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Structure, species composition and utilization of homestead forest: A case study in Gangni upazila of Meherpur district

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DECLARATION

I, **Mr. Md. Sohrab Hosain**, declare that this thesis work is a result of my own investigations and findings and it has not been submitted or accepted for a degree in any other University or Institutions.

I, hereby give consent for my thesis, if accepted, to be available for photocopying and inter-library loans and for the title and summary to be made available to outside organizations only for research and educational purposes.

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This is to certify that **Mr. Md. Sohrab Hosain**, Student ID: MS-120502 has been prepared this thesis paper entitled ***"Structure, species composition and utilization of homestead forest: A case study in Gangni upazila of Meherpur district"*** under my supervision and submitted to the Forestry and Wood Technology Discipline, Khulna university, Khulna-9208, Bangladesh in partial fulfillment of the requirements for the Degree of Master of Science (M.Sc.) in Forestry (major in Social Forestry).

I do hereby approve the style and content of this paper.

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DEDICATED

TO

My Beloved Parents and the Respondents of the study area

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ABSTRACT

In Bangladesh, homestead forest is one of the most important natural resources and it comprises a mixture of diversified plant species. This study was conducted by means of multistage random sampling from total of 60 homestead forests to assess the status, structure, species composition and species frequency, uses and importance of homestead forests in Gangni upazila of Meherpur district. A set of 60 homestead forests from six unions (10 homesteads from each union) and five homesteads from each village (two villages from each union) were selected randomly. The results showed that 60% of the total homesteads were medium, 30% were small and only 10% were large size with reference to the size of homestead forests. It was within the ranges of 0.03 ha to 0.4 ha with an average of 0.12 ha. The total survey area was 7.05 ha from the set of 60 homestead forests. Total 73 plant species (including tree, shrub and herb) under 39 families were identified and recorded from the study area. It was found that the number of trees, shrubs and herbs species were 43 (57%), 13 (17%) and 18 (25%) respectively. Trees and herbs species were predominated accounting for about 82% of all the identified species. The highest types of plant species (47) and the lowest (28) were found in the large and small farm category respectively. A total number of 4168 individual trees and shrubs were identified and recorded from the set 60 homesteads and among theses 87.72% were trees and the rest 12.28% were shrubs. Most of the species were planted both in the border and interior parts of the homesteads. Food and fruit producing species were dominated near the living quarter of this region. The lowest number of individual trees and shrubs (456) was found in Bamondi Union and the highest (954) in Sholotaka Union with different species in the study area. Four canopy strata were observed in the study area with reference to the *top layer or over story* (above 15m from ground level), *middle canopy layer* (above 5m to 15m), *Understory* (above 2m to 5m) and the *ground layer* (up to 2m). Every stratum was consisted of different species but some species were overlapped in each. Most of the homestead forests about 60% contained the number of species ranges between 16-30 species. Mango and Mehagoni were the most important fruit and dominant tree species, Lemons and Mendi were the most important shrub species, Mankachu and Papaya were the most important herb species based on their frequencies, relative frequencies and uses. Among the 15 most important plant species (5 trees, 5 shrubs and 5 herbs) six were native and nine were exotic according to their origin, uses and relative frequencies.

ABREVIATION AND ACRONYMS

BBS	Bangladesh Bureau of Statics
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GOB	Government of Bangladesh
LGED	Local Government and Engineering Division
MPTs	Multipurpose Tree Species
NGO	Non-Government Organization

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CHAPTER ONE- INTRODUCTION

1.1 Background of the study

Bangladesh, being a subtropical country, enjoys a wide range of diversity of plants in homestead forests. Land is the basic resources of human society. Bangladesh is an over populated and land hungry country having about 14.4 million hectares of land with population of 152.52 millions (BBS, 2011). Because of the rapid growth of population and indiscriminate destruction of forest cover, it is difficult to meet the country's huge demand for timber, fuel, food and fodder and maintaining ecological balance. In such a situation homegarden represents a land use system involving deliberate management of multipurpose trees and shrubs in close association with seasonal vegetables (Fernandes and Nair, 1986). Homestead forests are common features in rural Bangladesh. These forests are described as a multistoried vegetation of shrubs, bamboos, palms, and trees surrounding homesteads that produce materials for a multitude of purposes, including fuel, shelter, structural materials, fruits and other foods, fodder, resins, and medicines (Douglas, 1981). The area of homestead forest in Bangladesh is 0.27 million hectares, representing 10.5% of forestlands (Government of Bangladesh, 1993). Homestead forest comprises 2% (2951.40 km^2) of the total land area of Bangladesh, which spreads over 20 million homesteads (Salam *et al.*, 2000).

Although the forest department presently considers 14.6% of total land area of Bangladesh as forested, in reality, only about 6-8% of the total land area of Bangladesh merits the term forested. Specifically 6.4% of total land areas of Bangladesh under tree cover (Salam *et al.*, 2000). Homestead forests around the world often exhibit remarkable variation in floral composition and structure depending on the physiographic and climatic conditions of the area and a wide variety of household characteristics. Homestead forestry practices are prevalent not only in Bangladesh but also in many South and Southeast Asian, Latin American and African countries. The terminology for homestead-based plant production varies between 'home garden' and 'backyard agro-forest garden' in the Philippines; 'village-forest gardens' (Michon, 1983) in Java; and 'mixed gardens' in Central America. In Bangladesh, the terms 'homestead forest' or 'tree cover' are commonly used. Homestead forest or forest grove's are mostly on privately owned lands covered with trees and bamboo corps of varying quality and density (Anam, 1999).

Homestead forests play a vital role in providing firewood, fodder, medicine, fruit and timber. It is estimated that about 70% of timber, 90% of firewood, 48% of sawn and veneer logs, and almost 90% of bamboo requirements are met from homestead forests (Uddin *et al.*, 2001; Haq *et al.*, 2001). It is difficult to meet the country's huge demand for timber, fuel, fruit and fodder from the natural forest. Villages of Bangladesh have a long heritage of growing timber, fruit trees and medicinal plants along with other perennial shrubs and herbs (Rahman *et al.*, 2009). A wide variety of factors may be associated with homestead forest diversity and structure, including biophysical features such as biogeography, proximity to forest and elevation (Soemarwoto, 1987; Kumar *et al.*, 1994; Hocking *et al.*, 1996; Trinh *et al.*, 2003; Ali, 2005). The homestead forests are the most highly productive forest and meet most of the demand of timber and fuelwood in the country (Khan and Alam, 1996). Bangladesh, being a small country, never had huge forest resources. Per capita forestland in Bangladesh is 0.022 ha which is among the lowest in the world (FAO, 2011). It is estimated that about 61-70% of saw logs and 90% of fuel wood and bamboos come from homestead forests. Most of the native fruits, country vegetable, fuel wood and timber come from homestead home yard and marginal lands attached to or nearby homesteads (Basher, 1999).

Naturally, agriculture practice provides the seasonal rural income to the rural poor. But homestead forests can play a vital role as a source of employment and income generating activities all the year round and thus these are more important and dependable to the rural people in the area. These can ensure the uplift of the socio-economic condition of the area (Abedin, 1990). Now-a-days homestead forests are becoming popular to the study area. Because, people are generally benefited from it for diversifying products like fuelwood, fodder, medicinal plants, fruit and timber etc. It will help to quantify the utilization of homestead forests and facilitate sustainable production and conservation of biological diversity in the study area.

1.2 Rationale of the Study

The homestead in Bangladesh is one of the most important natural resources containing a huge number of diversified plant species and it is perhaps the most important production unit in Bangladesh. Much of the biodiversity has already been destroyed in the form of the over exploitation and deforestation. Now, forest vegetation cover has presented less than 11% of the total land area (FAO, 2011) but needed 25% tree cover of the total land area. Homestead agro-forestry systems often show promise for the sustainable supply of forest products and

services to both rural and urban inhabitants of Bangladesh (FAO, 2005) and also promise for biodiversity conservation (Montagnini, 2006; Kabir and Webb, 2008a). Millat-E-Mustafa *et al.*, (1996) recorded eight major uses of the homestead forest plants: fruit/food, timber, firewood, spice, fodder, medicine, fencing and miscellaneous uses. The miscellaneous uses include brooms, handicrafts, shade, ornamental, ceremonial, environmental, and aesthetic. Siddiqi and Khan, (1999) studied on the Floristic composition and socio-economic aspects of rural homestead forestry in Chittagong. Kabir and Webb, (2008) worked on the Floristic and structure of southwestern Bangladesh homegardens.

Study on homestead forest was carried out in different regions of Bangladesh. Kabir and Webb, (2008) showed that they have generally planted native species for food, medicinal, fuelwood, and timber because they are considered to provide better products than exotic species. Mean annual income from home gardens may vary depending on the component products and nature of the products utilization. There have been a few studies reported on Bangladeshi homegardens vegetation (only Millat-e-Mustafa *et al.*, 1996; Salam *et al.*, 2000; Uddin *et al.*, 2002; Ahmed and Rahman, 2004; Ali, 2005; Kabir and Webb, 2008b). But there is no specific management plan for the homestead forests (FAO, 2010) which are being traditionally managed by the household owners.

Gangni upazila of Meherpur district is situated on the southwestern part of Bangladesh. This area was selected because it has a reputation of cultivating various types of fruit crops, woody and timber species like mango, guava, litchi, jackfruit, mehagoni, ipil-ipil etc. and as well as producing huge amount of seasonal vegetables. This area contains fresh water and the soil is free from salinity (LGED and BBS, 2011). But no study was so far carried out on the structure, species composition, species frequency and diversity, utilization of homestead forests specific to Gangni upazila of Meherpur district in Bangladesh. So, the assessment on species composition, species frequency, diversity and structure of homestead forest as well as its utilizations was important to make the people aware about the importance of homestead forest.

Therefore, this study was carried out to identify the present status of homestead forests through investigating the plant species composition, species frequency, diversity and structure of homestead forests as well as to explore the utilization of tree based products of homestead forests.

1.3 Objectives of the study

- To know the structure of homestead forest.
- To explore the plant species composition and species frequency of homestead forest.
- To know the contribution of homestead forest to the household demands for tree based products and services.

CHAPTER TWO- LITERATURE REVIEW

2.1 Introduction

A homestead forest in Bangladesh is an integrated production system and a stable ecosystem that maintains the diversity of life as well as the biological wealth. It is the main source of food, fruits, vegetables, timber and fuelwood for the household and is a reliable source of household income. Shortage of fuel was common irrespective of farm size but it was more acute in the smaller farm categories. About 75% timber demand and 85% of fuelwood demand are met by homestead forests production. It was estimated that about 10% of the standing volume of wood on homestead forests is removed every year, indicating that homestead plantations are under competitive pressure (Haque, 1992). Continued denudation of the forest vegetation has turned to barren with mostly covered by grass, scrub or bush. Though the forest area of Bangladesh is 17.8%, 40% of the forest area has less than 30% tree cover (GOB, 2009a).

2.2 Concepts and definition of homestead forest

Homestead forestry, popularly known as home garden, is an important component of rural economy in the tropical region of the world as well as in Bangladesh. In a typical home garden a number of crops including trees are grown with livestock, poultry or fish production, mainly for the purpose of satisfying the farmer's basic needs (Leuschner and Khaleque, 1987; Muhammad Abul Foysal *et al.*, 2013).

Homesteads are privately owned dwelling areas in rural and semi-urban settings that include a dwelling unit equipped with a kitchen, backyard, front yard and occasionally a pond and home garden. A homestead forest or home garden is a mixture of deliberately planted vegetation, usually with a complex structure and designed to produce natural products for household consumption or for the market (Vogl and Vogl-Lukasser, 2003; Kabir and Webb 2008a, 2008b, 2009).

Homestead forests are a major source of forest products that play an important role in the economic life of the country by supplying the bulk of wood and other forest products in the market (Government of Bangladesh, 1998). Despite such importance, homestead forests are often ignored by scientists and development agents as an important part of traditional farming

systems largely because of their small size and apparent insignificance (Bunderson *et al.*, 1990; Nair, 1993).

Generally, home gardening refers to the cultivation of a small portion of land which may be around the household or within walking distance from the family home. Home gardens can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income (Odebode, 2006).

2.3 Characteristics of homestead forests

Michelle and Hanstad (2004) list five intrinsic characteristics of homestead forests: 1) are located near the residence; 2) contain a high diversity of plants; 3) production is supplemental rather than a main source of family consumption and income; 4) occupy a small area; and 5) are a production system that the poor can easily enter at some level (Brownrigg, 1985).

While some similarities exist across the board, each home garden is unique in structure, functionality, composition, and appearance as they depend on the natural ecology of the location, available family resources such as labor, and the skills, preferences, and enthusiasm of family members (Fernandes and Nair, 1986). A study from Indonesia observed that the structure, composition, intensity of cultivation, and diversity of home gardens can be subjected to the socioeconomic status of the household (Wiersum, 2006).

2.4 Structure of homestead forests

The structure of homegardens has well-defined vertical and horizontal stratification. The stratification cannot be easily dissociated from one another (Nair and Sreedharan, 1986). The multi-tiered canopy structure is most distinguishing features of homegardens, and delineates three-to-six-strata (Gillespie *et al.*, 1993; Jose and Shanmugaratnam, 1993; Kumar *et al.*, 1994; Millat-e-Mustafa *et al.*, 1996). Vertical stratification provides a gradient in light and relative humidity, shade tolerant crops constitute the lower stratum, shade in tolerant trees the top layer and species with varying degrees of shade tolerance in the intermediate strata (Kumar and Nair, 2004).

Canopy stratification is one of the oldest concepts in tropical forest ecology. However, there has been considerable debate over the existence and identification of strata. Much of the

confusion arises from the differing definitions of strata (i.e., vertical stratification of phytomass, individual crowns, or species) and the methods used to evaluate them (e g. Profile Diagrams). Strata are defined by comparing sorted tree heights to a moving average of height at the base of the live crown (Baker and Wilson, 2000).

Homegardens function like natural forest ecosystem (Mergen, 1987). Their multistoried structure and the high diversity of their cultivated species are alike the structure of tropical forest ecosystems (Michon, 1983). Great diversity in the tree, shrubs, vegetables and crop species as well as in the spatial arrangement of these components is also found (Mergen, 1987). Two to five houses remain in a isolated cluster and the surroundings space is covered by various types of plants (trees, shrubs, herbs etc) from ground up to 30 m high (Michon, 1983). They have layered vertical structure of plants and provide the nutrient recycling, soil protection, effective utilization of space below and above along with this (Godbole, 1998).

Varieties of plants and uncommon species are tested there and they also become a repository site of these species (Padoch and Jong, 1991). They are sustainable, viable and efficient agro-ecosystems both economically and ecologically by providing sustained yields (Michon, 1983) Plants have to exploit light and humidity according to their ecological and sociological requirements which are provided by layered vegetations of homegardens (Michon, 1983).

In spite of the very small average size of the management units (Chundawat and Gautam, 1993), homegardens are characterized by a mixture of annual or perennial species grown in association (Godbole, 1998), having a high species diversity (Chundawat and Gautam, 1993), by a multistoried structure (Mergen, 1987), usually three to four vertical canopy strata (Chundawat and Gautam, 1993). A study by Millet-e-Mustafa *et al.* in 1996 on the structure and floristic of Bangladesh home gardens recognized six vertical strata with higher plant density and species richness in the lower three.

2.4.1 Horizontal structure of homestead forests

Typical home garden usually represent the appearance of a crowded haphazard assemblage of trees, shrubs, herbs, climbers and creeping plants. Most farmers try to optimize their home gardens by planting as many crops as they can in the limited space available and in the

physical constraints of their home environment. The horizontal structure is assessed in terms of species locations within the home gardens. Species locations within the home gardens are assessed in relation to distance from the living quarters. Species locations in the home gardens could be considered with respect to major locations. Only the border only, the interior part only and both border and interior parts (Muhammad Abul Foysal *et al.*, 2013; Alam, 1997).

