Homestead based agro biodiversity- a farmer participatory study

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled **"Homestead based agro biodiversity- a farmer participatory study**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis ,entitled **"Homestead based agro biodiversity- a farmer participatory study"** is a record of research work done independently by **Miss. Krishna Priya N**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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KRISHNA PRIYA N

AFFECTIONATELY DEDICATED
TO MY
MOTHER AND BROTHER

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

CHAPTER I

INTRODUCTION

Homestead farming is a traditional practice of multiple and mixed cropping in small holdings in Kerala. This farming system is a need based crop production system adjacent to homes of Keralites, which can be described as the "man made forest fitted to family needs". At first sight, the homestead gardens of Kerala can be seen blending with the surrounding landscape mimicking that of a natural forest ecosystem in structure and function.

Home gardens are traditional farming systems which may have evolved over time from the practices of hunters/gathers and continued in the ancient civilizations up to modern times, therefore is one of the oldest agro-ecosystems that exist throughout the world (Soemarwoto, 1987; Soemarwoto and Conway, 1992). Home gardens are an integral part of the livelihood systems, and could contribute to the family food, income and the conservation of biodiversity (Shrestha *et al*., 2004).They involve the deliberate management of multipurpose trees and shrubs (the woody component), grown in intimate association with herbaceous species (mainly annual, perennial, and seasonal agricultural crops), and livestock (Fernandes and Nair, 1986).

Home gardens are living gene banks and reservoirs of plant genetic resources that preserve landraces, obsolete cultivars, rare species and endangered species and species neglected in larger ecosystems (Eyzaguirre and Linares, 2001).

Home garden is one of the components of agro biodiversity. According to Heywood (1999) agro biodiversity includes all those species and the crop varieties, animal breeds and races, and microorganism strains derived from them that are used

directly or indirectly for food and agriculture both as human nutrition and as feed (including grazing) for domesticated and semi-domesticated animals and the range of environments in which agriculture is practiced. It also includes habitats and species outside of farming systems that benefit agriculture and enhance ecosystem functions. Many studies on home gardens in other parts of world have revealed that home gardens are dynamic systems and are highly acknowledged for retaining higher diversity that represent microenvironments within larger farming systems; mimics the natural, multi-layered ecosystem; and are agro-ecosystems in themselves (Agelet *et al*., 2000; Nair, 2001; Lukasser *et al*., 2002; Gessler *et al*., 1998; Hoggerbrugge and Fresco, 1993; Soemarwoto and Conway, 1992; Padoch and de Jong, 1991; Okafor and Fernandes, 1987).

Traditional home gardens typically have a multilayered arrangement, resembling an agro-forestry system, which brings different plant species together in a temporal and/or spatial succession. This stratified and dynamic architecture, more than the identity of single species, has been shown to make a home garden a sustainable and resilient ecosystem in which differentiated root structures utilize nutrients from various soil levels and both ground and aerial space are efficiently utilized (Eyzaguirre and Linares, 2004). Home gardens' specific relevance for conservation purposes resides in their capacity to represent agro-biodiversity at multiple levels (Hodgkin, 2001) over small spaces. By harbouring species with different life cycles and domestication status—wild, semi-domesticated and domesticated—which require diversified cultivation practices and serve multiple purposes (food, fodder, medicine, fuel and fibre, ritual, or ornamental), home gardens become living storehouses for a variety of end-products. Studies carried out in home gardens of various regions have recorded notable richness of species and varieties.

In terms of composition, high diversity of species with an immediate use in the homestead is the most prominent feature of home gardens (Hoogerbrugge and Fresco 1993). The home garden agro ecosystem is an important system for the maintenance of agro biodiversity beyond its primary function in crop production, household food security and nutrition. It is an important area for effectively implementing programmes geared towards biodiversity conservation, food security and sustainable development.

Home gardens are an integral part in a typical Kerala homestead and play a crucial role in supplying household members with diversity of different food crops (Shrestha *et al*., 2001; Rana *et al*., 1998). The composition of such species in a home garden is governed by many factors that make home garden a dynamic system.

The reason that agro biodiversity is so important is that it is essential to life, by providing the raw material for evolution and the base of ecological stability and also without it, crop improvement is impossible (Long *et al*., 2000). It provides both economic and social benefits that are essential to the nutritional welfare and food security of the household. Home gardens, with their diversified agricultural crops and trees, fulfill the basic needs of the local population. In addition, the multistoried arrangements of plants and relatively high species diversities prevent the environmental degradation that is commonly associated with monocultures (Nair, 1993). Thus home gardens provide economical benefits while remaining ecologically sound and biologically sustainable.

Socioeconomic and cultural factors that influence home gardens need to be properly documented. Many of home gardens follow indigenous agricultural practices that are logical and rational, and have been followed for centuries. Loss of this traditional knowledge would be disastrous to the culture that defined the evolution of

Kerala farmers and their knowledge of the land. The non-market benefits potentially provided by these systems, such as biodiversity, carbon sequestration, aesthetics and ornamentation, wild life habitat provision, are likely to be very valuable to the times to come.

The agro-biodiversity of Kerala homesteads has declined drastically during the last four to five decades. Majority of the homesteads face the threat of fragmentation. For example *Anjili*, a variety of the Artocarpus species which, with the jackfruit tree, supplied the bulk of timber for house construction, has disappeared from farmlands because farmers just haven't replanted it. Thus, it is most important that biodiversity of the homesteads be conserved.

Relying on biodiversity may not increase the short-term economic benefits generated from agriculture. However, biodiversity will improve the stability of the system, improve the quality and diversity of commodities available for home consumption, improve the ability of the farmer to make resilient dwelling unit, and reduce fluctuations in cash income. It is because of this that, even in this context of generally declining biodiversity, farmers remain interested in preserving it. Within the constraints of distorted market, lack of information, habit change, lack of awareness and lack of concern for long-term impacts, farmers still use diverse plant and genetic material for their survival and their economic improvement.

Largely due to the absence of sufficient quantified data, home gardens are not given enough attention to warrant major research investment. However, for many urban and rural households, backyard gardens represent a crucial day-to-day source of food as well as minor cash income. Home gardens are also considered, by some scientists, as “living gene banks” and are characterized by containing numerous species, which have economical, food and aesthetical, psychological and spiritual benefits for the urban farmer.

Home gardens are largely neglected in national and international agricultural research for several reasons. The significance of this research is that it contributes to a better understanding of the dynamic homesteads of Kerala farmers in relation to agro biodiversity.

Even though the predominant farming system in the state is the homestead farming system, the role and contribution of this system to agro biodiversity of the state has not been studied in depth. With modernization and urbanization picking up on a large scale, agriculture is being pushed to the back stage and as a reflection of this, the homesteads are also declining. The new generation farmers are losing interest in subsistence crops and instead, take up high paying cash crops wherever they can. A life style, largely dependent on nature and utilizing natural products and processes, has almost bowed out. In this context, it is highly essential that we document the homesteads and their contribution to agro biodiversity. There is lack of in- depth knowledge and information on aspects such as species composition, diversity, richness and component interaction in the homesteads. There present study is taken up to throw light on these aspects as far as possible.

Objectives of the study

Specific objectives of the study are:

- To inventory the components of agro biodiversity in homesteads.
- To examine the farming mechanisms to conserve biodiversity using farmer participatory methods.
- To study gender equity in conserving agro biodiversity and its role in maintaining the ecosystem services of homesteads.

- To identify the present and future threats of agro biodiversity conservation.

Scope of the study

Very little information is available on the internal dynamics of homestead based agro biodiversity. There seems to be a lack of adequate knowledge about the concept of agro biodiversity among people. Home gardens based agro biodiversity play an important role in agricultural production. A better understanding of the basic mechanisms governing diversity in home gardens is essential for the integration of home gardens into national *in situ* programmes as an indigenous conservation measure (Trinh, 1997). Another important aspect was to examine spread of the concept at farmer level, for ultimately, they are the real trend setters.

Limitations of the study

The study was conducted as a part of Master's Research work and was restricted to Thrissur district comprising uplands, midlands and coastal lands based on maximum diversity of components. It had the inherent limitations of resources such as time, finance and researcher's experience. The student researcher had to confine the coverage of the study to a feasible level in the case of sample size, location etc. Inspite of all these, all efforts have been made to conduct the study in an as objective and systematic manner as possible.

Agro biodiversity is a vast topic. A relatively small scale study of the present sort cannot reach upto all of its implications. Still, an attempt has been made to come out with tangible and comprehensive suggestions.

Presentation of the thesis

The thesis is presented in six chapters. The first chapter, as already seen, deals with introduction, highlighting the objectives, scope and importance, and limitations of the study.

The second chapter presents the review of literature pertaining to the objectives of study. The third chapter is the methodology followed in executing the research programme. The fourth chapter deals with the results and discussion of the study. The fifth chapter includes summary, implications and conclusion of the study. References, appendices and abstract are furnished at the end.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The prime objective of the chapter on review of literature is to establish the theoretical tenets of the concepts and ideas that are being explored in the study. The review would bring out the status of the theoretical and empirical work done on the topic so far. Since research on the concept of homestead based agro biodiversity in Kerala was limited, the works on home gardens reported from other countries were reviewed to identify and internalize different variables that are relevant to present research and to identify probable relationships among them. Not much work has been done on agro-biodiversity in the field of social science in accordance with the specific objectives. In this circumstances review of the studies on agro-biodiversity presented is short. The following is the review of the work done on various concepts that are explored in this study.

This chapter is presented under the following headings:

2.1 HOME GARDENS

Home gardens are agro-ecosystems located close to the area that serves as a permanent or temporary residence. Within a very small area one can find a combination of trees, shrubs, vegetables, root crops, grasses and herbs that provide food, spices, medicines and construction materials. Domestic animals are often integrated into the system too.

Home gardens, characterized by multi-storied poly cropping of various trees and crops along with or without animals/birds has been a common feature of the agricultural scenario of the state of Kerala from very ancient times (KSLUB, 1995)

Home gardens are subsets of the larger production system, and are characterized by extremely rich biodiversity of cultivated and uncultivated plant species. This is evident from the following features:

- ✓ Complex integration of plant species within a small area, carefully exploiting the spatial and temporal niches, making home gardens biodiversity rich production systems (Gautam *et al*., 2004).

- ✓ Home gardens promote *in-situ* conservation of a wide range of plant species, especially vegetables, fruits, spices and herbs, fodder trees on-farm (Gautam *et al*., 2004).

- ✓ Home gardens have been found as viable units of on-farm biodiversity conservation of certain crops when considered at landscape and/or community scale as they are interconnected by farmers' seed system (Gautam *et al*., 2004).

- ✓ Home gardens have been found to maintain unique varieties and key species (Gautam *et al*., 2006).

2.1.1 Importance of home gardens

(a) Home garden as a source of nutrition

Torquebiau (1992) had reported that dietary supplies from home gardens accounted for 3% to 44% of the total calorie and 4%to 32% of the protein intake.

The home gardens are significant sources of minerals and nutrients (Asfaw and Woldu, 1997).

The fruits and vegetables contribute to a balanced diet by providing not only energy-rich food but also a supply of vital protective nutrients like vitamins and minerals. Comparatively vegetables are the cheapest source of nutritious food. Fresh fruits and vegetables provide us carbohydrate, protein, vitamins, mineral, fats which are essential to our body. Hence, home garden can provide nutritious and balanced diet to the family, that makes the farm families healthy and strong. This is the reason that home garden is also called a Primary Health Centre (Thapa, 2004)

(b) Home garden as a means of food security

Christanty *et al.,* (1986) and Karyono (1990) had reported that the diverse products available year-round in the home gardens contribute to food security especially during ‘lean’ seasons.

Sustainable food security involves strengthening the livelihood security of all members within a household by ensuring both physical and economic access to balanced diet including the needed micronutrients, safe drinking water, environmental sanitation, basic health care and primary education (Swaminathan, 1996).

Related to food security is the issue of nutritional quality of food. As little or no chemical inputs are used in home garden systems, the products from home gardens can be expected to be of superior quality (Muschler, 2001).

(c) Home gardens as a source of income

Along with nutrition supply and food security, home garden is a source of income. The surplus cereals and vegetable, livestock, poultry, fish, honey can be sold in local market. Due to integration of different agricultural components in home garden, the productivity of each component increases stability in income. In the rural and remote areas where other employment opportunities are meagre, it plays an important role in providing additional job and income. Although interest in home gardens has been primarily focused on producing subsistence items, its role in generating additional cash income cannot be overlooked (Christanty, 1990; Torquebiau 1992; Dury *et al*., 1996; Mendez *et al*., 2001).

(d) Home gardens help to reduce environmental pollution and control soil erosion

Environmental pollution in the form of air and water pollution and soil erosion have become major problems in the country that need to be addressed to make the environment healthy and safe for all the living beings to live. The different

kinds of plants that are grown in the home-garden contribute in absorbing carbon dioxide and releasing oxygen in the environment. In sloping lands, it helps in conserving the soil and water. Moreover, home gardens also support recycling of household organic waste (Pulami and Paudel, 2004).

(e) Home garden as a contributor to medicinal and aesthetic value

Kumar *et al*., (1994) reported that out of the 127 trees and shrubs found in Kerala home gardens, 25 were medicinally important.

Similarly, 27% of the 272 species maintained or cultivated as domestic flora in the Democratic Republic of Congo (Zaire) are reported to be for medicinal purposes (Mpoyi *et al*., 1994).

The various kinds of trees and plants in and around the homestead of farming families have high medicinal and aesthetic value. The different flowering trees and plants add beauty to the landscape of homestead. For example holy basil, *Neem* (*Azadirachta indica*), ginger, garlic etc have high medicinal value and they are commonly found in almost every home garden (Pulami and Paudel, 2004).

(f) *Timber and fuel wood production*

Singh (1987) noted that 70% of the sawlogs in Bangladesh came from homesteads, and Krishnankutty (1990) found that homesteads provided 74% to 84% of wood requirements in Kerala, India.

The average standing stock of commercial timber in the Kerala home gardens has been estimated to range from 6.6 to 50.8 m^3 ha^{-1} (Kumar *et al*., 1994).

Several workers (Krishnankutty, 1990; Wickramasinghe 1996; Levasseur and Olivier, 2000; Shanavas and Kumar, 2003) have also reported that the traditional home gardens constitute a principal source of biofuels for the rural households.

(g) Home garden as a practice of conservation of agro-biodiversity

Eyzaguirre and Watson (2002) had reported that the sustainable use of plant genetic resources in agriculture is inseparable from agro biodiversity conservation. Home-gardens are vivid examples of production systems with rich diversity that serve both a development and a conservation function.

2.2 DEFINITIONS OF HOMESTEAD

The home garden system is practiced extensively in many tropical countries. Home gardening is especially highly evolved, specialized and popular in the state of Kerala, located in the southwest corner of the Indian peninsula. Kerala is often considered to be the land of home gardens and the natural beauty of the region to a great extent depends on this system.

The importance of home gardens is evident across countries and societies. Home gardens, one of the oldest forms of managed land-use systems, are considered to be the richest in species diversity per unit area. Several landraces and cultivars, and rare and endangered species have been preserved in the home gardens (Watson and Eyzaguirre, 2002; Kumar and Nair, 2004).The term “home garden” is preferred because it stresses the close relationship between the garden and the social group residing at home. The home garden provides a bridge between the social and biological, linking cultivated species and natural ecosystems, combining, and conserving species diversity and genetic diversity (Eyzaguirre and Linares, 2004).

Some of the definitions provided by the scientists and experts are presented in the reviews mentioned below:

Nizen (1984) defined homestead as a subset system, which aims at the production of household consumption items not obtainable, not readily available or not affordable through field agriculture

Hanman (1986) referred homestead to the home and its adjoining land owned and occupied by dwelling unit of the household including the immediate area surrounding the dweller's unit and space used for cultivation of trees and vegetables.

Nair and Sreedharan (1986) defined homestead as an operational farm unit in which a number of crops (including tree crops) are grown with livestock, poultry and/or fish production mainly for the purpose of satisfying the farmer's basic needs.

Jose (1991) opined that wetlands adjoining the homestead could be considered as a part of homesteads. The term extended garden was employed to refer to such additional cropland operated by homestead farmer. The extended garden, either wetland or cropland, influences the activities of the homestead farmer in terms of planning, resource allocation, implementation strategy etc. Extended gardens act as satellite units to the main homestead which plays an important role on the performance of the homestead farming, even if the extended garden is at far away place.

Salem *et al.*, (1992b) defined homestead farming as a special type of agricultural production system practiced around the home with multi-species of annual and perennial crops along with/without poultry and/or fish for the purpose of meeting the fundamental requirements of the home viz., food, fodder, fuel, timber

and organic mulch and also to generate additional income through the sale of surplus to purchase the non-producible items of the homesteads.

A home garden is a micro-environment composed of a multi-species (annual to perennial, root crops to climbers etc), multi-storied and multi-purpose garden situated close to the homestead (Watson and Eyzaguirre, 2002; Hodgkin, 2001).

A piece of land with a definite boundary surrounding a homestead, being cultivated with a diverse mixture of perennial and annual plant species, arranged in a multilayered vertical structure, often in combination with raising livestock, and managed mainly by household members for subsistence production (Christanty, 1990; Fernandes and Nair, 1986; Hoogerbrugge and Fresco, 1993; Kumar & Nair, 2004; Rugalema *et al*., 1994; Soemerwoto, 1987).

Home-gardens are increasingly recognized as ecosystems for *in situ* conservation of agro-biodiversity. A home garden refers to the traditional land use system around a homestead, where several species of plants are grown and maintained by the household members and their products are primarily intended for the family consumption. Several terms have been used to describe these garden production systems, such as “homestead garden, backyard garden, kitchen garden, agro- forestry, mixed garden, garden culture, etc” (Helen Keller International, 2001) Mitchell and Hanstad, 2004).

