Khulna University
Life Science School
Forestry and Wood Technology Discipline

Author(s): Md. Masiur Rahman

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Supervisor(s): Dr. Md. Enamul Kabir, Professor, Forestry and Wood Technology Discipline, Khulna University

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DIVERSITY AND STRUCTURE OF HOMESTEAD FORESTS AND ITS CONTRIBUTION TO HOUSEHOLD ECONOMY AT BHOLA DISTRICT OF BANGLADESH

Md. Masiur Rahman
Student ID: MS-140520

FORESTRY AND WOOD TECHNOLOGY DISCIPLINE
LIFE SCIENCE SCHOOL
KHULNA UNIVERSITY
KHULNA – 9208
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Md. Masiur Rahman

Student ID: MS – 140520

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Name and Designation of Supervisor

Dr. Md. Enamul Kabir
Professor
Forestry and Wood Technology Discipline
Khulna University, Khulna – 9208
Bangladesh.

Prepared By

Md. Masiur Rahman
Student ID: MS – 140520
Forestry and Wood Technology Discipline
Khulna University, Khulna – 9208
Bangladesh.

DECLARATION

I, Md. Masiur Rahman, 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 Institution.

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 Md. Masiur Rahman, Student ID: MS – 140520 has been prepared this thesis paper entitled "Diversity and structure of homestead forests and its contribution to household economy in a remnant island of Bangladesh" 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).

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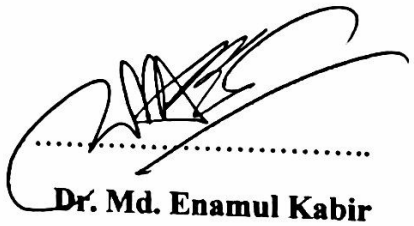

Dr. Md. Enamul Kabir

Professor

Forestry and Wood Technology Discipline

Khulna University, Khulna – 9208

Bangladesh.

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ABSTRACT

Homestead Agroforestry is playing an important role for reversing the present trend of resource degradation and also promoting the biodiversity conservation in Bangladesh. The objective of this study is to assess the structure, species composition and diversity of homestead forests and explore its contribution household economy. This study was conducted in Bhola; a central remnant island of Bangladesh. A total of 60 homesteads were selected using a multistage random sampling from three upazilas (sub-district) namely Charfassion, Lalmohan and Tazumuddin of Bhola district during August and September, 2016. A total of 69 plant species in 34 families of which 51 tree species (74%), 7 shrubs (10%), 8 herbs (11%) and 3 non-woody climbers (4%) were recorded. Tree species were predominated accounting for about 74% of all the identified species and 55% of all recorded species were native to the Indian Subcontinent. An average of 29 species was recorded in each homestead and stem density were 1533 ha^{-1} in a median of 1800 m^2 homestead area. Five canopy strata were observed among which middle canopy (45%) were dominant followed by understory stratum (23%). Of the total species, 43 food yielding, 20 profitable timber species, 6 medicinal, 4 ornamental, 7 fodder, and 34 fuelwood species were found. Out of 69 species, 26 species were recorded as multipurpose species having more than two uses. These species were treated as poor man's species for "poverty reduction" and diverse economic and profitable uses. *Mangifera indica, Areca catechu, Cocos nucifera, Samanea saman, Citrus limon,* and *Amaranthus gangeticus* were dominant species. Homestead forests in the study area contributed about 20% of the total annual household income in the form of food and commercial sales. The result of this study stated the potentiality of homestead forests in biodiversity conservation and great support to the household subsistence.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Forest is an essential natural resource upon which a large population of the world depends directly or indirectly for their subsistence. Forest covers almost 30.6% land of the world and is critical in meeting human needs for food, shelter, medicine, fuelwood, fodder and timber (FAO, 2015). Along with 30.6% forest cover, there are some other areas under tree cover which are not classified as forest. And in all, about 40% of the total world's land surface is under tree cover. Deforestation and biodiversity loss has become a common phenomenon throughout the world in last several decades. And it is much more frequent in developing countries like Bangladesh (Khan *et al.*, 2007). Bangladesh has about 14.6% of forestland but the actual tree covered area is about 6.4% of the total land of the country (Salam *et al.*, 2000).

In keeping view on the present scenario of rapidly growing population leading to the over-exploitation of natural resources upon which the huge population depends on for their subsistence, it is very urgent to find alternative way to ensure the sustainability of the natural resources. Homestead forests are such an alternative way and are the most prospective form of production site along with the shelter of the family (Masum *et al.*, 2008). The concept of homestead forests started with the establishment of house and in spite of many variations in design and pattern, the basic features of homestead forests are almost same all over the world (Christanty, 1985). It is a distinct type of traditional agroforestry systems where a clearly bounded piece of land immediately surrounding the dwelling house is cultivated with a wide variety of plants characterized by a complex structure and numerous functions (Fernandes and Nair, 1986; Kumar and Nair, 2004). Homestead forests are one of the oldest forms of agro-ecosystems and are present throughout the world (Soemarwoto and Conway, 1992).

Homestead forests around the world often show remarkable variation in floral composition and structure depending on the climatic and physiographic condition of the area as well as the household characteristics (Muhammed *et. al.*, 2011). Homestead forests are called by different local names all over the world like agroforestry homegardens, backyard gardens, kitchen gardens, homestead farms, dooryard garden (America and other English speaking coutries), Bari Bagan (Bangladesh), Kebun (Malaysia), Kampung (Indonesia), Jardin creole (West Indies) and many more (Michon, 1983; Nair, 1993; Millat-e-Mustafa *et al.*, 1996). Homestead forest provide year round subsistence, economic, social and biological benefits from its wide variety of plant components which are essential for food, nutritional security,

religio-cultural values, environmental stability, and biodiversity conservation (Christanty, 1990; Torquebiau, 1992). The benefits of homestead forests are mainly divided into productive and protective benefits. Along with productive and protective roles, homestead forests also play different social and ecological roles respectively for the homestead owner and environment (Nair, 1985; MacDicken and Charles, 1990).

Bangladesh is an over populated and land hungry country having about 14.75 million ha of land with population of 142.3 millions (BBS, 2013a). The country holds a wide variety of plant diversity in homestead forests. The area of homestead forests in Bangladesh is 0.27 million ha representing 10.5% of forestlands and 2% of the total land area of the country which spreads over 20 million homesteads (Kabir, 2007). Bangladesh, being a small country, never had excessive forest resources and the per capita forestland is only 0.022 ha which is among the lowest in the world (FAO, 2011). It is difficult to meet the country's huge demand for timber fuelwood, fruit, and fodder from the natural forest. In this context, homestead forests in Bangladesh are highly productive and meet most of the demand of timber and fuelwood of the country (Khan and Alam, 1996) and provide about 70% of timber, 90% of fuelwood, 48% of sawn and veneer logs, and almost 90% of bamboo of the total requirement of the country (Uddin *et al.*, 2002). The productivity of homestead forests in Bangladesh is 7 – 8 folds higher than that of primary forests (Huda and Roy, 1999) and thus could provide strong subsistence and economic incentives to the landowner to grow and maintain plants in and around their homestead.

1.2 Rationale of the study

Once the habitat of around 5000 species of flowering plants, Bangladesh has lost about 30% of its primary forest in last few decades because of high population pressure, demand of more and more agricultural land, over dependence and exploitation of forest resources etc (FAO, 2003; Kabir and Webb, 2008b). In this context, homestead forest can act as a major alternative in providing sustainable forest products and services both in urban and rural areas as well as biodiversity conservation (Montagnini, 2006; Kabir and Webb, 2008b). Millat-e-Mustafa *et al.*, (1996) recorded eight major uses of homestead forest plants in Bangladesh namely food/fruit, timber, fuelwood, spice, fodder, medicine, fencing and miscellaneous uses. The miscellaneous uses include handicrafts, shade, ornamental, environmental, ceremonial and aesthetic uses.

So many studies have been conducted on different sectors of homestead forests in different regions of Bangladesh. Siddiqi and Khan (1999) studied on the floristic composition and socio-economic aspects of homestead forestry in Chittagong. Kabir and Webb (2008b) worked on the floristic composition and structure of southwestern Bangladesh homegardens. Along with them, Das (1990), Hasan and Mazumdar (1990), Alam and Mohiuddin (1992), Khan and Alam (1996), Alam *et al.*, (1996) also conducted different studies on the floristic composition of homestead forests in different regions of the country. Alam *et al.*, (1990), Miah *et al.*, (1990), Momin *et al.*, (1990), Millat-e-Mustafa *et al.*, (2002) studied about the plantation and traditional uses of homestead forests. Choudhury and Sattar (1993), Ahmad (1997), Islam (1998), Bashar (1999), studied about the homestead agroforestry in Bangladesh. Kabir *et al.*, (2010) studied about the management of homestead forests in Bangladesh. But there is no specific management plan for the homestead forests (FAO, 2011) and being traditionally managed by the household owners.

Bhola is an isolated riverine delta and offshore island situating at southern extremity of Bangladesh. This area was selected as study area because it has a reputation of cultivating different types of annual crops, woody, timber and medicinal species etc. as well as seasonal vegetables at the homestead (BBS, 2013b). But no study was so far carried out on the structure, species composition, diversity and utilization of homestead forests of Bhola district in Bangladesh. So, the assessment on species composition, 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. Thus, the study attempted to identify the present status of homestead forest of Bhola district through investigating plant species composition, frequency, abundance, diversity and structure of homestead forests as well as to explore the utilization of the products of homestead forest.

1.3 Objectives of the study

1.3.1 General objective

The main objective of this research is to explore the diversity and structure of homestead forests of Bhola district and its contribution to the household's socio-economic condition. Following are the specific objectives in addressing the general objective of this research.