Homegardens have distinct horizontal zones depending on the size, location, and distance from home, species composition, planting pattern which directly guide other management principles (Padoch and de Jong, 1991; Millat-e-Mustafa *et al.*, 1996; Agelet *et al.*, 2000; Ceccolini, 2002; Blanckaert *et al.*, 2004). Plant associations are groups of plant species chosen to complement each other in fulfilling a range of functions (Christanty, 1990).

Trees of particular purposes such as fruits, food, vegetable, timber, boundary, shade, ornamental, and religious will be placed in several zones of the horizontal strata based on the gardener's management priorities, socioeconomic status, and needs (Blanckaert *et al.*, 2004; Kumar and Nair, 2004), plant requirements, and soil conditions (Mendez *et al.*, 2001).

Generally the position of plants in the homegarden is related to their use, social, economic, and ecological importance. Trees are in the back of the house, annual food crops were in front of the house, ornamentals are clustered round the path and walls of the house, while animal pens are behind the house in the shade of trees and chickens roam freely, a typical arrangement of a tropical homegarden (Gliessman, 1990).

2.4.2 Vertical structure of homestead forests

It expresses the home garden with many life forms varying from those creeping on the ground such as pumpkins to tall trees of 10m or more e.g. the coconut palm. These create the forest like the multistoried canopy structure of many home gardens. On a more local scale a structural approach can be used to simplify the organization of complex vegetation types the vertical strata in the basis of specific height classes (Muhammad Abul Foysal *et al.*, 2013).

The layered canopy configurations and combination of compatible species are the most conspicuous characteristics of all homegardens. Vertical stratification of homegarden can mimic the structure and function of tropical forest ecosystems (Michon, 1983, Gliessman,

1990, Kumar et al., 1994). Tropical homegardens often show a large variation in vertical stratification. Minimum two to maximum six vertical strata have been documented from tropical homegardens (Kumar and Nair, 2004).

Generally, a homegarden consists of herbs, shrubs, trees, and climbers in several layers from ground to emergent strata. However, the Mediterranean and the arid tropical homegardens are the exception of this, where only herbs are in ground and trees in emergent stratum (Agelet *et al.*, 2000; Ceccolini, 2002). Vertical stratification broadly depends on the geographical location, local site condition, garden's age, gardener's socioeconomic status and plantation objectives, and the overall management objectives of homegarden (Karyono, 1990; Millat-e-Mustafa *et al.*, 1996; Hochegger, 1998; Salam *et al.*, 2000).

Vertical architecture of multiple layers vegetation in homegarden is purposefully making efficient use of light, space, and soil nutrients (Gillespie *et al.*, 1993; Gajaseni and Gajaseni, 1999). Thus, it maintains a relatively constant moisture and temperature level on grounds which reduce water stress during the low rainfall periods and keep production through weather pattern fluctuations (Wojtkowski, 1993). Sparsely planted homegardens with no canopy overlap reduced competition for limited water and soil, whilst the wetter areas were more intensively cultivated and architecturally complex. Similar plantation patterns exist in sub-humid West Africa, Guatemala, and Bangladesh (Okigbo, 1990; Gillespie *et al.*, 1993; Millat-e-Mustafa *et al.*, 1996).

2.5 Species composition and diversity

Species composition in the home garden of Bangladesh is ranging from small herbs to big trees. Of the total land mass of Bangladesh, 63.74% are occupied by agricultural land, 6.94% un class state forest, 0.79% tea gardens, 2.46% uncultivated lands, 9.21% national forest, 7.26% homestead land and 9.6% marshy land respectively (Das, 1986). The limited space forces people to accommodate many different species in relatively small numbers on small plots. The religious, cultural beliefs, customs of the villagers influence the diversity or composition of home gardens. For example, crops, trees, animals are retained or excluded depending on the above considerations (Millat-e-Mustafa *et al.*, 1996). Species richness of home gardens within a region is influenced by farm size (Kumar and Nair, 2004).

The crop combinations in the homegardens are strongly influenced by the specific needs and preferences of the household, besides ecological and socioeconomic factors (Christanty *et al.*, 1986; Vogl *et al., 2002).* A new species may be chosen by the garden owner because of its properties, i.e., food, wood, medicinal, religious, ornamental (Kumar and Nair, 2004*),* and no specific time of the year for planting new plant species into the gardens; it will depend on the space available and soil conditions (Rico-Gray *et al.*, 1990).

Species composition in the home gardens of Bangladesh ranging from small herbs to big trees. The most common species (trees and shrubs) constitute the important part of village growing stock are coconut *(Cocos nucifera), Betel Nut (Areca catechu),* Mango *(Mangifera indica),* Jackfruit *(Artocarpus heterophyllus),* Litchi *(Litchi chinensis),* Jam (Syzugium spp.), Guava *(Psidium guajava),* Lemon *(Citrus lemon),* Jujube *(Zizyphus jujuba),* Papya *(Carica papaya),* Banana (Musa spp), Koroi *(Albizia* spp.), Rain tree *(Samanea* saman), Mahogany *(Swietenia macrophylla),* Neem *(Azadirachta indica), Kadarn (Anthocephalus chinensis),* Hijal *(Barringtonia acutangulata),* Mandar *(Erythrina indica),* Ficus *(Ficus spp),* Tentul *(Tamarindus indiccrs),* Simul (Bombax *ceiba),* Jarul *(Alstonia* scholaris) and Bamboo *(Bambusa* spp.) form an important part of village growing stock.

The commonly grown vegetables are Aroid *(Calocacia indica),* Egg Plant *(Solanum melongena),* Okra *(Hibiscus esculentus),* Bitter Gourd *(Momordica* charantia), Snake Gourd *(Trichosanthes angcrina)* and different varieties of beans Among cereal crops, pulses like Lentil (Lens esculenta), Cow Pea *(Vigna sinensis),* Black Gram *(Phaseolus mungo),* Oil Seeds, Groundnuts and Castor beans are common. Farmers also rear a variety of animals in their homegardens such as cows, goats, buffaloes, sheep and poultry (Haruni, 1999; FMP, 1993a).

2.6 Species frequency of homestead forests

Frequency, as introduced by Raunkiaer (1934), indicates the number of sampling units in which a given species occurs (Mishra, 1968). Frequency of mangrove vegetation refers to the degree of dispersion of individual species in an area and is usually expressed in terms of percentage of occurrence. The contribution made by each species in a home garden can be expressed as a percentage of the total number of species, which is called frequency. Since frequency often reflects the patterns of distribution of individuals as well as their density. It

also expresses information about both patterns and abundance. Species and individuals can be grouped into growth form classes on the basis of their similarities in structure and growth, which displays an obvious relationship to important environmental factors.

Frequency and relative frequency of species in the study area are measured by using the formulae of Curtis and McIntosh (1950), Shukla and Chadale (2000) and Kabir and Webb (2008) which are given below.

$$Frequency = \frac{Total\ no.of\ the\ sample\ in\ which\ the\ species\ occurs}{Total\ no.the\ sample\ studied} x\ 100$$

$$Relative\ Frequency = \frac{No.of\ occurrance\ in\ particular\ species}{Total\ no.occurrances\ of\ all\ species} x\ 100$$

The values of relative frequency are calibrated on a 10-point scale to assign a status to the species in each region. Four distinct groups are derived from this 10-point scale and each group in each region is designated as follows:

7 – 10	Very Frequent
5 – 7	Frequent
3 – 5	Less Frequent
< 3	Rare

2.7 Importance and scope of homestead forests

Homestead forests supply about 80 percent of the fuel wood of the country. The homestead forest woodlot plays an important role in meeting the needs of traditional fuel resources. Within the social context of Bangladesh, the homestead is defined as an area physically occupied by one or more households for habitation. Functional usages of homestead land area are for housing, cooking space, water sources, latrine, post harvest processing of crops, animal sheds, planting areas for trees, herbs, shrubs and vegetables and limited grazing space. On homesteads, people share a number of facilities along with traditional fuel from tree resources (Islam, 1988).

The combination of different cultivated plant allows permanent production throughout the year. The flow of small quantities of various products helps the farmers in maintaining economic and nutritional stability. Village homestead forest resources are very important in

the socioeconomic of many countries in the south Asian countries. In Bangladesh, homestead forest occupy about 0.27 million ha. It is believed that as much as 80% supply of the forest products come from this source, though it covers only 2% of total forest area. Homestead forest or forest grove's are mostly on privately owned lands covered with trees and bamboo corps of varying quality and density. The traditional Bangladeshi homesteads are arranged in multistoried fashion and biodiversity is so rich that they are more efficient than rich tropical rain forests in terms of their production, protection amenity and values (Millat-e-Mustafa *et al.*, 1996).

Tree species, are the important components of the homestead forestry resources of Bangladesh. They play a vital role to satisfy the local needs and demands. The homestead forest is also keeping the balance of ecosystem. Tree species diversity plays an inevitable role in the conservation of species and also of the current environmental issue of Bangladesh, as well as other tropical countries. Homestead forestry resources can alloy this distortion substantially as the homesteads are supplying about 70% of timber, 90% of fuel wood, 48% of sawn and veneer logs and almost 90% of bamboos required by the nation (FAO, 1982).

In Bangladesh, homestead agroforestry plays a vital in providing fuel wood, fodder, fruit and timber. It is estimated that about 61-70% of saw logs and 90% of fuel wood and bamboos come from homestead forests. Most of the native fruits, country vegetable, fuel wood and timber come from homestead home yard and marginal lands attached to or nearby homesteads. Through homestead agroforestry the production of various types of fruits, vegetables, spices, fodder, forage, fuel wood and timber can be increased considerably (Haque, 1994).

2.8 The key benefits of homestead forests

2.8.1 Social benefits

Reviews of studies from various countries reveal that the degree and combination socio-cultural impacts on societies engaged in home gardening vary across the board. Multiple social benefits of home gardens include enhancing food and nutritional security in many socio-economic and political situations, improving family health and human capacity, empowering women, promoting social justice and equity, and preserving indigenous knowledge and culture. The most fundamental social benefit of home gardens stems from their direct contributions to household food security by increasing availability, accessibility,

and utilization of food products. Home gardens are maintained for easy access to fresh plant and animal food sources in both rural and urban locales. Food items from home gardens add substantially to the family energy and nutritive requirements on a continuous basis (Mitchell and Hanstad, 2004).

2.8.2 Economic benefits

The economic benefits of home gardens go beyond food and nutritional security and subsistence, especially for resource-poor families. Bibliographic evidence suggests that home gardens contribute to income generation, improved livelihoods, and household economic welfare as well as promoting entrepreneurship and rural development (Calvet-Mir *et al.*, 2012).

Home gardens are widely promoted in many countries as a mechanism to avert poverty and as a source of income for subsistence families in developing countries. Although home gardens are viewed as subsistence-low production systems, they can be structured to be more efficient commercial enterprises by growing high-value crops and animal husbandry (Ranasinghe, 2009).

2.8.3 Environmental benefits

Home gardens provide multiple environmental and ecological benefits. They serve as the primary unit that initiates and utilizes ecologically friendly approaches for food production while conserving biodiversity and natural resources. Home gardens are usually diverse and contain a rich composition of plant and animal species. Hence they make interesting cases for ethno-botanical studies (Blanckaert *et al.*, 2004).

Gardens are complex and may resemble ecological agricultural production systems that sponsor biodiversity conservation. The rich diversity and composition of species and the dense distribution of faunal and floral strata denote extraordinary features of home garden ecology (Fernandes and Nair, 1986).

2.9 Prospects and potentials of homestead forests

There is a great opportunity and prospect for improvement of the existing traditionally managed homegardens. Majority of the homegardens were found under-utilized with limited fruit trees and vegetables. No scientific management practices have been

identified to improve the homegarden productivity. In the homegardens may fulfil the basic requirement of fuel, food or fruit, timber and fodder for the farmers. It can serve as source of cash income. Similarity, planting of quick growing nitrogen fixing tree species like Babla (*Acacia nilotica*), Sissoo *(Dalbergia* sissoo) etc. will help the farmers to overcome the fuelwood and timber crisis and maintain the fertility and productivity of the homegarden. Proper management practices may enhance total dry matter, flower and fruit production. Simultaneously, branches, twigs leaves, etc. as by-products of management practice can help minimizing fuel crisis to some extent. Introduction of intensive mixed farming (trees, crops, livestock and fish) may be a useful tool to meet the agricultural and other needs (Miah *et al.,* 1990). Two primary areas of improvement are brought to have the greatest potential (a) introduction of new or improved trees or crops species and (b) intensified cropping pattern (MacDicken, 1990a).

Substantial work has already been conducted and documented on the floristic, structure, and functions of homegardens around the world. There is a great potential for biodiversity conservation.

- Homegardens are islands of high levels species diversity and may have species different from those found in neighboring natural systems (Kabir and Webb, 2008a).
- Homegardens are living gene banks where landraces, obsolete cultivars, rare species, and endangered species are preserved (Vogl *et al.,* 2002).
- Most researchers indicate that homegardens may mimic the composition and structure of natural forests. Species diversity in traditional homegardens is comparable with adjacent forest formations (Kabir and Webb, 2008a).
- Tropical homegardens with their large crop species and varietal diversity are regarded as an ideal production system for *in situ* conservation of plant genetic resources (Blanckaert *et al.,* 2004).
- Other researchers mentioned that homegarden represents an important repository of genetic diversity of the last traces of the original lowland forest species and some of its supported wildlife (Kumar *et al.,* 1994; Michon and Mary, 1994).

2.10 Homegardens or homestead forests of Bangladesh

Homegarden (small lands averaged of 0.16 ha in area) in Bangladesh normally built on a raised land to avoid flood water during the monsoon. Each homestead normally consists of a dwelling house and the homegarden. Diverse indigenous and introduced plants in multiple structures are deliberately growing in the homegarden.

- Das, (1990) documented that Bangladesh home gardens have a total of 149 species of trees. About 444 million mature and about 611 million immature culms of bamboo, and about 198 million trees with 0.54 million m^3 standing volume, 469 million mature and immature palms, and about 4.6 million clumps of canes are in Bangladesh home gardens (FMP, 1992).
- From the physical and socio economic points of view, homegardens are more reliable than crops fields for growing trees and vegetables and are important sources of subsistence income for the farmers of Bangladesh.
- Homegardens are very important suppliers of forest products which contribute about 80–82% of all forest products in Bangladesh. About 85– 90% fuel wood, 80% round wood, 65–75% saw logs, and 73% bamboo come from homegardens (Leuschner and Khaleque, 1987; FMP, 1992; Khan, 2001).

Thus, during the last 40 years the relative importance has shifted from the traditional forestry to home gardens (Kabir and Webb, 2008b).

Homegardens reduce pressure on forestlands as the trees growing in homesteads ensure easy access to fuelwood, fodder and other products, thus which are otherwise heavily burdened by these demands. Even functionally landless farmers have their own homegardens, where they grow the essential commodities for subsistence. Woody vegetation at homesteads has a positive effect on the improvement in soil moisture through shading and mulching.

Homegardens are planted with diverse mixture of species depending on how they fit into homegardeners farm-family strategies (Bannister and Nair, 2003).

- A recent trend of planting multipurpose plants in the homegarden is common among the farmers rather only for fuelwood and timber in Bangladesh (Kabir and Webb, 2009).

- The planting of trees in household is heterogeneous depending on local demand, availability of space and planting materials, and duration of flood near the households. It is also determined by the prevailing macro and micro environment at the household.
- The changing ecological factors combined with economic conditions influence local people to replace some of the earlier species with new ones (Millat-e-Mustafa *et al.*, 2002; Salam *et al.*, 2000; Ahmed and Rahman, 2004).

Therefore, interpretation of farmer's tree planting decision is complex.