Above all, the fact that the home garden farming system has evolved over hundreds of years in Kerala has great significance from the point of view of conservation, consumption and management of biodiversity in the home garden farming system.

2.3 CONCEPT AND DEFINITIONS OF AGRO BIODIVERSITY

Agro biodiversity results from the interaction between the abiotic and biotic environment, genetic resources and the land and water resource management practices applied by culturally diverse people in agriculture. These systems produce food, fodder, fibre, fuel, ornamentals and other goods (FAO, 1999a; FAO, 2004a).

Sufficient agro biodiversity (i.e. intraspecific) is a main condition for obtaining agricultural goods and thus for sustainable agriculture. Furthermore, agro biodiversity is important to be able to adapt to future changes in production systems, climate or market conditions. Agricultural production is not only important for food for the farmer's own household and income. On a wider scale it applies to countries and also to the world community. Both goods for own consumption and income contribute to the improvement of human well-being for the household, local communities and national economies. Therefore, it is important to have an idea about the status of agro biodiversity in the past, present and future.

The Convention on Biological Diversity defines biodiversity as the variety among living organisms, including diversity within and among species and diversity within and among ecosystems. Agro biodiversity is essentially the biodiversity present in and supported by agricultural landscapes. It includes the diversity of knowledge and management styles ('culture'). It is the source of many agro-ecosystem benefits and services that are of local value, but it can also represent global values, especially in areas that are connected to 'protected areas'.

Agro biodiversity can be considered at three levels based on:

- Genetic diversity ('within species'): the diversity of genes within already domesticated plants and livestock species and their wild relatives;

- Species diversity ('among species'): the number and population size of wild species (flora and fauna) surviving in agricultural landscapes, including soil biota; acknowledging the effects of non-native species on agriculture and native biodiversity;

- Ecosystem diversity ('of ecosystems'): the ecosystems formed by biotic and abiotic interactions of species relevant to agriculture or of species and communities partially dependent on agricultural habitats.

Agro-biodiversity is the subset of biodiversity, which feeds and nurtures people and is nurtured by the people. It encompasses diversity of crops, livestock, fish, insects, microorganism, and related wild species of cultivated flora and fauna at genetic, species and ecosystem levels. Farming communities have conserved and used agro-biodiversity for the survival of the humankind over time and space. The food security and sustainable utilization of agro-ecosystems depends on the extent of availability of diversity and its management practices in the ecosystems.

Agro biodiversity has various impacts on the safety and security of food and agricultural production, (micro) climate, water and soil management, culture and several sociological and economic conditions of people. In a sustainable agricultural production system all of these impacts have been optimized with a minimum amount of negative side effects. Agro biodiversity also provides other ecosystem services on

the farm, such as pollination, pest and disease management and water retention (Hajjar, *et al*., 2008).

2.3.1 The role of agro-biodiversity (Thrupp, 1997)

I. Increase productivity, food security, and economic returns
II. Reduce the pressure of agriculture on fragile areas, forests and endangered species
III. Make farming systems more stable, robust, and sustainable
IV. Contribute to sound pest and disease management
V. Conserve soil and increase natural soil fertility and health
VI. Contribute to sustainable intensification
VII. Diversify products and income opportunities
VIII. Reduce or spread risks to individuals and nations
IX. Help maximize effective use of resources and the environment
X. Reduce dependency on external inputs
XI. Improve human nutrition and provide sources of medicines and vitamins, and
XII. Conserve ecosystem structure and stability of species diversity.

2.3.2 Definitions of agro biodiversity

Agricultural biodiversity is defined as the variety and variability of plants, animals and microorganisms at genetic, species and ecosystem level involving the whole agro-ecosystem that is actively managed by farmers (Cromwell *et al*., 1999).

Agro-biodiversity, sometimes also called agricultural biodiversity, ‘encompasses the variety and variability of animals, plants and micro-organisms

which are necessary to sustain key functions of the agro ecosystem, its structure and processes for, and in support of, food production and food security‘ (FAO, 1999).

The variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries comes under agro-biodiversity. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems.

2.4 DIVERSITY INDICES

“Diversity refers to many different species and their interactions, occurring in small space at one time (Hammer, 1991)” and this definition holds the concept of diversity in home-gardens as there is great diversity of interactions taking place vertically, horizontally, and temporally within one garden often less than one hectare (Zemede, 1997; Millat-e-Mustafa, 1998).

Brookfield (2001) indicated that home-gardens are the valuable sources of agro biodiversity notably with regard to plant diversity.

According to Shaw (2003), the concept of diversity contains two elements: richness and balance (evenness); the first and most obvious measurement to make is the species richness (i.e. the count of the the total number of species within the sample) which is a valid index of diversity in its own right, and the other indices of

diversity are also constructed as a measure of the evenness with which species are distributed.

Diversity Indices are used to assess the level of biodiversity in systems. Diversity can be expressed as a function of scale, where α-diversity represents diversity within a single community or ecosystem (such as home garden) and β-diversity represents the diversity among communities along an environmental gradient such as ecosystems of Kerala. Diversity in any vegetated system is a product of its richness and evenness. Richness is simply the presence or absence of species, without regard to abundance. Evenness refers to the balance between the numbers of individual members of species (Soumya, 2004).

2.4.1 Species Richness

The Margalef richness index adjusts the number of species sampled in an area by the log of the total number of individuals sampled, summed over species. The higher the Margalef index, the richer would be the species diversity of the population.

$$\text{Margalef Index} = (S-1) / \ln (N)$$

Where S is the number of species, and N is the total number of individuals in the sample.

The species richness of perennials as indicated by the Margalef Index was greater in the home gardens in the flat land category (2.87) as there were more species than in the home gardens in moderate and steep slope land categories. The fact that there was no greater difference in Margalef indices for perennials in the

home gardens across land categories of home gardens implies that species richness is not affected by the size of the home garden (Varghese and Balasubramanyan, 1998).

2.4.2 Species diversity

The following equation from Krebs (1985), which was used for this study, looks at the diversity of those species in the garden that are grown on an annual or perennial basis.

$$H = - \sum_{i=1}^{s} p_i \ln p_i$$

where H is the Shannon-Weiner Diversity Index. The proportion of species i relative to the total number of species is calculated and multiplied by the natural logarithm of this proportion. The resulting product is summed across species and multiplied by –1.

Values of the index usually lie between 1.5 and 3.5 although in exceptional cases, the value can exceed 4.5. The higher the value of H', the more diverse the species are within the site.

Okigbo (1990) reported that significant variation is observed in home-gardens in terms of size, shape, intensity of cultivation and intricacy of species diversity.

Sanchez *et al.*, (1996) had reported that a widespread constraint to crop growth is the poor availability of soil nutrients, largely due to the low inherent fertility of highly weathered soils. This problem is further aggravated in home

gardens in the steep slope categories as a result of severe soil erosion and inadequate land management.

Eyzaguirre and Watson (2002) and Kumar and Nair (2004) reported that home gardens, one of the oldest forms of managed land-use systems, are considered to be the richest in species diversity per unit area. Several landraces and cultivars, and rare and endangered species have been preserved in the home gardens

Shannon- Weiner and Margalef Indices for perennial species in home gardens in three slope categories were identified with the exception of weed and ornamental species. The highest Shannon Weiner Index (1.77) was found in the steep land category due to a more uniform distribution of perennial species (Senanayake *et al.*, 2009).

Senanayake *et al.,* (2009) had observed that mean Shannon Index was higher in home gardens in the flat category in all four cropping seasons. This was probably due to the greater productivity of the soil and the availability of resources in the flat land category when compared to the moderate and steep slope categories.

2.5 CONSERVATION OF HOMESTEAD BASED AGRO BIODIVERSITY

The home garden system is a well-evolved land use system usually integrating humans, crops and livestock. Home gardens in Kerala effectively and efficiently combine a very high level of cropping intensity with multistoried levels integrating different factors of production. In some cases, fish culture and duck rearing are also seen. Usually the cropping system is perennial-based. Often agro-forestry species are also included, in which case home gardens can be treated as an agro-forestry system with a livestock component.

The size of home gardens varies widely, from larger joint-family home gardens covering hectares to the currently widespread small nuclear-family home gardens. The crop varieties/types and combinations encountered vary widely within home gardens depending upon many factors.

A crop and varietal mixture of coconut, fruits, pepper, vegetables, tubers, ornamentals, spices, agro forestry species, medicinal plants, pulses, among others, are commonly found in the home gardens of Kerala. A home garden farmer interested in mango may have a wide collection of mango varieties and types along with other crops of his choice. A traditional Ayurvedic physician will have a rich collection of medicinal plants. One conventional black pepper farmer will be eager to have as much variability of that crop as possible in his home garden.

At the farm household level, *in situ* conservation of agricultural biodiversity has a very important role for family health and food safety, especially in home gardens. At present, new cultivation practices have been applied to raise maximum productivity with too much chemical usage. Moreover, control of food safety with fresh vegetables and fruit remains so weak that *in situ* conservation of genetic resources in home gardens is very important. Fresh fruit, vegetables and spices in home gardens are safe sources of fresh food supplies for home consumption and local markets.

Above all, the fact that the home garden farming system has evolved over hundreds of years in Kerala has great significance from the point of view of conservation, consumption and management of biodiversity.

In this context, this study focuses on *in situ* conservation of agro-biodiversity in those small but highly diversified ecological niches generally known as home

gardens. These complex microenvironments, traditionally integrated within a larger surrounding ecosystem (Gliessman, 1990a; Eyzaguirre and Linares, 2004) have been described as sustainable and diversified niches shaped by a close interaction between nature and human culture.

Home gardens provide good ecological and social conditions for understanding and contributing to *in situ* conservation of diversity and evolution of plant genetic resources (Hammer *et al.*, 1992).

Maintenance of genetic variation within agricultural crops provides a broad range of essential goods and services which support ecosystem functioning, resilience and productivity (Tilman, 1999) and for this reason it has become a core principle of sustainable agriculture and agro-ecology (Altieri and Merrick, 1987; Paoletti 2001; Le Coeur *et al*., 2002; Marshall and Moonen, 2002).

Hetterschijt **(**2001) had reported that home-gardens are considered, by some scientists, as "living gene banks" and are characterized by containing numerous species, which have economical, food and aesthetical, psychological and spiritual benefits.

Home-gardens are vivid examples of production systems with rich diversity that serve both a development and a conservation function (Eyzaguirre and Watson, 2002). They are micro-environments within a larger farming system containing high level of species and varietal diversity

Subedi *et al.,* (2004) reported that home gardens, with their intensive and multiple uses, provide a safety net for households when food is scarce. These gardens are not only important sources of food, fodder, fuel, medicines, spices, herbs, flowers,

construction materials and income in many countries, they are also important for the *in situ* conservation of a wide range of unique genetic resources for food and agriculture

Gautam *et al*., (2004) reported that home gardens promote *in situ* conservation of a wide range of plant species, especially vegetables, fruits, spices and herbs, fodder trees on-farm.

Das and Das (2005) further advocated that home-gardens are the sites of conservation of a large diversity of plants both wild and domesticated, because of their uses to the households.

While it is commonly acknowledged that the diversity of life forms in the natural world is being depleted under increasing human pressure on the Earth's ecosystems, there is much less awareness that agro-biodiversity is under similar threats. Agro-biodiversity is a subset of natural biodiversity which includes the plant genetic resources used for food and agriculture (cultivars, landraces, ecotypes, weedy races and wild relatives) (Negri *et al*., 2009).

2.6 ECOSYSTEM SERVICES OF HOMESTEADS

An **ecosystem** is a functional unit of interaction between animals, plants and the physical environment, e.g. a lake or forest.

Ecosystem services are all the fundamental benefits that an ecosystem provides which are essential for our survival e.g. food and bioenergy production, water purification, climate regulation, soil production, erosion control and mitigation of the effects of natural catastrophes. The United Nations global study, the

Millennium Ecosystem Assessment, which was completed in 2005, showed that 60% of the 24 studied ecosystems were in the process of being depleted.

Sustaining ecosystem services are crucial to human health. Biodiversity is necessary to reach the three health-related United Nations Millennium Development Goals. A rich and varied biodiversity, both wild and cultivated, strongly contributes to reducing malnutrition amongst poor people who often do not consume a varied diet. More than 50 percent of all commercial medicines used today come from natural substances, mainly coming from the rainforests.

2.6.1 Typology of Ecosystem Services (MEA, 2003)

1. Provisioning services: products obtained from ecosystems

- Food
- Freshwater
- Fuel wood
- Fibre
- Bio-chemicals
- Genetic Resources

2. Regulating services: Benefits obtained from regulation of ecosystem processes

- Climate regulation
- Disease regulation
- Water regulation
- Water Purification
- Pollination
- Micro climate modification-a whole complex of environmental changes
- Erosion control and soil conservation

- Control of crop pests-structural complexity with high plant diversity regulate pest populations
- Carbon sequestration-potential to increase soil organic matter, store significant amount of C in woody biomass

3. Cultural services: non material benefits obtained from ecosystems

- Spiritual and religious
- Recreation and Ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage

4. Supporting services: Services necessary for the production of all other ecosystem services

- Soil formation
- Nutrient cycling
- Primary production

A range of management practices are employed by farmers to manage biodiversity in agricultural landscapes. Home gardens are micro-environments within the system that provide many goods and services of environmental, economic, social and cultural importance. These environmental goods and services also contribute to sustainable livelihoods in a number of ways.

Nair and Sreedharan (1986) reported that the difference between typical agricultural systems and home gardens is that these gardens also enable continuance

of various essential ecological processes that occur in natural tropical forest ecosystems, such as regeneration and conservation of soil, nutrient and water cycling

Christanty (1990) reported that biodiversity, especially that of the below ground part of the system, performs a variety of ecological services such as nutrient recycling, regulation of local hydrological processes, and detoxification of noxious chemicals. Farmers have a rich traditional knowledge on the complementarities of annual-perennial species composition and structure, and they use this traditional knowledge and genetic diversity for rich and healthy home gardens.

Kuchelmeister and Braatz (1993) reported that garden plants help remove pollutants from the air in three ways: absorption by the leaves or the soil surface; deposition of particulates and aerosols on leaf surfaces; and fallout of particulates on the leeward (downwind) side of the vegetation because of the slowing of air movement.

Soil erosion is minimized because of vegetation cover that prevented the exposure of bare ground to heavy rainfall. In this regard, suggestion forwarded by Kuchelmeister and Braatz (1993) underlines that the shades of trees, shrubs and other vegetation help to control temperature extremes by modifying solar radiation.

According to Altieri (1995), in agricultural systems, beyond the production of food, fibre, fuel, and income, biodiversity performs ecosystem services such as recycling of nutrients, control of local microclimate, regulation of local hydrological processes, and detoxification of noxious chemicals.

Westernkamp and Gottsberger (2000) reported that healthy home gardens not only increase the diversity of soil micro-organisms and predators of natural enemies, but also increase populations of pollinator, fruit setting and gene flow.

Trinh *et al*., (2002) had reported that home gardens employ the character of the surrounding ecological system, and provide a place where plants, animals, insects, microorganisms and soil and air media mutually interact to maintain the agro ecological balance.

Shanahan (2004) had observed that the closer coffee bushes are planted to patches of forest or home gardens, the higher the quality and quantity of beans they produce, due to greater pollination by wild bees.

2.7 GENDER ROLES IN AGRO BIODIVERSITY CONSERVATION IN HOMESTEADS

Gender is defined by FAO as 'the relations between men and women, both perceptual and material. Gender is not determined biologically, as a result of sexual characteristics of either women or men, but is constructed socially. It is a central organizing principle of societies, and often governs the processes of production and reproduction, consumption and distribution'. Despite this definition, gender is often misunderstood as being the promotion of women only. However, as we see from the FAO definition, gender issues focus on women and on the relationship between men and women, their roles, access to and control over resources, division of labour, interests and needs. Gender relations affect household security, family well-being, planning, production and many other aspects of life.

Gender roles are the 'social definition' of women and men. They vary among different societies and cultures, classes, ages and during different periods in history. Gender-specific roles and responsibilities are often conditioned by household structure, access to resources, specific impacts of the global economy, and other locally relevant factors such as ecological conditions.

Gender refers to the social roles that men and women play and the power relations between them, which usually have a profound effect on the use and management of natural resources. Gender is not based on biological differences between men and women or sex. Gender is shaped by culture, social relations, and natural environments. Thus, depending on values, norms customs and laws men and women in different parts of the world have evolved different gender roles.

In most farming systems, there is a division of labour. This determines the different tasks for which men and women are responsible. Generally, women have an important role in the production, processing, preservation, preparation and sale of staple crops. Men tend to focus on market-oriented or cash crop production. Often we find a division in crop and livestock management practices. Weeding is often a women's task, while spraying or fertilizer application is mainly carried out by men. Women and children often look after the smaller livestock species and men are often in charge of cattle. These are only a few examples, which are not generally applicable, but will depend on the specific situations and cultures we are working on.

The maintenance and management of activities in home garden are highly gender based. The gender roles also depend on the ethnic and cultural setting of the community. However, in depth understanding of the importance and influence of gender to the management of homestead based agro biodiversity is lacking in Thrissur district.

Planting and maintaining of home gardens also reflect the culture and status of the household, especially the women, in the local society. In many places, women play a vital role in the design and management of these land use systems. The fact that home gardens are predominant in the traditionally matrilineal societies of south and Southeast Asia (e.g., Kerala, Central Java and West Sumatra) further underscores this point (Menon *et al*., 2002; Soemarwoto and Conway 1992).

Women's particular responsibility for the management of home gardens has been extensively documented in other parts of the world (Boncodin and Vega, 1999).

Asfaw (2002) remarked that the male family head is often accountable for designing home-garden structure, identifying suitable places for positioning the major crops, and monitoring and strongly impacting the structure and direction of home-garden development. The same author explained that with the exception of arduous works, women take part in many activities and children also assist in home garden tasks.

