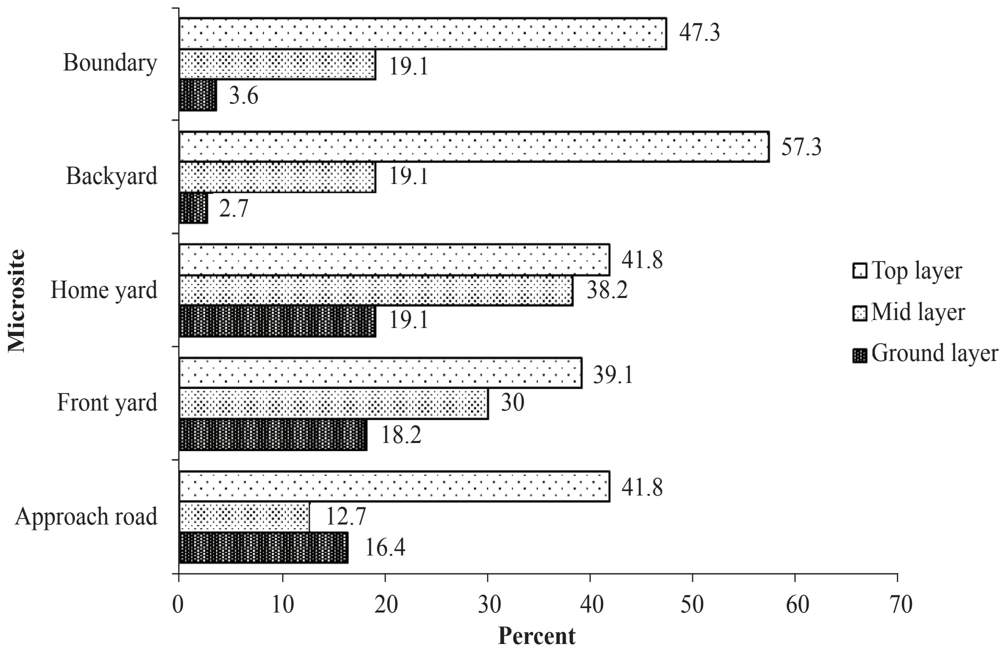

Fig. 3. Distribution of canopy layer of different microsites.

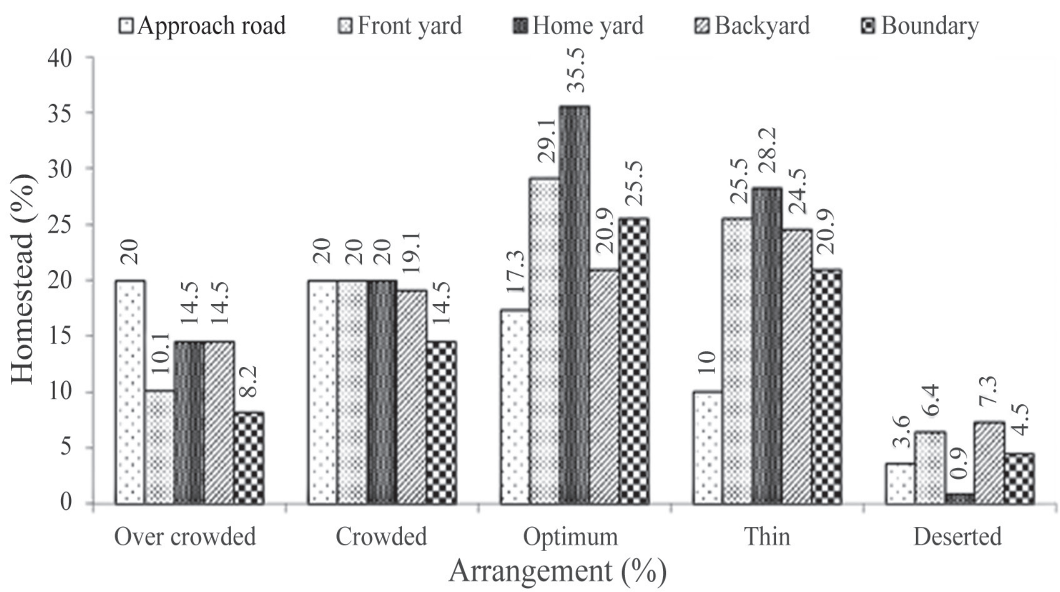

Fig. 4. Distribution of spatial arrangement of different microsites.