Several studies have already been conducted on homegardens in various corner of the country (see Kabir, 2007). However, most of those studies explored basically the floristic and structure of the home gardens. Investigation on homegarden management practices (but Millat-e-Mustafa *et al.*, 2000; Kabir and Webb, 2008) and relation between garden and household characters forming model equation (but Salam *et al.*, 2000; Kabir and Webb, 2008; Kumari *et al,* 2009) is largely overlooked by the homegarden researchers. Homegardens are said to be the important repositories of biodiversity. No studies except Kabir and Webb, 2008 have been conducted investigating the potential of homegardens in biodiversity conservation in Bangladesh, where natural forests have lost their potential to meet basic needs for forest resources.

CHAPTER THREE- MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter includes detail methods and materials used to conduct this study. The study was conducted in Gangni upazila of Meherpur district of Bangladesh for three month from July to September 2014. An exploratory inventory was conducted continuously for exploring the structure, species composition and utilization of homestead forests products.

3.2 Study Area Profile

3.2.1 Area and Location: Gangni Upazila (sub-district) is located in Meherpur District of southwestern part of Bangladesh. The upazila occupies an area of 363.95 sq. km. This upazila is bounded on the north by Daulatpur upazila of Kushtia Zila and on the east by Mirpur upazila of Kushtia Zila and Alamdanga upazila of Chuadanga Zila, on the south by Meherpur Sadar upazila and on the west by India. This upazila has a population of 299607 and 77580 units of household. It has 9 Unions, 1 Pourasava, 90 Mauzas, 29 Mahallas, and 137 villages and 5 borders out post (Source: Banglapedia, LGED and BBS, 2011).

3.2.2 Latitude and Longitude: It is located between 23°44' and 23°52' north latitudes and between 88°34' and 88°47' east longitudes (LGED and BBS, 2011).

3.2.3 Soil and Water Condition: The soil mainly calcareous brown flood pain and composed of alluvium and sandy clay with a good percentage of potash and phosphate. This area contains fresh water and the soil is free from salinity (LGED and BBS, 2011).

3.2.4 Climatic condition: Annual average maximum temperature of this upazila is 37.1°C and lowest 11.2°C. Annual average rainfall is 1467 mm (Banglapedia).

3.2.5 Topography: The land area is totally cultivated, not much natural vegetation is left. The landscape is mostly covered with mosaic croplands/vegetation. There are fallow land, crop fields, ponds, ditches and beels in the study area (Banglapedia, LGED and BBS, 2011).

3.2.6 Common Agricultural practices:

Main Crops- Paddy, jute, sugarcane, tobacco, chilli, kachu, sweet potato, ground nut. Extinct or nearly extinct crops are indigo, arahar, aus paddy, mustard seed, khesari.

Main Fruits: Mango, banana, litchi, jackfruit, coconut, guava and palm (Source: Banglapedia, LGED and BBS, 2011).

3. 3 Research Methods/ Sampling Design

The study was conducted in Gangni upazilla of Meherpur district from southwestern part of Bangladesh. A multistage random sampling method was applied to locate the village and households for data collection with upazila as primary sampling unit and households of the villages as ultimate sampling unit. From three upazillas of Meherpur district, Gangni upazilla was selected purposively as study area. Out of nine unions in Gangni upazila, six unions were selected randomly. Two villages from each union and five homestead forests from each village were selected randomly. Finally, total sixty homestead forests were selected for study.

Table-3.1: Name of the all sampling units and no. of total homestead forests in the study area.

Upazila	Unions	Villages	No. of homestead forests
Gangni	Bamundi	Badiapara	5
		Chhatian	5
	Shaharbati	Dharmachaki	5
		Shaharbati	5
	Raypur	Ekuri	5
		Gopalnagar	5
	Sholotaka	Baniapukur	5
		Sholotaka	5
	Tentulbaria	Karomdi	5
		Tentulbaria	5
	Dhankhola	Kashba	5
		Shanghat	5
Total	**6**	**12**	**60**

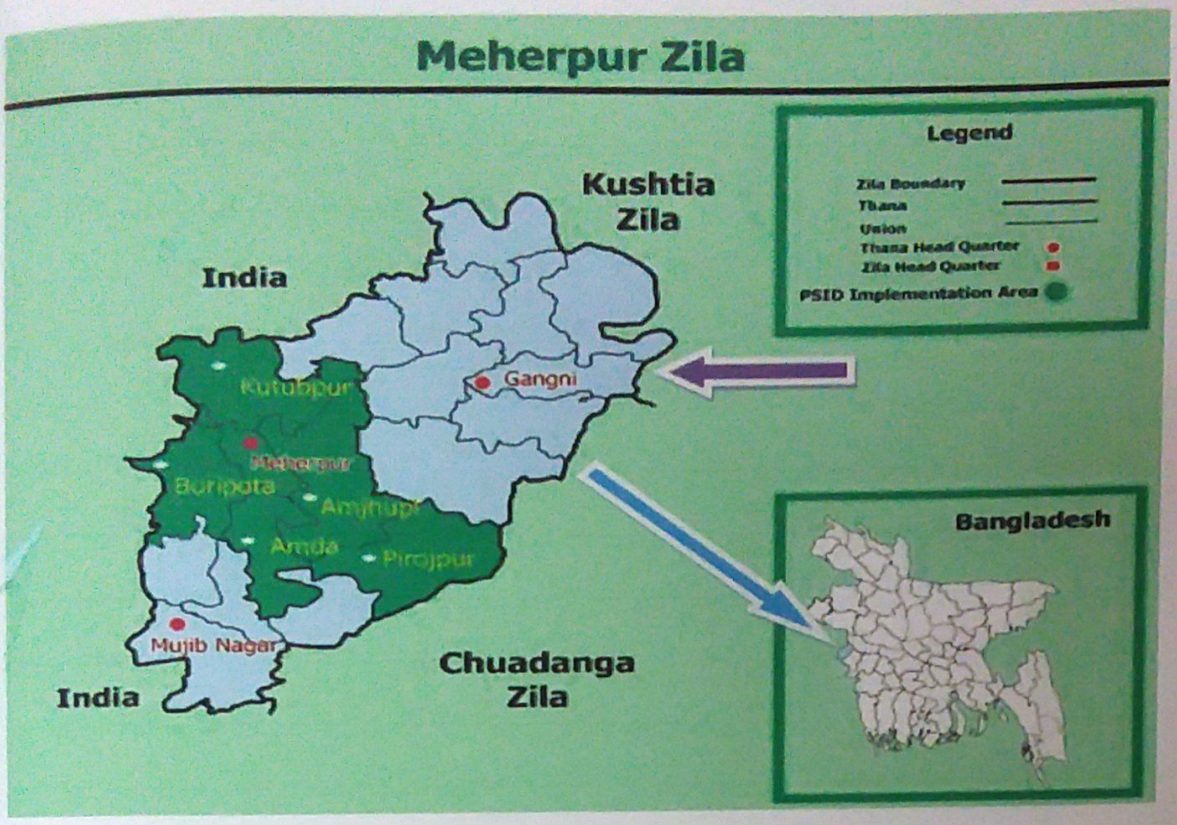

Fig- 3.1: Location and relative position of the study area (Arrow signs indicate study area)

Source: LGED, Meherpur, Home

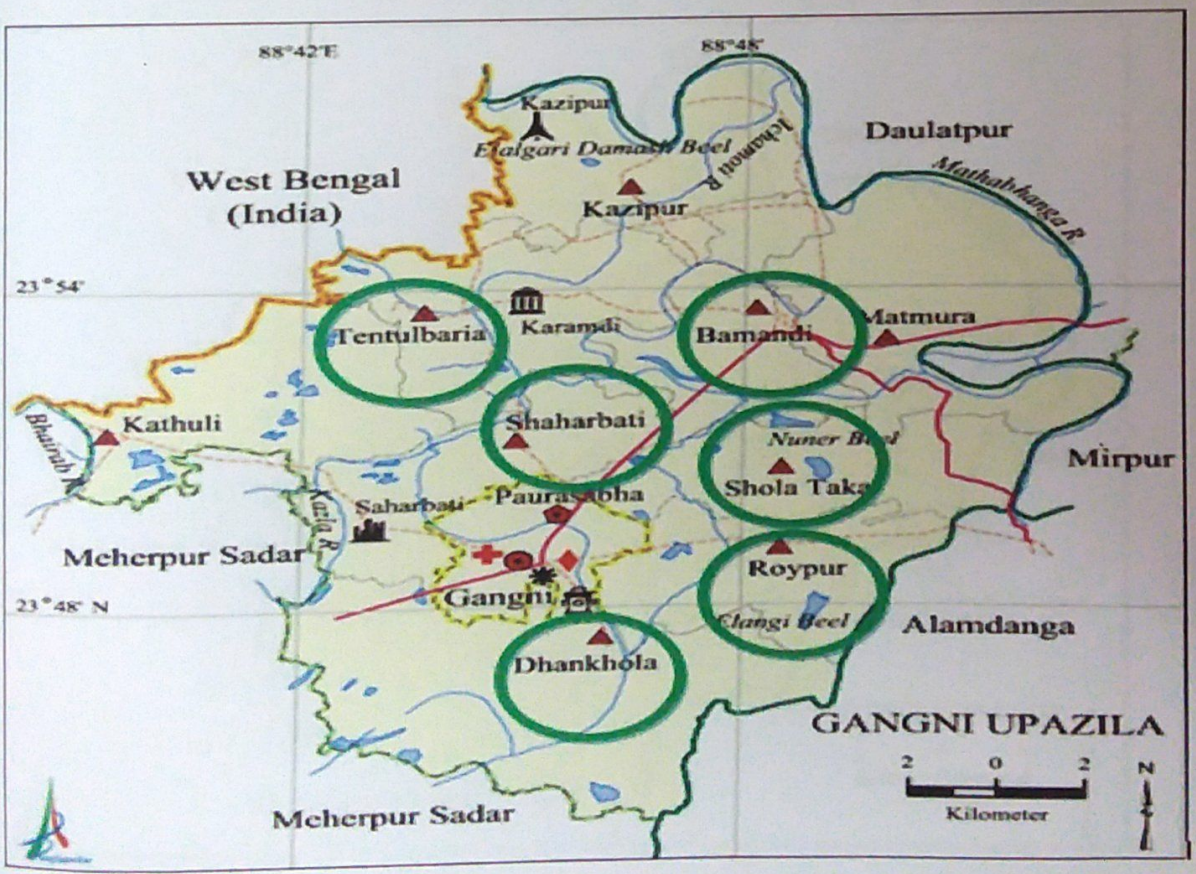

Fig- 3.2: The map shows the study area (Circle signs indicate Union of the study area)

Source: LGED; Banglapedia

3. 4 Data collection process

In order to fulfill the objectives set out for this study, relevant information and literature were collected from the two following sources:

3.4.1 Primary data collection

This process was done by two ways.

a. Inventory Part:

A botanical inventory was conducted in each homestead forest by using a "Homestead Forest Inventory Form" (Appendix-1).

For horizontal structure, homestead forest was assessed in terms of species locations within it. Species locations within the homestead were assessed in relation to distance from the living quarters. Species locations in the homestead forests were considered with respect to major locations. On the basis of planting locations the homestead forest species were divided into three categories such as only the border, the interior part only and both border and interior parts (Muhammad Abul Foysal *et al.*, 2013 and Alam *et al.*, 1997). Every individual trees and shrubs were counted, except those in hedgerows, due to the difficulty in differentiating stems. Individuals of herbs were not counted due to difficulty in differentiating stems (Kabir and Webb, 2008).

For vertical structure, homestead forest was summarized by stratifying the individual plant species into 4 strata on the basis of specific height classes. These stratums were the ground layer (up to 2m), understory (above 2m to 5m), middle canopy (above 5m to 15m) and top layer or Overstory (above 15m) (Kabir and Webb, 2008; Muhammad Abul Foysal *et al.*, 2013). The individual of plant species up to 1 meter tall, a scaled measuring pole and more than 1 meter tall, a SUUNTO clinometers and Haga altimeter were used to measure of height classes (Kabir and Webb, 2008; Muhammad Abul Foysal *et al.*, 2013).

For plant species composition (Trees, shrubs and herbs) all plant species in each homestead forest were identified and recorded (species name, no. of species and plant category based on the main used) by local name and on the basis of their maturity, domesticity (planted or naturally grown in the site) origin (native to Indian subcontinent vs. exotic) according to Kabir and Webb, 2008; Alam and Masum, 2005; Bishwajit Roy *et al.*, 2013.

Frequency and relative frequency of species in the study area are measured by using the formulae of Curtis and McIntosh (1950), Shukla and Chadale (2000) and Kabir and Webb (2008) which are given below.

$$Frequency = \frac{Total\ no.of\ the\ sample\ in\ which\ the\ species\ occurs}{Total\ no.the\ sample\ studied} x\ 100$$

$$Relative\ Frequency = \frac{No.of\ occurrance\ in\ particular\ species}{Total\ no.occurrances\ of\ all\ species} x\ 100$$

b. Questionnaire survey:

A semi structured questionnaire survey and field observation were conducted on 60 homesteads for utilization and importance of homestead forests. The necessary data and information were collected through reconnaissance survey. The survey was conducted on the variety of demographic and socioeconomic indicators of the respondents such as name, sex, occupation, educational status, family income, size of homesteads (ha) according to Alam and Masum (2005), choice of species, use of tree species, attitudes towards homestead forests, problems of homestead forests etc. (Appendix-2).

3.4.2 Secondary data collection

The secondary sources of information of the study were collected from the following sources:

- Khulna University Central Library.
- Seminar Library, Forestry and Wood Technology Discipline, Khulna University.
- Published and Unpublished Reports, Research Papers Articles, National Newspapers and Journals, Books of Government and other Organizations.
- Upazilla Offices, Different NGOs' Office, Forest Department and Regional Center, BBS, Meherpur.
- Internet Browsing.

3.5 Data processing and analysis

The collected literature and information were vigilantly reviewed and sorted according to the sequence and requirements. Each recorded species in the homestead forests was classified by family, habit (tree, shrub and herb), domesticity (planted vs. naturally established), origin (native to the Indian Subcontinent vs. exotic or introduced), and stratum: ground layer (up to 2m), understory (above 2m to 5m), middle canopy (above 5m to 15m) and top layer or Over

story (above 15m) and use by local people (Kabir and Webb, 2008; Muhammad Abul Foysal *et al.*, 2013).

Frequency (the fraction of homestead forests containing the species) for each species of tree, shrub and herb (except those planted in hedgerows) were computed. Relative frequency of plant species was used to rank species (Curtis and McIntosh, 1950; Shukla and Chadale, 2000; Kabir and Webb, 2008).

The unwanted part of the collected information and data were discarded from the final paper to avoid the bulky size of the paper. In course of compilation I took sincere advice from my supervisor time to time. After sorting information, data were complied sequentially and systematically. Then collected data was analyzed in percentages for easy explanation with graphs. MS Excel was used to process and analyze the collected data.

3.6 Report writing and Submission

After successful completion of primary data analysis and arrangement all primary and secondary information, then a draft final report was prepared and it was finalized after some necessary correction.

3.7 Limitation of the study

There were several limitations occurred to conduct this survey. As Bangladesh is developing countries, households do not keep any records of income, cost, production and benefits from homestead forests in year basis. Some problems were following-

- Survey was costly and time consuming.
- Sometime respondents were confused to give their information.
- Many data were collected on the basis of assumptions of the farmers and my own observation due to scarcity of absolute data.

CHAPTER FOUR- RESULTS AND DISCUSSIONS

4.1 Introduction

Homestead forests are clusters of trees around homesteads (Rahman *et al.*, 2005). The findings of this study also confirmed that homestead forest in Gangni upazila of Meherpur district was truly rich in plant species composition. It became illuminated too that homestead forests of the study sites represented an intensive delicate structure of multi-layered species.