1.3.2 Specific objectives

- To assess the diversity and structure of homestead forests in Bhola district.
- To assess the contribution of homestead forest to the household economy.
- To synthesis the findings of this study for promoting homestead forest systems in Bangladesh.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

A homestead forest is treated as an integrated production system and a steady ecosystem maintaining the diversity of life as well as natural resources. It provides a major portion of food, timber, fuelwood, and fodder for the household and considered as a trustworthy source of household earnings. Homestead forest is a good niche of multipurpose trees and shrubs and provides multiple products for subsistence as well as it is also a part of the culture and heritage of the rural areas (Haruni, 1999). Homestead forests also provide a more favorable microenvironment and higher relative humidity than outside environment (Gajaseni and Gajaseni, 1999).

2.2 Concept and definition of homestead forests

Homestead forests which is popularly known as home garden, is a vital component of rural economy in the whole world. It is a distinct type of agroforestry system where annual and perennial plant species are grown along with livestock, poultry or fish production to satisfy the basic need of households (Foysal *et. al.*, 2013). Around the world, a number of researchers and scientists attempted to delineate homestead forests on different basis like structure, component, functions etc. (Hoogerbrugge and Fresco, 1993). Homestead forests is generally a privately owned areas in rural and semi-urban settings including a dwelling unit equipped with kitchen, backyard, front yard and occasionally a pond and a home garden. It is a mixture of deliberately planted vegetation with a complex structure intended to produce products for household consumption as well as for earning from surplus products (Kabir and Webb, 2008a-b, 2009). Homestead forests around the world are known by different names like dooryard garden, kitchen garden, backyard garden etc. (Nair, 1993).

2.3 Characteristics of homestead forests

Mitchell and Hanstand (2004) listed five fundamental characteristics of homestead forests like (a) situated near the dwelling area; (b) contain a high diversity of plants; (c) occupy a small area; (d) production is supplemental rather than a main source of family income and consumption; and ; (e) such type of production system where poor can have easy access at some level.

In Spite of some similarities, each homestead forest is unique in structure, function, composition and appearance as they rely on the natural ecology of the location, available resources, skills, preferences and enthusiasm of family members (Fernandes and Nair, 1986). Wiersum (2006) observed that the structure, composition, intensity of cultivation and diversity of homestead forests are subjected to the socio-economic status of the household in Indonesia.

2.4 structure of homestead forests

The homestead forests structure has well defined vertical and horizontal stratification. But it is not very easy to separate one from another (Nair and Sreedharan, 1986). The most distinctive feature of homestead forest is the multi-tiered canopy structure, and describes three-to-six strata (Gillespie *et al.*, 1993; Millat-e-Mustafa *et al.*, 1996). Vertical stratification provides a gradient in light and relative humidity. Shade tolerant crops constitute the lower stratum; shade intolerant trees constitute the top layer and species with varying degrees of shade tolerance in the intermediate strata (Kumar and Nair, 2004). Mitchell and Hanstand (2004) stated that in a homestead forest, plants of different heights and architectural types, optimally occupy the available space both horizontally and vertically.

2.4.1 Horizontal structure

The horizontal structure of homestead forests is assessed on the basis of planting location within the homestead area. Foysal *et. al.* (2013) mentioned three major horizontal structure of homestead forests namely on the border only, the interior part only and both interior and borders. Depending on the size, location and distance from dwelling area, species composition and planting pattern homestead forests have distinct horizontal structure (Millat-e-Mustafa *et al.*, 1996; Blanckaert *et al.*, 2004). Blanckaert *et al.* (2004), and Kumar and Nair (2004) stated that farmers plat different types of plant species on different horizontal strata on the basis of their socio-economic status and requirements.

2.4.2 Vertical structure

The vertical strata of homestead forests are simply the organization of complex multilayer vegetation on the basis of height class (Foysal *et. al.*, 2013). Different researchers like Karyono (1990), Salam *et al.* (2000) revealed that, vertical stratification largely depends on the geographical location, local site condition, homestead's age, owner's socio-economic

condition, plantation objectives and the overall management objectives of the homestead forest.

2.5 species composition and diversity

The limited space forces people to accommodate a large number of species in a relatively small area with a limited number of individuals. Different factors like religious-cultural belief, customs of the rural people have influence on the diversity or composition of homestead forests (Millat-e-Mustafa *et. al.*, 1996). Farm size and farmers' choice often influence the species richness of homestead forests in any region (Kumar and Nair, 2004). Species composition in the homestead forests are sturdily prejudiced by specific needs and preferences of households, along with ecological and socio-economic factors (Christanty *et. al.*, 1986). Often farmers plant new species in their homestead forests based on its utilization like food, medicinal, ornamental, religious etc. (Kumar and Nair, 2004). Species diversity in homestead forests can be varied on the basis of the age of the household. A study revealed that older homestead forests have more species diversity than relatively younger homestead forests (Coomes and Ban, 2004). On the contrary, a study revealed that there is no relationship between species diversity and age of household (Blanckaert *et al.*, 2004). Socioeconomic status of the household has direct impact on the species diversity of homestead forests. Homestead forests of wealthy family have more species, whereas in the homestead forests of low-income families possess more diversified species than that of high income families (Coomes and Ban, 2004).

2.6 Key benefits of homestead forests

Homestead forests provide a wide variety of direct and indirect and optional benefits (Balnckaert *et al.*, 2004). The major benefits derived from homestead forests are productive and protective benefits. Along with these two major benefits homestead forests also provide numerous social and ecological benefits for the household as well as for environment (Kabir, 2007).

2.6.1 Social benefits

Reviews of studies from different countries reveal that the degree and combination of socio-cultural impacts on societies engaged in home gardening vary across the border. A wide variety of social benefits of homestead forests include enhancing food and nutritional security in different 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 benefits of homestead forests are the direct contribution to the household food security by increasing availability, accessibility, and utilization of food products. Homestead forests are maintained for easy access to fresh food sources in both rural and urban areas. Homestead forests meet the requirement of energy and nutrition of households on a continuous basis (Mitchell and Hanstad, 2004). Homestead forests also act as a status symbol and strengthen community links through the sharing of produces (Christanty, 1990).

2.6.2 Economic benefits

The economic benefits of homestead forests go beyond food and nutritional security and subsistence, especially for resource-poor families. Different studies revealed that homestead forests contribute to income generation, improved livelihoods, and household economic welfare as well as promoting entrepreneurship and rural development (Calvet-Mir *et. al.*, 2012). Homestead forests are widely promoted in many countries as a mechanism to alleviate poverty and as a source of income for subsistence in developing countries. Although homestead forests are observed 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).

2.6.3 Environmental benefits

Homestead forests provide a wide range of environmental and ecological benefits. They serve as the primary unit that initiates and utilizes ecologically friendly approaches for food production along with biodiversity and natural resources conservation. Homestead forests are usually diverse and contain a rich composition of plant and animal species. Hence they make interesting cases for ethno-botanical studies (Balnckaert *et al.*, 2004). Homestead forests are complex and may resemble ecological and agricultural production systems that sponsor biodiversity conservation. The rich diversity and composition of species and the intense distribution of faunal and floral strata symbolize extraordinary features of homestead forest ecology (Fernandes and Nair, 1986).

2.7 Prospects and potentials of homestead forests

There is a great opportunity and prospect for improvement of the existing traditionally managed homestead forests. Majority of homestead forests were found under-utilized with

limited fruit trees and vegetables. No scientific management practices have been identified to improve homestead forest productivity. Homestead forests serve as source of cash income. Different parts of trees like twigs, leaves, branches etc. can fulfill the requirement of fuel. 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). Different studies have been conducted on the potential of homestead forests across the world. Kabir and webb (2008a) stated homestead forests as a island of high level species diversity. Homestead forests also act as living gene banks where landraces, rare species, and endangered species are conserved (Vogl *et. al.*, 2002).

2.8 Homestead forests of Bangladesh

Homestead forests in Bangladesh are normally built on a raised land to avoid flood water during the monsoon. Each homestead normally consists of a dwelling house and the homegarden. A wide variety of indigenous and introduced plants in multiple structures are found in the homestead forests of Bangladesh. Das (1990) have documented that a total 149 tree species are found in the homestead forests of Bangladesh. About 444 million mature and about 611 million immature bamboo culms, 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 cane are in the homestead forests of Bangladesh (FMP, 1992). Homestead forests in Bangladesh are more reliable source of substance income for the farmers than the crop field. Homestead forests are known as very important suppliers of forest products of the country which contribute about 80 – 82% of all forest products in Bangladesh (Douglas, 1982). The homestead forests of Bangladesh provide about 85 – 90% fuelwood, 80% round wood, 65 – 75% saw logs and almost 90% bamboo of the total requirement of the country (Khan, 2001; Uddin *et al.*, 2002). Woody vegetation at homesteads has a positive effect on the improvement in soil moisture through shading and mulching. A recent trend of planting multipurpose plants in the homestead forests is common among the homestead owners rather only planting 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 household. Different researchers like Salam *et al.* (2000), Millat-e-Mustafa *et al.* (2002), Ahmed and Rahman (2004) stated that the changing ecological factors combined with economic conditions influence local people to replace some of the earlier species with new ones. Species composition in the homestead forest forests of Bangladesh is ranging from small herbs to big trees. Of the total land mass of

Bangladesh 7.26% are occupied by homestead forests (Das, 1986). The limited space forces people to accommodate a large number of species in relatively small areas. The religious and cultural belief, customs etc. of the villagers influence the composition and diversity of homestead forests in Bangladesh (Millat-e-Mustafa *et al.*, 1996).

Several studies have already been conducted on homestead forests in various corner of the country (Kabir, 2007). Most of these studies explored basically the floristic and structure of the homestead forests (Ahmed and Rahman, 2004; Ali, 2005). Investigation on the management practice of homestead forests (except Millat-e-Mustafa *et al.*, 2000; Kabir and Webb, 2008) and relation between garden and household characters forming model equation (except Salam *et al.*, 2000; Kabir and Webb, 2008) is largely overlooked by the researchers. Homestead forests are said to be an important repositories of biodiversity, but no studies (except Kabir and Webb, 2008) have been conducted on the investigation of the potential of homestead forests in biodiversity conservation in Bangladesh where natural forests have lost their potential to meet their basic needs for forest resources.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter includes details methods and materials used to conduct the study. The study was conducted in Charfassion, Lalmohan and Tazumuddin upazilas (sub-districts) of Bhola district in Bangladesh. An exploratory inventory was conducted for exploring the structure, species composition, diversity and utilization of homestead forests products.