26.4% decreasing nature of species. Most of the boundaries had decreasing (39.1%) nature of species followed by 33.6% unchanging and 27.3% increasing nature of species (Fig. 5).

Species richness and diversity

Species richness across the microsites A total of 68 different plant species were recorded from the studied 110 homesteads. Marked variation in species richness and diversity was found in the microsites of different homesteads. The highest type of species (41) was found in home yard and front yard whereas, the lower types of species (17) were found in the boundary. To indicate the abundance and species richness of a plant species, relative prevalence of species was calculated. Relative prevalence of different plants (fruit, herb, timber and medicinal) species was measured microsite-wise. Among the fruit species, mango (*Mangifera indica*) was the most dominant species irrespective of microsites and the values were 0.67, 0.97, 0.76, 1.09 and 0.91 at the approach road, front yard, home yard, backyard and boundary, respectively. The other prevalent fruit species were jackfruit (*Artocarpus heterophyllus*), banana (*Musa sapientum*), coconut (*Cocos nucifera*), guava (*Psidium guajava*), etc. (Table 2). Among the timber and fuel species, teak (*Tectona grandis*) was the most dominant species and the values of relative prevalence were 0.14, 0.07, 0.05 and 0.13 in the approach road, front yard, back yard and boundary, respectively. The other prevalent timer species were acacia (*Acacia auriculiformis*) and sal (*Shorea robusta*).

Beli (*Iasminum sambac*) was the most dominant ornamental species. The relative prevalence of beli was 0.05, 0.06 and 0.03 in the approach road, front yard and home yard, respectively. In the back yard and boundary microsites, beli plant was not found. The other ornamental species were rose (*Rosa sinensis*) and shiuli (*Nyctanthes arbor-tristis*). Here, it should be mentioned that the relative prevalence was measured for individual microsites (sub production system of homestead) of a household, not for the entire household.

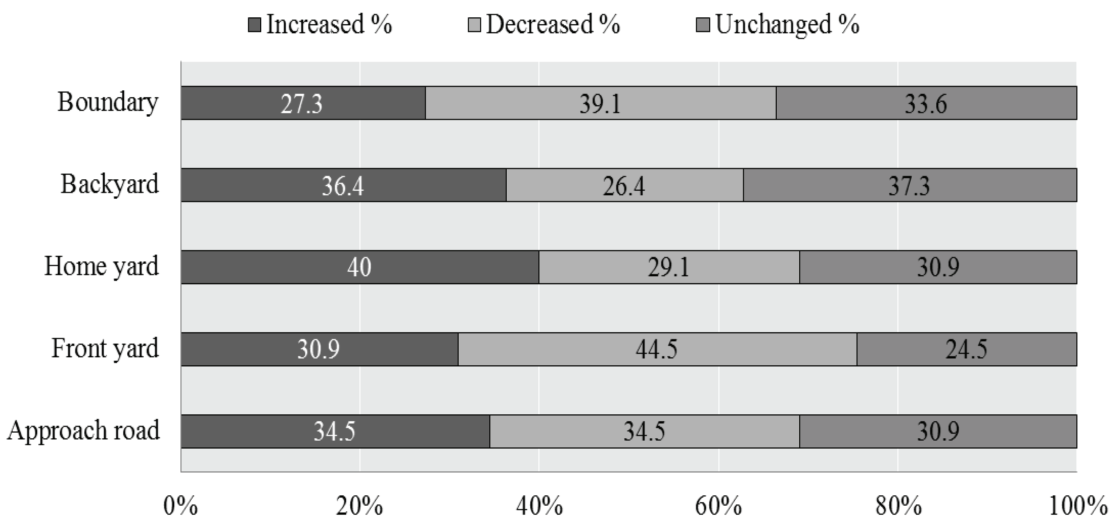

Fig. 5. Distribution of microsites according to nature of species change during last 10 years.

Species diversity index

The species diversity index of the microsites of the homesteads was measured by Shannon-Wiener Index (H). This study revealed that front yard species were more diversified than all other microsites. Across the microsites, species diversity of front yard was highest (1.99) followed by approach road (1.88), home yard (1.81), back yard (1.63) and boundary (1.51) (Fig. 6). At present, species diversity of the fruits has been found decreased in Kapasia as against 15 years back as reported by Ahmed (1999). Similar result was also reported by Ahmed (2011).