4.2 Distribution and Size of homestead forests

The size of the homestead forests varied from home to home. It was within the ranges of 0.03 to 0.4 ha with an average of 0.12 ha. The total surveyed area was 7.05 ha from a total of 60 homesteads. The largest area of homestead forests (1.57 ha) was surveyed in Sholotaka Union and the lowest area of homestead forests (0.67 ha) was surveyed in Bamundi Union. The average area of homestead forests per Union was 1.17 ha (Table-4.1). Comparison with the other studies, the average size of the homestead in the study area was smaller than those found in other areas of Bangladesh by Alam and Masum (2005), Muhammad Abul Fotsal et al. (2013) showed in Sandwip Upazila (0.206 ha), in Fatickchari Upazila (0.19 ha) of Chittagong district respectively. The average size of the homesteads was also higher than those found by Motiur et al. (2006), Sourovi Zaman (undated) and Kabir and Webb (2008) in Southwest Bangladesh (average of 0.10 ha), Dinajpur district (0.06 ha) and Southwestern Bangladesh (0.11 ha) respectively. The size of the homesteads was varied from 0.043 ha to 0.435 ha, 0.05 ha to 0.41 ha, 0.02 to 0.48 ha and 0.05 to 0.25 ha according to Alam and Masum (2005), Muhammad Abul Fotsal et al. (2013), Sourovi Zaman (undated) and Bishwajit Roy et al. (2013) respectively.

Table-4.1: Number and area of the homestead forests

Union	HF No.	Total HF area (ha)	Average HF area (ha)
Bamundi	10	0.67	0.07
Shaharbati	10	1.23	0.12
Raypur	10	1.08	0.11
Sholotaka	10	1.57	0.16
Tetulbaria	10	1.46	0.15
Dhankhola	10	1.03	0.10
Mean	**10**	**1.17**	**0.12**
Total	**60**	**7.05**	

The size of the homestead forests area was considered into three categories according to Alam and Masum (2005). These were small size (up to 0.05 ha), medium size (above 0.05 ha to 0.25 ha) and large size (more than 0.25 ha) of homesteads. In the surveyed area, 60% of the total homesteads were medium size, 30% were small and only 10% were large size of size of homestead forests. To determine the farm size only land surrounding the homestead was counted i.e. house, yard (back and front) and pond. The percentage of the homestead forests on the basis of the size of the area has been shown in the figure-4.1.

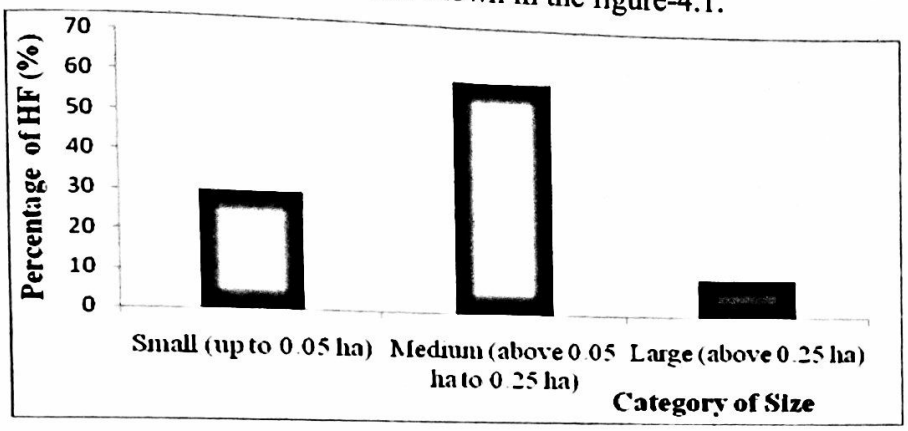

Fig. 4.1: The percentage of homestead forests according to categories of size

4.3 Structure of homestead forests

The structure of home garden vegetation can be defined by two components: (i) the horizontal arrangement of species, i.e. the spatial distribution of individuals; and (ii) The vertical arrangement of species i.e. the stratification of vegetation (Kabir and Webb, 2008; Muhammad Abul Foysal *et al.*, 2013).

4.3.1 Horizontal structure of homestead forests

A total of 4168 tree and shrub individuals were identified and recorded from the study area. Each homestead forest was contained the average of 70 individual trees and shrubs species which were represented by 61 trees and 9 shrubs. Among the total number of individual trees and shrubs 87.72% trees and the rest 12.28% were shrub species (Table-4.2). Every individual of trees and shrubs were counted. In case of herbs only species were recorded. Comparison to the other study, it was found that in the study area, the percentages individual of trees are lower and shrubs are higher than that found by Kabir and Webb, (2008) in Southwest Bangladesh (93% were tree and only 7% were shrub individuals).

Table-4.2: Number of individual trees and shrubs in the sample HF.

Form	Total no. of Individuals	Average no. of Individuals	% of individuals
Tree	3656	60.93	87.72
Shrub	512	8.53	12.28
Total	**4168**	**69.47**	**100**

On the basis of planting locations, plant species were divided into three categories such as only in border, only in interior and both border and interior. From the surveyed area, out of all species most of the respondents planted in both the border and interior parts of their homesteads. These were included many medium and small crown timber and fruit species; i.e. Mango, Jackfruit, Betel nut, Ata, Neem etc. About 68.33% homesteads were planted species both in the border and interior parts, 20% species were planted border only i.e. Coconut, Betel nut, Mehagoni, Sissoo, Jam etc. and only 11.67% were interior part only. Lemons, Papaya, Guava, and Boroi were planted in the interior part of the homestead forests (Table-4.3). The most frequently plants were generally grown in the back yard, at the pond side and around the house. Food and fruit producing species were the dominant part of the homestead forest near the living quarters. Comparison to the other study, it was found that in the study area, most of the respondents planted plant species in both the border and interior parts of their homesteads but Alam *et al.*, (1997); Muhammad Abul Foysal *et al.*, (2013) were showed in Sandwip Upazila, and Fatickchari Upazila of Chittagong only interior part in their studies respectively.

Table-4.3: Plant species location in homestead forests

Category of the species location	No. of HF	Percentage (%)
Species in border only	12	20
Species in interior only	7	11.67
Species in both border and interior	41	68.33
Total	**60**	**100.00**

4.3.2 Comparison of individual trees and shrubs species per union and homestead

In the study area, it was found that the average number of individual trees and shrubs were about 695 per Union (10 homesteads) and it was ranging from 456–954 individuals. The average no. of individual trees was 609 and individual shrubs were 85. Each homestead forest was contained the average of 70 individual trees and shrubs species which were represented by 61 trees and 9 shrubs (Table-4.4). The number of individual trees and shrubs can be increased if inventory included the individuals from hedgerows (Kabir and Webb, 2008).

Table-4.4: Number of individual trees and shrubs per union and homestead.

Union Name	Total no. of individual Trees	No. of individual tree per homestead	Total no. of individual Shrubs	No. of individual shrub per homestead	Total individuals (Both Tree & Shrub)	No. of individual tree & shrub per homestead
Bamundi	390	39	66	6.6	456	45.6
Shaharbati	799	79.9	81	8.1	880	88
Raypur	434	43.4	52	5.2	486	48.6
Sholotaka	853	85.3	101	10.1	954	95.4
Tetulbaria	678	67.8	125	12.5	803	80.3
Dhankhola	502	50.2	87	8.7	589	58.9
Average	**609.33**	**60.93**	**85.33**	**8.53**	**694.67**	**69.47**
Total	**3656**		**512**		**4168**	

4.3.3 Vertical structure of homestead forests

The homestead forests in the study area demonstrated complex structure with a generally multilayered canopy configuration. There were convenient and relatively feasible to distinguished four vertical strata. Canopy was stratified into four strata on the basis of specific height classes. In the study area, the *top layer or over-storey* (above 15m) was consisted of different mature and dominant fruit and timber trees such as Coconut, Mehagoni, Sissoo, Koroi, Betel nut, Date palm, Palmyra palm, Neem, Blackberry, Bamboo etc. Some sapling of fruit trees and timber species such as Mango, Jackfruit, Lemons, Indian plum, Wood apple, Bullock's heart, Kat badam etc. were occupied *middle canopy* from above 5m to 15m. *Under-storey* (above 2m to 5m) were consisted of Guava, Banana, Golden apple,

Lemon, Litchi, Papaya, Pomegranate and some flowering species. A mixture of shrubs and climbers were predominated in the under storey. The *ground layer* (up to 2m) most of the species were herbaceous perennial plants, vegetables and medicinal plants like lady's finger, Elephant foot aroid, Eggplant, Ginger, Turmeric etc. (Table-4.5). This stratum receives little direct sunlight than other stratums. The result was shown that the homestead forests with many life forms were varying from ground to top strata and also created the forest like multistoried canopy structure of homestead forests. The vertical structure of homestead forests was similar to the other studies were reported from different regions of Bangladesh (Millat-e-Mustafa *et al.*, 1996; Ali, 2005). This study was done to simplify the organization of complex vegetation types on the basis of specific height classes.

Table-4.5: Vertical structure of homestead forests

Stratum	Height	Category of the species	Name of the species
Ground	Up to 2m	Vegetables, medicinal, tubers etc.	Giant taro, Lady's finger, Elephant foot aroid, Egg plant, Turmeric etc.
Under-storey	Above 2m to 5m	Food plants, saplings of fruits, some shrubs	Guava, Papaya, Banana, Lemons, Indian plum, Golden apple, Pomegranate etc.
Middle canopy	Above 5m to 15m	Small and Medium size Fruit/timber trees	Mango, Jackfruit, Wood apple, Bullock's heart etc.
Top/Over -storey	Above 15m	Large size Fruit and timber trees	Coconut, Betel nut, Palmyra palm, Date palm, Mehagoni, Neem, Blackberry etc.

4.4 Plant species composition of homestead forests

The total number of 73 plant species under 39 families was recorded from the set of 60 homestead forests (Appendix-3). Among the 73 species, 42 (57.53%) were trees, 13 (17.81%) were shrubs and 18 (24.66%) were herbs. Trees and herbs species were predominated in the study area, accounting for about 82% of all the identified species (Table-4.6). About 93% (68) of all species were planted and 52% (38) of species were native to the Indian sub-continent (Table-4.6). In the study area, most of the respondents prefer fruits and vegetables for their subsistence consumption and sale of any surplus to supplement family income.

Analysis of the existing plant species composition in the study area, the number of plant species was higher than those found in other homesteads of Bangladesh by Bishwajit Roy et al. (2013) found 62 species in Kishoreganj Sadar Upazila, Motiur et al. (2005) found 60 species in Sylhet Sadar; Motiur et al. (2006) found 58 species in Southwest Bangladesh, Abedin and Quddus (1990) found in Tangail (52 species), Ishurdi (34 species), Jessore (28 species), Patuakhali (20 species), Rajshahi (28 species) and Rangpur (21 species) districts respectively. The existing plant species composition in the study area was lower than those found in other homesteads of Bangladesh by Kabir and Webb (2008) recorded a total of 419 plant species from southwestern Bangladesh, Alam and Masum (2005) recorded a total of 142 species, Masum et al. (2008) found 101 species in an offshore island (Sandwip Island) in Chittagong district of Bangladesh respectively and Millat-E-Mustafa (1997) identified 92 perennial plant species in one study conducted in different parts of the country.

Table-4.6: Plant species composition in the sample homestead forests.

	Species	**Domesticity**		**Origin**	
Form	Number	Planted	Natural	Native	Exotic
Tree	42 (57.53%)	40 (95.24%)	2 (4.76%)	25 (59.52%)	17 (40.48%)
Shrub	13 (17.81%)	12 (92.31%)	1 (7.69%)	3 (23.08%)	10 (76.92%)
Herb	18 (24.66%)	16 (88.89%)	2 (11.11%)	10 (55.56%)	8 (44.44%)
Total	**73**	**68 (93%)**	**5 (7%)**	**38 (52%)**	**35 (48%)**

4.5 Family wise species diversity

It was found that the family Leguminosae ranks top of the list and was represented by 7 species. Palmae (4 spp.) and Rutaceae (4 spp.) were the major families available in the sample homesteads. Amaranthaceae, Araceae, Combretaceae, Compositae, Moraceae, Myrtaceae and Oleaceae families were represented by three species. Anacardiaceae, Annonaceae, Malvaceae, Meliaceae, Rosaceae, Rubiaceae, Rubiaceae, Rubiaceae, Solanaceae and Verbenaceae families denoted two species and the rest of the families comprised only one species (Table-4.7).

Table-4.7: Families with the number of species observed in the sample homesteads.

S/N	Family Name	Species No.	S/N	Family Name	Species No.
1	Leguminosae	7	21	Cactaceae	1
2	Palmae	4	22	Caricaceae	1
3	Rutaceae	4	23	Ebenaceae	1
4	Amaranthaceae	3	24	Euphorbiaceae	1
5	Araceae	3	25	Gramineae	1
6	Combretaceae	3	26	Lauraceae	1
7	Compositae	3	27	Liliaceae	1
8	Moraceae	3	28	Lythraceae	1
9	Myrtaceae	3	29	Moringaceae	1
10	Oleaceae	3	30	Musaceae	1
11	Anacardiaceae	2	31	Nyctaginaceae	1
12	Annonaceae	2	32	Oxalidaceae	1
13	Malvaceae	2	33	Punicaeae	1
14	Meliaceae	2	34	Rhamnaceae	1
15	Rosaceae	2	35	Sapindaceae	1
16	Rubiaceae	2	36	Sapotaceae	1
17	Solanaceae	2	37	Sterculiaceae	1
18	Verbenaceae	2	38	Ulmaceae	1
19	Agavaceae	1	39	Zingiberaceae	1
20	Bombacaceae	1			
Total no. of family was 39 and total no. of species was 73					

4.6 Types of plant species and family wise species composition in the sample HF

4.6.1 Types of plant species

In the study area, a total of 73 plant species recorded where the highest types of plant species (47) were found in the large farm category and the lowest types of species (28) were found in the small farm category (See the Fig. 4.2). Mango, Coconut, Mehagoni, Neem, Blackberry, Guava, Lemons, Papaya, Banana were found common in most homesteads. Comparison to the other study, it was found that the highest and lowest types of plant species in the each category of homestead forests were lower than those found in small (71), medium (98) and large (108) by Alam and Masum, (2005) in an offshore island (Sandwip Island) in Chittagong district.

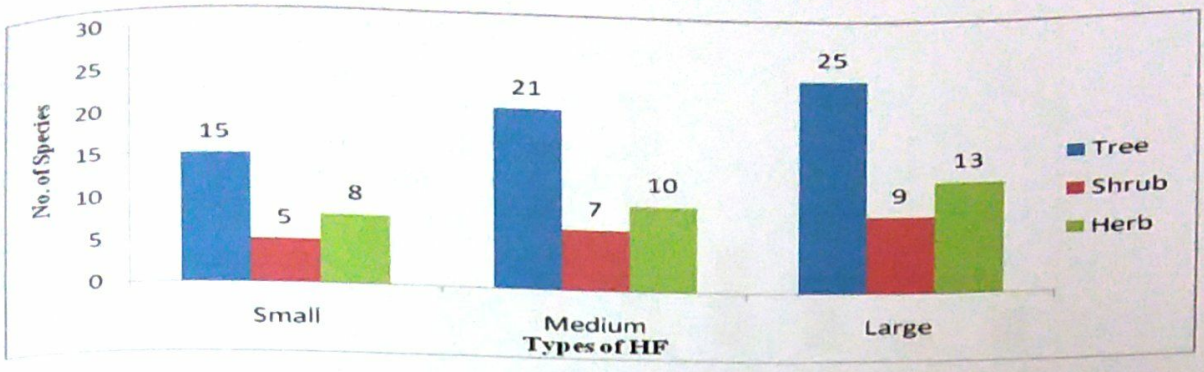

Fig. 4.2: Types of plant species according to size of homestead forest

4.6.2 Family wise species composition

A total of 73 plant species under 39 families were recorded from the set of 60 homestead forests (Table-4.7). Among these families of plant species, only the number of one species was represented by 21 families (54%), two species were represented by 8 families (20%), three species were represented by 7 families (18%), four species were presented by 2 families (5%) and only seven species were represented by one family (3%) in the study area (Table-4.8). We found two studies (Alam and Masum, 2005; Bishwajit Roy et al., 2013) that have been documented total number of family (61 and 36 respectively) of plant species. One was greater and another was less than this study.