3.2 Study area profile

3.2.1 The study area

Bhola district (under Barisal division) is a riverine delta and offshore island and is comprised of 3403.48 sq km, which is bounded by Lakshmipur and Barisal districts on the north, Bay of Bengal on the south, Lakshmipur and Noakhali districts, Meghna (lower) river and Shahbazpur channel on the east, Patuakhali district and Tentulia river on the west (BBS, 2013b).

Bhola is the largest riverine delta island of the world (BBS, 2013b) and one of the nineteen coastal districts of Bangladesh (Ahmed, 2011; Islam *et al.*, 2013). It is an offshore island and was established as a district in 1984. The district lies between 21°54' and 22°52' north latitudes and between 90°34' and 91°01' east longitudes. The total area of the district is 3403.48 sq km (1314.08 sq miles) of which 1456.87 sq km is under forest. Bhola district consists of 7 upazilas (sub-districts), 68 unions, 438 villages, 5 paurashavas, 45 wards and 68 mahallas. The names of upazilas are Bhola sadar, Daulatkhan, Burhanuddin, Tazumuddin, Lalmohan, Charfasson and Manpura (BBS, 2013b).

3.2.2 Soil condition

The estuarine floodplain landscape occupies Bhola district and the landscape has been formed by the combined actions of river Meghna, Brahmaputra and Ganges. The soil of Bhola district is mainly calcareous grey flood-plain soils and is almost silty to clayey in texture. The soil of this area is slightly saline in nature (BBS, 2013a; Islam *et al.*, 2013).

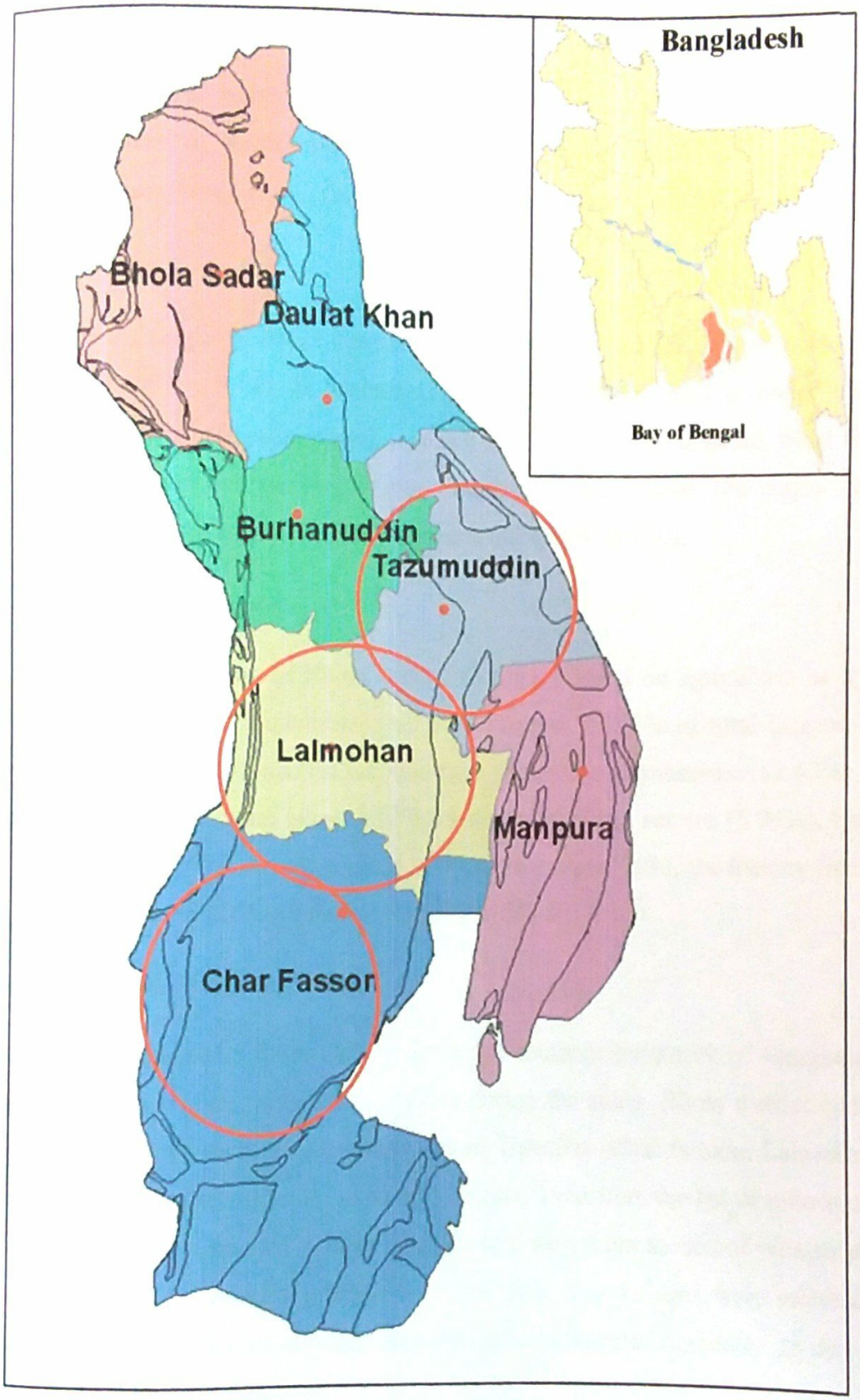

Figure 3.1: Location and relative position of the study area. Circles indicate the study area. (Source: LGED)

3.2.3 Climate

The annual average maximum temperature of this district is 32.7°C and the minimum is11.6°C. The amount of annual rainfall is about 2360mm. Bhola district faces different natural calamities like river erosion, flood and storm almost every year (BBS, 2013b).

3.2.4 Land use

The majority of the people in Bhola district depend on agriculture for their subsistence. The total cultivable land is 167848.90 hectare of which only 2.16% area is under irrigation facility. The main crops are paddy, potato, onion, chili, mustard seed, garlic, betel leaf and betel nut etc. and extinct and near extinct crops are tobacco and linseed. The major fruits are jackfruit, mango, coconut, papaya, amra and banana etc. (BBS, 2013b).

3.2.5 Socio-economic condition

The socio-economic condition of Bhola district is largely based on agriculture as it is the occupation of the majority of inhabitants of Bhola district. 64.01% of total income comes from agriculture in this district and the second major profession is commerce (12.67%). Other occupations are non-agricultural labor (4.95%), industry (0.50%), service (5.74%), transport and communication (2.47%) etc.. According to the census report 2011, the literacy rate of the district is 43.3%; male 43.60% and female 42.90% (BBS, 2013b).

3.3 Research methods/ sampling design

The study was conducted in Bhola district from the southern extremity of Bangladesh. A multistage random sampling method was applied during the study. Bhola district consist of seven Upazilas and from these seven upazilas, three Upazilas (Char fassion, Lalmohan, and Tazumuddin) were selected randomly as sampling units. Then from the list of unions of each Upazila, two unions were selected randomly. In the next step, from the list of villages of each union, two villages were selected randomly. In this way, four villages were selected from each Upazila. Then five homesteads from each village were selected randomly. In this way, a total of 60 homesteads were surveyed.

3.4 Data Collection

Relevant information and literature were collected from the following two sources in order to fulfill the objectives set out for this study.

3.4.1 Primary data collection

The necessary data required to fulfill the objective of the study was collected from the selected samples by using a "Homestead Forest Inventory Form" and a "semi structured questionnaire".

In case of obtaining information about horizontal structure, vertical structure, species composition and diversity the "Homestead Forest Inventory Form" was used. And in case of obtaining information about the demographic and socio-economic indicators of the households semi structured questionnaire was used.

a. Inventory part:

A botanical inventory was conducted in each homestead forest by using a "Homestead Forest Inventory Form". All tree and shrub species of the homestead forests were identified and recorded by to local name, domesticity, origin, and major uses. Every individual tree and shrub species excluding those located on hedgerows were counted. The tree and shrub species located on the hedgerows and individuals of herbs were not counted due to difficulty in differentiating stems. The height of individual tree and shrub species were measured. In case of measuring the height up to 1m, a scaled measuring pole and in case of measuring the height above 1m, a Haga altimeter was used (Kabir and Webb, 2008b).

b. Questionnaire survey:

A semi structured questionnaire survey and field observation were conducted on 60 homesteads to get information about utilization and importance of homestead forests. The survey was conducted on the variety of demographic and socio-economic indicators of the respondents such as occupation, literacy level, , family size, number of earning members, size and area of homestead, agricultural and total landholdings, annual income from agriculture, off-farm and homestead forests, hours spent for homegardening etc.

3.4.2. Secondary data collection

The secondary sources of data included books, journals, various publications of government, institutions, and many other different non-govt. organizations, articles of different newspapers and other different research papers on the same or similar issues have been used for data collection. In addition to this, internet has also been used as secondary source of data collection.

3.5 Data processing and analysis

The collected data of "Homestead Forest Inventory" and "semi structured questionnaire were classified in different categories to fulfill the objective of the study. The data were categorized according to the family of species, horizontal stratum or founding location in the homestead (only the border, interior part only, or both border and interior part), vertical stratum (ground layer [up to 2m], understory [above 2m to 5m], middle canopy [above 5m to 15m], overstory [above 15m to 25m], or emergent [above 25m]), domesticity (planted or naturally grown) and uses (Kabir and webb, 2008b; Foysal *et. al.*, 2013; Roy *et. al.*, 2013).