The maintenance and management of activities in home garden are highly gender based and women are mostly responsible. Similarly, in Kerala's context women occupy an important place in terms of management and sharing of benefits from home garden, as they are involved in providing food for the household. (Subedi *et al*., 2003a and Shrestha *et al.*, 2002).

Howard (2003) reported that the role of women in gardening is often less visible than the role of men, as women often assume the tasks most closely linked to the domestic realm.

From an ecological and land use perspective, home gardens involve the management of multipurpose trees, shrubs, annual and perennial agricultural crops, herbs, spices, medicinal plants, fish ponds and animals on the same land unit, in a spatial arrangement or on a temporal sequence (Eyzaguirre and Linares, 2004).

Sayma *et al.* (2010) reported that labor-intensive activities like digging holes (55%), pruning (53%), and planting species (52%) were done by men, while watering (65%), fertilizing (52%), weeding (56%), and fencing (53%) were mainly done by women. Women spend most of their time in pre-harvesting activity. The average time they spend in the home garden is 6-8 hours/week while men spend four to five hours a week. It was observed that a majority (57%) of the women is involved in dead-branch collection and most men are involved in collection of fallen (52%) and standing (58%) trees. The study also revealed that 52% of the women participate in decision-making in selecting species for home gardens.

Agelet *et al*. (2000) and Rigat *et al*. (2009) reported that home gardens were mainly managed by women as a part of their household activities, with the help of men in the physically hardest tasks, such as plowing, digging out crops like potatoes, or cleaning the irrigation ditches.

2.4 CONSTRAINTS FACED BY HOME GARDEN FARMERS IN AGRO BIODIVERSITY CONSERVATION

Important problems perceived in agro-biodiversity conservation have been reported in very few studies.

Okafor (1985) reported that lack of seed and planting material were main constraints in agro biodiversity conservation.

Padoch and Jong (1991) indicated that agricultural support system is the chief constraint of the biotic change and variation of home-gardens.

Zemede (1997) described that garden space tends to reduce due to urbanization and population growth.

Gessler *et al.* (1998) have documented a number of factors, such as labour availability, level of on-farm returns, off-farm employment and migration that have influence on home garden species and varietal diversity.

Soleri and Cleveland (1989), Padoch and Jong (1991), Zemede (1997) and Talemos (2007) confirmed that the diversity of plant species in home-gardens is limited by the availability of adequate water.

Talemos (2007) indicated that home-garden plants / crops were being replaced by some cash crops in order to get good amount of money in return.

2.9 THREATS AND CHALLENGES OF AGRO BIODIVERSITY CONSERVATION

Soemarwoto (1987) reported that from West Java, Indonesia, 27 varieties of mango were reportedly lost during a 60-year period.

Rugalema *et al.* (1994b) reported that fragmentation of land holdings due to population growth had triggered species losses in the *chagga* home gardens of Tanzania.

Ashokan and Kumar (1997) observed that a large proportion of Kerala home gardens have been converted into small-scale plantations of coconut and rubber (*Hevea brasiliensis*) or to cropping systems consisting of less number of crops.

Agelet *et al*. (2000) also noted the loss of many autochthonous varieties of crop plants and medicinal plants from the Catalonian gardens.

Agelet *et al*. (2000) reported that migration of the work force to urban areas, mechanization of agriculture and the consequent specialization of agricultural tasks have led to an impoverishment of the traditional home garden system.

In Catalonia (Spain) during the last few decades, migration of the work force to urban areas, mechanization of agriculture and the consequent specialization of agricultural tasks have lead to an impoverishment of the traditional home garden system (Agelet *et al.*, 2000).

Khatri (2001) reported that there is lack of incentives for farming systems that enhance biodiversity and lack of knowledge and awareness on the importance of conservation of biodiversity.

Eyzaguirre and Watson (2002) have shown that lack of local awareness on the importance of biodiversity is the threat that should not be overlooked as it affects their richness.

Rana *et al.* (1998) also reported that the market incentives would motivate the farmers to conserve the local crops especially when the seed source is easy to maintain, low production cost and disease pest resistance Trinh *et al*., (2003) reported the similar result in Vietnamese home garden.

With increasing emphasis on industrial models of agricultural development, fragmentation of land holdings due to demographic pressures driving land use intensification and, to some extent, decreasing appreciation, traditional agroforestry systems declined (Jose and Shanmugaratnam, 1993; Kumar and Nair, 2004) and monocultures of commercial crops became dominant in Kerala

Kumar and Nair (2004) reported that a large proportion of the Kerala home gardens has been converted into small-scale plantations of coconut and rubber or cropping systems consisting of fewer crops due to commercialization and fragmentation of land holdings.

Santhakumar (1996) and Kumar and Nair (2004) had reported that with the advent of the high-yielding variety (HYV) coincidentally, many local varieties of mango (*Mangifera indica*), jackfruit (*Artocapus heterophyllus*) and other traditional fruit/vegetable crops, which were once abundant in the Kerala home gardens, are now thought to be extinct.

Negri (2005) reported that replacement of rural areas once used for the production of services (home gardens, wooded areas, living fences, pastures) by monocultures has caused a depletion of local species, primitive varieties and wild relatives.

Sunwar *et al.* (2006) who conducted studies of species richness in home gardens in Rupandehi and Gulmi in Western Nepal over 10–15 years recorded the disappearance of as many as 20 crop species and declared another 11 under threat of extinction, mainly because of changes in land use patterns and inaccessibility of local seed.

Sunwar *et al.* (2006) also reported that land fragmentation is common in Nepal where the parcel size of land decreased during the past 10 to 15 years mainly due to increasing fragmentation of land.

CONCEPTUAL FRAMEWORK OF THE STUDY

Based on the review of relevant literature on the various theoretical concepts under study, the following conceptual framework has been formulated to establish the inter relationship between dependent and independent variables selected for the study

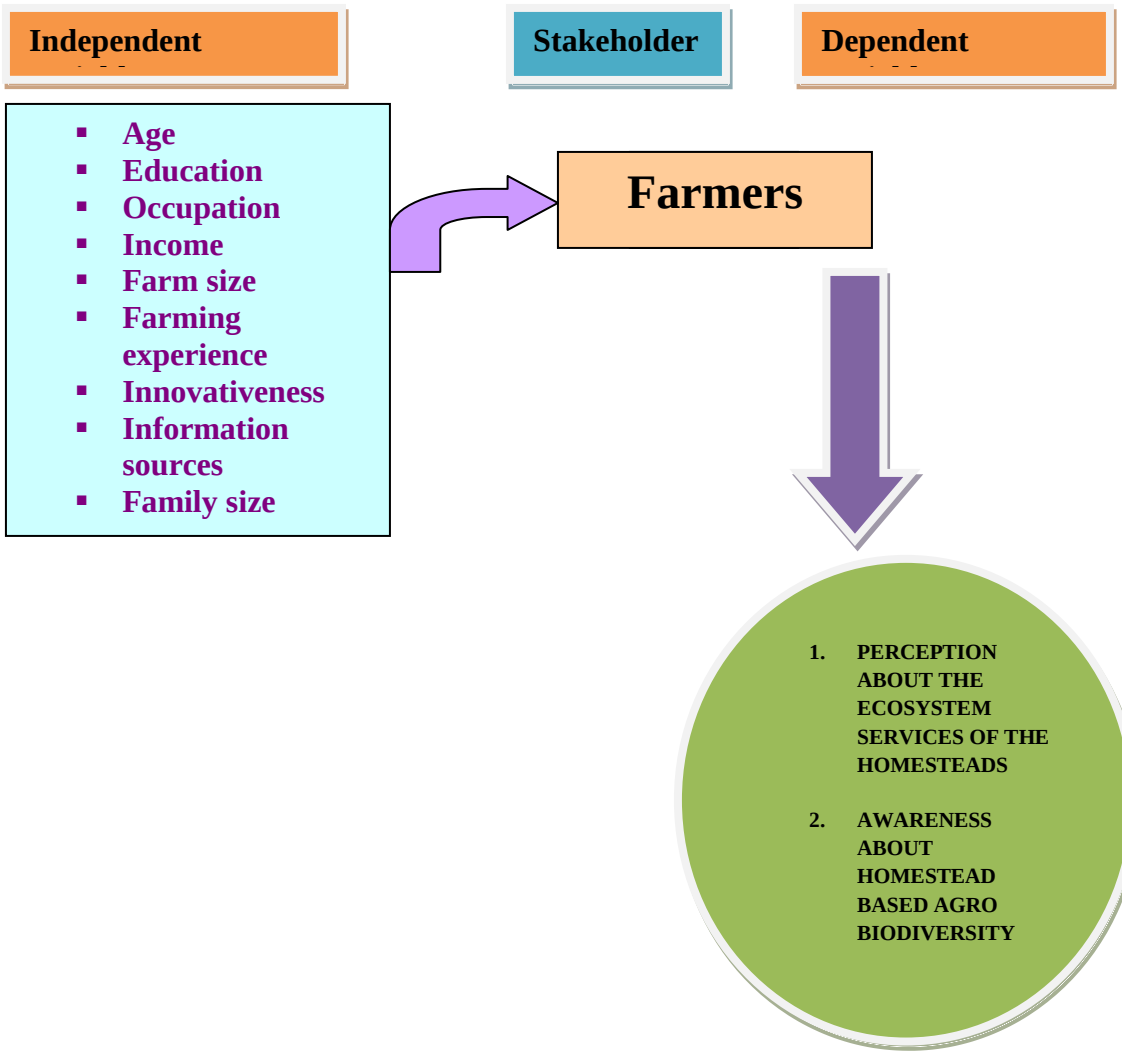


Fig. 1. Conceptual frame work of the study

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

A suitable design of the study or research methodology is an important component of any systematic research. Research methodology is the description, explanation and justification of various methods of conducting research.

This chapter deals with the brief description of methods and procedures that are required for meeting the objectives set forth in this study. The methodology followed in the study is presented under the following subheads.

3.1 RESEARCH DESIGN OF THE STUDY

This study follows ex post-facto research design as there is no scope to manipulate the independent variables. ‘Ex-post-facto’ research design is a systematic

3.2 LOCALE OF STUDY

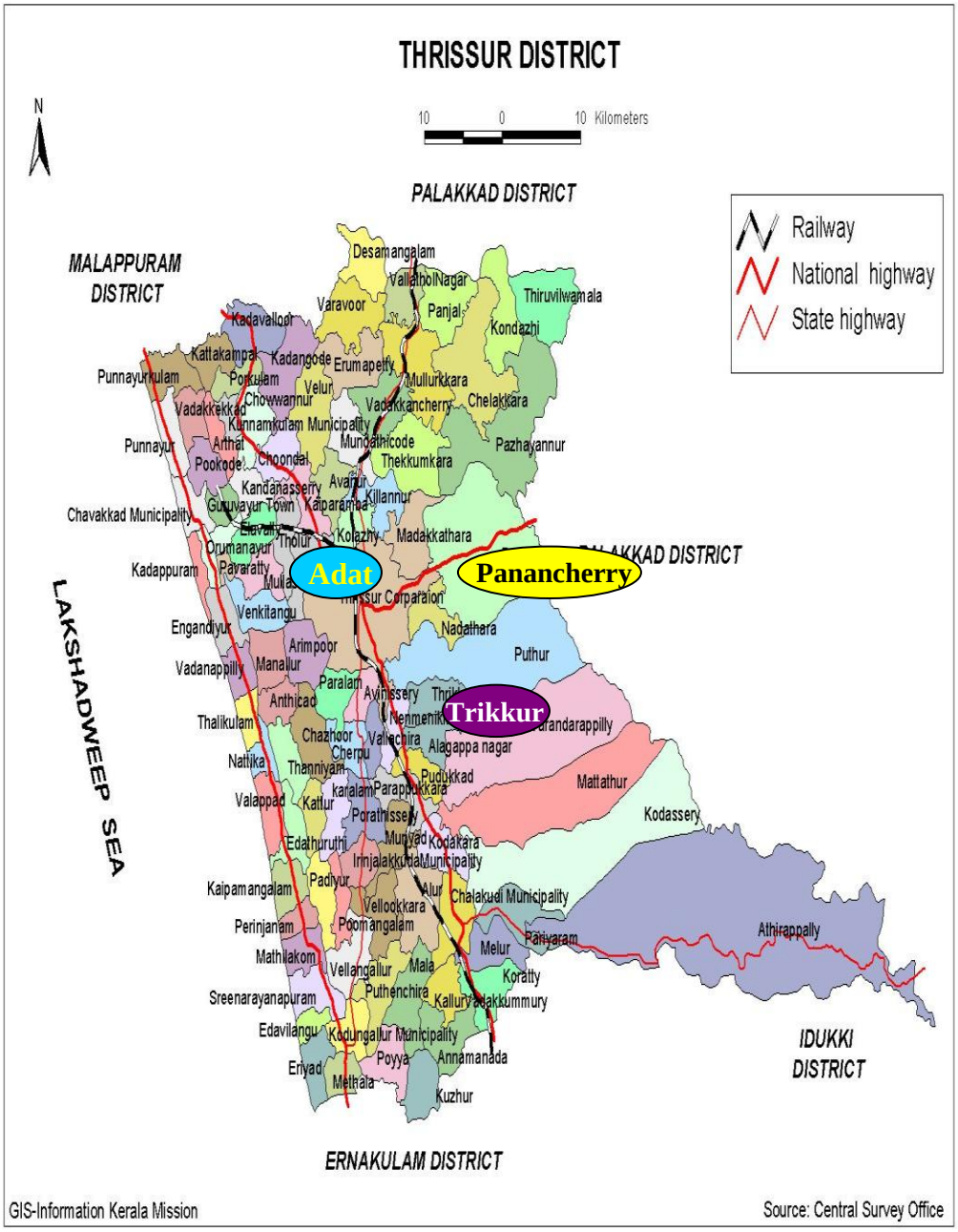


Fig. 2. Map showing locale of study

inquiry in which the reseacher does not have direct control over the independent variables because their manifestations have already occurred or because they are inherently not manipulatable (Kerlinger, 1983).

3.3 SELECTION OF RESPONDENTS FROM HIGH ELEVATION LANDS, MID ELEVATION LANDS AND LOW ELEVATION LANDS

3.3.1 Selection of district

Thrissur district of Kerala was purposively selected for the study comprising of higher elevation lands, medium elevation lands and low elevation lands based on maximum diversity of components in home gardens. Samples were taken mainly from high elevation lands, medium elevation lands and low elevation lands. Thrikkur panchayat of Kodakara block was selected randomly representing high elevation lands, Pananchery panchayat of Ollukkara block was selected randomly representing medium elevation lands and Adat panchayat of Puzhakkal block was selected randomly representing low elevation lands. Samples were taken based on farm size from these three panchayats of Thrissur district. The map showing the location of the study is given as **Fig.2.**

3.3.2 Selection of respondents

The respondents of the study comprise home garden farmers and scientists/experts/subject matter specialists.

Selection of home garden farmers

From among the three selected Panchayats fifteen farmers per panchayat were selected as respondents, making a total sample size of 45 farmers. For this, a list of farmers with home gardens was prepared consulting the respective agricultural officers. (Plate 1) The household farms which do not, *prima-facie*, confirm to the requirements of a home garden situation were omitted from the list in consultation with agricultural officer, and new farms were selected. Three types of home gardens were identified from each panchayat with the following inclusion criteria. From each of these types 5 home gardens were selected based on farm size, making the sample from each panchayat 15.

Criteria	Holding size (cents)
1	25
2	75
3	125

a) Selection of scientists/experts/subject matter specialists

The scientists/experts/subject matter specialists (n=40) concerned with agro biodiversity research belonging to different institutions in the region like KAU/Dept of Agriculture/Land use board/State biodiversity board were selected as the respondents for the study.

3.4 SELECTION AND OPERATIONALISATION OF VARIABLES

3.4.1. Selection of variables

In order to assess the influence of the profile characteristics of the home garden respondent, the characteristics of the homestead farmer were identified as detailed below.

A list of 24 independent variables related to the personal characteristics of the respondents and important for meeting the objectives of the study were collected after detailed review of literature and discussion with subject matter specialists. The lists of variables were then sent to 40 judges comprising extension scientists and home garden experts. They were asked to examine the variables critically and to rate the relevance of each variable on a five point continuum ranging from most revelant, more revelant, revelant, less relevant and least relevant with weightages of five, four, three, two and one respectively. Out of 40 judges only 30 responded.

The final variables were selected based on the criterion of mean relevancy score, which was obtained by summing up the weightages obtained by variable and dividing it by the number of judges who responded. Those variables governing a score more than the mean was selected for the study.

The independent variables thus selected for the study were age, education, occupation, farm size, annual income, farming experience, family size, innovativeness, information source utilization and live stock component.

Table 1: List of variables with their measurement procedure

Sl. No.	Variables	Measurements
A. Independent variables		
1	Age	Scoring procedure followed by Allan (2004)
2	Education	Scoring procedure followed by Jayasree (1995)
3	Occupation	Scoring procedure followed by Allan (2004)
4	Farm size	Scoring procedure followed by Allan (2004)
5	Monthly income	Scoring procedure followed by Vilas (2005)
6	Farming experience	Scoring procedure followed by Jayasree (2004)
7	Information source utilization	Scoring procedure followed by Babu (1995)
8	Innovativeness	Scoring procedure followed by Allan (2004)
9	Family size	Scoring procedure fallowed by Allan (2004)
B. Dependent variables		
12	Awareness	Scoring procedure followed by Kothari (1985)
13	Perception	Scoring procedure followed by Kothari (1985)

3.4.2. Measurement of independent variables

The operational definition and scoring method used to quantify the independent variables selected for the study are explained below.

3.4.2.1 Age

Age is operationally defined as the number of chronological years respondents have completed at the time of study since birth. Scoring procedure followed by Allan (2004) was used with slight modifications as given below. The respondents were classified based on percentage analysis.