Table 2. Relative prevalence of plant species in different microsites

Common name	Scientific name	Relative prevalence (RP)				
		Approach road	Front yard	Home yard	Back yard	Boundary
Mango	*Mangifera indica*	0.67	0.97	0.76	1.09	0.91
Jackfruit	*Artocarpus heterophyllus*	0.45	0.88	0.63	0.74	0.57
Banana	*Musa sapientum*	0.296	0.41	0.21	0.43	0.35
Coconut	*Cocos nucifera*	0.10	0.10	0.21	0.21	0.13
Guava	*Psidium guajava*	0.11	0.11	0.17	0.23	0.08
Palm	*Borassus flabellifer*	0.095	0.04	0.05	0.14	0.05
Pineapple	*Ananus comosus*	1.25	0.21	0.01	0.04	-
Betel nut	*Areca catechu*	0.05	0.05	0.05	0.07	0.16
Blackberry	*Syzigium cumini*	0.12	0.21	0.14	0.13	0.15
Date palm	*Phoenix sylvestris*	0.03	0.03	0.03	0.05	0.35
Lemon	*Citrus spp.*	-	0.07	0.08	-	0.04
Litchi	*Litchi chinensis*	0.06	0.13	0.17	0.11	0.05
Jujube	*Giziphus jujuba*	0.06	0.11	0.18	0.14	-
Hena	*Lawsenia ineromis*	0.02	0.04	0.04	0.03	-
Neem	*Azadirachta indica*	0.05	0.02	0.009	0.01	-
Acacia	*Acacia auriculiformis*	0.10	0.03	-	-	0.15
Teak	*Tectona grandis*	0.14	0.07	-	0.05	0.13
Eucalyptus	*Eucalyptus cameldulensis*	0.03	0.01	-	-	0.06
Sal	*Shorea robusta*	-	0.02	0.01	0.03	0.05
White siris	*Albizia procera*	-	0.01	-	0.09	0.02
Papaya	*Carica papaya*	-	0.13	0.33	0.21	-
Country bean	*Dolichos lablab*	-	0.02	0.15	0.05	-
Shiuli	*Nyctanthes arbor-tristis*	0.01	-	0.009	0.01	0.05
Beli	*Iasminum sambac*	0.05	0.06	0.03	-	-
Rose	*Rosa sinensis*	0.02	0.02	0.06	-	-

Performance of species at different microsites

All microsites were not equally balanced with the containing species. Different species performed remarkably different ways with the variation of orientation. It was observed that some species were found to perform exceptionally well at particular microsite. Among them, the highly performed species are shown in Table 3. Mango (15.37%) was the major dominant species among all high performing species in approach road followed by jackfruit (12.83%), banana (10.29%), palm (9.02%) and pineapple (9.02%). In front yard, jackfruit (25.73%) was found as the major high performing species followed by mango (19.61%), banana (6.23%), coconut (4.08%) and jujube (4.08%).

In case of home yard, mango (12.01%) performed best among all the species followed by jackfruit (11.09%), papaya (8.35%), jujube (8.35%) and blackberry (5.6%). In back yard, major high performing species was mango (12.78%) followed by that of jackfruit (11.63%), banana (10.48%) and coconut (8.18%). Among boundary species, jackfruit (14.47%) performed best followed by mango (9.26%), betel nut (9.26%), teak (9.26%) and coconut (7.6%). Among other high performing species, guava, litchi, wood apple, date palm, betel nut, palm, pineapple and teak were found at different microsites with variation in number.

Performance of tree species in terms of height and DBH

Different species perform differently in different positions. Table 4 makes it clear that almost all high performing species, such as mango, coconut, guava, blackberry and