Different ecological equations were applied to assess the species composition, diversity and structure of homestead forests. Frequency, relative frequency, density, relative density, abundance, and relative abundance of species in the study area were measured by using the following formulas according to Curtis and McIntosh (1950), Kabir and Webb (2008). And then the importance value index (IVI) for each tree and shrub species was estimated by totaling relative abundance and relative frequency according to Das and Das (2005), Kabir and Webb (2008). And in case of estimating species diversity, the formula of Shanon-Winner index for diversity (Michael, 1990), species richness index and species evenness index formula by Margalaf (Margalef, 1958) were used.

For data analysis IBM SPSS statistics version 20.0 and Microsoft excel version 2007 software were used.

CHAPTER FOUR: VEGETATION OF HOMESTEAD FORESTS AND ITS CONTRIBUTION TO HOUSEHOLD ECONOMY

4.1 Introduction

Homestead forests are the clusters of trees around homesteads (Rahman *et. al.*, 2005) and exhibit remarkable variability in composition and structure (Muhammed *et. al.*, 2011). Rapid deforestation and over-exploitation of forest resource put a question mark on the capability of biodiversity conservation of homestead forests in Bangladesh. The initial step in assessing the capability of homestead forests in biodiversity conservation is to undertake floristic and structural inventory. Total species richness is the key to measure the direct conservation value of homestead forests (Michon and Mary, 1994; Montagnini, 2006). This chapter includes the floristic composition and structural characteristics of homestead forests in Bhola district and it's relation to household characteristics addressing the potential of homestead forests to contribute to plant biodiversity conservation and improvement in household socio-economic condition.

4.2 Homestead forest size

The total homestead area surveyed in this study was 12.75 ha ranged from 0.13 ha to 0.39 ha from a total of 60 sampled households with the median of 0.18 ha.

4.3 Vegetation of homestead forest

4.3.1 Species composition

A total of 69 plant species in 34 families were recorded in the homestead forests of all 60 sampled households of remnant island Bhola. The number of plant species would increase if surveys are conducted across seasons. Leguminosae sub-families accounted for approximately 17% of the total accounted species. There were 51 tree, 7 shrub, 8 herb and 3 non-woody climbers out of 69 plant species from the study area. Trees accounted about 74% of all identified species. Species native to the Indian subcontinent accounted for 55.07%.

Homestead forests of Bhola Island contained an average of 29 species containing minimum 23 and maximum 35 plant species and represented by 14 native and 15 exotic species. A mean homestead forest was represented by 21 species of trees, 3 shrubs, 4 herbs, and 1 non-woody climber.

Table 4.1: Species composition of the homestead forests in the study area

Study of plant life form	All homestead forest					Per homestead forest			
	Number of species			No. of family	Percent of species	Number of species			Percent of species
	Native	Exotic	Total			Native	Exotic	Total	
Tree	31	20	51	21	73.91			21	72.41
Shrub	2	5	7	5	10.14			3	10.34
Herb	4	4	8	8	11.59	14	15	4	13.79
Climbers	1	2	3	1	4.35			1	3.45
Total	38	31	69	34	100	14	15	29	100

Total number of homestead forest sampled 60 totaling 12.75 ha area. Species origins were determined according Kabir (2007).

4.3.2 Species richness

Out of 69 plant species, 51 species were recorded as tree species (74%), 7 shrub species (10%), 8 herb species (12%) and 3 non-woody climber species (4%). Betel nut (*Areca catechu*), Rain tree (*Samanea saman*), Coconut (*Cocos nucifera*), Velvety apple (*Diospyros phillipensis*), and Mango (*Mangifera indica*) were top five tree species, where as Lemon (*Citrus limon*), and Banana (*Musa spp.*) and Lalshak (*Amaranthus gangeticus*) are the most prominent shrub and herb species respectively in the homestead forests of the study area. The calculated value of Shannon-Winner index, species richness index and species evenness index were 2.06, 5.25 and 0.524 respectively representing more richness and more evenly distribution of tree species.

4.3.3 Species rarity

Although the species similarity across the study area were high, the majority of species could be considered as rare (low frequency and abundance) among the available plant species in the homestead forests. In terms of all species, 2.94% were found in 5 or fewer homestead forests and 15.94% in 10 or fewer homestead forests. *Annona squamosa* L. and *Cassia fistula* L. were found very rare in all 60 surveyed homestead forests. Only 9 plant species (13.05% of all recorded species) were found in more than 50 out of 60 homestead forests. In terms of native plant species, only 3 out of 69 species were found in more than 50 homestead forests.

In addition around 68% species were found in 30 or fewer of all surveyed homestead forests (Figure 4.1).

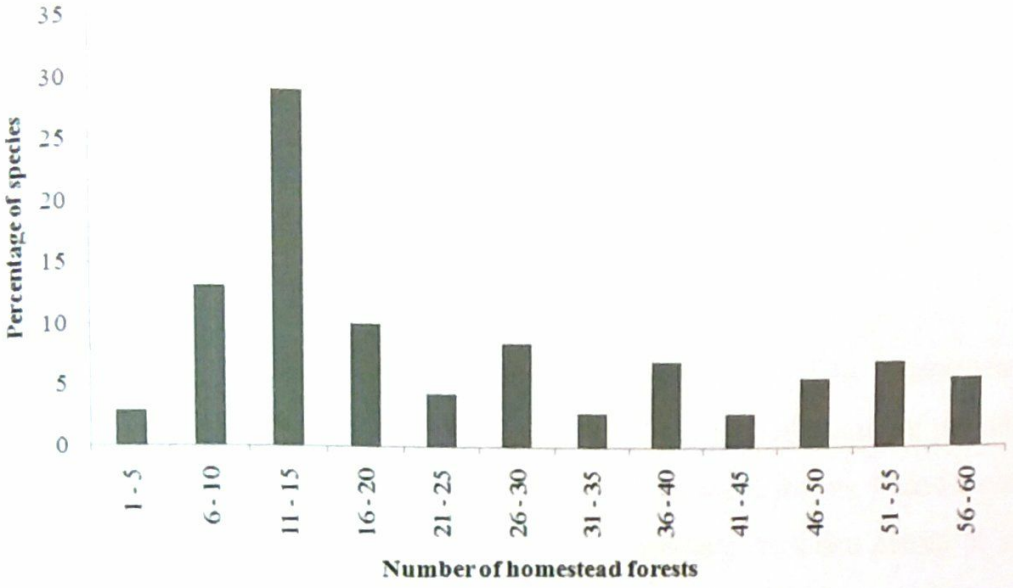

Figure 4.1: Proportion of species growing in number of homestead forests.

About 57% of all species of tree (43.14%) and shrub (71.43%) had 25 or fewer individuals each and about 72% (58.83% tree and 85.72% shrub) had 50 or fewer individuals each. Only four out of all 51 recorded tree species had 1,000 or more individuals each (max 8,558) and only one out of seven shrub species had 100 or more individuals (Figure 4.2).

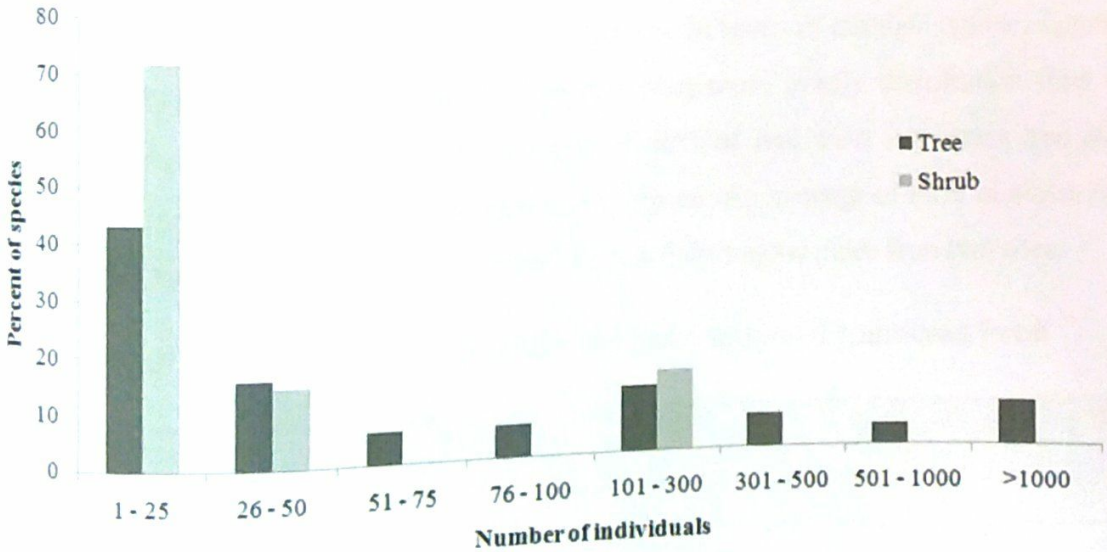

Figure 4.2: Proportion of species with number of individuals

4.4 Homestead forest structure

4.4.1 Horizontal structure

A total number of 16,784 individuals of tree and shrub species were recorded form the homestead forests in the study area. About 98% of all recorded individuals of trees and shrubs were for trees and the rest for shrubs. The individuals of trees were substantially higher than that of shrubs within and between homestead forests. About 23% of all recorded individuals of trees and shrubs were native to Indian Subcontinent.

The median homestead forest of 0.18 ha contained 276 individuals (1533 ha^{-1}) represented by 272 trees and 4 shrubs. Tree and shrub stem density would increase if inventory included the individuals from hedgerows. Overall stem density in the homestead forests would increase if the surveys were conducted across seasons and if the inventory included plants of all life forms.