Sl. No:	Category	Age group	Score
1	Young	Less than 35 years	1
2	Middle aged	35-50 years	2
3	Old	More than 50 years	3

3.4.2.2 Education

Education is operationally defined as the extent of formal schooling undergone by the respondents at the time of investigation and their ability to read and write. The sub-items were illiterate (people who didn't know how to read and write), people who can only read, functionally literate (people who can read and write), people with primary education (up to fifth standard in schools), people with high school education (up to tenth standard in schools) and collegiate (pre degree/degree/diploma after schooling). Scoring procedure followed by Jayasree (1995) was adopted with slight modification.

Sl. No.	Education	Score
1	Illiterate	1
2	Can read only	2
3	Functionally literate (Can read and write)	3
4	Primary education	4
5	High school	5
6	Collegiate	6

3.4.2.3 Occupation

Occupation was operationalised as the main vocation and other additional vocations that the respondents were engaged in at the time interview. The scoring procedure developed for the study is as follows:

Category of occupation	Score
Agriculture alone	1
Agriculture + Private employment	2
Agriculture + Government employment	3

3.4.2.4 Monthly Income

Monthly income is operationally defined as the amount earned by the respondents from on farm and off farm activities in a month. The respondents were classified into three categories *viz*., low, medium and high based on the monthly income obtained. The scoring procedure followed and adopted by Vilas (2005) was used with slight modification.

Sl. No:	Category	Monthly income	Score
1	Low income	Upto Rs.5000	1
2	Middle income	From Rs.5000-10000	2
3	High income	Above 10000	3

3.4.2.5 Farm size

This refers to the actual area of land (both wet and garden land) possessed by the farmer respondent, which was expressed in cents.

3.4.2.6 Experience in farming

Farming experience was measured in terms of the number of years since the farmer respondent was actually involved in the farming activities. Scoring procedure followed by Jayasree (2004) was adopted as given below. The respondents were classified into three categories, *viz*. low, medium and high based on cumulative frequency method.

Sl. No.	Category	Experience in farming	Scores
1	Low	Less than 5 years	1
2	Medium	5-10 years	2
3	High	More than 10 years	3

3.4.2.7 Family size

This refers to the number of members of either sex living in a household/family dependent on the head of the family. The scoring procedure followed by Allan (2004) was adopted in this study as shown below.

This was measured in numbers

Sl. No.	No: of members in the family	Scores
1	1-4	1
2	5-7	2
3	8-10	3

3.4.2.8 Innovativeness

Innovativeness denotes the quality of being innovative. An innovation involves creation of entirely new knowledge as well as an idea perceived as new. Innovativeness is operationalised as the degree to which a farmer was relatively earlier in adopting new ideas. The scoring procedure followed by Allan (2004) was adopted in this study as shown below. The respondents were classified into low and high based on the responses given by them to a query as to when would they prefer to adopt an improved practice that would help in achieving agro biodiversity conservation.

Response	Score
Yes	2
No	1

3.4.2.9 Information source utilization

The information sources used were studied in terms of utilization of both mass media sources and inter-personal sources of communication.

The procedure followed by Babu (1995) is adopted in the present study to develop an index on mass media utilization.

Sl. No.	Utilization	Score
1	Most often	4
2	Often	3
3	Sometime	2
4	Rarely	1

The scores were summed up across each item to form the index of mass media utilization.

Interpersonal source utilization is operationally defined as the extent of use of different personal sources by a homestead farmer with a view to obtain information about improved agricultural practices.

The procedure followed by Babu (1995) was adopted in this study to develop an index of interpersonal source utilization.

Each respondent was asked to indicate as to how often he received information regarding improved agricultural practices from each of the personal sources.

The scores were summed up across each item to form the index of interpersonal source utilization.

The index for information sources used of each respondent was arrived at by summing up the indices of both mass media source and interpersonal source utilization.

After obtaining the total score standard deviation and mean were worked out then they were grouped as high, medium and low categories of information sources utilization.

3.4.3 Measurement of dependent variables

The dependent variables for the study were awareness and perception of homestead farmers with regard to homestead based agro biodiversity and ecosystem services respectively.

3.4.3.1 Awareness

Lionberger (1960) defined awareness as “the first knowledge about a new idea, product or practice”. At the awareness stage a person has only general information about the subject. However, as far as agro biodiversity is concerned, in this study awareness is operationally defined as the general information level a stakeholder has with respect to different dimensions of homestead based agro biodiversity.

3.4.3.2 Measurement of awareness on homestead based agro biodiversity

The statements were prepared based on an exhaustive review of literature on various dimensions of agro biodiversity conservation that is relevant to homesteads, discussion with experts and researcher's own insight. The list of statements was subsequently given to 40 selected judges for relevancy rating .The judges were requested to rate each statement based on the degree of relevancy attached to them with regard to its ability to express the concerned domains.(Appendix-II). They gave ratings for each statement on a highly relevant – least relevant five point continuum which was scored as given below.

Sl. No.	Item	Score
1	Highly relevant	5
2	Relevant	4
3	More or less relevant	3
4	Less relevant	2
5	Least relevant	1

After rating is done by 40 selected judges the procedure followed for selecting statements to be included in the final interview schedule was Likert- type or summated scale. In this scale, the judges are asked to respond to each of the statements in terms of five point continuum. Each point on the scale carries a score as given above in the table. Response indicating the least favorable degree is given the least score i.e 1 and the most favourable is given the highest score i.e 5. Thus, it assigns a scale value to each of the five responses. The same thing is done in respect of each and every statement in the instrument. This way the instrument yields a total score for each respondent, which would then measure the respondent's favourableness or otherwise towards each statement.

Statements which were having highest score were included in the final interview schedule. Three positive and three negative were included. If the respondent ticked yes then its score was 2 and if no, the score was 1. This scoring procedure was reversed for the negative statements. Then the scores were summed up to get the total score for each respondent. Based on the total score obtained for each respondent they were classified into high, medium and low category by calculating the standard deviation and mean.

3.4.3.3 Perception about the ecosystem services of homesteads

Statements were prepared based on the exhaustive review of literature on various dimensions of ecosystem services of homesteads, discussion with experts and researcher's own insight. The list of statements was subsequently given to 40 selected judges for relevancy rating .The judges were requested to rate each statement based on the degree of relevancy attached to them and the ability to express the relevant domains. (Appendix-II). They gave ratings for each statement under a five point continuum ranging from highly relevant to least relevant. Scoring was done as given below.

Sl. No.	Item	Score
1	Highly relevant	5
2	Relevant	4
3	More or less relevant	3
4	Less relevant	2
5	Least relevant	1

After rating the scoring was done by using Likert- type scale technique. Statements which were having highest scores were included in the final interview schedule as given in the table below:

Strongly agree	Agree	Undecided	Disagree	Strongly disagree
5	4	3	2	1
1	2	3	4	5

Three positive and three negative statements were included in the final interview schedule. Based on the total score obtained by each respondent the results were worked out. Respondents were classified as high category, medium and low category by calculating the standard deviation and mean.

3.4.3.5 Measurement of species diversity

Diversity indices are used to assess the level of biodiversity present in systems. Diversity was estimated using two methods: Margalef Index to assess species richness (Margalef, 1958), and Shannon-Wiener Index (Krebs, 1985) to assess the species diversity index.

3.4.3.6 Species Richness

The Margalef richness index adjusts the number of species sampled in an area by the log of the total number of individuals sampled, summed over species.

The higher the Margalef index, the richer would be the species diversity of the population.

$$\text{Margalef Index} = (S-1) / \ln(N),$$

Where S is the number of species, and N is the total number of individuals in the sample.

After obtaining the Margalef Index values for each homestead separately based on elevation they were summed up separately and mean index worked out in order to find out the species richness.

3.4.3.7 Shannon-Weiner Index

The Shannon-Weiner Index (H) is the most commonly used diversity indicator in plant communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance. The following equation from Krebs (1985), which was used for this study, looks at the diversity of those species in the garden that are grown on an annual or perennial basis.

$$H = \sum_{i=1}^{s} pi.\,\mathrm{In}.\,pi$$

Where, s= no: of species, *i*= no: of individuals, p*i*= proportion of species i relative to the total number of species and ln= natural logarithm.

The proportion of species i relative to the total number of species is calculated and multiplied by the natural logarithm of this proportion. The resulting product is summed across species and multiplied by –1.

After obtaining the H values for each homestead separately based on elevation they were summed up separately and mean index worked out in order to find out the species diversity.

3.4.3.8 Modified formula of Shannon-Weiner index

This formula is used to find the affect of area on species diversity.

$$H = \sum_{i=1}^{s} pi.\,\mathrm{In}.\,pi.* S/A$$

Where, s= no. of species, *i*= no: of individuals, p*i*= proportion of species i relative to the total number of species, ln= natural logarithm, S= no. of species and A= area of the home garden.

After obtaining the H values for each homestead separately based on elevation they were summed up separately and mean index worked out in order to find out the species diversity.

3.5 INVENTORY OF THE COMPONENTS OF AGRO BIODIVERSITY IN HOMESTEADS

During the time of survey all the species that were present in each home garden were recorded and then the percentage worked out based on occurrence of the crop. Then they were categorized into cereals, pulses, fruits, vegetables, oil yielding crops, other tree crops, spices and condiments, green manures, other crops and ornamental crops.

3.6 FARMING MECHANISMS FOR CONSERVING AGRO-BIODIVERSITY

In order to assess the farming mechanisms for conservation of agro-biodiversity, a list of 20 statements was prepared based on discussion with experts and available literature. The list of statements was subsequently given to 40 selected judges for relevancy rating .The judges were requested to rate each statement based on the degree of relevancy attached to them and the ability to express the relevant

domains. They gave ratings for each statement under a five point continuum ranging from highly relevant to least relevant. Scoring was done as given below:

Sl. No.	Item	Score
1	Highly relevant	5
2	Relevant	4
3	More or less relevant	3
4	Less relevant	2
5	Least relevant	1

Out of 20 statements seven statements was included in the final interview schedule based on total score obtained for each statement. Then the respondents were asked to rate the each statement based on five point continuum.

Sl. No.	Item	Score
1	Highly relevant	5
2	Relevant	4
3	More or less relevant	3
4	Less relevant	2
5	Least relevant	1

Based on the score obtained for each statement they were interpreted and ranked.

3.7 GENDER ROLES IN AGRO BIODIVERSITY CONSERVATION

3.7.1 Role

Role is operationally defined role as a set of behavioral patterns consisting of privilege and duties associated with position of women in the farming community.

3.7.2 Gender role

Gender role is defined as a set of socially and culturally determined, expected and approved behavioral pattern for each sex.

easurement of gender role

Gender roles in agro biodiversity were identified and analyses were carried out using the following procedure.

The major homestead farming activities in relation to the agro biodiversity conservation were prepared. The respondents of each system were asked to point out who performed each of the activities in the farm. The list of specific practices included for eliciting the response from participants for agro biodiversity conservation was prepared in consultation with subject matter specialists and extension personnel.

The details of the categorization of the data are given below in the following format.

Sl. No.	Task	Men	Women	Both
1	Kitchen garden			
2	Hedge of a green manure crop			
3	Digging holes for water harvesting			
4	Pruning			
5	Planting different species of crops			
6	Watering			
7	Fertilizing			
8	Weeding			
9	Fencing			
10	Seed selection			
11	Mulching			
12	Pest control			
13	Dried waste and other disposal			

Based on the response of extent of involvement of men and women in homestead based agro biodiversity conservation the following procedure was developed to categorize the farm activities in terms of gender involvement as male dominant, female dominant or equally participated.

The procedure followed was by calculating the total number of respondents involved in each activity and then calculating percentage for each activity.

3.8 CONSTRAINTS FACED BY THE HOMESTEAD FARMERS IN AGRO BIODIVERSITY CONSERVATION

Based on discussion with farmer respondents, extension agents, agricultural experts, scientists from other disciplines in KAU and also through review of literature, some of the constraints faced by homestead farmers in agro biodiversity conservation were identified. A list containing ten such constraints was included in the final interview schedule.

Each constraint was marked by each respondent. Their responses were collected, ranked and interpreted.

The constraints were ranked according to the percentage obtained.

3.9 THREATS AND CHALLENGES TO AGRO BIODIVERSITY CONSERVATION THROUGH HOMESTEADS

Based on review of literature, some of the threats and challenges to agro biodiversity through homesteads were identified and a list prepared containing fifteen statements. A draft was prepared to mark the most important threat to homestead

based agro-biodiversity by the 40 subject matter specialists. (Appendix-III). Their responses were collected, ranked and interpreted.

The threats were ranked according to the percentage obtained for each statement.

3. 10 METHODS OF DATA COLLECTION

The data were collected using well structured and pre-tested interview schedule prepared for the purpose (Appendix 1). A draft interview schedule was prepared which was pre-tested by conducting a pilot study in non sample area and suitable modifications were made in the final interview schedule which was then directly administered to the home garden farmers by the investigator. Responses were recorded at the time of interview. The data was collected during February 2011 by directly interviewing the home garden farmers, by the researcher (Plate 2)

3.11 STATISTICAL TOOLS USED IN THE STUDY

The collected data were scored, tabulated and analysed using statistical methods.

The following statistical tests were used for the analysis and interpretation of the data.

1. Percentage analysis
2. Correlation analysis
3. Margalef Index
4. Shannon-Weiner Index
5. Modified Shannon-Weiner

3.11.1 Percentage analysis

Simple percentage was worked out to find out distribution of farmers according to different variables. It was also used to interpret the results of independent variables selected for the study.

3.11.2 Correlation

Correlation coefficient was worked out to measure the degree of relationship between independent variables and dependent variables

The data was analyzed using SPSS version 14.0.

3.11.3 Margalef Index

The Margalef richness index adjusts the number of species sampled in an area by the log of the total number of individuals sampled, summed over species.

$$\text{Margalef Index} = (S-1) / \ln(N),$$

where S is the number of species, and N is the total number of individuals in the sample.

3.11.4 Shannon- Weiner Index

The Shannon-Weiner Index is the most commonly used diversity indicator in plant communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance.

$$H = \sum_{i=1}^{s} pi.\,\mathrm{In}.\,pi.$$

where H is the Shannon-Weiner Diversity Index. The proportion of species i relative to the total number of species is calculated and multiplied by the natural logarithm of this proportion. The resulting product is summed across species and multiplied by –1.

3.11.5 Modified Shannon-Weiner Index

The Shannon-Weiner Index was used to find out the relationship between size of area and species diversity. The formula used is given below:

$$H = \sum_{i=1}^{s} pi.\,\mathrm{In}.\,pi.* \mathrm{S/A}$$

Where, s= no. of species, *i*= no: of individuals, p*i*= proportion of species i relative to the total number of species, ln= natural logarithm, S= no. of species and A= area of the home garden.

RESULTS

CHAPTER IV

RESULTS

This chapter presents the highlights of the results that have emerged out of this study. The results of the study have been presented in the following sections in the light of the objectives set forth.

4.1 Inventory of the components of agro biodiversity in homesteads

4.2 Profile characteristics of selected homesteads.

4.3 Agro biodiversity components of each of the selected homesteads based on spatial, temporal and scalar dimensions.

4.4 Awareness about agro biodiversity by the homestead farmers and the independent variables.

4.5 Perception of the stakeholders about the ecosystem services of the homesteads and the independent variables.

4.6 Farming mechanisms for agro-biodiversity conservation.

4.7 Gender roles in agro biodiversity conservation.

4.8 Constraints faced by home garden farmers in agro biodiversity conservation

4.9 Threats and challenges of agro biodiversity conservation.

4.1 INVENTORY OF THE COMPONENTS OF AGRO BIODIVERSITY IN HOMESTEADS

Table 2. Inventory of the crop species with their percentage of occurrence.

Name of the crop	Botanical name	Family	% of occurrence
Cereals			
Rice	*Oryza sativa*	Poaceae	22.22
Pulses			
Cowpea	*Vigna unguiculata*	Leguminosae	33.33
Fruits			
Banana	*Musa spp.*	Musaceae	97.78
Mango	*Mangifera indica*	Anacardiaceae	55.56
Jack	*Atrocarpus heterophyllus*	Moraceae	60.00
Papaya	*Carica papaya*	Caricaeae	2.22
Guava	*Psidium guajava*	Myrtaceae	11.11
Sapota	*Achras sapota*	Sapotaceae	22.22
Lime	*Citrus spp.*	Rutaceae	13.33
Custard apple	*Annona squamosa*	Annonaceae	8.89
Tamarind	*Tamarindus indica*	Leguminosae	13.33
Vegetables			
Brinjal	*Solanum melongena*	Solanaceae	91.11
Tomato	*Lycopersicon esculentum*	Solanaceae	66.67
Amaranthus	*Amaranthus* spp.	Amaranthaceae	88.89
Bhendi (Okra)	*Abelmoschus*	Malvaceae	77.78
Drumstick	*Moringa pteriosperma*	Moringaceae	11.11
Cauliflower	*Brassica oleraceae var*	cruciferae	2.22
Oil yielding crops			
Coconut	*Cocos nucifera*	Palmae	100
Spices and condiments			
Pepper	*Piper nigrum*	Piperaceae	60.00
Ginger	*Zingiber officinale*	Zingiberaceae	2.22
Nutmeg	*Mysristica fragrans*	Myristicaceae	48.89
Chilli	*Capsicum* spp.	Solanaceae	80.00
Other crops			
Rubber	*Hevea brasiliensis*	Euphorbiaceae	28.89

Arecanut	*Areca catchu*	Palmae	84.44
Betelvine	*Piper betle*	Piperaceae	26.27
Green manures			
Glyricidia	*Glyricidia maculata*	Leguminosae	13.33
Other tree crops			
Teak	*Tectonia grandis*	Verbenaceae	8.89
Neem tree	*Azadiracta indica*	Meliaceae	17.78
Bamboo	*Bambusa arundinaea*	Gramineae	6.67
Ornamental crops			
Rose	*Rosa* spp	Rosaceae	55.56
Jasmine	*Jasminum* spp	Oleaceae	28.89
Marigold	*Calendium officinalis*	Calenduleae	20.00

Inventory of agro biodiversity components was surveyed in 45 homesteads and divided into different categories as is represented in **Table 2.** with the percentage of occurrence. From the table it is clear that 100 per cent percentage of occurrence is obtained for coconut crop in the oil yielding category. Next crop which recorded the highest percentage of occurrence is banana i.e. 97.78 (Plate 3) which belongs to the fruit crops followed by jack and mango with 60 and 55.56 per cent respectively. Among vegetables brinjal recorded the highest frequency i.e. 91.11 followed by amaranthus with a frequency 88.89 per cent. From other crops arecanut recorded the highest percentage of occurrence i.e. 84.44 per cent (Plate 4) From spices and condiments chilli recorded the highest percentage of occurrence i.e. 80 per cent (Plate 5) followed by pepper i.e. 60. Among ornamental crops rose recorded the highest percentage of occurrence i.e. 55.56 per cent.