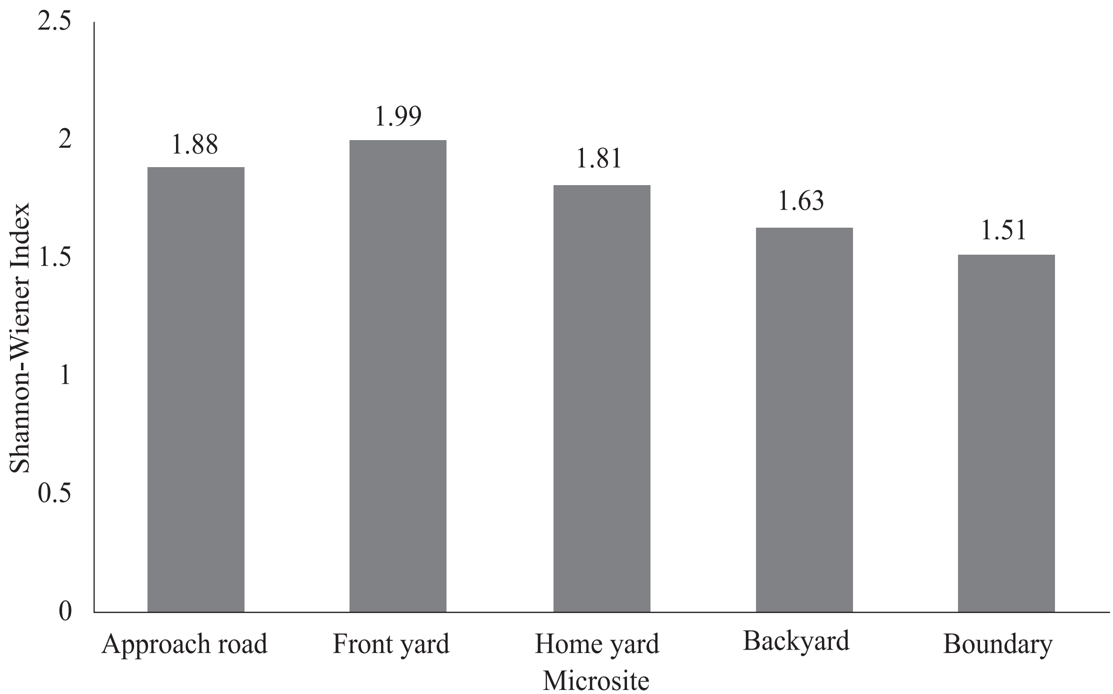

Fig. 6. Species diversity index in different microsites.

Table 3. Highly performing species in different microsites

Highly performed species	Approach road		Front yard		Home yard		Back yard		Boundary	
	Percent	Rank	Percent	Rank	Percent	Rank	Percent	Rank	Percent	Rank
Mango	15.37	1	19.61	2	12.01	1	12.78	1	9.26	2
Jackfruit	12.83	2	25.73	1	11.09	2	11.63	2	14.47	1
Banana	10.29	3	6.23	3	4.58	5	10.48	3	5.2	5
Coconut	3.81	6	4.08	4	2.75	7	8.18	4	7.6	3
Guava	-	-	2.04	6	3.66	6	4.6	7	2.6	7
Blackberry	2.54	7	-	-	5.6	4	-	-	-	-
Papaya	-	-	2.04	6	8.35	3	4.6	7	3.9	6
Jujube	1.27	8	4.08	4	8.35	3	2.3	9	-	-
Litchi	-	-	2.04	6	3.66	6	2.3	9	-	-
Woodapple	-	-	2.04	6	3.66	6	2.3	9	3.9	6
Date palm	1.27	8	2.04	6	0.92	9	-	-	6.51	4
Betel nut	2.54	7	-	-	2.75	7	7.03	5	9.26	2
Palm	9.02	4	1.02	7	-	-	3.45	8	5.21	5
Pineapple	9.02	4	6.23	3	-	-	-	-	-	-
Teak	2.54	7	2.04	6	-	-	-	-	9.26	2
Durba grass	5.07	5	1.0	7	1.83	8	1.15	10	5.2	5

papaya performed best in home yard as the average height and DBH are higher. Home yard having such a high performance may be due to the sunlight effect which is usually less insufficient at other microsites.

Only few species performed better in boundary i.e., jackfruit, banana and wood apple. Majority of the species performed least in the approach road, namely mango, jackfruit, banana and coconut. Performance of species in the front yard is also lower but higher than in the approach road such as in mango, jackfruit, banana, coconut and jujube. Species behave differently for a number of reasons, sometimes due to a single reason and sometimes due to combined effect of several reasons. No waterlogging is a unique character of central terrace system that served as a great factor here for high performance of four microsites among five; they are approach road (44.85%), front yard (42.29%), back yard (36.48%) and boundary (48.62%). Sufficient sunlight (49.08%) is the most possible reason for high performance of home yard species. The other possible reasons are sufficient space, damp environment, high average temperature and slightly acidic soil (Fig. 7). Damp environment was suitable for those species which required high moisture.