Approximately 38% of all recorded plant species of five most important plant species in each life from were native to the Indian Subcontinent. Five most important species of trees showed relatively similar evenness among them in all surveyed homestead forests. In terms of shrub life form, *Citrus limon* (Kagoji lebu) showed substantially higher abundance and frequency than other four species among the five most important shrub species. In terms of herb synuse, *Musa spp.* (Kola) and *Amaranthus gangeticus* (Lal shak) had higher frequency than other three species among five most important herb species. In terms of climber synuse, *Lagenaria siceraria* (Lao) showed higher frequency representing more evenly distribution than other climber species in the study area. An average of 40% of five most important tree (60%), shrub (20%), and herb (40%) species were multipurpose. An average of 90% of shrub (80%) and climber (100%) species in the homestead forests didn't show more than two uses.

Table 4.2: The five most important tree, shrub and herbs species of homestead forest

SL no.	Botanical name	Local name	Family	Origin	Uses	RF
	Trees					
1	*Areca catechu*	Supari	Palmae	E	2, 6	4.81
2	*Cocos nucifera*	Narikel	Palmae	N	1, 2, 4	4.81
3	*Mangifera indica*	Aam	Anacardiaceae	N	1, 2, 6, 7	4.65
4	*Samanea saman*	Rain tree	Leguminosae	E	4, 6	4.65
5	*Artocarpus heterophyllus*	Kanthal	Moraceae	E	1, 2, 6	4.17

Table 4.3: Number of species and individuals in different stratum of homestead forests

Stratum	Species		Individuals of trees and shrubs	
	No. of species	% of all species	No. of individuals	% of individuals
Ground	5	7	11	0.07
Understory	16	23	547	3.26
Middle canopy	31	45	3325	19.81
Overstory	10	14	1046	6.23
Emergent	7	10	11855	70.63
Total	69		16784	

4.5 Product utilization of homestead forests

4.5.1 Uses diversity of species

Farmers use all plant species those were found in the homestead forests and performed any use out of major nine uses. Total numbers of species used for food (fruits and vegetables) were 43 (62.32% of all recorded species), 6 (8.70%) for medicine, 34 (49.28%) for fuelwood, 20 (28.99%) for timber, 4 (5.80%) for ornamental and religious and 7 (10.14%) for fodder. Species used to earn cash from the sale of surplus homestead forest products after subsistence consumption to supplement family income were 65.22% of all recorded species (Table 4.4). Cash income from the sale of homestead forest products was not an end use. Generally, native plant species were more commonly used for all purposes except for commercial and fibre production because of the capability of exotic species to produce these valuable products faster than native plant species. Multipurpose species (more than two uses) in the sampled homestead forests were 26 (37% of all recorded species), with 12 species (17% of all recorded species) having four uses. About 45% (31 species) of all the recorded species are used for two purposes.

Table 4.4: Functional diversity of plants in the homestead forests

Uses	Total		Native		Exotic	
	Species	%	Species	%	Species	%
Food	43	62.32	21	48.84	22	51.16
Commercial	45	65.22	21	46.67	24	53.33
Medicinal	6	8.70	3	50.00	3	50.00
Fuelwood	34	49.28	23	67.65	11	32.35
Ornamental	4	5.80	2	50.00	2	50.00
Timber	20	28.99	12	60.00	8	40.00
Fodder	7	10.14	4	57.14	3	42.86
Fibre	1	1.45	1	100.00	0	0.00

Religious/ceremonial	4	5.80	1	25.00	3	75.00
1 use	12	17	11	91	1	9
2 uses	31	45	13	42	18	58
3 uses	14	20	6	43	8	57
4 uses	12	17	8	67	4	33

Total percent for species and individuals in nine different use categories exceeded 100 because many of the recorded species were multipurpose.

4.5.2 Annual contribution of homestead forest products to household economy

In many households of Bangladesh, a major source of subsistence economy and self-sufficiency is homestead forests because of their miscellaneous products (Salam *et. al.*, 2000; Millat-e-Mustafa *et. al.*, 2002; Ali, 2005). In this study, it was found that about 65.22% of all recorded species are used to earn cash from the sale of surplus homestead forest products after subsistence consumption representing a good mix of subsistence and commercial use of homestead forest products by the farmers.

Mean annual income from the homestead forest may vary depending on the components and nature of product utilization. Kabir and Webb (2009) stated that household income from homestead forest may vary from 6% to 54% in South and Southeast Asia. In this study it was found that about 20% of the total household income came from homestead forest products. Across the households, the homestead forest contribution ranged from 10.22% to 35.68% of total household income. Major portion of household income (69.55%) came from agriculture and the rest (10.60%) from off-farm income (Table 4.5).

Table 4.5: Mean annual income from three major household income sources per household in the study area

Source of household income	Per household income	
	Amount US$**	Income %
Off-farm	217.85	10.60
Agriculture	1429.40	69.55
Homestead forest	407.90	19.85
Total	2055.15	*10.22 – 35.68

* Range of homestead forest contribution to total household income. ** 1 US$ = 78.5 BDT as dated 25/9/16.

4. 6 Contribution of homestead forests to household economy

4.6.1 Household biophysical condition

Access to both the local market and nearest urban center from the households was paved in the study area. The mean distance to the nearest market and urban center from the household were 1.7 Km and 16.7 Km respectively ranged from 1 to 3 Km and 5 to 33 Km.

4.6.2 Demographic conditions

A wide range of age of the household and household head was identified in this study (Figure 4.3). All of the household heads were male and married. 8.33% of the household heads were illiterate and 91.67% were educated among which 65.46% have attained primary level, 30.91% have completed secondary level and the rest 3.64% have completed higher secondary level. The median family size was 7 members ranging from 5 to 11 members. The median earning and literate members were 1 and 6 respectively.

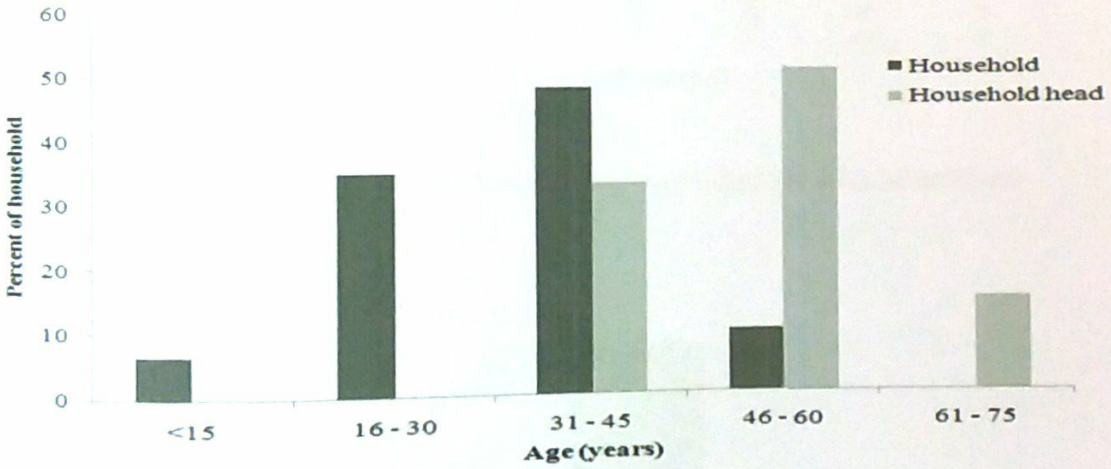

Figure 4.3: Age distribution of households and household's head

The median landholding size per household was 0.82 ha, of which 79% was used for agriculture and the rest for homestead, occupied by dwelling house and homestead forest. About 73% household had ≤ 1.0 ha total landholdings. 25% of the household had more than 1 to maximum 1.5 ha total landholdings and the rest 1.67% had more than 1.5 ha total land (Figure 4.4). The maximum total land holding was 1.62 ha only for one household.

In terms of agricultural landholdings, only 5% household had more than one hectare and 8% household had no agricultural land (Figure 4.4). Land allocated for homestead is significantly smaller than that for agricultural activities. No household was found in this study having

more than 0.50 ha homestead land (Figure 4.4). The median homestead size was 0.18 ha ranging from 0.13 ha to 0.39 ha. About 78% household had ≤ 0.30 ha homestead land (Figure 4.5).