4.1 PROFILE OF CHARACTERISTICS OF SELECTED HOMESTEADS

4.1.1 Age

Table 3. Distribution of respondents based on age

n=45

Category (years)	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
<35	0	0	1	6.67	0	0	0	2.22
35-50	5	33.33	5	33.33	2	13.33	12	26.67
>50	10	66.64	9	60	13	86.67	32	71.11

It is evident from the **Table 3** and **Fig. 3**. that more than three fourth of the sampled farmers were in aged category as where, middle and young age category were less i.e. 2.22 and 26.67 per cent respectively.

Viewing the region wise distribution i.e. high elevation, medium elevation and low elevation, highest number of low elevation farmers are more under aged group followed by high elevation and then comes medium elevation. One third of the farmers sampled fell in the middle aged group in the high elevation and mid elevation regions. While in the low elevation the percentage was less.

Thus, more than three fourth of the homestead farmers were in aged category.

4.1.2 Education

Table 4. Distribution of respondents based on education

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Illiterate	1	6.67	1	6.67	1	6.67	3	6.67
Can read only	1	6.67	2	13.33	0	0	3	6.67
Functionally literate (Can read and write)	2	13.33	2	13.33	1	6.67	5	11.11
Primary education	3	20	3	20	4	26.67	10	22.22
High school	8	53.33	7	46.67	9	60	24	53.33

The educational status of the farmers presented in **Table 4** and **Fig. 4.** indicates that all farmers were under the literate category. Nearly 75 per cent of the farmers were having educational qualification ranging from high school to collegiate level.

Looking at the region wise distribution, it was seen that more than 86 percent of farmers of low elevation had high school to collegiate education. 55 per cent of high elevation respondents were having educational status of high school to collegiate level and in medium elevation; more than 48 per cent came under this category.

Thus it is clear that about 75 per cent of the farmers had educational level from high school to collegiate level. Lowland had maximum number of farmers (>86%) attaining high school to collegiate level of education.

4.1.3 Occupation

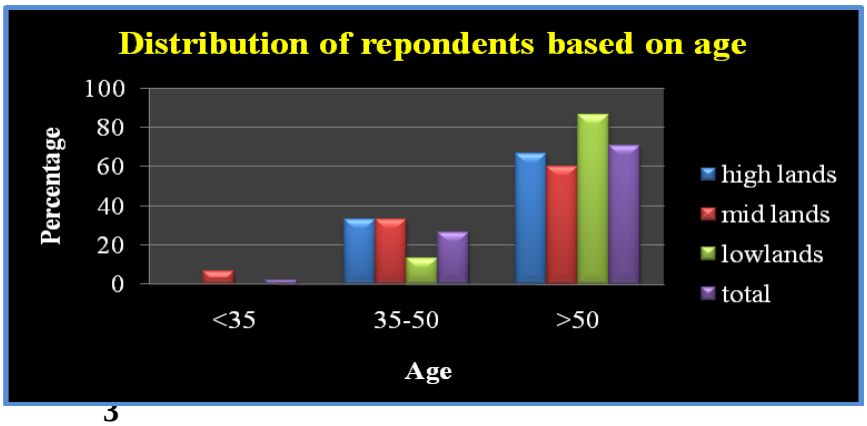
Table 5. Distribution of respondents based on their occupation

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Agriculture alone	5	33.33	5	33.33	6	40	16	35.56
Agriculture + Private employment	3	20	7	46.64	1	6.67	11	24.44
Agriculture + Government employment	7	46.67	3	20	8	53.33	18	40

The farmers were almost evenly distributed among two categories i.e. agriculture and agriculture+ government employment, with more than 35 per cent of total sampled farmers in each of these categories.

Whereas, in the region wise distribution of farmers under occupational category, more than 50 per cent of low elevation respondents were under the group agriculture+ government job. In the case of high elevation, more than 45 per cent fell



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. Distribution of respondents based on age

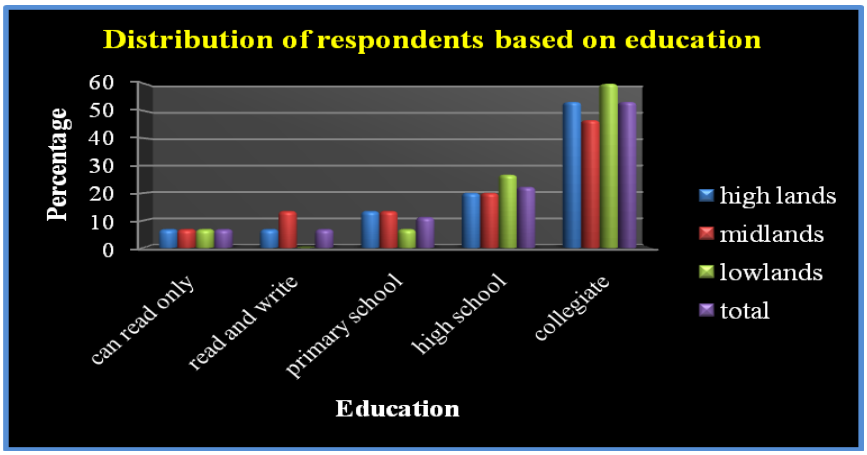

Fig. 4. Distribution of respondents based on education

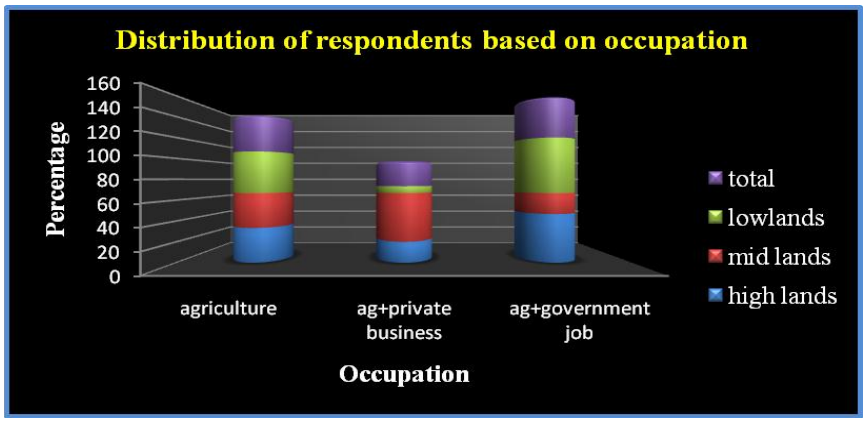

Fig. 5. Distribution of respondents based on occupation

in the category agriculture + government job and 20 per cent of farmers of mid elevation region relied on agriculture along with a government job.

Hence, it is seen that more than 35 per cent of the sampled farmers had agriculture alone as occupation where as 40 per cent of farmers had agriculture + government employment as occupation.

4.1.4 Monthly income

Table 6. Distribution of respondents based on their monthly income

n= 45

Category (Rs/month)	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
<5000	0	0	0	0	2	13.33	2	4.44
5000-10000	5	33.33	4	26.67	2	13.33	11	24.44
>10000	10	66.67	11	73.33	11	73.33	32	71.11

It is evident from the **Table 6** and **Fig. 6** that more than three fourth of the sampled respondents (71.11%) had monthly income in the category of more than Rs 10000/- followed by nearly one fourth (24.44%) respondents with monthly income of Rs 5,000/- to Rs 10,000/-. Only 4.44 per cent of the total sample received a monthly income of less than Rs 5000/-

Region wise interpretation shows that about three fourth (73.33%) of the respondents of both medium elevation and low elevation received a monthly income of more than Rs 10,000 whereas more than two third (66.67%) of the sample of high elevation region had monthly income of more than Rs 10,000/-. It was observed that about one third (33.33%) of respondents from high elevation received a monthly income of Rs 5,000/- to Rs 10,000/- followed by respondents from medium elevation (26.67%) and low elevation (13.33%).

Hence it could be seen that about three fourth of the respondents (71.11%) generated a monthly income of more than Rs 10,000/- and one fourth of the respondents (44.44%) generated a monthly income ranging from Rs 5,000 to Rs 10,000/-.

4.1.5 Farming experience

Table 7. Distribution of respondents based on their farming experience

n=45

Category (Years)	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
<5	0	0	0	0	0	0	0	0
5-10	2	13.33	6	40	0	0	8	11.11
>10	13	86.67	9	60	15	100	37	88.89

It is evident from the **Table 7** and **Fig. 7.** that more than three fourths of the sampled farmers (88.89%) were in the category of more than 10 years of farming experience.

Similar results were noted in the region wise analysis where 100 per cent of the respondents in low elevation region had more than 10 years of farming experience followed by high elevation with 86.67 per cent and mid elevation with 60 per cent.

Hence it is clear that more than three fourths of the respondents had farming experience of more than 10 years and less than one fifth of the respondents had farming experience ranging from 5-10 years.

4.1.6 Family size

Table 8. Distribution of respondents based on their family size

n=45

Category (No. of members)	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
1-4	10	66.67	12	80	12	80	34	75.56
5-7	4	26.67	3	20	1	6.67	8	17.77
8-10	1	6.66	0	0	2	13.33	3	6.67

It is evident from the **Table 8** and **Fig. 8.** that more than three fourths of the respondents (75.56%) were having the family size with 1-4 members.

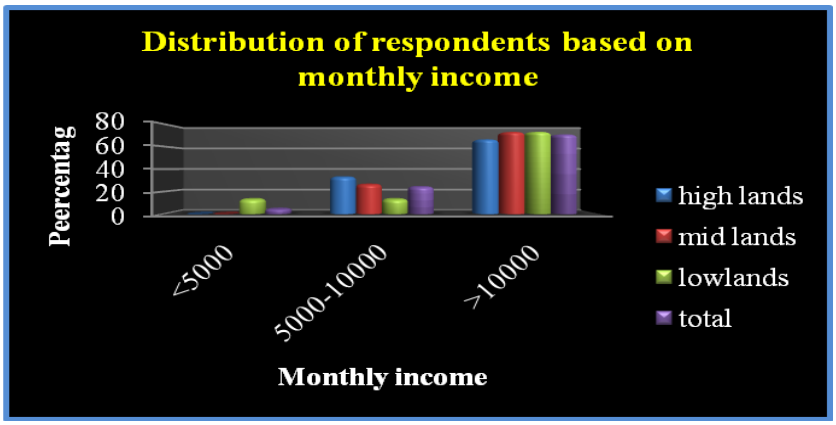

Fig. 6. Distribution of respondents based on monthly income

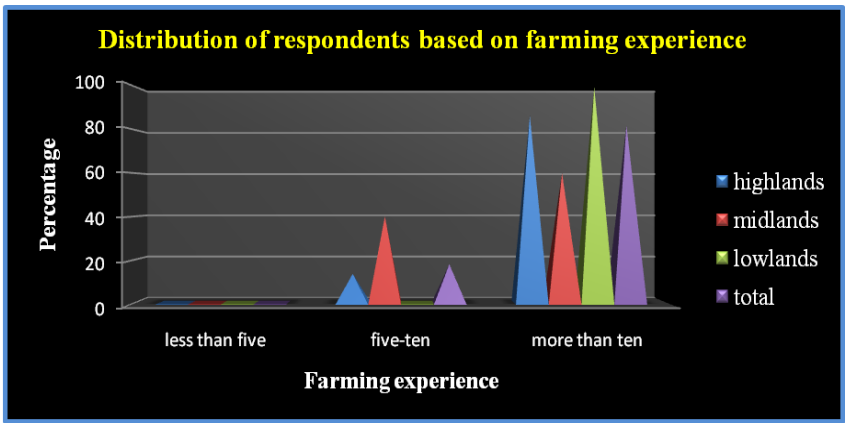

Fig. 7. Distribution of respondents based on farming experience

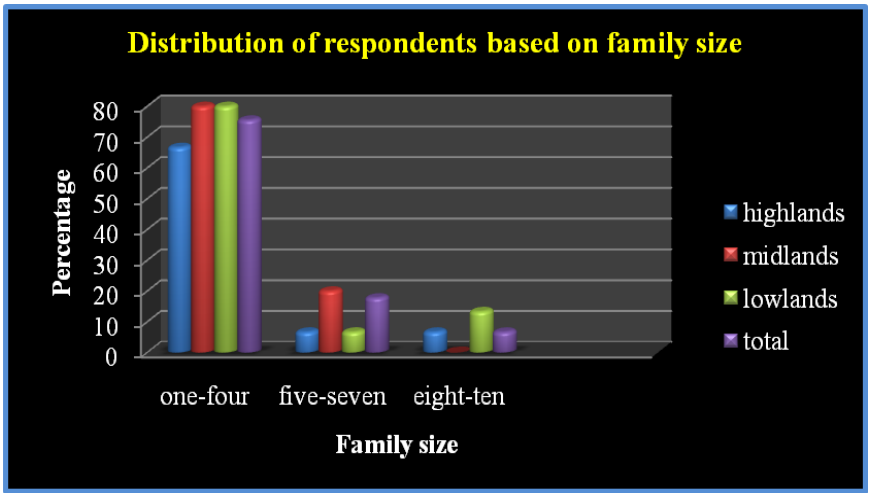

Fig. 8. Distribution of respondents based on family size

In the region wise analysis, 80 per cent of the households in both medium elevation and low elevation had 1-4 members. In the high elevation, 66.67 per cent of households had 1-4 members. More than one fourth of the both high elevation and medium elevation households had 5-7 members. In low elevation one fourth of households had 8-10 members. In the total sample, only 6.67 per cent households had 8-10 members.

Hence it is clear that three fourth of the respondents had family size with 1-4 members and one fourth with 5-7 members.

4.1.7 Information sources utilization

Table 9. Distribution of respondents based on their information sources utilization

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
High	6	40	4	26.67	8	53.33	18	40
Medium	6	40	5	33.33	6	40	17	37.78
Low	3	20	6	40	1	6.67	10	22.22

It is observed from **Table 9** and **Fig. 9.** that 40 per cent of total respondents fall under high information sources utilization. It also clear that more than 35 per cent of the respondents were under medium level of information source utilization and only 22.22 per cent under low level information source utilization.

Region wise analysis revealed that high information sources utilization is observed in low elevation i.e. 53.33 per cent followed by high elevation i.e. 40 per cent. Where as, low source information sources utilization is generally seen in medium elevation lands i.e 40 per cent

Hence it is clear that most of the respondents had high level of information source utilization.

4.1.8 Innovativeness

Table 10. Distribution of respondents based on their innovativeness

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
High	6	40	5	33.33	8	53.33	19	42.23
Medium	5	33.33	5	33.33	5	33.33	15	33.33
Low	4	26.67	5	33.34	2	13.34	11	24.44

It is evident from **Table 10** and **Fig. 10.** that more than 40 per cent of the farmer respondents are having high innovativeness in adopting improved practices.

Region wise analysis also revealed that more than 50 per cent of the low elevation land respondents were highly innovative followed by high elevation land and low elevation land respondents, with 40 per cent and 33.33 per cent respectively. There was equal per cent of respondents under medium level innovativeness i.e. 33.33 per cent.

Hence, it is clear that most of the respondents were having high innovativeness.