Table-4.8: Family wise species composition

No. of Species	No. of Represented Families and (%)
1 species	21 (54%)
2 species	8 (20%)
3 species	7 (18%)
4 species	2 (5%)
7 species	1 (3%)
Total 73 species	**Total 39 families**

4.7 Species frequency of homestead forests

Among the 73 plant species, the ranges between 6-10 species were found in 3.33% homesteads, 11-15 species were 8.33% homesteads, 16-20 species were 26.67% homesteads, 21-25 species were 33.33% homesteads, 26-30 species were 13.33% homesteads and more than 35 species were found in only 8.33% homestead forests in the study area (See the fig. 4.3). So, most of the homestead forests about 60% contained the number of species ranges between 16-30 species.

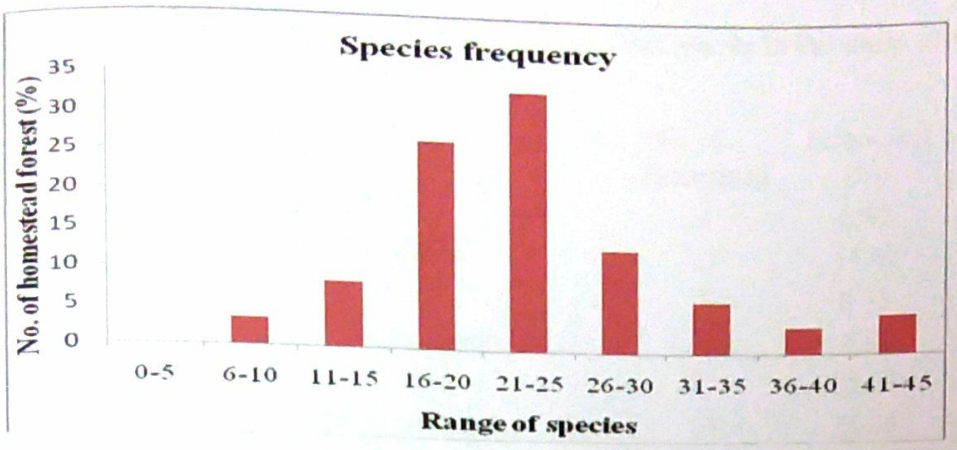

Fig. 4.3: Frequency distribution of species in the homestead forests

4.7.1 Frequency and relative frequency of plants species in the homestead forests

The importance value of different species have discussed on the basis of their respective frequency in the study area (Appendix-3). The study revealed that among tree species of Am (*Mangifera indica),* Narikel (*Cocos nucifera),* Neem (*Azadirachta indica),* Batabi lebu *(Citrus grandis) and* Peara *(Psidium guajava)* were frequently distributed species with Relative Frequencies of 6.41%, 6.03%, 5.78%, 5.65 and 5.15 respectively and Kanthal *(Artocarpus heterophyllus*), Mehagoni (*Swietenia macrophylla*), Jam (*Syzygium cumini*), and Kul (*Ziziphus nummularia*) were dominant species than other trees with the frequencies of 39, 39, 36 and 34 respectively (Table-4.9). Am (*Mangifera indica),* Narikel (*Cocos nucifera)* were the most important fruit species in the study area (Curtis and McIntosh, 1950; Shukla and Chadale, 2000). In terms of shrubs, Kagogee lebu (*Citrus limon*) and Mendi (*Lawsonia inermis*) were the most important species with their frequencies of 38 and 28 respectively. Among the herb species, Mankachu (*Alocasia indica*) and pape (*Carica papaya*) were the most important species with their frequencies of 44 and 39 respectively in the study area (Table-4.9).

Five most important species of trees such as Am (*Mangifera indica),* Narikel (*Cocos nucifera),* Neem (*Azadirachta indica),* Batabi lebu *(Citrus grandis) and* Peara *(Psidium guajava)* were shown relatively similar relative frequency among the other species. *Citrus limon* which was shown substantially higher frequency than other four species among the five most important shrubs in homesteads. In terms of herb, *Alocasia indica* and *Carica papaya* were highly frequent than other three out of the five most important herbs in homestead forests. But among the most important plant species, particularly *Citrus limon* and *Alocasia indica* were dominated shrub and herb species respectively (Table-4.9).

Table-4.9: Frequency (F) and Relative Frequency (RF) of plant species in the study area.

Tree Species

S/N	Common/Local Name	Scientific Name	No. of Homestead	Frequency (%)	Relative Frequency (%)
1	Babla	*Acacia nilotica* Karst.	4	6.67	0.50
2	Bel	*Aegle marmelos* (L.) Correa	31	51.67	3.89
3	Kala Koroy	*Albizia lebbeck* (L.) Benth.	5	8.33	0.63
4	Sada koroy	*Albizia procera* (Roxb.) Benth.	4	6.67	0.50
5	Ata	*Annona reticulata* L.	33	55.00	4.15
6	Kadam	*Anthocephalus chinensis* (Lmk.)	15	25.00	1.88
7	Supari	*Areca catechu* L.	14	23.33	1.76
8	Kanthal	*Artocarpus heterophyllus* Lam.	39	65.00	4.90
9	Kamranga	*Averrhoa carambola* L.	12	20.00	1.51
10	Neem	*Azadirachta indica* A.Juss.	46	76.67	5.78
11	Shimul	*Bombax ceiba* L.	24	40.00	3.02
12	Tal	*Borassus flabellifer* L.	22	36.67	2.76
13	Tejpata	*Cinnamomum tamala*	1	1.67	0.13
14	Batabi Lebu/Badam	*Citrus grandis* (L.) Osbeck	45	75.00	5.65
15	Narikel	*Cocos nucifera* L.	48	80.00	6.03
16	Sissoo	*Dalbergia sissoo* Roxb.	14	23.33	1.76
17	Krishnochura	*Delonix regia* (Boj. *ex* HK.) Raf.	5	8.33	0.63
18	Gab	*Diospyros peregrina* Gurke	3	5.00	0.38
19	Dumur	*Ficus hispida* L.f.	27	45.00	3.39
20	Pakur	*Ficus lacor Buch.-Ham.*	2	3.33	0.25
21	Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	21	35.00	2.64
22	Litchu	*Litchi chinensis* Sonn.	29	48.33	3.64
23	Apel	*Malus domestica*	2	3.33	0.25
24	Am	*Mangifera indica* L.	51	85.00	6.41
25	Bokul	*Mimusops elengi* L.	9	15.00	1.13
26	Sajna	*Moringa oleifera* Lam.	19	31.67	2.39
27	Sheuli	*Nyctanthes arbor-tristis*	16	26.67	2.01
28	Khejur	*Phoenix sylvestris* Roxb.	27	45.00	3.39
29	Debdaru	*Polyalthia longifolia* (Sonn.)	6	10.00	0.75
30	Peara	*Psidium guajava* L.	41	68.33	5.15
31	Dalim	*Punica granatum* L.	15	25.00	1.88
32	Amra	*Spondias pinnata* (L.f.) Kurz	24	40.00	3.02
33	Mehegoni	*Swietenia macrophylla* King	39	65.00	4.90
34	Jam	*Syzygium cumini* (L.) Skeels	36	60.00	4.52
35	Jamrul	*Syzygium samarangense* (Blume)	4	6.67	0.50
36	Tentul	*Tamarindus indica* L.	6	10.00	0.75
37	Segun	*Tectona grandis* L.f.	6	10.00	0.75
38	Arjun	*Terminalia arjuna* Wight & Arn.	2	3.33	0.25
39	Katbadam	*Terminalia catappa* L.	5	8.33	0.63
40	Horitoki	*Terminalia chebula* Retz.	2	3.33	0.25
41	Jibon	*Trema orientalis* (L.) Blume	8	13.33	1.01
42	Boroi/Kul	*Ziziphus nummularia* (Burm.f.)	34	56.67	4.27

Shrub Species

SN	Common/Local Name	Scientific Name	No. of Homestead	Frequency (%)	Relative Frequency (%)
1	Ulotkambal	*Ambroma augusta* (L.) L.f.	13	21.67	6.16
2	Hasnahena	*Cestrum nocturnum* L.	5	8.33	2.37
3	Kagojee Lebu	*Citrus limon* (L.) Burm.f.	38	63.33	18.01
4	Patabahar	*Codiaeum variegatum* (L.) Blume	21	35.00	9.95
5	Gongharaj	*Gardenia jasminoides* Ellis	10	16.67	4.74
6	Joba	*Hibiscus rosa-sinensis* L.	16	26.67	7.58
7	Jui	*Jasminum auriculatum* Vahl	5	8.33	2.37
8	Beli	*Jasminum sambac* (L.) W.A.T.	7	11.67	3.32
9	Kutuskata/Putuskata	*Lantana camara* L.	27	45.00	12.80
10	Mendi	*Lawsonia inermis* L.	28	46.67	13.27
11	Kamini	*Murraya paniculata* (L.) Jack	11	18.33	5.21
12	Golap	*Rosa damascena* Mill.	15	25.00	7.11
13	Begun	*Solanum melongena L.*	15	25.00	7.11
		Herb Species			
1	Deros/ Vendi	*Abelmoschus esculentus* (L.)	13	21.67	3.50
2	Man Kachu	*Alocasia indica* (Lour) Koch	44	73.33	11.86
3	Ghrita Kumari	*Aloe indica* Royle	5	8.33	1.35
4	Lal Shak	*Amaranthus gangeticus* L.	19	31.67	5.12
5	Data Shak	*Amaranthus oleraceus* L.	23	38.33	6.20
6	Ol Kachu	*Amorphophallus* paeoniifolius	25	41.67	6.74
7	Bansh	*Bambusa spp.*	31	51.67	8.36
8	Pape	*Carica papaya* L.	39	65.00	10.51
9	Morogfull	*Celosia argentea* L.	12	20.00	3.23
10	Kachu	*Colocasia esculenta* (L.) Schott	31	51.67	8.36
11	Holud	*Curcuma longa* L.	32	53.33	8.63
12	Dalia	*Dahlia rosea Cav.*	8	13.33	2.16
13	Tarulata	*Mikania cordata (Burm.f.)*	3	5.00	0.81
14	Shondhamaloti	*Mirabilis jalapa* L.	18	30.00	4.85
15	Kola	*Musa spp.*	30	50.00	8.09
16	Fonimonsa	*Opuntia dillenii* Haw.	14	23.33	3.77
17	Rajanigondha	*Polianthes tuberosa* L.	11	18.33	2.96
18	Gada	*Tagetes patula* L.	13	21.67	3.50

4.8 Demographic and socio-economic status of the respondents in the study area

The study was also conducted to find out the demographic and socio-economic status of the respondents such as age distribution, educational status, occupation, household size and family income (Table-4.10).

Table-4.10: Demographic and socio-economic status of the respondents

Age Distribution		
Categories	No. Respondent	Percentage (%)
Young Aged (up to 35)	11	18.33
Middle Aged (36-50)	34	56.67
Old Aged (Above 50)	15	25.00
Total	**60**	**100**
Educational status		
Categories	No. Respondent	Percentage (%)
Primary	26	43.33
Secondary	20	33.33
Higher Secondary	4	6.67
Graduate	5	8.33
Illiterate	5	8.33
Total	**60**	**100.00**
Household size		
Categories	No. Respondent	Percentage (%)
Small (up to 4)	15	25
Medium (5-8)	36	60
Large (above 8)	9	15
Total	**60**	**100**
Main Occupation of the Respondent		
Categories	No. Respondent	Percentage (%)
Agriculture	38	63.33
Business	10	16.67
Service	6	10.00
Others	6	10.00
Total	**60**	**100.00**
Annual Income of the Respondent		
Categories	No. Respondent	Percentage (%)
Below Tk. 75000	23	38.33
Tk. 75000-150000	31	51.67
Tk. Above 150000	6	10.00
Total	**60**	**100.00**

4.9 Respondents attitudes towards homestead forest

The results revealed that majority of the farmers had favorable attitudes towards homestead forest in the study area. Among them about 70% were shown favourable attitude for meeting their necessary of diversified forest products, about 16.67% respondents were shown not favourable because they thought that sometimes tall and disperse fruit and timber trees also created problem with neighbours and prevents direct sunlight to the undergrowth and hampering to the production of vegetables and only about 13.33% were confused (Table-4.11).

Table-4.11: Respondents attitudes towards HF

Categories	No. of Respondents
Favourable	42 (70%)
Not favourable	10 (16.67%)
Confused	8 (13.33%)
Total	**60**

4.10 Utilization of homestead forests

In the study area, the five most important homestead forest plant species were denoted and recorded in each life form according to their uses and relative frequencies.

4.10.1 Uses and Importance of plant species in the study area

Five most important species of trees were showed relatively similar relative frequency among the other species. *Citrus limon* which showed substantially higher frequency than other four species among the five most important shrubs in homesteads. In terms of herb, *Alocasia indica* and *Carica papaya* were highly frequent than other three out of the five most important herbs in homestead forests (Table-4.12).

Among the 15 most important plant species six were native and nine were exotic according to their origin (Kabir and Webb, 2008b). But among the most important plant species, particularly *Citrus limon* and *Alocasia indica* were dominated shrub and herb species respectively (Table-4.12).

Table-4.12: The five most important homestead forest plant species in each life form.

Tree species					
Local Name	**Scientific Name**	**Family**	**Origin**	**Uses**	**RF%**
Am	*Mangifera indica* L.	Anacardiaceae	N	1, 2, 4, 6, 7	6.41
Narikel	*Cocos nucifera* L.	Palmae	N	1, 4	6.03
Neem	*Azadirachta indica* A.Juss.	Meliaceae	N	1, 3, 4, 7	5.78
Batabi Lebu/Badam	*Citrus grandis* (L.) Osbeck	Rutaceae	E	1, 2	5.65
Peara	*Psidium guajava* L.	Myrtaceae	E	1, 2, 4	5.15
Shrub species					
Local Name	**Scientific Name**	**Family**	**Origin**	**Uses**	**RF%**
Kagojee Lebu	*Citrus limon* L.	Rutaceae	E	1, 2	18.01
Mendi	*Lawsonia inermis* L.	Lythraceae	E	2	13.27
Kutuskata/Putuskata	*Lantana camara* L.	Verbenaceae	E	3	12.80
Patabahar	*Codiaeum variegatum* L.	Euphorbiaceae	E	5	9.95
Joba	*Hibiscus rosa-sinensis* L.	Malvaceae	E	3, 5, 9	7.58
Herb Species					
Local Name	**Scientific Name**	**Family**	**Origin**	**Uses**	**RF%**
Man Kachu	*Alocasia indica* (Lour) Koch	Araceae	N	1, 2	11.86
Pape	*Carica papaya* L.	Caricaceae	E	1, 2	10.51
Holud	*Curcuma longa* L.	Zingiberaceae	N	1, 2, 3, 8, 9	8.63
Bansh	*Bambusa spp.*	Gramineae	N	2, 4, 6, 7	8.36
Kachu	*Colocasia esculenta* (L.) Schott	Araceae	E	4, 7	8.36

Native species are denoted with "N" and exotic species with "E". For uses, 1 = food, 2 = commercial (not an end use, used to earn cash from the sale of surplus products after subsistence consumption), 3 = medicinal, 4 = fuel-wood, 5 = ornamental, 6 = timber, 7 = fodder, 8 = fiber, and 9 = religious/ceremonial. RF is relative frequency of the species which represent the relative importance of the species in their respective life form.