Contribution of microsites to homestead productivity

Comparative contribution of different microsites to the total homestead production is shown in Fig. 8. Here it is reported that the highest contribution was found from home yard (32.24%) followed by that in back yard (21.34%), front yard (18.3%), boundary (16.3%) and approach road (11.76%). Almost every household had home yard and area

Table 4. Performance of different species in different microsites in the study area

Highly performed species	Relative performance of species in different microsites									
	Approach road		Front yard		Home yard		Back yard		Boundary	
	Height (m)	DBH*	Height (m)	DBH	Height (m)	DBH	Height (m)	DBH	Height (m)	DBH
Mango	3.31	0.74	3.56	0.8	4.35	1.1	4.17	1.05	4.02	0.95
Jackfruit	2.98	0.67	3.29	0.7	3.9	0.9	3.79	0.8	4.2	1
Banana	2.13	0.5	2.17	0.48	2.2	0.5	2.18	0.49	2.33	0.6
Coconut	3.81	0.81	3.89	0.9	4.1	1	4.02	.97	4.0	0.95
Guava	-	-	3.25	0.3	3.66	0.33	3.5	0.35	3.43	0.34
Blackberry	4.2	0.63	-	-	4.57	0.69	-	-	-	-
Papaya	-	-	1.65	-	2.09	-	2.04	-	1.8	-
Jujube	2.1	0.45	2.32	0.51	2.3	0.5	2.3	0.48	-	-
Litchi	-	-	2.04	0.24	2.25	0.31	2.1	0.25	-	-
Woodapple	-	-	2.15	0.24	2.2	0.26	2.25	0.27	1.9	0.2
Date palm	2.67	0.58	2.9	0.6	3.4	0.7	-	-	3.2	0.65
Betel nut	7.5	0.3	-	-	7.8	0.33	7.03	0.29	7.8	0.35
Palm	7.79	0.7	7.81	0.7	-	-	6.4	0.65	7.05	0.69
Teak	2.54	0.6	2.61	0.62	-	-	-	-	.3.2	0.7

*DBH: Diameter at Breast Height

coverage of home yard was also higher in the study area. Furthermore, some respondents also reared poultry and livestock in their home yards. These may be the most possible reasons for higher production of home yard.

Contribution of microsites to total homestead income

Total homestead income is mainly comprised of income from different micro sites. In general, annual homestead income is dependent on production and income from

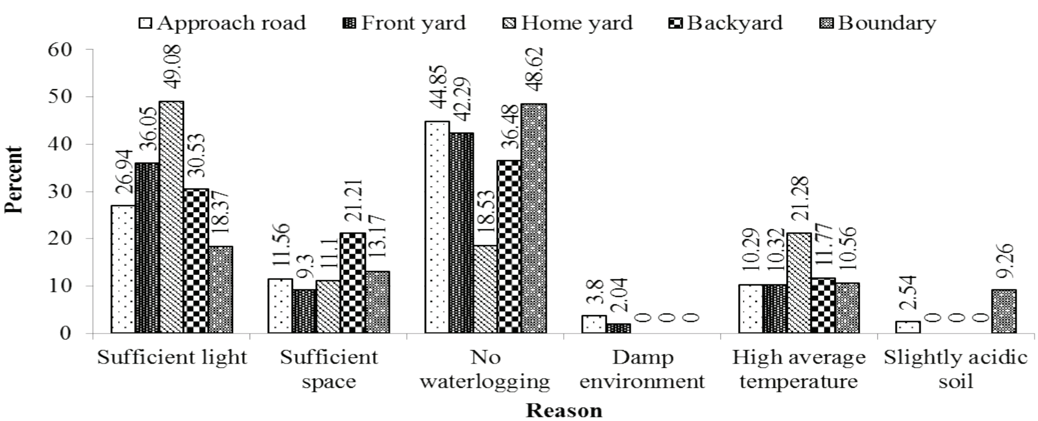

Fig. 7. Possible reasons for high performance of species in different microsites.

the microsites. Comparative contribution of microsites to total homestead income is shown in Fig. 9. It shows that home yard (33.2%) had the highest contribution in annual homestead income followed by front yard (23.5%), back yard (18.10%), boundary (15.10%) and approach road (10.10 %).