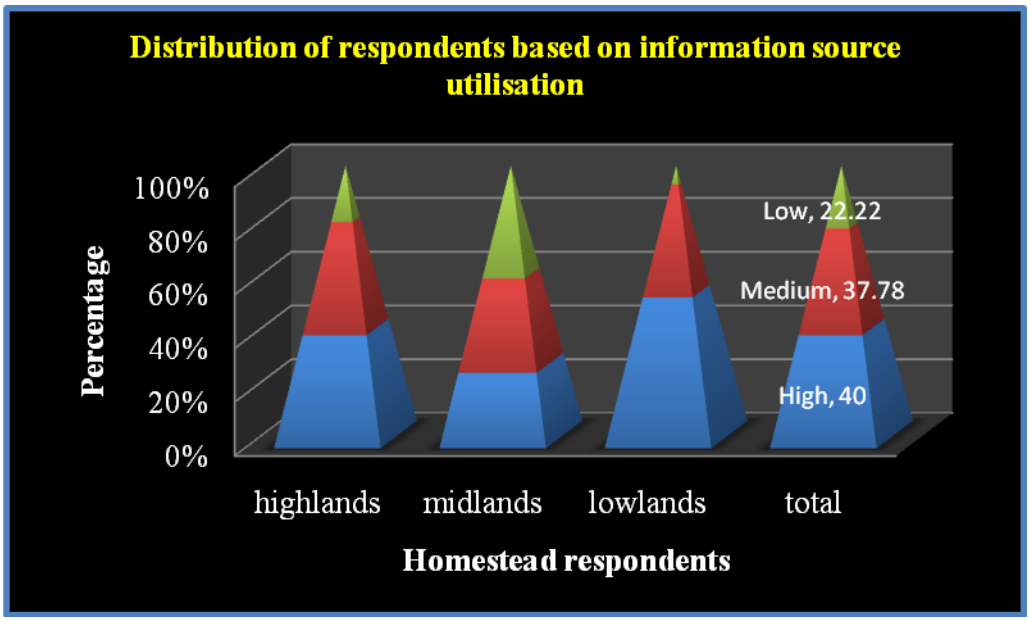

Fig. 9. Distribution of respondents based on information sources utilization

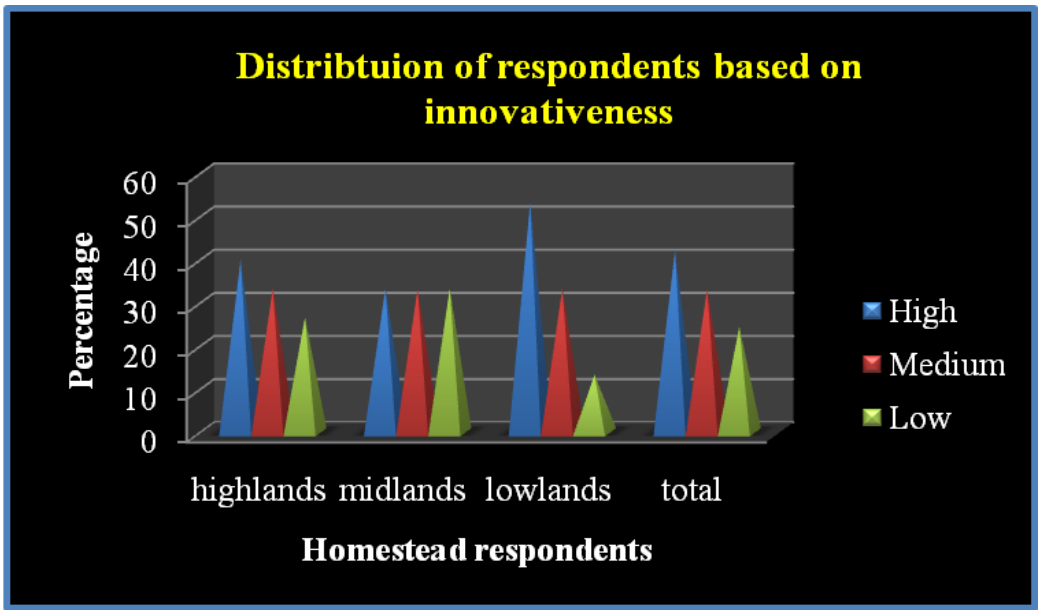

Fig. 10. Distribution of respondents based on innovativeness

Table 11. Awareness of farmers in high elevation lands about homestead based agro-biodiversity

Sl. No.	Farmers	Awareness score
1	F1	9
2	F2	10
3	F3	10
4	F4	12
5	F5	12
6	F6	12
7	F7	8
8	F8	12
9	F9	10
10	F10	8
11	F11	10
12	F12	10
13	F13	9
14	F14	10
15	F15	9

Table 11.1 Awareness of farmers in high elevation lands about homestead based agro-biodiversity

Sl. No.	Farmers	Awareness score
1	F1	9
2	F2	8
3	F3	12
4	F4	10
5	F5	9
6	F6	10
7	F7	10
8	F8	8
9	F9	10
10	F10	8
11	F11	12
12	F12	10
13	F13	9
14	F14	12
15	F15	9

Table 11.3. Awareness of farmers in low elevation lands about homestead based agro-biodiversity

Sl. No.	Farmers	Awareness score
1	F1	8
2	F2	10
3	F3	9
4	F4	10
5	F5	12
6	F6	12
7	F7	12
8	F8	10
9	F9	9
10	F10	10
11	F11	8
12	F12	10
13	F13	8
14	F14	12
15	F15	12

Sl. No.	Standard deviation	Mean
1	1.6	9.97

4.1.9 Awareness about agro biodiversity by the homestead farmers

Table. 11.3. Distribution of respondents based on awareness about homestead based agro- biodiversity

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
High	4	26.67	3	20	5	33.33	12	26.66
Medium	9	60	9	60	7	46.67	25	56.56
Low	2	13.33	3	20	3	20	8	17.78

It is evident from **Table 11.3** and **Fig. 11**. that more than 55 per cent of the respondents fall under medium category of awareness about agro biodiversity.

Region wise analysis also showed that 60 per cent of the high elevation land and medium elevation land respondents fall under medium category of awareness followed by more than 45 per cent of low elevation land respondents.

Hence it is clear that more than 55 per cent of the respondents fall under the category of medium awareness about agro biodiversity and more than one fourth of the respondents fall under high category of awareness about agro biodiversity.

Table 12. Perception of farmers in high elevation lands about ecosystem services of homesteads

Sl. No.	Farmers	Awareness score
1	F1	15
2	F2	17
3	F3	18
4	F4	26
5	F5	26
6	F6	27
7	F7	15
8	F8	26
9	F9	26
10	F10	23
11	F11	26
12	F12	20
13	F13	26
14	F14	20
15	F15	17

Table 12.1. Perception of farmers in medium elevation lands about ecosystem services of homesteads

Sl. No.	Farmers	Awareness score
1	F1	23
2	F2	15
3	F3	26
4	F4	23
5	F5	24
6	F6	23
7	F7	24
8	F8	17
9	F9	25
10	F10	20
11	F11	27
12	F12	24
13	F13	23
14	F14	26
15	F15	24

Table 12.3. Perception of farmers in low elevation lands about ecosystem services of homesteads

Sl. No.	Farmers	Awareness score
1	F1	28
2	F2	20
3	F3	24
4	F4	20
5	F5	17
6	F6	23
7	F7	24
8	F8	27
9	F9	25
10	F10	15
11	F11	24
12	F12	27
13	F13	26
14	F14	26
15	F15	25

Sl. No.	Standard deviation	Mean
1	3.96	22.51

4.1.9 Perception of the stakeholders about the ecosystem services of the homesteads

Table 12.3. Distribution of respondents based on perception about the ecosystem services of homestead

n=45

Category	Highlands		Midlands		Lowlands		TOTAL	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
High	1	6.67	1	6.67	3	20	4	8.89
Medium	9	60	12	80	10	66.67	31	68.89
Low	5	33.33	2	13.33	2	13.33	10	22.22

It is clear from the **Table 12.3** and **Fig. 12** that more than 65 per cent of the respondents were in the medium category of perception of ecosystem services.

Region wise analysis also revealed that 80 per cent of medium elevation land respondents fell in the medium category followed by low elevation lands with more than 66 per cent and high elevation lands with 60 percent.

Hence it is clear from the **Table 12.3** and **Fig. 12.**that most of the respondents were in medium category of perception of ecosystem services i.e. more than 65 per cent.

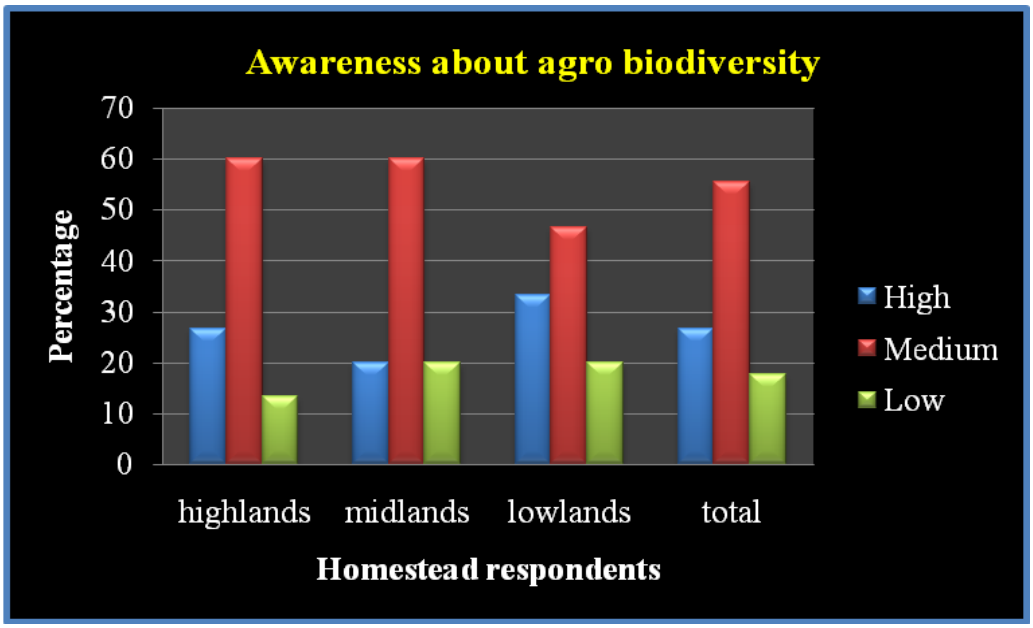

Fig. 11. Distribution of respondents based on awareness about agro biodiversity

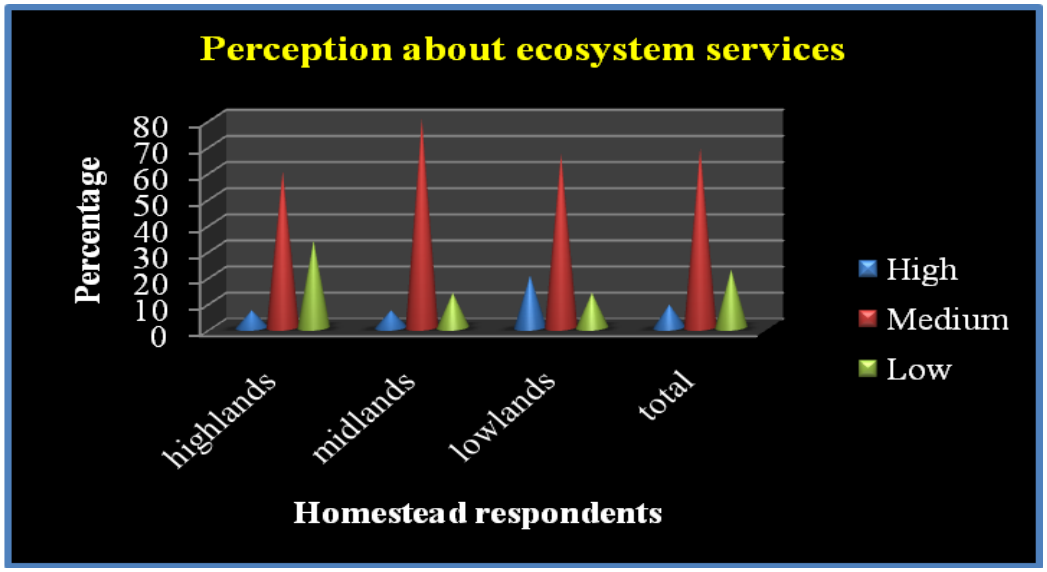

Fig. 12. Distribution of respondents based on perception about ecosystem services of homesteads

4.2 AGRO BIODIVERSITY COMPONENTS OF EACH OF THE SELECTED HOMESTEADS BASED ON SPATIAL, TEMPORAL AND SCALAR DIMENSIONS.

Measurement of diversity indices based on agro biodiversity components of selected homesteads in terms of species richness and diversity index are worked out in the study. These results are well explained below.

4.1.10 The measure of species richness

Species richness is a measure of the number of species found in a sample. The higher the Margalef index, the richer would be the species diversity of the population. The values for three regions are given the **Table 13**.

Table 13 Margalef index values of species richness in 45 homesteads

Sl. No. of homesteads	Margalef Index (high elevation lands)	Margalef Index (medium elevation lands)	Margalef Index (low elevation lands)
1	0.71	0.48	0.74
2	0.41	0.62	0.60
3	0.78	0.55	1.51
4	1.21	0.61	1.06
5	1.04	0.84	1.38
6	1.15	1.03	0.13
7	1.19	0.34	1.62
8	0.43	1.24	1.85
9	1.10	0.51	1.25
10	0.47	0.86	1.04
11	0.56	0.66	0.39
12	0.31	0.91	0.93
13	0.89	0.69	1.27
14	1.08	0.81	0.92
15	0.79	081	1.19

Table 13.1. Mean Margalef index values of species richness

Region	Mean index
High elevation lands	0.80
Medium elevation lands	0.73
Low elevation lands	1.05

The results of species richness in home gardens of different regions in Thrissur district are represented in **Table 13** and **Table 13.1** representing mean indices

Low land region in general recorded the highest richness of species. This was followed by highland and midland in which only slight difference was there representing in **Fig. 13.**

4.2.2. Shannon-Weiner Index of diversity.

Table 14. Shannon- Weiner Index values for high elevation lands (n=15)

Shannon-Weiner Index	Total no. of species	Total no. of individuals species
1.34	5	169
1.20	4	1360
1.07	6	585
1.85	8	315
1.77	7	307
1.28	5	76
1.23	5	150
0.97	4	1050
1.73	7	277
1.01	3	65
1.18	4	210
0.68	2	23
1.25	5	86
1.22	6	100
1.18	5	157

Table 15. Shannon- Weiner Index values for medium elevation lands (n=15)

Shannon-Weiner Index	Total no: of species	Total no. of individuals species
0.60	4	510
1.00	4	121
0.99	4	230
0.63	5	692
1.02	5	114
0.15	7	385
0.73	3	312
1.20	7	115
0.01	4	364
1.24	5	95
0.76	5	335
1.17	6	242
0.55	5	315
1.43	6	475
0.82	5	285

Table 16. Shannon- Weiner Indices for low elevation lands (n=15)

Shannon-Weiner Index	Total no: of species	Total no. of individuals species
1.31	5	217
1.27	4	140
1.57	7	113
1.66	6	110
1.68	8	157
1.79	8	170
1.94	10	259
2.00	9	75
1.74	8	260
1.47	6	120
0.97	3	150
1.42	6	215
1.77	8	240
1.61	6	230
1.23	7	155

Table 17. Mean Shannon- Weiner Index values

Sl. No.	Mean index
High elevation lands	1.26
Medium elevation lands	0.82
Low elevation lands	1.56

It is clear from the **Table 17** and **Fig.14** that high species diversity was recorded high in low elevation lands, followed by high elevation lands and medium elevation lands.

4.1.11 Modified Shannon-Weiner Index

Table 18. Relationship between area and species diversity values

Sl. No.	Area (cents)	Species diversity
1	25	67.09
2	25	48.28
3	25	64.20
4	25	148.61
5	25	124.43
6	25	24.19
7	25	40.25
8	25	39.63
9	25	31.50
10	25	51.11
11	25	65.60
12	25	51.16
13	25	110.42
14	25	100.16
15	25	134.99
16	75	21.38
17	75	20.52
18	75	13.01
19	75	40.52
20	75	6.06

Sl. No.	Area (cents)	Species diversity
21	75	3.55
22	75	7.36
23	75	28.12
24	75	0.39
25	75	16.65
26	75	47.97
27	75	64.66
28	75	60.06
29	75	46.47
30	75	29.47
31	125	9.45
32	125	2.73
33	125	12.51
34	125	14.65
35	125	11.83
36	125	7.66
37	125	14.08
38	125	5.5905
39	125	17.22
40	125	8.24
41	125	5.82
42	125	17.05
43	125	28.42
44	125	19.42
45	125	17.26

The results obtained from this index revealed that there was an inverse relationship between area of home garden and species diversity. As area increased it was found the species diversity decreased. So it was found that species diversity was more for 25 cents of area of home garden followed by 75 cents and then 125 cents. **(Fig.15).**

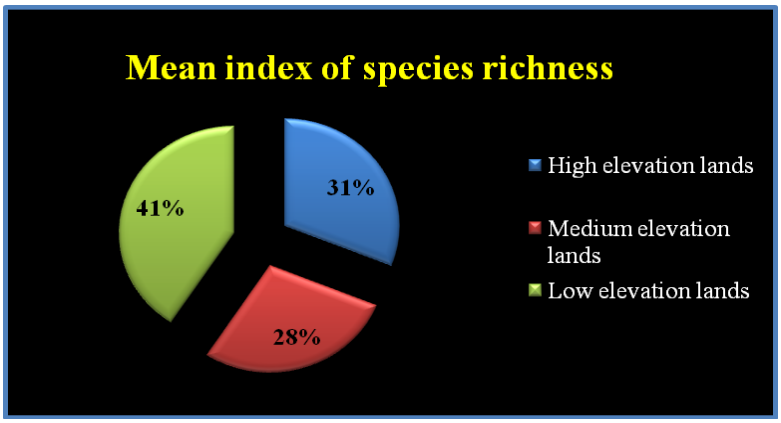

Fig. 13. Distribution of homesteads based on species richness

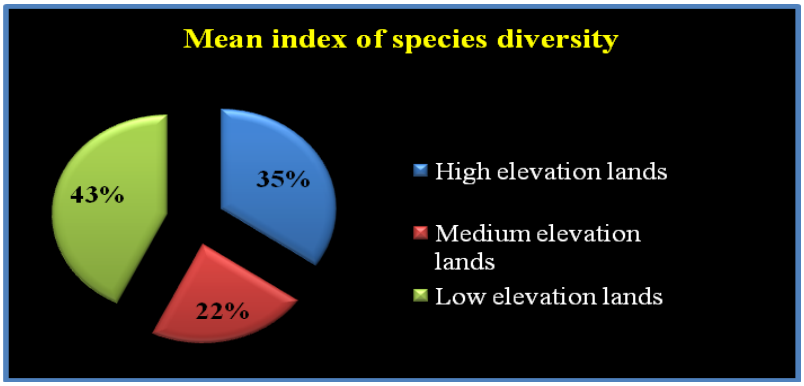

Fig. 14. Distribution of homesteads based on Shannon-Weiner index

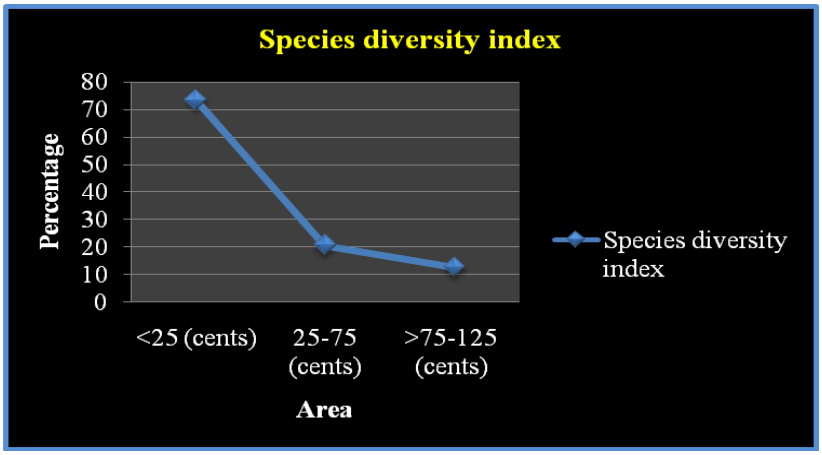

Fig. 15. Distribution of homesteads based on relationship between area and species diversity

Table 19: Cross tabulated values between area and modified Shannon-Weiner index values

Area (cents)	1-20(very poor)	>20-40 (poor)	>40-60 (better)	>60-80 (good)	>100-120 (best)
25	0	37.50	57.14	60.00	100
75	30.00	50.00	42.85	40.00	0
125	70.00	5	0	0	0

From **Table 19** and **Fig.15**. cross tabulation between area and modified Shannon-Weiner index values it was found that best species diversity was observed in 0.1 ha i.e.100 per cent. Poor diversity was observed in 0.5 ha i.e. 70 per cent.