4.10.2 Types of benefits derived from homestead forests

Most of the respondents benefited from trees on their homestead forests. Homestead forests act as a 'reserve bank' of food and cash for the respondents. They got fruits/food, timber, cash to fulfill their own needs, fuelwood, fodder for their livestock and fencing and construction materials, while other respondents got shelter or shade requirements for their living house and livestock from homestead forests. From fig. 4.4 shows that most of the farmers 96% got food/fruits from trees for consumption. About 68% got fodder, 60% got fuel wood, 51% got shelter and shade, 45% got timber, 40% got cash return from tree. Only 7%

farmers said, they got seeds, seedlings, construction and fencing materials etc. (See the Fig. 4.4). These percentages can be overlapping because of respondents had multiple response.

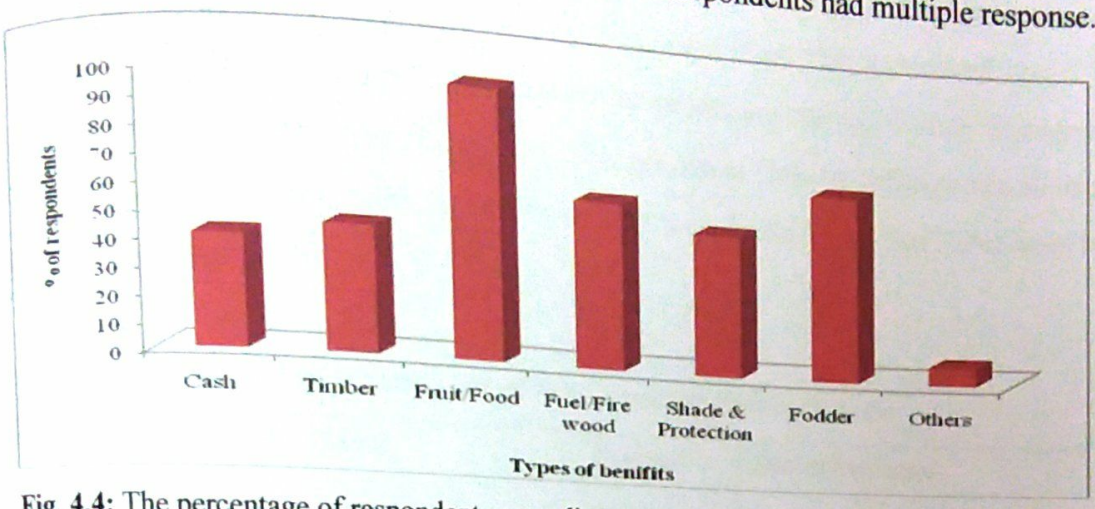

Fig. 4.4: The percentage of respondents according to benefits derived from homestead forests

4.10.3 Major utilizations of tree based products from homestead forests

Majority of the people of southwestern part of Bangladesh largely depend on homestead forests for their needs and own consumption. The owners of the homestead forest preferred fruit and timber species for making a future asset as well as food security. Major utilizations of tree based products were the following-

4.10.3.1 Fruit:

Food preference of the respondent is depended on their income level. When income increased, his /her food preferences also improved. It was observed that food/fruit species were the dominant in the study area and were almost common in every homestead forest. About 96% respondents said that they got benefit of food/fruits from their homestead forests. Uses of five most usable food species were found in the study area have been shown in the following table.

Table-4.13: Primary and secondary uses of five important food species.

Local Name	Scientific Name	Primary uses	Secondary uses
Am	*Mangifera indica* L.	Fruit/Food	Furniture, Fodder, Construction
Narikel	*Cocos nucifera* L.	Fruit/Food	Fuelwood, Construction
Batabi Lebu	*Citrus grandis* (L.)	Fruit/Food	Medicine, Fuelwood
Peara	*Psidium guajava* L.	Fruit/Food	Fuelwood, Fodder
Kanthal	*Artocarpus heterophyllus*	Fruit/Food	Furniture, Fodder, Construction

4.10.3.2 Timber:

People of the study area selected timber species for furniture making and future investment. Among the Respondents, 45% fill up their timber demand from their homestead forest. For these purpose, they planted different types of timber producing species in their homesteads. Timber was needed for furniture made. They also generated cash by selling extra timber in the market. Uses of five most valuable timber species were found in the study area have been shown in the following table.

Table-4.14: Primary and secondary uses of five important timber species.

Local Name	**Scientific Name**	Primary uses	Secondary uses
Mahegoni	*Swietenia macrophylla* King	Timber	Furniture, Construction
Neem	*Azadirachta indica* A.Juss.	Timber	Medicine, Construction
Kanthal	*Artocarpus heterophyllus*	Timber	Furniture, Construction
Jam	*Syzygium cumini* (L.)	Timber	Furniture, Construction
Kadam	*Anthocephalus chinensis*	Timber	Furniture, Boxes

4.10.3.3 Fuel and Fire Wood:

Generally, the people of the study area did not plantation any species only for the purpose of using it as fuel. Most of the fuelwood species are used as other purpose with fuel. About (60%) respondents said that when they collected fuel from their homestead forests. Sometimes they used fallen dry leaves for fuel and also sold the extra fuel wood and leaves for cash generation. Ipil-ipil (*Leucaena leucacehala*), Kadam (*Anthocephalus chinensis*), Sissoo (Dalbergia sissoo), Mehagoni (*Swietenia macrophylla*) etc. were the most usable fuel species in the study area.

4.10.3.4 Fodder:

Trees of several species having palatable and nutritious fodder were used as fodder bank during scarcity periods. Several species such as Kanthal *(Artocarpus heterophyllus*), Ipil-ipil (*Leucaena leucacehala*), Am (*Mangifera indica)*, Peara *(Psidium guajava) etc.* were provided better quality of fodder. Among the respondents about 68% said, they got fodder from homestead forests. The respondents met up their fodder demand by planting different fodder

species in their homesteads. They got some others benefits from homestead forests such as pole, fencing and construction materials etc.

4.10.3.5 Cash generation:

Most of the respondents (40%) of the study area increased their income through generating cash from the homestead forest. They spent cash for buying food, for housing, children education, medical cost and others purposes. Cash was generally earned by selling timber, fruit, fuel wood, vegetables etc.

4.11 Problems and constraints of tree growing in the homesteads

The respondents of the study area were faced various types of problem during practice of homestead forests. Various constraints like physical, technical and socioeconomic were identified in case of tree growing in the homestead by the farmers. Lack of technical knowledge was the most common constraint of tree growing which was reported by 65% of the household. Lack of good seedlings (58%) and problems of livestock rearing (55%) were reported to be the other constraints. Other major constraints of planting new trees on households were restricted sunshine and air (32%), Unavailability of space (30%), conflicts with neighbours (25%), other problems (20%) (Table-4.15).

Table-4.15: Constraints of planting new trees on the homesteads in the study area.

Constraints	No. respondents and (%)
Lack of good seed/seedlings	35 (58.33%)
Lack of technical knowledge	39 (65%)
Unavailability of space	18 (30%)
Problem of livestock	33 (55%)
Prevents sunlight and air	19 (31.67%)
Conflicts with neighbours	15 (25%)
Others	12 (20%)

Fig.4.5: Some pictures of field survey in the study area (1-6)

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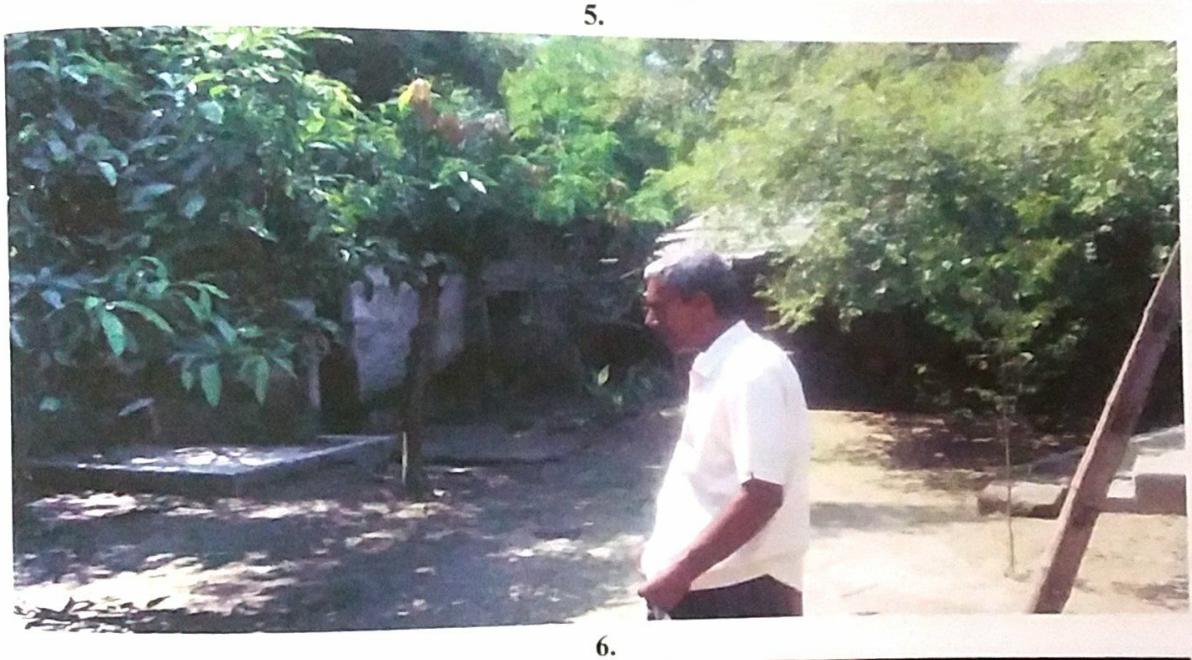

6.

CHAPTER FIVE- CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Now-a-days population is increasing at an alarming rate in our country. With the increasing population pressure, the forest and forest related resources are depleting at a danger rate. The existing forest cannot meet the demand for the nation. The study area is famous for producing fruits and vegetables in our country. Here most of the people were dependent on agriculture and homestead land for the fulfilment of their need of forest products. But there was no natural forest. Employment opportunity was also not available here. So, homestead forest resources were one of the major sources of fulfilling the local people consumption need and also income generation. More tree species planting in homestead forest can be desirable for the aesthetic, environmental and economic perspectives. It can provide employment opportunities for both male and female members in the study area. It can also increase family income for better livelihood to a large population in this region. Different tree species can play important roles in enhancing the diversity and distribution of homestead forests products in the study area.

In spite of the immense scope and prospects of the homestead forests no systematic program has so far been taken to improve their productivity. A clear understanding of the physical characteristics and economic role of homestead forests in rural livelihoods can be vital for ensuring sustainable resource management. Homestead forests can emerge as an effective mean for both economic and environmental well-being. Therefore, the government should try to help the farmers by providing trainings, seedlings, technical and financial support which encourages the farmers to grow more plant species in their homesteads.

5.2 Recommendations

From the observations of the field survey and on the basis of the synthesized results some recommendations can be followed for improving the forest cover in the homesteads.

- Unused land is available around most of the households (about 70% respondents said they had available space for planting trees). These lands can be planted with suitable tree species for desired products and services. This will improve food security, nutritional balance, income opportunities and environmental amelioration.

- The respondents did not follow any planting pattern of plant species in their homesteads. They planted trees wherever the space was available. So training would be beneficial to overcome this situation.

- With the implications of this study, to find out on the economic and conservation value of homestead forests, coordinated research by the multidisciplinary scientists is required in order to better understand and promote improved homestead forests for the study area.

- Structure can be improved by better allocation of plants in relation to HF areas. For this further study is necessary on structural improvements.

REFERENCES

Abedin, M.A. and Quddus, M.A. 1998. Household fuel situation, home gardens and agroforestry practices at six agro-economically different locations of Bangladesh. Bangladesh Agricultural Research Institute (BARI), Joydepur, Bangladesh.

Abedin, Z. and M.A. Quddus, 1990. Household fuel situation, homegardens and agroforestry practices at six agro-ecologically different locations of Bangladesh. In: Abedin, Z., C.K. Lai and M.O. Ali (Eds) Homestead plantation and agroforestry in Bangladesh, pp 19-34, BARI, Joydebpur, Bangladesh. pp: 19-34.

Agelet, A.; Angels, B. M. and Valles, J. 2000. Homegardens and their role as a main source of medicinal plants in mountain regions of Catalonia (Iberian Peninsula). Economic Botany 54: 295–309.

Ahmed, M.F.U. and Rahman, S.M.L. 2004. Profile and use of multi-species tree crops in the homesteads of Gazipur District, Central Bangladesh. Journal of Sustainable Agriculture 24(1): 81–93.

Alam, M.K.; Ahmed, F. U. and Ruhul Amin, S.M. (eds.), 1997. Agroforestry: Bangladesh Perspective. Asia Pacific Agroforestry Network., Bang. Agril. Res. Council, Dhaka. 297pp.

Alam, M.S. and Masum, K.M. 2005. "Status of homestead biodiversity in the offshore Island of Bangladesh," Research Journal of Agriculture and Biological Sciences, vol. 1, no. 3, pp. 246–253.

Ali, A.M.S. 2005. Homegardens in Smallholder Farming Systems: Examples from Bangladesh. *Human Ecology* 33(2): 245–270.

Anam, K. 1999. Homestead Agroforestry in the level Barind Tract: A Diagnostic Study, M.S. Thesis. Department of Agroforestry and Environment. Bangabandhu Sheikh Mujibur Rahman Agriculture University, Salna, Gazipur, Bangladesh. pp. 1-55.

Baker, P.J. and Wilson, J.S. 2000. A quantitative technique for the identification of canopy stratification in tropical and temperate forests. *Forest Ecology and Management*: 127 (1-3) College of Forest Resources, University of Washington, USA. pp. 77-86.

Bannister, M.E. and Nair, P.K.R. 2003. Agroforestry adoption in Haiti: the importance of household and farm characteristics. *Agroforestry Systems* 57: 149–157.

Bashar, M.A.1999. Homegarden Agroforestry: Impact on biodiversity conservation and household food security. (A case study of Gazipur district, Bangladesh). M.Sc.Thesis, Agricultural University of Norway, Oslo, Norway.

BBS, 2011. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics (BBS), Statistics Division, Ministry of Planning, Bangladesh Secretariat, The Government of the Peoples Republic of Bangladesh, Dhaka.

Bishwajit Roy, Md. Habibur Rahman, and Most. Jannatul Fardusi. 2013. Status, Diversity, and Traditional Uses of Homestead Gardens in Northern Bangladesh: A Means of Sustainable Biodiversity Conservation. ISRN Biodiversity, Volume 2013 (2013), Article ID 124103, 11 pages, http://dx.doi.org/10.1155/2013/124103

Blanckaert, I.; Swennen, R.L.; Paredes Flores, M.; Rosas Lopez, R. and Lira Saade, R. 2004. Floristic composition, plant uses and management practices in homegardens of San Rafael Coxcatlan Valley of Tehuacan-Cuicatlan, Mexico. Journal of Arid Environments 57: 39–62.

Brownrigg, L. 1985. Home Gardening in International Development: What the Literature Shows. The League for International Food Education, Washington, DC, 330 pp.

Bunderson, T.W.; Wakeel, A.E.L.; Saad, Z.A. and Hashim, I. 1990. Agroforestry practices and potentials in western Sudan. In: Budd WW, Ducchart I, Hardsesty LH, Steiner F (eds) Planning for agroforestry. Elsevier, Oxford, pp 227–246

Calvet-Mir, L.; Gómez-Baggethun, E. and Reyes-García, V. 2012. Beyond food production. Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain. Ecological Economics 74: 153–160.