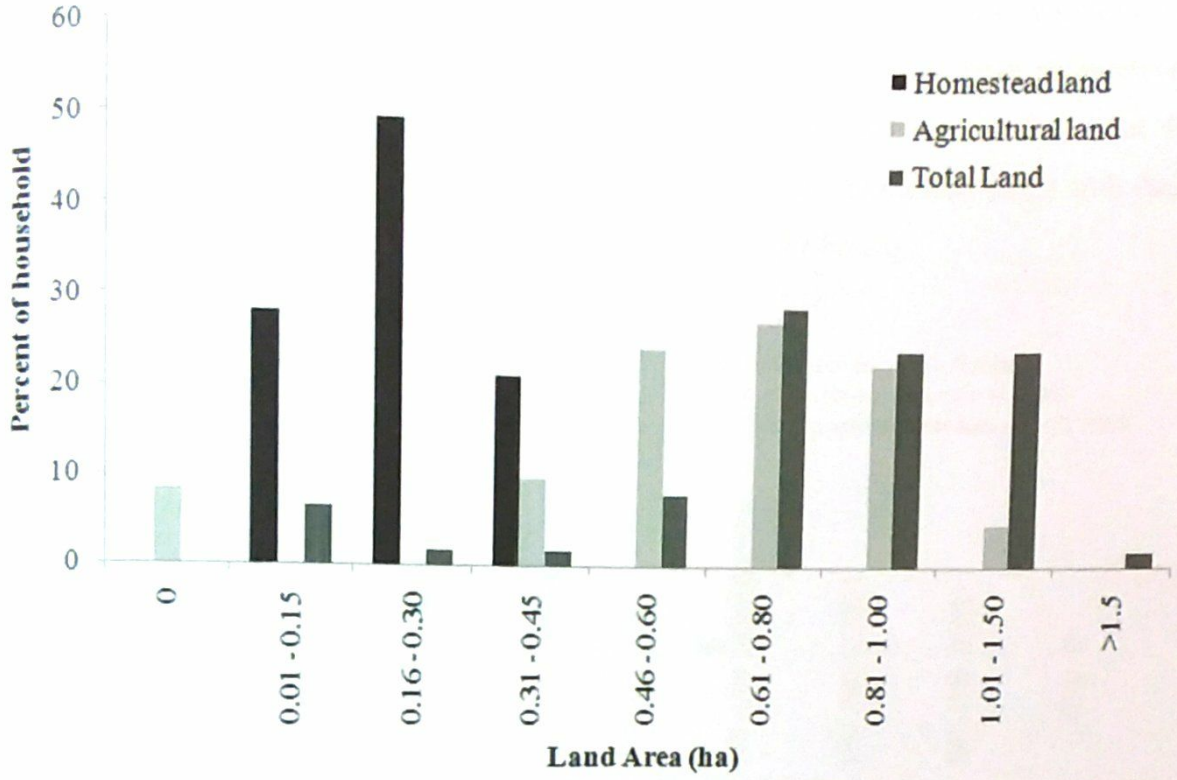

Figure 4.4: Household's area allocation for agriculture and homestead use

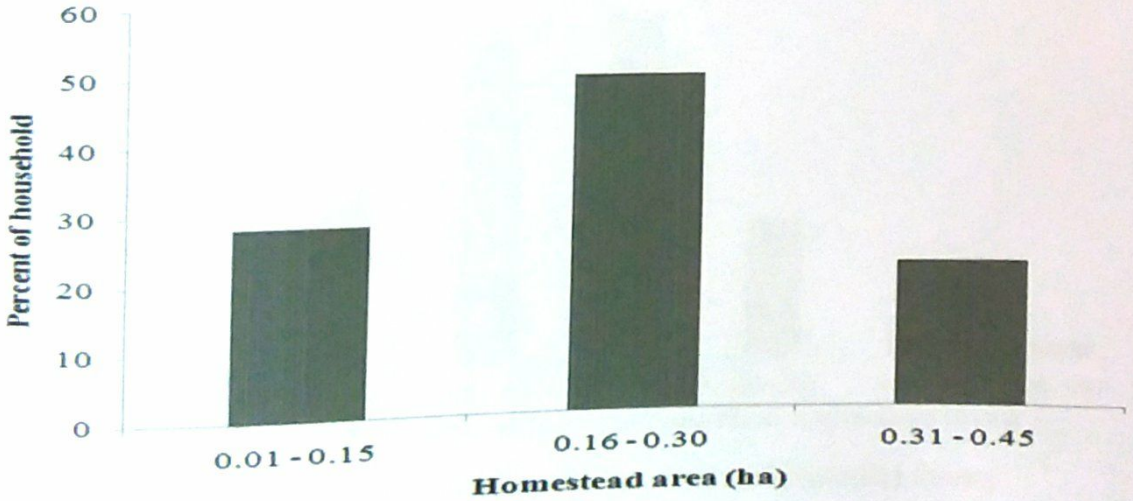

Figure 4.5: Frequency distribution of households homestead size.

Agriculture was the occupation and major source of income for 90% of the household and the rest were fishermen and small scale businessmen. The median annual income per household was 1808 US$, consisting of 1275US$ (70%) from agriculture, 343 US$ (19%) form

homestead forest and the rest 190 US$ (11%) from off-farm income. In terms of off-farm and agricultural income 33.33% and 8.33% household had no income respectively. In terms of household had more than 1000US$ income per year and 5% household had more than 2500US$ income per year (Figure 4.6). In terms of income from homestead forest, about 71% household had ≤ 500 US$ income per year from the homestead forest products. Homestead forest contributed 0–20% of the total income for about 49% households (Figure 4.7). Most households (98%) managed their homestead forest with family labor spending a median of seven hours per week (range: 2–17 hours).

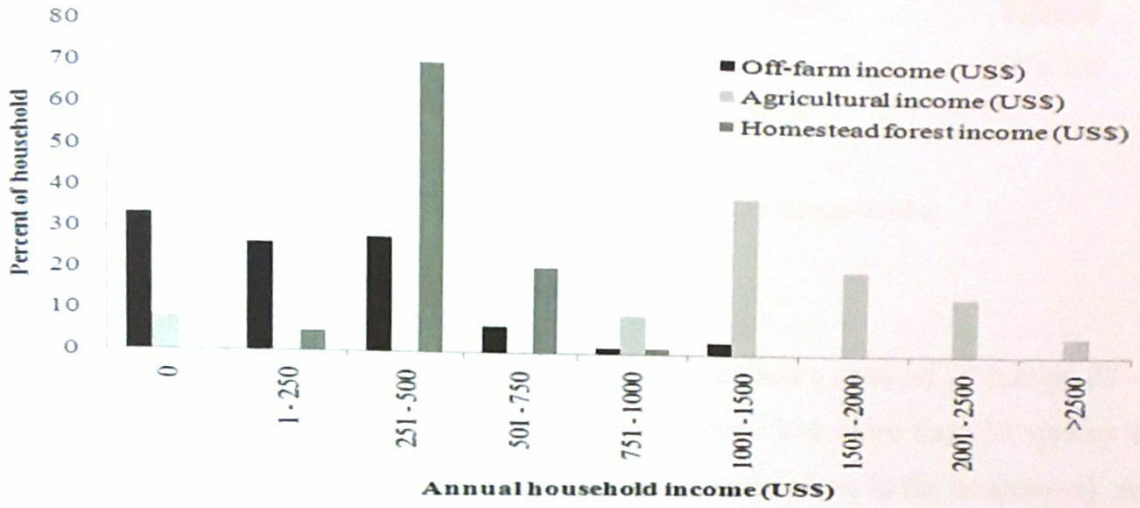

Figure 4.6: Households income from various sources.

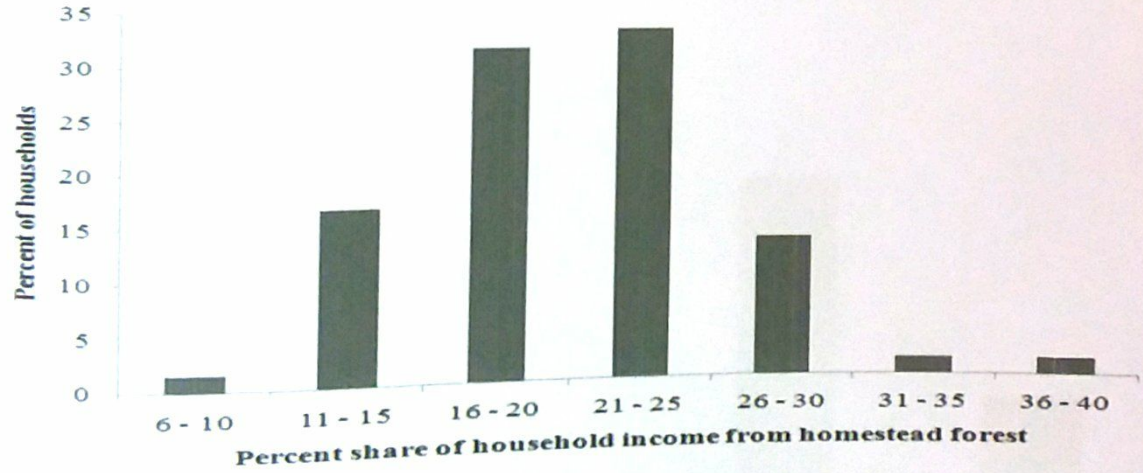

Figure 4.7: Share of household's income from homestead forests

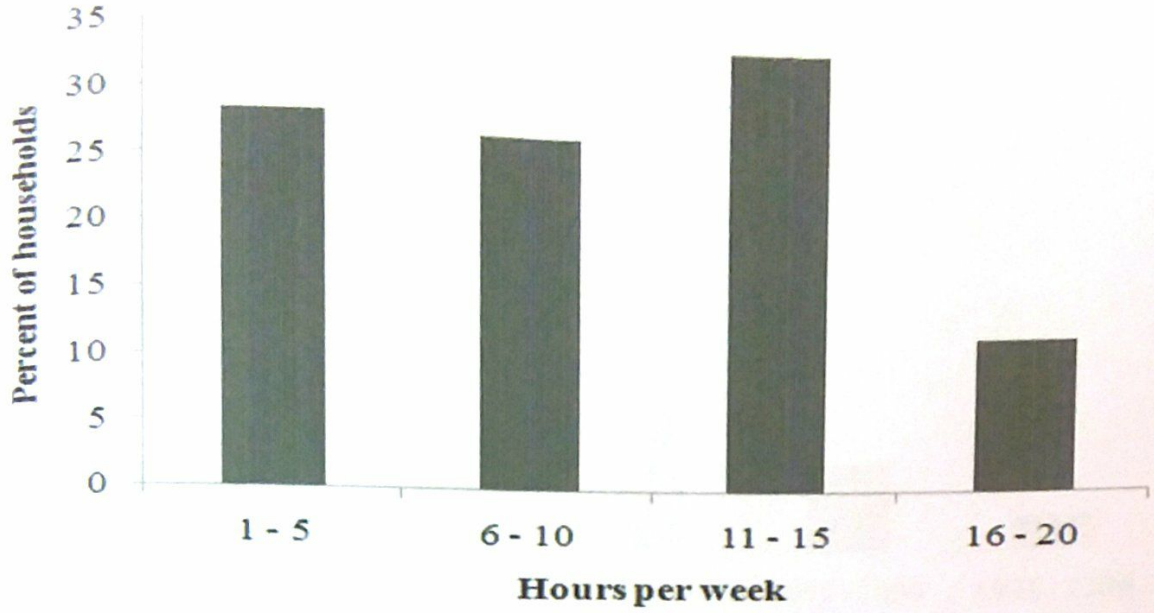

Figure 4.8: Pattern of labor investment for homegardening

4.6.3 Homestead forest biophysical conditions

The median homestead forest of 0.18 ha (1800m^2) contained a mean of 29 (range: 23 – 35) species (Figure 4.9). 25% of the total homestead forests had more than 30 species each. Overall tree and shrub stem density were 1316 ha^{-1} (except stems in the hedgerows). About 76% of the homestead forests had stem density between 1000 to 1600 ha^{-1}. 11% of the homestead forest had ≤ 1000 ha^{-1} and only one homestead forest had ≥ 2000 ha^{-1} stem density (Figure 4.10).