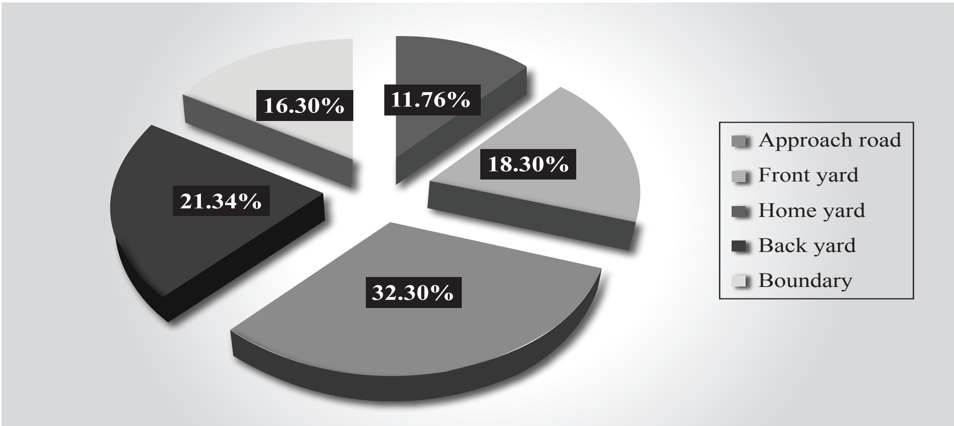

Fig. 8. Contribution of different microsites to total homestead production.

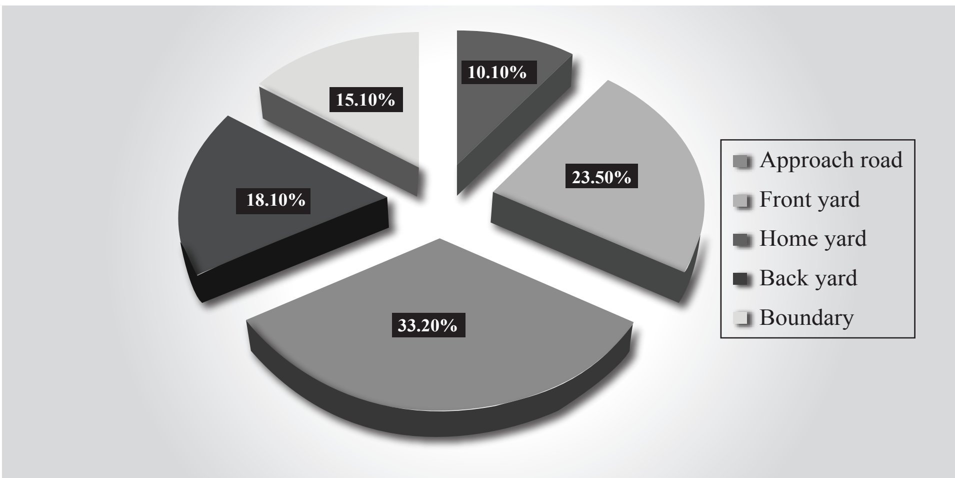

Fig. 9. Contribution of different microsites to total homestead income.

Conclusion

Among all microsites, home yard had most species increasing nature, which was likely due to higher production of annual vegetables. Out of a total of 68 different plant species identified from surveyed homesteads, the most of the prevalent and top ranked fruit species were *Mangifera indica, Artocarpus heterophyllus, Musa sapientum, Cocos nucifera, Psidium guajava,* etc; timber species were *Tectona grandis, Acacia auriculiformis, Shorea robusta*etc; among ornamental species *Iasminum sambac, Rosa sinensis* and *Nyctanthes arbor-tristis*etc were prevalent. Front yard species were more diversified than that of all other microsites.

Home yard (32.24%) contributed maximum to the total annual production of household among all other microsites. Almost every household possessed a home yard and area coverage of home yard was also higher in the study area, some respondents also rear poultry, livestock and grow vegetables in the home yard to meet daily requirements. These may be the most possible reasons for higher production of home yard as it served as an ideal agroforestry system combining fruit trees, vegetables and livestock. Home yard (33.2%) had the highest contribution in annual homestead income followed by front yard (23.5%), back yard (18.10%), boundary (15.10%) and approach road (10.10%). In order to bring about a positive change in the productivity of the homestead, farmers' knowledge, understanding and utilization of homestead microsites should be improved by proper training and other technical assistance for these purposes. Identifying different shade tolerant vegetables and to motivate and train farmers to increase vegetable production can be a suitable way for farmers to improve their income and utilize shade prone bare homestead land.

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