Ceccolini, L. 2002. The homegardens of Soqotra island, Yemen: an example of agroforestry approach to multiple land-use in an isolated location. Agroforestry Systems 56: 107–115.

Christanty, L. 1990. Home gardens in tropical Asia, with special reference to Indonesia. pp 9–20. In K. Landauer, and M. Brazil (eds.), *Tropical Home Gardens*, United Nations University Press, Tokyo, Japan.

Christanty, L.; Abdoellah, O.S.; Marten, G.G. and Iskandar, J. 1986. Traditional Agroforestry in West Java: The *Pekarangan* (homegardens) and *kebun-talun* (annual-perennial rotation) cropping system. pp 132–158. In G.G. Marten (ed.), *Traditional Agriculture in Southeast Asia*. Boulder, Colorado, USA.

Chundawat B.S. and Gautam, S.K. 1993. Textbook of Agroforestry. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. 188 pp.

Das, D.K. 1990. *List of Bangladesh Village Tree Species*. Forest Research Institute Chittagong (Mimeo), pp 11.

Das, S. 1986. The Forest Management practices in Bangladesh. Procedings in second National Conference on Forestry. Bangladesh forest Department, Dhaka.pp 6-18.

Douglas, JS. Nov 16–19, 1981. "Future wood requirements and bamboo usage in Bangladesh". In *Second Bangladesh National Forestry Conference*, Edited by: Chowdhury, RA. Nov 16–19, 261–268. Government of the People's Republic of Bangladesh.

Douglas, J.J. 1982. Consumption and supply of wood and bamboo in Bangladesh. Field Document No. 2, UNDP/FAO Project BGD/78/010, Bangladesh Planning Commission, Dhaka.

FAO, 2011. State of the world's forests. Rome (Italy): FAO.

FAO, 2005. The State of World's Forest 2005. Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO, 1982. Village Forest Inventory, Bangladesh. Projects Findings and Recommendations. Terminal Report,FAO:UNDP/BGD/78/020,P.25.

Fernandes, E.C.M. and Nair, P.K.R. 1986. An evaluation of the structure and function of tropical homegardens. *Agricultural Systems* 21: 279–310.

FMP, 1992. Statistical report. Village Forestry Inventory, Forestry Master Plan (FMP). ADBTA 1355-Ban/UNDP/FAO/BGD/88/025.

FMP, 1993a. Forestry Master Plan (FMP). Ministry of Environment and Forest, Government of the People's republic of Bangladesh, Main Plan 1993-2012, Volume 1. Asian Development Bank (TA No.1355-BAN). UNDP/FAO Project/BGD/88/025.Dhaka, Bangladesh and Manila, Philipines. pp. 77-80.

Gliessman, S.R. (eds.), 1990. Integrating trees into agriculture: the homegarden agroecosystem as an example of agroforestry in the tropics. Agroecology: Researching the Ecological Basis for Sustainable Agriculture. pp. 160–168. Ecological Studies 78, University of California, Santa Cruz, CA.

Gillespie, A.R.; Knudson, D.M. and Geilfus, F. 1993. The structure of four homegardens in the Peten, Guatemala. Agroforestry Systems 24: 157–170.

Godbole, A. 1998. Homegardens: Traditional system for maintenance of biodiversity. In: A. Rastoni, A. Godbole and P. Shengii (eds) Apllied Ethnobotany in Natural Resource Management – Traditional Homegardens. ICIMOD, Kathmundu, Nepal.

Government of Bangladesh, 2009a. National Forest and Tree Resources Assessment 2005–2007 Bangladesh. Dhaka (Bangladesh): GOB.

Government of Bangladesh, (1998) The fifth five year plan (1997–2002) Planning Commission, Ministry of Planning, Dhaka

Government of Bangladesh, (1993) Forestry master plan (environment and landuse), Ministry of Environment and Forests, Dhaka

Haruni, A.K. 1999. Vegetation characteristics, indigenous management techniques and enthobotany of home gardens in Bangladesh. M. Sc. Thesis, Institue of Forestry and Environmental Science, University of Chittagong, Chittagong, Bangladesh. 145 pp.

Haque, M.A.1994. Agroforestry in Bangladesh (etd.), joint publication of Swiss Development Cooperation, Dhaka and Bangladesh Agricultural University, Mymensingh.

Haque, M.A. 1992. Homestead agroforestry in Bangladesh. Proceedings of the. Symposium on Horticulture in National Development. Bangladesh Horticultural Society. Bangladesh Agricultural University, Mymenshingh; pp. 182-90.

Hochegger, K. 1998. Farming like the forest: traditional homegarden systems in Sri Lanka. Tropical Agroecology, Margraf Verlag, Weikersheim, 203 pp.

Hocking, D.; Hocking, A. and Islam, K. 1996. Trees on farms in Bangladesh 3. Farmers' species preferences for homestead trees, survival of new tree planting, and main causes of tree death. *Agrofor Syst.*, 33(3): 231–247.

Islam, N.M. 1998. Homegarden agroforestry in Bangladesh; A case study in Rangpur district. MSc Thesis, Agricultural University of Norway (AUN).

Jose, D. and Shanmugaratnam, N. 1993. Traditional homegardens of Kerala: a sustainable human ecosystem. Agroforestry Systems 24: 203–213.

Kabir, Md.E. and Webb, E.L. 2009. Home Gardening for Tropical Biodiversity Conservation. *Conservation Biology*, Volume 23, No. 6, 1641–1644.

Kabir, Md.E. and Webb, E.L. 2009. Household and homegarden characteristics in southwestern Bangladesh. *Agro-forestry Systems* 75:129–145.

Kabir, Md.E. and Webb, E.L. (2008a). Can homegardens conserve biodiversity in Bangladesh? *Biotropica 2008 (published online early August 16 2007)* 40(1):95–103

Kabir, Md. E. 2007. Biology and management of homegardens in southwestern Bangladesh. Ph.D. Dissertation, Asian Institute of Technology, School of Environment, Resources and Development, Thailand.

Kabir, Md. E. and Webb, E.L. (2008b). Floristic and structure of southwestern Bangladesh homegardens *International Journal of Biodiversity Science and Management* 3:1–11 and 4:54.

Karyono, 1990. Home Gardens in Java. Their Structure and Function. In K. Landauer, and M. Brazil (eds.), Tropical Home Gardens. The United Nations University Press, Tokyo, Japan. 257 pp.

Khan, S.A. and Alam, M.K. 1996. Homestead Flora of Bangladesh, Bangaldesh Agricultural Research Council, International Development Research Cenbtre, Village and Farm Forestry Project (SDC), Dhaka, Bangladesh.

Khan, M.S.; Rahman, M. M. and Ali, M. A. (eds.), 2001. *Red data book of vascular plants of Bangladesh*. Bangladesh National Herbarium. Dhaka. 179 pp.

Khan, N.A. 2001. *Social Forestry Versus Social Reality: Patronage and Community- Based Forestry in Bangladesh.* Gatekeeper Series no. 99. International Institute for Environment and Development (IIED).

Kumar, B.M. and Nair, P.K.R. 2004. The enigma of tropical homegardens. Agroforestry Systems 61: 135–152.

Kumar, B.M.; George, S.J. and Chinnamani, S. 1994. Diversity, structure and standing stock of wood in the homegardens of Kerala in peninsular India. Agroforestry Systems 25: 243–262.

Kumari et al. 2009. Plant Diversity in Home Gardens and Its Contribution to Household Economy in Suburban Areas in Sri Lanka. *Environment and Natural Resources Journal* Vol.7, No.2.

Leuschner, W.A. and Khaleque, K. 1987. Homestead agroforestry in Bangladesh. Agroforestry Systems 5: 139–151.

MacDicken, K G. 1990a. Research on Multipurpose Tree Species in Asia. Proceedings on an International Workshop, Los Banos, Philippines.

Masum, K.M.; Alam, M.S. and Abdullah-Al-Mamun, M.M. 2008. "Ecological and economical significance of homestead forest to the household of the offshore island in Bangladesh," Journal of Forestry Research, vol. 19, no. 4, pp. 307–310. View at Publisher· View at Google Scholar· View at Scopus

Mendez, V.E.; Lok, R. and Somarriba, E. 2001. Interdisciplinary analysis of homegardens in Nicaragua: micro-zonation, plants use and socioeconomic importance. *Agroforestry Systems* 51:85–96.

Mergen, F. 1987. Research opportunities to improve the production of homegardens. Agroforestry System 5: 57-67 Kluwer academic Publisher, The Hague, The Netherlands.

Miah, M.G.; Abedin, M.Z.; Khair, AB.M.A.; Shahidullah, M. and Baki, A.J.M.A. 1990. Homestead plantation and household fuel situation in Ganges floodplain of Bangladesh. In: Homestead Plantation and Agroforestry in Bangladesh. M. Z. Abedin, C. K. Lai and M. O. Ali (eds.), BARI/FAO/Winrock International, Joydevpur, Bangladeh. pp. 120-135.

Michon, G. 1983. Village forest gardens in West Java. In: Huxley PA, editor. Plant research and agroforestry. Nairobi (Kenya): ICRAF. p. 13–24.

Michon, G. and Mary, F. 1994. Conversion of traditional village gardens and new economic strategies of rural households in the area of Bogor, Indonesia. *Agrofor Syst.*, 25(1): 31–58.

Millat-e-Mustafa, M.; Hall, J.B. and Teklehaimanot, Z. 1996. Structure and floristics of Bangladesh homegardens. *Agroforestry Systems* 33: 263–280.

Millat-e-Mustafa, M.; Teklehaimanot, Z. and Haruni, A.K.O. 2002. Traditional use of perennial homestead garden plants in Bangladesh. *Forests Trees Livelihoods* 12: 235–256.

Millet-e-Mustafa, M. 1997. Floristic and Indigenous Management Techniques of Homegardens in Bangladesh. In: Agroforestry: Bangladesh Perspective. By Alam, M.K.; Ahmed, F.U. and Amen, S.M.R. (Eds.). APAN, NAWG, BARC, Bangladesh.

Millet-e-Mustafa, M. 1998. Overview of Research in Homegarden Systems. In: Agroforestry. Rastoni, A. Godbole and Shengii, P. (eds.) Apllied Ethnobotany in Natural Resource Management – Traditional Homegardens. ICIMOD, Kathmundu, Nepal.

Misra, R. 1968. Ecology WorkBook. Oxford and IBH Publishing Company, Calcutta.

Mitchell, R. and Hanstad, T. 2004. Small homegarden plots and sustainable livelihoods for the poor. FAO LSP Working Paper 11. Access to Natural Resources Sub-Programme. Rural Development Institue (RDI), USA, pp 44

Montagnini, F. 2006. Homegardens of Mesoamerica: biodiversity, food security, and nutrient management. pp 61–84. In: B. M. Kumar, and P. K. R. Nair (eds.), Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Springer. Dordrecht, The Netherlands.

Motiur, R.M.; Furukawa, Y.; Kawata, I.; Rahman, M.M. and Alam, M. 2006. "Role of homestead forests in household economy and factors affecting forest production: a case study in southwest Bangladesh," Journal of Forest Research, vol. 11, no. 2, pp. 89–97. View at Publisher· View at Google Scholar· View at Scopus

Motiur, R.M.; Tsukamoto, J.; Furukawa, Y.; Shibayama, Z. and Kawata, I. 2005. "Quantitative stand structure of woody components of homestead forests and its implications on silvicultural management: a case study in Sylhet Sadar, Bangladesh," Journal of Forest Research, vol. 10, no. 4, pp. 285–294. View at Publisher· View at Google Scholar· View at Scopus

Muhammad Abul Foysal, Md. Lokman Hossain, Ashik Rubaiyat, Md. Byzid Hasan. 2013. Economics of Homestead Forestry and Their Management Activities at Fatickchari Upazila of Chittagong District, Bangladesh. *Agriculture, Forestry and Fisheries*, Vol. 2, No. 4, pp. 161-176. doi: 10.11648/j.aff.20130204.12.

Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer, Dordrecht. The Netherlands. 499 pp.

Nair, M.A. and Sreedharan, C. 1986. Agroforestry farming systems the homesteads of Kerala, southern India. Agroforestry Systems 4: 339–363.

Odebode, O.S. 2006. Assessment of home gardening as a potential source of household income in Akinyele Local Government Area of Oyo State. *Nig J Horticulture Sci*, 2:47-55.

Okigbo, B.N. 1990. Homegardens in tropical Africa. pp. 21–40. In K. Landauer, and M. Brazil (eds.), Tropical Homegardens. United Nation University Press, Tokyo, Japan.

Padoch, C. and de Jong, W. 1991. The housegardens of Santa Rosa: diversity and variability in an Amazonian agricultural system. Economic Botany 45: 166–175.

Rahman, M.L.; Furukawa, Y.; Kawata, I. and Alam, M. 2009. Fruit Distribution and Diversity in the Homestead of a Southern Island of Bangladesh. *Advances in Biological Research* 3 (5-6): 208-214.

Rahman, M.M.; Furukawa, Y.; Kawata, I.; Rahman, M.M. and Alam, M. 2005. Homestead forest resources and their role in household economy: a case study in the villages of Gazipur Sadar Upazila of Central Bangladesh. *Small Scale Econ Manage Policy.*, 4(3): 359–376.

Ranasinghe, T.T. 2009. Manual of low/no-space agriculture (L/N-S) -cum- family business gardens (FBG). Colombo, Sri Lanka: International Water Management Institute (IWMI); Leusden, the Netherlands: International Network of Resource Centres on Urban Agriculture and Food Security (RUAF Foundation).

Raunkiaer, C. 1934. The Life Forms of Plants and Statistical Plant Geography. The Clarendon Press, Oxford.

Rico-Gray, V.; Garcia, F.J.G.; Chemas, A.; Puch, A. and Sima, P. 1990. Species composition, similarity, and structure of Mayan homegardens in Tixpeual and Tixcacaltuyub, Yucatan, Mexico. *Economic Botany* 44(4): 470–487.

Salam M.A.; Nogochi, T. and Koie, M. 2000. Understanding why farmers plant trees in homestead agroforestry in Bangladesh. Agrofrestry system , Vol. 50, pp. 77-93.

Siddiqi, M.S. and Khan, N.A. 1999. Floristic Composition and Socio-economic Aspects of Rural Homestead Forestry in Chittagong: A Case Study. Bangladesh Journal of Forest Science 28 (2): 94-101.

Soemarwoto, O. 1987. Homegardens: A traditional agroforestry system with a promising future. pp 157–172. In: Steppler, H.A. and Nair, P.K.R. (eds.), Agroforestry: A Decade of Development, International Centre for Research in Agroforestry, Nairobi, Kenya. Nairobi, Kenya.

Shukla, R.S. and Chandle, P.S. 2000. Plant Ecology and Soil Science, S. Chand and Company, Ram Nagar, New Delhi, India.

Trinh, L.N.; Watson, J.W.; Hue, N.N.; De, N.N.; Minh, N.V.; Chu, P.; Sthapit, B.R. and Eyzaguirre, P.B. 2003. Agrobiodiversity conservation and development in Vietnamese home gardens. Agriculture, Ecosystems & Environment 97: 317–344.

Uddin, M.S.; Rahman, M.J. and Mannan, M.A. 2001. "Plant biodiversity in the homesteads of saline area of Southern Bangladesh," in Proceedings of National Workshop on Agroforestry Research Development of Agroforestry Research in Bangladesh, Haq, M.F.; Hasan, M.K.; Asaduzzaman, S.M. and Ali, M.Y. (Eds.), pp. 45–54, Gazipur, Bangladesh.

Uddin, M.J. and Hasan M.K. Economics of Homestead agroforestyry at char areas at Noakhali district. On- Farm Research Division, Bandarban and Gazipur.

Vogl, C.R. and Vogl-Lukasser, B. 2003. Tradition, Dynamics and Sustainability of Plant Species Composition and Management in Homegardens on Organic and Non-Organic Small Scale Farms in Alpine Eastern Tyrol, Austria. Biological Agriculture and Horticulture 21: 149–366.