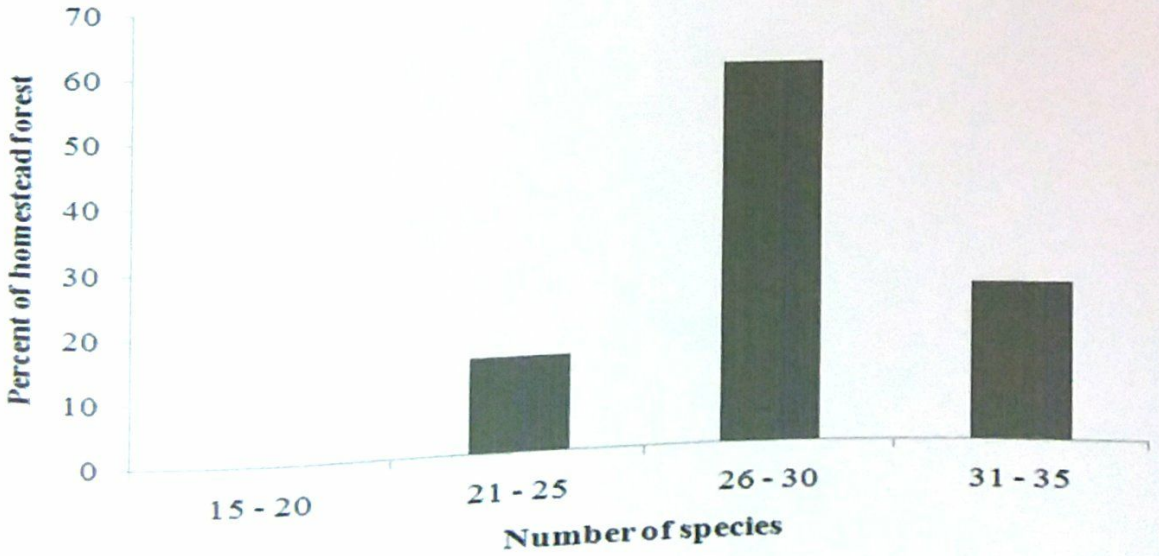

Figure 4.9: Species richness in homestead forests

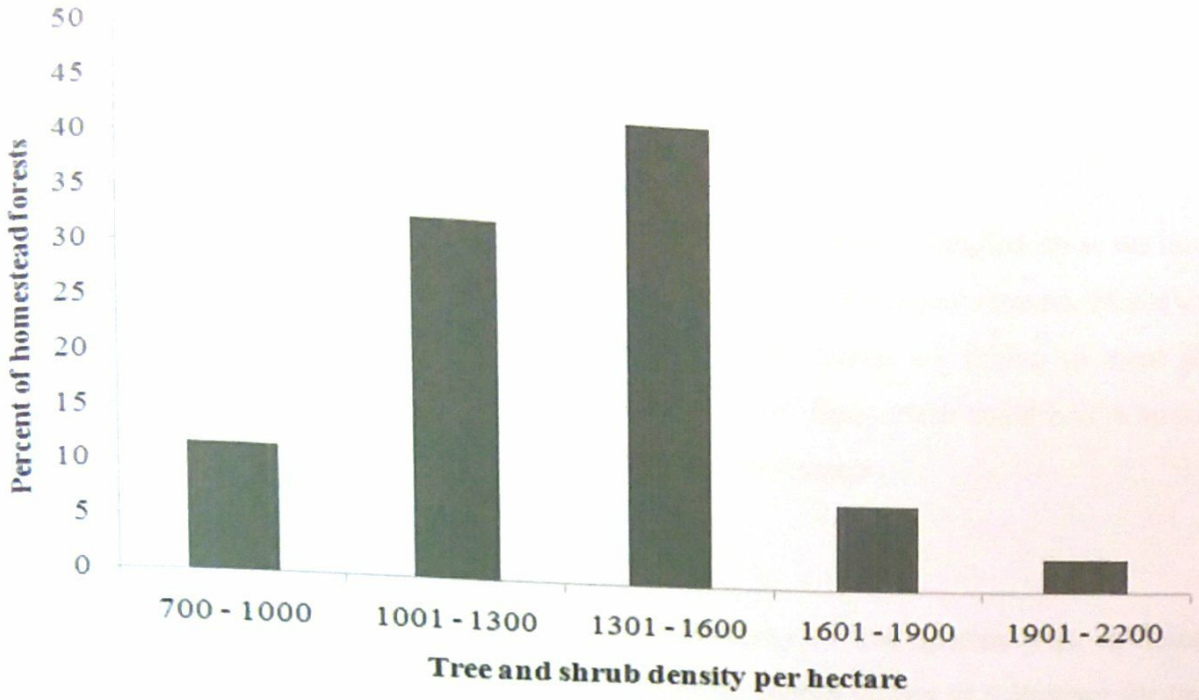

Figure 4.10: Tree and shrubs stem density in homestead forests

CHAPTER FIVE: SYNTHESIS OF THE RESEARCH FINDINGS

5.1 Target of synthesis

Biological resources and diversity act as the backbone of economy of Bangladesh as we have limited mineral resources. But with the rapid increase in population and demand, biological resource is degrading at an alarming rate and the natural forests are failing to meet the demand of the country. In this context, homestead forests of Bangladesh could hold a strong potential for biodiversity conservation and livelihood improvement.

5.2 Synthesis of research findings

- The findings of this study stated a wide diversity of tree species with sufficient individuals. It is a sign of efficacy of homestead forests system as a strategy for tree species conservation outside their natural habitat. The homestead forests of the study area are playing a crucial role to conserve numerous native and rare species. The number of shrubs, herbs and climbers were comparatively lower in the study area. It indicates that it is necessary to put more emphasize on increasing the number of shrubs, herbs and climber species in the study area and ensure their conservation.
- This study has identified many species with very low frequency and abundance. So, the findings of this study can help policy makers of the country to take initiatives to increase the frequency and abundance of these rare species and ensure its sustainability.
- As the population of the country is increasing day by day and forest cover is diminishing rapidly, homestead forests can cope with this problem to meet the increasing demand of natural resources for daily requirement of huge population.
- The finding of this study states that the surplus products of homestead forests are playing a very crucial role in the household economy of the study area. This will help to understand the significance of homestead forests in the improvement of socio-economic conditions of the households of the study area and can be a example for any other places of the country.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6. 1 Conclusion

The study was conducted in three upazilas namely Charfassion, Lalmohan and Tazumuddin of Bhola district. Multistage random sampling was used to collect data from 60 sampled homestead forests. A total of 69 plant species including 51 trees, 7 shrubs, 8 herbs and 3 climbers were recorded and about 55% of them were native to the Indian Subcontinent representing a wide diversity of species, especially for tree species. An average of 29 plant species and 276 individuals were recorded in a median of 1800 m^2 homestead forests. Tree and shrub stem density was recorded 1533 ha^{-1} representing higher number of individuals per homestead. The middle canopy consisted the highest proportion of all recorded species. About 13% of all recorded species were found in more than 50 out of 60 homestead forests representing that majority of the species were rare. About 65% of all recorded species were used for commercial purposes which represents the choice of household for growing and maintaining homestead forests for financial support. The median annual income per household was 1808 US$ and about 20% of the total income came from homestead forests which represent a good contribution of homestead forests in household economy.

6.2 Recommendation

The current situation of the study area agrees that no alternative means for subsistence and surplus income generation against homestead forest. The following recommendations are necessary to meet the demand for various forest products of the ever-increasing population and biodiversity conservation –

- The households grow and manage homestead forests traditionally. They don't have any advanced knowledge regarding planting and managing homestead forests. It is recommended to provide training on advanced technology related to homestead forests for better environmental and economical benefits.
- Structure of homestead forests can be improved by better allocation of plants in relation to homestead areas. So, it is recommended to conduct more details study on structural improvements of homestead forest.
- As the study area is much vulnerable to natural disasters like river bank erosion, cyclones etc., it is recommended to take initiative to motivate the farmers to plant more and more plant species for the protection from these disasters.

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Appendix 3.1

Homestead forest inventory form

1. Household no.:
2. Address:
   Village:
3. Homestead area: Union: Thana:
4. Plant species composition

S/N	Local Name	Scientific name	No. of individuals	Origin		Note
				N	E	
1						
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Appendix 3.2

Household Characteristics Survey Questionnaire

Household no.: _____

Village: _____

Union: _____

Sub-district: _____

A. Biophysical conditions

1. Road access to local market _____ Mud _____ Paved
2. Road access to nearest urban center _____ Mud _____ Paved
3. Distance to local market _____ Km
4. Distance to nearest urban center _____ Km

B. Demographic conditions

1. Age of the household _____ Years
2. Age of the household head _____ Years
3. Gender of the household head _____ Male _____ Female
4. Education of the household head _____ Years of schooling
5. Total family size _____ Male _____ Female _____ Total
6. Number of earning members _____ Male _____ Female _____ Total
7. Number of literate members _____ Male _____ Female _____ Total

C. Socio-economic conditions

1. Homestead size (dwelling + Homestead) _____ Decimal
2. Agricultural landholding _____ Decimal
3. Total landholding _____ Decimal
4. Off-farm income _____ Taka per year
5. Agricultural income _____ Taka per year
6. Homestead forest income (use +sale) _____ Taka per year
7. Occupation of the household head _____ Agriculture ____Non-agriculture
8. Major source of income _____ Agriculture ____Non-agriculture
9. Time spent for homegardening _____Hours per week