Table 20. Temporal dimension of agro biodiversity components in homesteads

Sl. No.	**Perennial crops**	**Seasonal crops**
1	Mango	Brinjal
2	Jack	Tomato
3	Papaya	Amaranthus
4	Guava	Bhindi (Okra)
5	Sapota	Cauliflower
6	Cashewnut	Chilli
7	Lime	Rose
8	Custard apple	Jasmine
9	Tamarind	Marigold
10	Drumstick	Cowpea
11	Coconut	Banana
12	Pepper	
13	Nutmeg	
14	Rubber	
15	Arecanut	
16	Betelvine	
17	Teak	
18	Neem tree	
19	Bamboo	
Percentage	**63.67**	**36.33**

From the **Table 20** it is clear that perennials are predominantly more in the homesteads i.e. 63.67%. Seasonals are comparatively less i.e. it is only 36.33%.

4.2 CORRELATION OF INDEPENDENT VARIABLES WITH AWARENESS OF THE RESPONDENTS ABOUT AGRO BIODIVERSITY

The results obtained from the simple correlation analysis were taken into consideration for analysing the relationship between awareness of the homesteads respondents about agro biodiversity and their independent variables.

4.3.1 Correlation analysis

The results of correlation analysis in the regard are given in **Table 21** and **Fig. 16.**

The correlation analysis revealed that out of 9 independent variables, three variables namely education, information source utilization and innovativeness were positively and significantly related with awareness about agro biodiversity of the homesteads at 1 per cent level of significance. The rest of the independent variables were not significantly correlated with awareness.

Hence it is understood that the above three variables are directly influencing the awareness about agro biodiversity of the homesteads.

Table 21. Correlation between awareness about agro biodiversity by the homestead farmers and the independent variables

n=45

Sl. No.	Independent variable	Correlation coefficient (r)
1	Age	-0.183
2	Education	0.514**
3	Occupation	-0.008
4	Farm size	0.239
5	Monthly income	0.165
6	Farming experience	0.086
7	Information sources utilization	0.463**
8	Innovativeness	0.456**
9	Family size	0.019

** - significant at 1 per cent level; *- Significant at 5 per cent level

4.3 PERCEPTION OF THE STAKEHOLDERS ABOUT THE ECOSYSTEM SERVICES OF THE HOMESTEADS AND THE INDEPENDENT VARIABLES

The results of correlation analysis in this regard are given in the **Table 22** and **Fig 17.** The correlation analysis revealed that out of 10 independent variables, three variables namely education, information source utilization and innovativeness were

positively and significantly related with perception of the stakeholders about the ecosystem services of the homesteads at 1 per cent level of significance. The rest of the independent variables were not significantly correlated with perception.

Hence it is clear that all the above three variables are directly influencing the perception of the stakeholders about the ecosystem services of the homesteads.

Table 22. Correlation between perception of the stakeholders about the ecosystem services of the homesteads and the independent variables

n=45

Sl. No.	**Independent variables**	**Correlation coefficient (r)**
1	Age	-0.115
2	Education	0.893**
3	Occupation	0.046
4	Farm size	0.13
5	Monthly income	0.276
6	Farming experience	0.188
7	Information sources utilization	0.695**
8	Innovativeness	0.594**
9	Family size	-0.157

** - significant at 1 per cent level; *- Significant at 5 per cent level

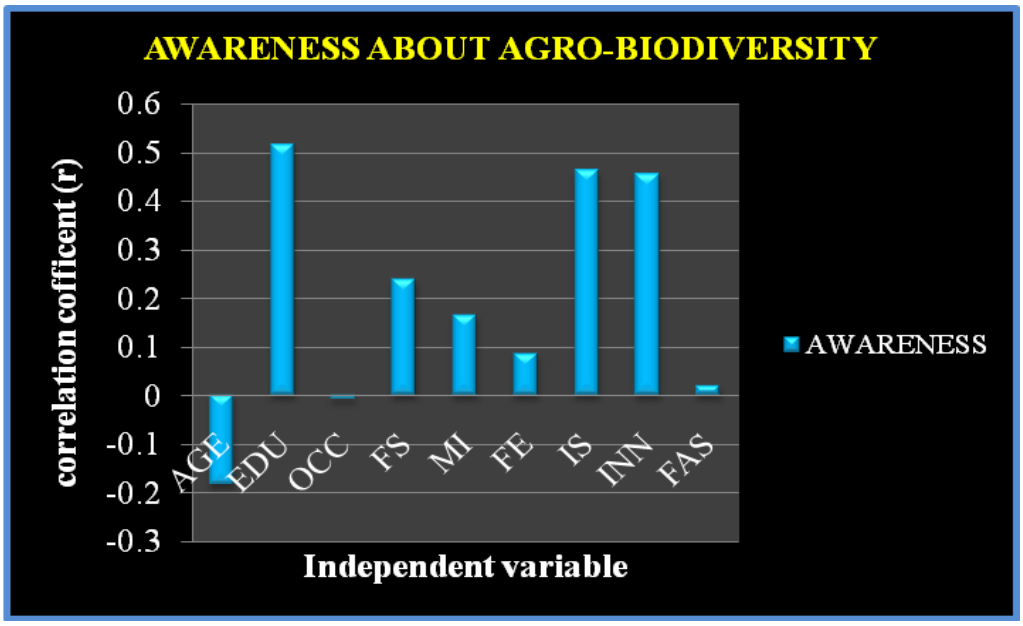

Fig. 16. Correlation between awareness about agro biodiversity by the homestead farmers and the independent variables

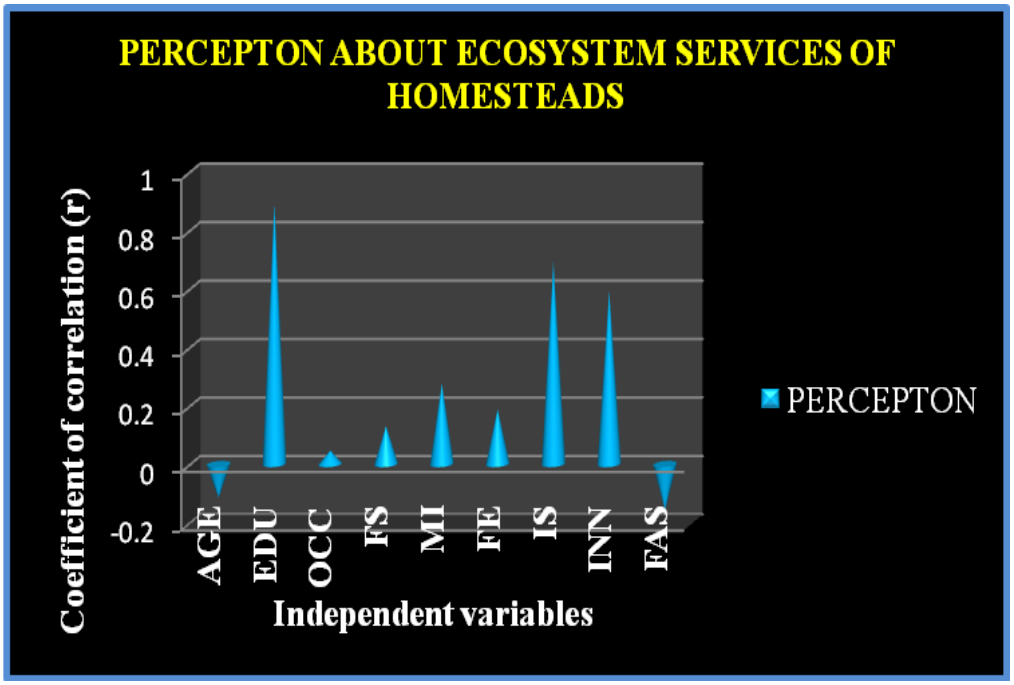

Fig. 17. Correlation between perception of the stakeholders about the ecosystem services of the homesteads and the independent variables

4.4 FARMING MECHANISMS FOR AGRO-BIODIVERSITY CONSERVATION

Table 23. Farming mechanisms for agro-biodiversity conservation in homesteads

n=45

Sl. No.	Statement	Percentage of respondents	Rank
1	Crop rotation	90	1
2	Mixed farming	85	2
3	Conservation of small water bodies in homesteads like ponds	84	3
4	Inclusion of seasonal crops	70	4
5	Kitchen gardens	66	5
6	Hedge crops/plants	50	6
7	Inclusion of medicinal plants	44	7
8	Conservation of traditional biodiversity spots like sacred groves	30	8
9	Conservation and maintenance of species with cultural values	20	9

From **Table 23** it is clear that crop rotation (90 per cent) is the main important farming mechanism for agro-biodiversity conservation and the next most important farming mechanism is mixed farming (85 per cent). The third most important mechanism is conservation of small water bodies in homesteads like ponds (84 per cent) (Plate 6)

4.6 GENDER ROLES IN AGRO BIODIVERSITY CONSERVATION

The results obtained by calculating the percentage of men, women and both involved in agro biodiversity conservation are given below.

Table 24. Genders roles in activities related to agro-biodiversity conservation

n=45

Sl. No.	Task	Men	%	Women	%	Both	%
1	.Kitchen garden	3	6.66	40	**90**	2	4.44
2	Hedge of a green manure crop	5	11.11	35	**77.79**	5	11.11
3	Digging holes for water harvesting	30	**66.67**	15	33.33	0	0
4	Pruning	25	**55.56**	15	33.33	5	11.11
5	Planting different species of crops	25	**55.56**	10	22.22	10	22.22
6	Watering	10	22.22	30	**66.67**	5	11.11
7	Fertilizing	8	17.79	32	**71.11**	5	11.11
8	Weeding	12	26.67	23	**51.11**	10	22.22
9	Fencing	10	22.22	25	**55.56**	10	22.22
10	Seed selection	18	40	20	**44.44**	7	15.56
11	Mulching	5	11.11	35	**77.79**	5	11.11
12	Pest control	15	33.33	20	**44.45**	10	22.22
13	Dried waste and other disposal	5	11.11	35	**77.79**	5	11.11

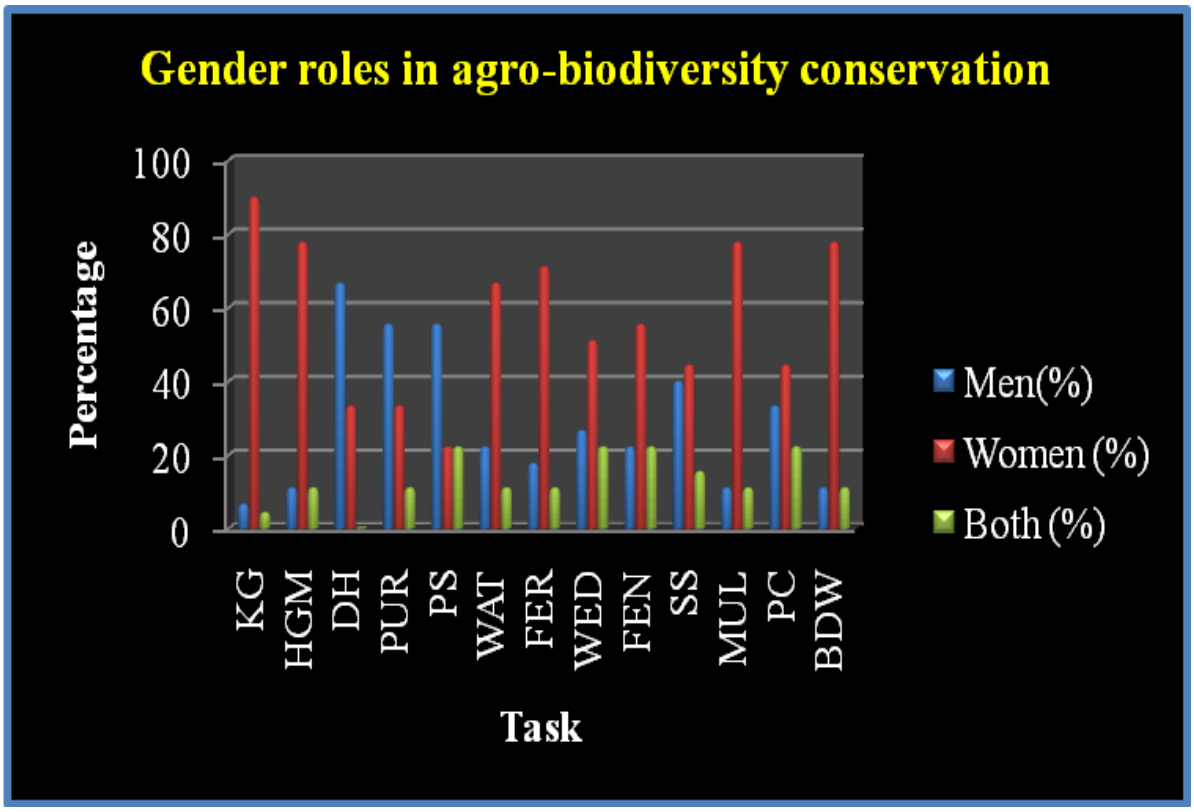

Fig. 18. Gender roles in agro biodiversity conservation

It is understood from **Table 24** and **Fig. 18.** that management of home garden in agro biodiversity conservation is mostly done by women respondents. kitchen garden activity recorded the highest per cent i.e. 90 followed by hedge of growing green manure, mulching and burning of dried waste with more than 75 per cent.

Activities such as digging holes, pruning and planting species in agro biodiversity conservation are undertaken by men farmers and very less per cent by women farmers i.e. more than 30 per cent in digging holes and pruning followed by planting species i.e. more than 20 per cent.

Hence it is understood from Table 24 and Fig. 18 that most of the activities are undertaken by women farmers in agro biodiversity conservation.

4.10 CONSTRAINTS FACED BY HOMESTEAD FARMERS IN AGRO BIODIVERSITY CONSERVATION

Table 25. Constraints faced by homestead farmers in agro-biodiversity conservation

Sl. No.	Constraints	Percentage of respondents	Rank
1	Unavailability of water	100	1
2	Unavailability of labour	95.56	2
3	High cost of labour	95.56	2
4	Unavailability of desired planting material	55.56	6
5	Depending more on high yielding varieties	77.78	4

Sl. No.	Constraints	Percentage of respondents	Rank
6	Preferential selection of seedlings by farmers	66.67	5
7	Lack of knowledge about agro biodiversity programme	22.22	8
8	Low level of awareness on agro biodiversity	66.67	5
9	Deep rooting habits of certain trees which affects the yield of agricultural crops	33.33	7
10	Smaller size of land holding	44.44	6
11	Lack of time in managing the homestead farming	88.89	3
12	Depletion of soil nutrients by growing of certain trees	8.89	9

The data presented in the **Table 25** shows that the most important constraint perceived farmers was the unavailability of water having the frequency percentage 100. The next important constraint was the unavailability of labour and high cost of labour which had the frequency percentage 95.56. Lack of time in managing the homestead farm (88.89) came in the 3rd with respect to their frequency percentage. The problem of depending more on high yielding varieties (77.78) came in the fourth position. Preferential selection of seedlings by farmers and smaller size of land holding came in the fifth position with the frequency percentage 66.67.

4.11 THREATS AND CHALLENGES OF AGRO BIODIVERSITY CONSERVATION

Table 26. Threats and challenges to homestead farmers in agro biodiversity conservation felt by experts

Sl. No.	Threat	Percentage of respondents	Rank
1	Unsustainable human activity is the greatest threat to biodiversity, causing environmental destruction of beneficial habitats, the killing of living organisms, the reduction of genetic diversity and species extinction.	100	1
2	Replacement of rural areas once used for the production of services (home gardens, wooded areas, living fences, pastures) by monoculture has caused a depletion of local species, primitive varieties and wild relatives.	83.33	5
3	Changes in land use patterns due to change in life style.	80	6
4	Unavailability of local seed	33.33	11
5	‘‘Modern’’ varieties which replace local landraces on a large scale	76.66	7
6	Fragmentation of holdings due to inheritance	86.67	4
7	Large scale introduction of cash crop monoculture, particularly rubber, has been detrimental to the stock of flora in the home gardens	96.67	2
8	Pressure on land due to public infrastructure	48.89	10

Sl. No.	Threat	Percentage of respondents	Rank
9	Increasing urbanization which causes encroachment of the rural areas for urban creeds.	90	3
10	Lack of incentives for farming systems that enhance biodiversity	50	9
11	Lack of knowledge and awareness on the importance of conservation of biodiversity	6.67	14
12	Environmental stresses (e.g. natural calamities, water scarcity, loss of soil fertility)	6.67	14
13	Mechanization of agriculture and the consequent specialization of agricultural tasks have led to an impoverishment of the traditional home garden system	10	13
14	Scarcity of labour	13.33	12
15	Change in lifestyle and occupational pattern which has reduced family involvement in home garden operations.	56.67	8

From the **Table 26** it is clear that unsustainable human activity is the main threat to homestead based agro biodiversity with the highest frequency of occurrence i.e. 100 per cent. Second most important threat is large scale introduction of cash crops e.g. rubber and also mono-cropping (96.67 per cent). Third most important threat is increasing urbanization (90 per cent). Fourth is the fragmentation of land holding (86.67 per cent). Fifth most is the replacement of rural areas which accounts for 83.33 per cent.