Vogl, C.R.; Vogl-Lukraser, B. and Caballero, J. 2002. Homegardens of Maya Migrants in the district of Palenque, Chiapas, Mexcio: Implications for Sustainable Rural Development. pp 1–12. In J. R. Stepp, F. S. Wyndham, and R. K. Zarger (eds.), *Ethnobiology and Biocultural Diversity*. University of Georgia Press, Athens, GA.

Wiersum K.F. 2006. Diversity and change in homegarden cultivation in Indonesia. Kumar BM, Nair PKR, editors. Tropical homegardens: a time-tested example of sustainable agroforestry, pp. 13–24. Dordrecht: Springer Science.

Wojtkowski, P.A. 1993. Toward an understanding of tropical homegardens. Agroforestry Systems 24: 215–222.

Appendices

Appendix-1

Homestead Forest Inventory Form

Structure, Species Composition and Utilization of Homestead Forest: A case study in Gangni Upazilla of Meherpur District (Only for research purpose)

1. Household No..... 2. Name of the Village: ..... Date:

3. Union: ..... 4. Upazila: Gangni 5. District: Meherpur

1. **Homestead area:** Bigha..... Katha.....
2. **Plant species composition:**

i) **Tree species**

S/N	Local/Common Name	Scientific name	No. of individuals	Domesticity		Uses and Importance
				P	N	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						

ii) **Shrub Species**

S/N	Local/Common Name	Scientific name	No. of individuals	Domesticity		Uses and Importance
				P	N	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

iii) **Herb species**

S/N	Local/Common Name	Scientific name	Uses and Importance
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

3. Horizontal Structure of Homestead forest:

Species location:

1. Species for the border only
2. Species for the interior part only
3. Both the interior + border

a) Total no. of individual trees

b) Total no. of individual shrubs

4. Vertical Structure of Homestead forest:

Stratum	**Height (m)**	**Category of the species**	**Species name**
Ground	Up to 2 m		
Understory	Above 2 to 5 m		
Middle canopy	Above 5 to 15 m		
Top/over story	Above 15 m		

Appendix-2

FIELD SURVEY QUESTIONNAIRE

Structure, Species Composition and Utilization of Homestead Forest: A case study in Gangni Upazilla of Meherpur District

Date:

Household No.:

Location :

Village: ..... Union..... Upazila: Gangni, Dist: Meherpur

Respondent:

i) Name: .... Age: ..... Sex: .....
Religion: .....

ii) **Occupation:** Primary..... ..... Secondary.....

iii) **Education level:** .... No..... Primary...Secondary....Higher secondary.... Graduate...

iv) **Marital status:** (a) Married (b) Single (c) Divorced (d) Widowed

v) **Total land area:** Bigha ___ Katha____
a) Homestead:
b) Agricultural land:
c) Marginal land:

vi) **Household size (Family Member):**

Socio-economic information:

1. What types of products do you get from homestead forest?
a) Cash b) Timber c) Food/Fruit/ d) Fodder e) Fuel /firewood f) Others

2. What types of trees do you grow in your homestead farmland?
i) Fruit trees ii) Timber species iii) Fruit trees + Timber species iv) Multipurpose tree species

3. What are the reasons for planting trees on your homestead? .....
i) Economic benefit ii) Consumed food/fruit iii) Environmental benefit iv) Constructional benefit v) Others

4. Sources of planting Material in homestead forest: a) Raised b) Purchased

5. What is your main source of fuel for cooking?
(a) Firewood/Fuelwood; (b) Charcoal; (c) Gas; (d) Crop residues e) others

6. Which type of plant species like to introduce in your homestead?

a) Fruit b) Timber c) Both Timber + Fruit iv) Multipurpose tree species

7. How much your family income per year? Tk.

8. What is the main source of income?
   a) Agriculture b) Business c) Service d) Others

9. Do you sell your homestead forest produce? Yes / No
   -If Yes/ No, why _____

10. What is your attitude about the homestead forest? i) Good ii) Bad iii) Confused
    Why? .....

11. Do you like to have more trees on your homestead forest? Yes /No
    Why? To get a) Cash b)Timber c) Food/Fruit/ d) Fodder e) Fuel/firewood f) Shade & protection
    g) Others

12. What are the most five important food/fruit species? (List them)

13. What are the most five important timber species? (List them)

14. Do you need any help/support for promoting homestead forest species? Yes/No
    Which types of help/support?
    i) Financial ii) Technical iii) both iv) others

15. How Transportation and Market facilities in your area?
    i) Excellent ii) Good iii) Poor

16. Which tree species are most important for meeting the family's daily needs?

17. Did you face any problem for planting new trees in your homestead? Yes / No
    If yes.....What kinds of problem? (List them)
    a) Lack of good seed/seedlings b) lack of technical knowledge
    c) Unavailability of space d) Restricted sunshine and air
    e) Livestock problem f) Conflicts with neighbours
    g) Insects and disease problem h) others

18. If extra information about the study area:

Investigator's signature:

Appendix-3

Plant species list, their common uses, domesticity and origin from homestead forests in Gangni upazila of Meherpur district. F is the frequency of homestead forests from where species was recorded. RF is the relative frequency. For uses, 1 = food, 2 = commercial, 3 = medicinal, 4 = fuelwood, 5 = ornamental, 6 = timber, 7 = fodder, 8 = fiber, and 9 = religious/ceremonial (Kabir and Webb, 2008).

Tree Species

S/N	Common/Local Name	Scientific Name	Family	Domesticity	Origin	Uses	No. of Homestead	F (%)	RF%
1	Babla	*Acacia nilotica* Karst.	Leguminosae, Mimosoideae	Planted	Exotic	2, 4, 6, 7	4	6.67	0.50
2	Bel	*Aegle marmelos* (L.) Correa	Rutaceae	Planted	Native	1, 2, 4	31	51.67	3.89
3	Kala Koroy	*Albizia lebbeck* (L.) Benth.	Leguminosae, Mimosoideae	Planted	Native	6	5	8.33	0.63
4	Sada koroy	*Albizia procera* (Roxb.) Benth.	Leguminosae, Mimosoideae	Planted	Native	6	4	6.67	0.50
5	Ata	*Annona reticulata* L.	Annonaceae	Planted	Exotic	1, 4	33	55.00	4.15
6	Kadam	*Anthocephalus chinensis* (Lmk.) A. Rich. *ex* Walp.	Rubiaceae	Planted	Native	4	15	25.00	1.88
7	Supari	*Areca catechu* L.	Palmae (Arecaceae)	Planted	Exotic	2, 6	14	23.33	1.76
8	Kanthal	*Artocarpus heterophyllus* Lam.	Moraceae	Planted	Exotic	1, 2, 6	39	65.00	4.90
9	Kamranga	*Averrhoa carambola* L.	Oxalidaceae	Planted	Exotic	1, 2, 4	12	20.00	1.51
10	Neem	*Azadirachta indica* A.Juss.	Meliaceae	Planted	Native	1, 3, 4, 7	46	76.67	5.78
11	Shimul	*Bombax ceiba* L.	Bombacaceae	Planted	Exotic	2, 8	24	40.00	3.02
12	Tal	*Borassus flabellifer* L.	Palmae (Arecaceae)	Planted	Native	1, 2, 4, 6	22	36.67	2.76
13	Tejpata	*Cinnamomum tamala*	Lauraceae	Planted	Native	1, 2	1	1.67	0.13
14	Batabi Lebu/Badam	*Citrus grandis* (L.) Osbeck	Rutaceae	Planted	Exotic	1, 2	45	75.00	5.65
15	Narikel	*Cocos nucifera* L.	Palmae (Arecaceae)	Planted	Native	1, 4	48	80.00	6.03
16	Sissoo	*Dalbergia sissoo* Roxb.	Leguminosae, Papilionoideae	Planted	Native	4, 6	14	23.33	1.76
17	Krishnochura	*Delonix regia* (Boj. *ex* HK.) Raf.	Leguminosae, Caesalpinioideae	Planted	Exotic	4, 5	5	8.33	0.63
18	Gab	*Diospyros peregrina* Gurke	Ebenaceae	Planted	Native	4	3	5.00	0.38
19	Dumur	*Ficus hispida* L.f.	Moraceae	Natural	Native	1, 2, 4, 6	27	45.00	3.39
20	Pakur	*Ficus lacor Buch.-Ham.*	Moraceae	Natural	Native	5	2	3.33	0.25
21	Ipil-Ipil	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae, Mimosoideae	Planted	Exotic	1, 2	21	35.00	2.64
22	Litchu	*Litchi chinensis* Sonn.	Sapindaceae	Planted	Exotic	1, 2, 4	29	48.33	3.64

S/N	Common/Local Name	Scientific Name	Family	Domesticity	Origin	Uses	No. of Homestead	F (%)	RF%
23	Apel	*Malus domestica*	Rosaceae	Planted	Exotic	1	2	3.33	0.25
24	Am	*Mangifera indica* L.	Anacardiaceae	Planted	Native	1,2,6,7	51	85.00	6.41
25	Bokul	*Mimusops elengi* L.	Sapotaceae	Planted	Exotic	1, 2, 4, 6	9	15.00	1.13
26	Sajna	*Moringa oleifera* Lam.	Moringaceae	Planted	Native	1, 2	19	31.67	2.39
27	Sheuli	*Nyctanthes arbor-tristis*	Oleaceae	Planted	Native	3, 4	16	26.67	2.01
28	Khejur	*Phoenix sylvestris* Roxb.	Palmae (Arecaceae)	Planted	Native	1, 2, 4	27	45.00	3.39
29	Debdaru	*Polyalthia longifolia* (Sonn.) Hook.f. & Thomson	Annonaceae	Planted	Native	4, 6	6	10.00	0.75
30	Peara	*Psidium guajava* L.	Myrtaceae	Planted	Exotic	1, 2, 4	41	68.33	5.15
31	Dalim	*Punica granatum* L.	Punicaeae	Planted	Exotic	1, 2	15	25.00	1.88
32	Amra	*Spondias pinnata* (L.f.) Kurz	Anacardiaceae	Planted	Native	1, 2, 4	24	40.00	3.02
33	Mehegoni	*Swietenia macrophylla* King	Meliaceae	Planted	Exotic	2, 6	39	65.00	4.90
34	Jam	*Syzygium cumini* (L.) Skeels	Myrtaceae	Planted	Native	2, 4, 6, 7	36	60.00	4.52
35	Jamrul	*Syzygium samarangense* (Blume) Merr. & L.M.Perry	Myrtaceae	Planted	Exotic	1, 2, 4, 7	4	6.67	0.50
36	Tentul	*Tamarindus indica* L.	Leguminosae, Caesalpinioideae	Planted	Exotic	1, 2, 4	6	10.00	0.75
37	Segun	*Tectona grandis* L.f.	Verbenaceae	Planted	Native	2, 6	6	10.00	0.75
38	Arjun	*Terminalia arjuna* Wight & Arn.	Combretaceae	Planted	Native	3, 4	2	3.33	0.25
39	Katbadam	*Terminalia catappa* L.	Combretaceae	Planted	Native	4	5	8.33	0.63
40	Horitoki	*Terminalia chebula* Retz.	Combretaceae	Planted	Native	1, 3, 6	2	3.33	0.25
41	Jibon	*Trema orientalis* (L.) Blume	Ulmaceae	Planted	Native	4	8	13.33	1.01
42	Boroi/Kul	*Ziziphus mummularia* (Burm.f.) W. & A.	Rhamnaceae	Planted	Native	1, 2	34	56.67	4.27
	Shrub Species								
1	Ulotkambal	*Ambroma augusta* (L.) L.f.	Sterculiaceae	Planted	Exotic	3	13	21.67	6.16
2	Hasnahena	*Cestrum nocturnum* L.	Solanaceae	Planted	Exotic	5	5	8.33	2.37
3	Kagojee Lebu	*Citrus limon* (L.) Burm.f.	Rutaceae	Planted	Exotic	1, 2	38	63.33	18.01
4	Patabahar	*Codiaeum variegatum* (L.) Blume	Euphorbiaceae	Planted	Exotic	5	21	35.00	9.95
5	Gongharaj	*Gardenia jasminoides* Ellis	Rubiaceae	Planted	Exotic	5	10	16.67	4.74
6	Joba	*Hibiscus rosa-sinensis* L.	Malvaceae	Planted	Exotic	3, 5, 9	16	26.67	7.58

S/N	Common/Local Name	Scientific Name	Family	Domesticity	Origin	Uses	No. of Homestead	F (%)	RF%
7	Jui	*Jasminum auriculatum* Vahl	Oleaceae	Planted	Native	5	5	8.33	2.37
8	Beli	*Jasminum sambac* (L.) W.A.T.	Oleaceae	Planted	Native	5	7	11.67	3.32
9	Kutuskata/Putuskata	*Lantana camara* L.	Verbenaceae	Natural	Exotic	3	27	45.00	12.80
10	Mendi	*Lawsonia inermis* L.	Lythraceae	Planted	Exotic	2	28	46.67	13.27
11	Kamini	*Murraya paniculata* (L.) Jack	Rutaceae	Planted	Native	5	11	18.33	5.21
12	Golap	*Rosa damascena* Mill.	Rosaceae	Planted	Exotic	5	15	25.00	7.11
13	Begun	*Solanum melongena* L.	Solanaceae	Planted	Exotic	1, 2	15	25.00	7.11
	Herb Species								
1	Deros/ Vendi	*Abelmoschus esculentus* (L.) Moench.	Malvaceae	Planted	Native	1, 2	13	21.67	3.50
2	Man Kachu	*Alocasia indica* (Lour) Koch	Araceae	Planted	Native	1, 2	44	73.33	11.86
3	Ghrita Kumari	*Aloe indica* Royle	Liliaceae	Planted	Native	3	5	8.33	1.35
4	Lal Shak	*Amaranthus gangeticus* L.	Amaranthaceae	Planted	Native	1, 2	19	31.67	5.12
5	Data Shak	*Amaranthus oleraceus* L.	Amaranthaceae	Planted	Native	1	23	38.33	6.20
6	Ol Kachu	*Amorphophallus* paeoniifolius (Denn.) Nicol.	Araceae	Planted	Native	1, 2	25	41.67	6.74
7	Bansh	*Bambusa spp.*	Gramineae (Poaceae)	Planted	Native	2, 4, 6, 7	31	51.67	8.36
8	Pape	*Carica papaya* L.	Caricaceae	Planted	Exotic	1, 2	39	65.00	10.51
9	Morogfull	*Celosia argentea* L.	Amaranthaceae	Planted	Native	5	12	20.00	3.23
10	Kachu	*Colocasia esculenta* (L.) Schott	Araceae	Planted	Native	4, 7	31	51.67	8.36
11	Holud	*Curcuma longa* L.	Zingiberaceae	Planted	Native	1, 2, 3, 9	32	53.33	8.63
12	Dalia	*Dahlia rosea Cav.*	Compositae	Planted	Exotic	5	8	13.33	2.16
13	Tarulata	*Mikania cordata (Burm.f.) B.L.Rob.*	Compositae (Asteraceae)	Natural	Exotic	5	3	5.00	0.81
14	Shondhamaloti	*Mirabilis jalapa* L.	Nyctaginaceae	Planted	Exotic	5	18	30.00	4.85
15	Kola	*Musa spp.*	Musaceae	Planted	Exotic	1, 2, 7	30	50.00	8.09
16	Fonimonsa	*Opuntia dillenii* Haw.	Cactaceae	Natural	Exotic	3	14	23.33	3.77
17	Rajanigondha	*Polianthes tuberosa* L.	Agavaceae	Planted	Exotic	5	11	18.33	2.96
18	Gada	*Tagetes patula* L.	Compositae (Asteraceae)	Planted	Exotic	3, 5	13	21.67	3.50