Appendix 4.1

Plant species list from homestead forests of remnant island Bhola. F is the frequency of homesteads from where species was recorded. RA is the relative abundance of each species. RIV is the relative importance value. RF is the relative frequency. For uses, 1 = food, 2 = commercial, 3 = medicine, 4 = fuelwood, 5 = ornamental, 6 = timber, 7 = fodder, 8 = fiber, and 9 = religious/ceremonial

S/N	Species name	Scientific name	Family	Origin	Uses	F	RF%	RA%	RIV
Trees									
1	Aam	*Mangifera indica* L.	Anacardiaceae	Native	1, 2, 6, 7	58	4.65	3.86	4.26
2	Akashmoni	*Accacia auriculformis* A. Cunn. Ex Benth.	Leguminosae	Exotic	4, 6	12	0.96	0.33	0.64
3	Amloki	*Phyllanthus emblica* L.	Euphorbiaceae	Native	1, 2, 4	8	0.64	0.12	0.38
4	Amra	*Spondias pinnata* (L.f.) Kurz	Anacardiaceae	Native	1, 2, 4	47	3.77	1.93	2.85
5	Arjun	*Terminalia arjuna* Wight & Arn.	Combretaceae	Native	3, 4	13	1.04	0.12	0.58
6	Ata	*Annona reticulata* L.	Annonaceae	Exotic	1, 4	17	1.36	0.12	0.74
7	Babla	*Acacia nilotica* Karst.	Leguminosae	Exotic	2, 4, 6, 7	9	0.72	0.07	0.40
8	Batabi Lebu	*Citrus grandis* (L.) Osbeck	Rutaceae	Exotic	1, 2	51	4.09	0.68	2.39
9	Bel	*Aegle marmelos* (L.) Correa	Rutaceae	Native	1, 2, 4	14	1.12	0.11	0.62
10	Bilati Gab	*Diospyros phillipensis* (Desr.) M.R. Almeida	Ebenaceae	Exotic	1, 2, 4, 6	48	3.85	7.52	5.69
11	Bokul	*Mimusops elengi* L.	Sapotaceae	Exotic	1, 2, 4, 6	15	1.20	0.10	0.65
12	Boroi	*Ziziphus nummularia* (Burm.f.) W. & A.	Rhamnaceae	Native	1, 2	30	2.41	0.89	1.65
13	Chalta	*Dillenia indica* L.	Dilleniaceae	Native	1, 2, 4	40	3.21	0.48	1.85
14	Chambul	*Albizia richardiana* King & Prain	Leguminosae	Native	4	34	2.73	2.54	2.63
15	Dalim	*Punica granatum* L.	Punicaeae	Exotic	1, 2	6	0.48	0.04	0.26
16	Daruchini	*Cinnamomum verum* J. Presl	Lauraceae	Exotic	1, 2	11	0.88	0.07	0.47
17	Deshi Gab	*Diospyros peregrina* Gurke	Ebenaceae	Native	4	16	1.28	0.16	0.72
18	Dewa	*Artocarpus lakoocha* Roxb.	Moraceae	Native	1, 2, 4, 6	10	0.80	0.09	0.45
19	Dumur	*Ficus hispida* L.f.	Moraceae	Native	1, 2, 4, 6	6	0.48	0.04	0.26
20	Jalpai	*Elaeocarpus floribundus* Blume	Elaeocarpaceae	Native	1, 2	8	0.64	0.06	0.35

S/N	Species name	Scientific name	Family	Origin	Uses	F	RF%	RA%	RIV
21	Jamrul	*Syzygium samarangense* (Blume) Merr. & L.M.Perry	Myrtaceae	Exotic	1, 2, 4, 7	29	2.33	0.26	1.29
22	Jiga	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Native	4, 6	13	1.04	0.10	0.57
23	Kalo Koroi	*Albizia lebbeck* (L.) Benth.	Leguminosae	Native	6	14	1.12	0.59	0.86
24	Kalojam	*Syzygium cumini* (L.) Skeels	Myrtaceae	Native	2, 4, 6, 7	17	1.36	0.19	0.78
25	Kamranga	*Averrhoa carambola* L.	Oxalidaceae	Exotic	1, 2, 4	36	2.89	0.35	1.62
26	Kanthal	*Artocarpus heterophyllus* Lam.	Moraceae	Exotic	1, 2, 6	52	4.17	2.45	3.31
27	Kaophal	*Garcinia cowa* Roxb.	Guttiferae	Native	1, 2	10	0.80	0.09	0.45
28	Karanja	*Pongamia pinnata* (L.) Pierre	Leguminosae	Native	4	12	0.96	0.10	0.53
29	Kat Badam	*Terminalia catappa* L.	Combretaceae	Native	4	39	3.13	1.19	2.16
30	Khejur	*Phoenix sylvestris* Roxb.	Palmae	Native	1, 2, 4	22	1.76	0.90	1.33
31	Kodbel	*Limonia acidissima* L.	Rutaceae	Native	1, 2	16	1.28	0.11	0.70
32	Litchu	*Litchi chinensis* Sonn.	Sapindaceae	Exotic	1, 2	26	2.09	0.21	1.15
33	Mandar	*Erythrina variegata* L.	Leguminosae	Native	4	26	2.09	0.35	1.22
34	Mehogoni	*Swietenia macrophylla* King	Meliaceae	Exotic	2, 6	50	4.01	3.98	3.99
35	Narikel	*Cocos nucifera* L.	Palmae	Native	1, 2, 4	60	4.81	6.93	5.87
36	Neem	*Azadirachta indica* A.Juss.	Meliaceae	Native	1, 3, 4, 7	17	1.36	0.18	0.77
37	Palash	*Butea monosperma* (Lmk.) Taub.	Leguminosae	Native	5	15	1.20	0.13	0.67
38	Peyara	*Psidium guajava* L.	Myrtaceae	Exotic	1, 2, 4	47	3.77	0.73	2.25
39	Pitraj	*Aphanamixis polystachya* (Wall.) R. N. Parker	Meliaceae	Native	4, 6	8	0.64	0.10	0.37
40	Ponial	*Calophyllum inophyllum*	Guttiferae	Native	4, 6	11	0.88	0.11	0.50
41	Rain tree	*Samanea saman* (Jacq.) Merr.	Leguminosae	Exotic	4, 6	58	4.65	7.47	6.06
42	Sada Koroi	*Albizia procera* (Roxb.) Benth.	Leguminosae	Native	6	27	2.17	0.96	1.56
43	Sarifa	*Annona squamosa* L.	Annonaceae	Exotic	1, 2	4	0.32	0.02	0.17
44	Shimul	*Bombax ceiba* L.	Bombacaceae	Exotic	2, 8	24	1.92	0.28	1.10
45	Sissoo	*Dalbergia sissoo* Roxb.	Leguminosae	Native	4, 6	12	0.96	0.17	0.57
46	Sofeda	*Manilkara zapota* (L.) P. Royen	Sapotaceae	Exotic	1, 4, 5	14	1.12	0.12	0.62
47	Sonalu	*Cassia fistula* L.	Leguminosae	Native	4	3	0.24	0.02	0.13
48	Supari	*Areca catechu* L.	Palmae	Exotic	2, 6	60	4.81	51.68	28.25

S/N	Species name	Scientific name	Family	Origin	Uses	F	RF%	RA%	RIV
49	Tal	*Borassus flabellifer* L.	Palmae	Native	1, 2, 4, 6	34	2.73	0.57	1.65
50	Tejpata	*Cinnamomum tamala* (B.-H.) F. Nees ex T.Nees & Eberm.	Lauraceae	Native	1, 2	11	0.88	0.07	0.48
51	Tentul	*Tamarindus indica* L.	Leguminosae	Exotic	1, 2, 4	27	2.17	0.24	1.20
	Shrubs								
1	Begun	*Solanum melongena* L.	Solanaceae	Exotic	1, 2	25	15.1	11.3	13.2
2	Joba	*Hibiscus rosa-sinensis* L.	Malvaceae	Exotic	3, 5, 9	12	7.2	5.4	6.3
3	Kagoji Lebu	*Citrus limon* (L.) Burm.f.	Rutaceae	Exotic	1, 2	54	32.5	44.8	38.7
4	Kamini	*Murraya paniculata* (L.) Jack	Rutaceae	Native	5	18	10.8	8.6	9.7
5	Koromcha	*Carissa carandas* L.	Apocynaceae	Native	1	10	6.0	6.3	6.2
6	Mehendi	*Lawsonia inermis* L.	Lythraceae	Exotic	9	36	21.7	18.6	20.1
7	Morich	*Capsicum annuum* L.	Solanaceae	Exotic	1, 2	11	6.6	5.0	5.8
	Herbs								
1	Anarash	*Ananas comosus* (L.) Merr. var. sativus (Schult.f.) Mez	Bromeliaceae	Exotic	1, 2, 3	11	4.56		
2	Bansh	*Bambusa spp.*	Gramineae	Native	2, 4, 6, 7	45	18.67		
3	Holud	*Curcuma longa* L.	Zingiberaceae	Native	1, 2, 3, 9	13	5.39		
4	Kachu	*Alocasia indica* (Lour) Koch	Araceae	Native	1, 2	13	5.39		
5	Kola	*Musa spp.*	Musaceae	Exotic	1, 2, 7	51	21.16		
6	Lalshak	*Amaranthus gangeticus* L.	Amaranthaceae	Native	1, 2	51	21.16		
7	Pepe	*Carica papaya* L.	Caricaceae	Exotic	1, 2	45	18.67		
8	Tulshi	*Ocimum basilicum* L.	Labiatae	Exotic	3, 9	12	4.98		
	Climbers								
1	Chal kumra	*Benincasa hispida* (Thunb.) Cogn.	Cucurbitaceae	Exotic	1, 2	17	25.76		
2	Korola	*Momordica charantia* L.	Cucurbitaceae	Exotic	1, 2	12	18.18		
3	Lao	*Lagenaria siceraria* (Md.) Standl.	Cucurbitaceae	Native	1, 2	37	56.06		