Frequency obtained for other threats and challenges are changes in land use patterns due to change in life style (80), ‘‘Modern’’ varieties which replace local

landraces in large scale (76.66), change in lifestyle and occupational pattern which has reduced family involvement in home garden operations (56.67), lack of incentives for farming systems that enhance biodiversity (50), pressure on land due to public infrastructure (48.89), unavailability of local seed (33.33), scarcity of labour (13.33), mechanization of agriculture and the consequent specialization of agricultural tasks which have led to an impoverishment of the traditional home garden system (10), lack of knowledge and awareness on the importance of conservation of biodiversity and environmental stresses (e.g. natural calamities, water scarcity, loss of soil fertility) (6.67).

DISCUSSION

CHAPTER V

DISCUSSION

The results obtained in the study can only be discussed under broard subheadings as each result is linked with one another. An attempt at discussion of the results is being made under the following major sub headings.

5.1 Inventory of the components of agro biodiversity in homesteads

5.2 Profile characteristics of selected homesteads.

5.3 Agro biodiversity components of each of the selected homesteads based on spatial, temporal and scalar dimensions.

5.4 Awareness about agro biodiversity by the homestead farmers and the independent variables.

5.5 Perception of the stakeholders about the ecosystem services of the homesteads and the independent variables.

5.6 Farming mechanisms for agro-biodiversity conservation

5.7 Gender roles in agro biodiversity conservation.

5.8 Constraints faced by homestead farmers in agro biodiversity conservation.

5.9 Threats and challenges to agro biodiversity conservation role of the homesteads.

5.1 INVENTORY OF THE COMPONENTS OF AGRO BIODIVERSITY IN HOMESTEADS

Based on the information and literature, crop species were classified into different categories such as cereals, pulses, fruits, vegetables, oil yielding crops, species and condiments, other crops and other tree crops.

From the results it is clear that 100 per cent frequency of occurrence was obtained for coconut crop because in Kerala coconut is the major crop found to be grown in almost every homestead. It fetch as high income to the farmer and also environmental benefits are more: for example it serves as a shade giving crop. Jose and Shanmugaratnam (1993) reported coconut palm (*Cocos nucifera*) forms the 'nucleus' of the Kerala home gardens, around which the other components are orchestrated

Nair and Sreedharan (1986) had reported that the coconut palm (*Cocos nucifera*), whose growth and planting patterns enable successful growing of other crops in between or under them, the date palm (*Phoenix dactilifera*), and the areca palm (*Areca catechu*), can be grown with annual or perennial crops and thus can be effectively utilized in home garden systems, and provide a source of market income.

Kerala is known for many varieties of palm trees (Renuka, 1999) and therefore, palms are of special importance in any home garden study in Kerala. So from this study it is confirmed that arecanut recorded the highest frequency of occurrence i.e. 84.44 per cent.

Next category which recorded the highest frequency of occurrence is fruit trees i.e. banana (97.78 per cent) and among vegetables brinjal recorded the highest per cent i.e. 91.11 because vegetables and fruits grown in these gardens provide a secure supply of fresh produce throughout the year and meet the food and nutritional requirements of the family. Fruit crops also fetch additional income to the family. Similarly, home gardens also provide a number of green leafy vegetables, which are rich in micronutrients (Agte *et al.*, 2000).

Banana cultivation in home garden farming systems ranges from: rainfed to irrigated; level land to steep hill slopes; at sea level to high ranges; wetlands to

uplands; nutrient-rich soil to poor soil; open to shaded areas; without ratooning to prolonged ratooning; as the sole crop or in mixed cropping systems. There are also specific cultivars of banana used for ceremonies and religious functions as well as those believed to have medicinal properties. Also, some varieties are grown for their leaves, for various household uses. In each home garden, depending upon the requirements of the farmer, a few banana types are being conserved and managed.

The fruits and vegetables contribute to a balanced diet by providing not only energy-rich food but also supply of vital protective nutrients like vitamins and minerals. Comparatively, vegetables are the cheapest source of nutritious food. Fresh fruits and vegetables provide us with carbohydrate, protein, vitamins, mineral and fats which are essential to our body. Hence, home garden can provide nutritious and balanced diet to the family that makes the farm families healthy and strong. This is the reason that home garden is also called a Primary Health Centre (Thapa, 2004).

Farmers often opt for perennial chilli , tomatoes and amaranthus over seasonal ones so that they provide a continuous supply of food items throughout the year.

5.2 PROFILE CHARACTERISTICS OF SELECTED HOMESTEAD FARMERS

Age, education, occupation, farm size, monthly income, farming experience, family size, information source utilization, innovativeness and livestock component in the homesteads were the independent variables selected for the study. The results of the categorization of the respondents based on the independent variables selected for this study had to be discussed as it has its own significance.

Majority of the homestead respondents belonged to the aged category. This is because the eldest in the home is often considered to be head of the homestead. The

higher level of education among the homestead respondents was high school level to collegiate due to the well developed educational system prevailing in the state as well as the high literacy of the people in the regions of the study. The average number of members of a family in the study area was below four, clearly highlighting the shift towards nuclear family concept. Thus the physical involvement of family members in home gardening activities over years may get diminished and they might just resort with supervisory role. The finding of this study was in conformity to the results of Babu (1995).

Occupational classification revealed that majority of the home garden farmers considered home gardening as an additional income generating activity and they use their free time getting involved in the home garden activities. This was well supported by the finding of this study where majority of home garden farmers were involved in government job or private job.

Most of the farmer respondents are having more than ten years of farming experience because majority of the farmers belong to aged category.

It was found that 40 per cent of the respondents had high level information source utilization. This showed that most of the respondents had high mass media participation by reading newspapers, farm magazines and listening to radio and television. This finding is obvious since the literacy rate in Kerala is high and that most of the households in Kerala subscribe to at least one daily newspaper.

Innovativeness is another variable in which case only 42 per cent of the total respondents congregated in the high category. Only those farmers who are sensitive to change might show the characteristics of innovators. According to Yohannes (2001), an innovation is defined as something new that has been started with in the

life time of the farmer, not something inherited from parents or grand parents. Moreover, because conditions are constantly changing farmers have to modify their farming techniques over time (Mitiku *et al*., 2001). The level of innovativeness is expected to be affected by the age of the farmer. There are some studies which indicate the level of innovativeness to be lower among older and younger farmers (Reij and Waters-Bayer, 2001). It was hypothesized that the pick in innovativeness is found among farmers in the age bracket of 35-50 years. Experience will enable farmers to have better knowledge which in turn may be the basis for innovativeness.

Awareness about agro biodiversity of homestead farmers fall under medium category i.e. more than 55 per cent because awareness means individual comes to know of something which is related to one's own need or arouses the need (Ray, 1991). The relationship between age of the household head and the level of awareness revealed that a 1 year increase in the age of the household head significantly decreased the odds of the household attaining a higher level of awareness by 0.9615 times. These results indicate that older farmers lack receptivity towards newly introduced technologies and thus they are more contented with their old ways of doing things.

With regard to perception of farmers towards ecosystem services of homestead based agro biodiversity, the data revealed that the majority of farmers had medium perception of ecosystem services of the homesteads. With regard to perception of farmers towards agro-biodiversity, the data reveled that the majority of farmers had moderately better perception towards the importance and advantages of promoting agro-biodiversity. This findings can be explained on the basis of the fact that agro-biodiversity itself is relatively new concept for farmers. It may take some more time of better understanding and to acquire more information on the importance of agro-biodiversity. Further, adequate efforts might not have been made by

concerned developmental agencies to educate and convince illiterate farmers. The farmers of Kerala possessed medium perception towards agro-biodiversity.

The results of both independent and dependent variables actually bring out the nature of personal-socio- psychological and economic profile of the home garden farmers. Proper understanding of these personal characters will enable the strategies to frame programmes for better and successful homestead based agro biodiversity.

5.3 AGRO BIODIVERSITY COMPONENTS OF EACH OF THE SELECTED HOMESTEADS BASED ON SPATIAL, TEMPORAL AND SCALAR DIMENSIONS.

The indices which are used to determine the components of agro biodiversity of selected homesteads were species richness and diversity index. Based on scalar species richness and based on spatial species diversity was estimated. Species diversity and richness measures were estimated for all 45 gardens. Perennial species were identified in the three slope categories with the exception of weed and ornamental species. Weeds and ornamental plants were merely noted in species count, and not included in the species diversity calculations because the presence of weeds and ornamentals are highly transitory and hard to count.

It was observed that high species richness is recorded high in lowlands (1.05) followed by highland (0.80) and midlands (0.73) with slight differences. Species richness was not found to be affected by home garden size as was confirmed from the findings (Soumya, 2004). The major soil types of the coastal region are sandy soils, alluvium soils, and clay soils. Kerala forms the “type locality” of the laterite soils which form the greater part of the midland zone (Varghese, 1993). This is one of the reasons for high species richness in lowland region (1.05).

The seasonal vegetables were not included in the Shannon-Weiner diversity tests, because they would not present an accurate estimate of the diversity index for the entire year. Gajaseni and Gajaseni (1999) conducted Shannon tests in the home gardens of Thailand, and found ranges from 1.9 to 2.7, which are also fairly comparable to the results from this study. In the present study, the higher Shannon Index value reported in the low elevation land category was due to even distribution of perennials. Mainly the species diversity depends not on the total number of individuals it had but on how equally it is distributed. In lowlands it was observed that total number of species was 9 and total number of individuals was 75 but it recorded the highest species diversity i.e. 2.00 because the total number of individuals was more or less equally distributed. In the same region one of the homesteads had more number of species i.e. 10 and total number individuals were 259, fairly greater than the former homestead but they were not equally distributed so it was found that species diversity was slightly lower i.e. 1.94.

Based on temporal dimension percentage of perennials and seasonals that were grown in homestead was calculated. From this study it was clear that perennials are predominantly more in the homesteads (66.67%). Seasonals are comparatively less and are mostly grown during the rainy periods. Herbaceous and other plants naturally coming up in the homesteads will be cleared by the farmers, considering them as weeds. Therefore from the temporal dimension, the scope for agro biodiversity cannot be considered as very high in the case of homesteads. Main aim of farming is maximization of profits from a limited area of land in the shortest time span. And they expect trees planted on the farm, should ensure ‘‘profitability’’ (44% of the farmers), ‘‘fast growth’’ (37% of the respondents), and ‘‘multifunctionality’’ (fruits for domestic consumption and sale, leaves as green manure, feed for livestock, firewood, and timber for meeting own needs or as a reserve of capital: 28% of the

respondents). Such preferences are usually based on the farmers' economical, ecological, and social value systems this as reported by Guillerme *et al.,* (2011).

In order to find the relationship between area and species diversity slightly Shannon-Weiner index was modified by multiplying the index values with number of species in each homestead and then dividing with area. The results obtained was fair the there was an inverse relation between area and species diversity. This finding was supported from another study in Kerala home gardens (Soumya *et al.*, 2007) found that the smallest gardens had highest Shannon-Weiner index, with medium and large gardens at 0.97 and 0.81.

5.4 CORRELATIONS OF INDEPENDENT VARIABLES WITH AWARENESS OF THE RESPONDENTS ABOUT AGRO BIODIVERSITY

The results of the simple correlation revealed that only three independent variables showed positive and significant relationship out of 10 independent variables. Education, information sources utilization and innovativeness were three independent variables which had direct influence on the awareness about agro biodiversity.

Education was found to be positively and significantly correlated with awareness about agro biodiversity of homestead farmers. Higher the level of education higher will be the degree of awareness. The relationship between level of awareness and education level reveals that a 1 year increase in years of schooling of the head of the household significantly increased the odds of the household attaining a higher level of awareness by 1.7744 times. These results are consistent with the expectation since education provides farmers with more information knowledge about avenues.

Information source utilization was another variable which was positively and significantly related with awareness about agro biodiversity. Mass media play a great role in creating awareness. The information conveyed through mass media can motivate farmers. It can also help to disseminate knowledge and raise awareness. Hence, mass media exposure would be having a positive influence on farmer awareness. Good extension contact for getting information play a great role in raising awareness. The increased awareness would enhance farmers' innovativeness.

Innovativeness had positive and significant relationship because innovativeness means knowing about and having an interest in new practices or ideas. Education enhances the capacity of individuals to obtain, and utilize information disseminated by different sources. This in turn strengthens their innovativeness. Based on this premise, most studies indicate that innovators are better educated (Reij and Waters-Bayer, 2001).

5.5 PERCEPTION OF THE STAKEHOLDERS ABOUT THE ECOSYSTEM SERVICES OF THE HOMESTEADS AND THE INDEPENDENT VARIABLES.

The results of simple correlation revealed that only three independent variables showed positive and significant relationship out of the 10 independent variables. Education, information sources utilization and innovativeness are three independent variables which had direct influence on the perception of the stakeholders about ecosystem services of the homesteads.

Education was found to be positively and significantly correlated with perception of ecosystem services of homestead farmers. Perception is a more complex process by which people select, organise and interpret sensory stimulus into

meaningful and coherent picture of the work. Higher the level of education better would be the degree of perception. Education widens the sphere of social perspective and helps the individual in proper interpretation of external stimuli. Even when induced flow of information ceases from the technology generating system to the consumption system, education enables individuals to tap information at their own capacity and assist in rational perception. This finding is in conformity with Sundaram (1986), Balan (1987) and Latha (1990).

The perception about ecosystem services was found to be positively and significantly related to the variable innovativeness. Bemis (1972) theory of self perception stated that people come to know their attitudes, emotions and other internal states partially by inferring them from their own behaviour and the context in which this behaviour occurs. An important cause for innovativeness is an underlying willingness to change and also to try new ideas.

Information sources utilization was another variable which was positively and significantly related with perception. By seeking information from different sources and getting more knowledge about a subject, the outlook of the individual gets changed which is reflected in his perception towards the subject. As outline in the theory of stability and change in behaviour (Secord and Backman, 1961) individuals attain congruent in perceptual- cognitive state in relation with elements of their own behaviour and self respect. This probably explains how information sources utilization and perception are related (Balan ,1987, Latha, 1990 and Babu, 1995).

5.6 FARMING MECHANISMS FOR AGRO-BIODIVERSITY CONSERVATION

The results obtained from Table 23 shows that crop rotation is the main farming mechanism for agro-biodiversity conservation and this is because many crops may have positive effects on succeeding crops in the rotation, leading to greater production overall. They also reduce pests and diseases in the cropping system and control weeds when smothering crop species (e.g. cowpea) or green manure cover crops are included. Rotations may also give benefits in terms of improved soil quality (more or deeper roots; root exudates), better distribution of nutrients in the soil profile (deep-rooted crops bring up nutrients from below) and increased biological activity. Through rotations, peak labour times may be reduced and labour better distributed throughout the year, if planting and harvest times are different. Crop rotations may decrease risk as bad seasons, or bad parts of a season, may affect some crops more than others. Crop rotations can balance the production of residues by alternating crops that produce few and/or short-lived residues with crops that produce a lot of durable residues. By there many crops can be saved from extinction which contributes to agro-biodiversity conservation.

The second important mechanism is mixed farming (85 per cent) because mixed farming systems provide farmers with an opportunity to diversify risk from single crop production, to use labour more efficiently, to have a source of cash for purchasing farm inputs and to add value to crops or crop by-products. Combining crops and livestock also has the potential to maintain ecosystem function and health and help prevent agricultural systems from becoming too brittle, or over connected, by promoting greater biodiversity, and therefore increased capability to absorb shocks to the natural resource base (Holling, 1995).

The third most important mechanism is conservation of small water bodies in homesteads because they are very important for day to day activities. Small water bodies form in the resulting hollows and are used for fisheries, livestock management, irrigation, bathing and washing clothes

Other farming mechanisms shown in the table 23 are minor as the percentage contribution of such mechanisms is very low.

5.7 GENDER ROLES IN AGRO BIODIVERSITY CONSERVATION

Home gardens show actual and potential values in the provision of food, medicine, and other household necessities as well as in the conservation of plant genetic diversity. The perceived threat of genetic erosion to plant resources for food and agriculture can be reduced through home gardens, since they ensure conservation of useful plants. This potential of home gardens can only be achieved when they are managed properly.

The cultivation and management of home gardens by women is a widespread phenomenon among settled groups the world over. In developing countries, the role of women in the use/management of agricultural resources is usually greater than that of men who are generally only directly involved in hard- work tasks. Women are usually responsible for a large part of food production. Sharing of tasks between woman and man for the management of home gardens is something to be analyzed.

The results obtained in Table 24 and Fig 18 revealed that both men and women play a significant role in plantation activities. It was found that labor-intensive activities like digging holes (66.67%), pruning (55.56%), and planting species (55.56%) were done by men, while watering (66.67%), fertilizing (71.71%),

weeding (51.11%), and fencing (55.56%) were mainly done by women. Women spend most of their time in pre-harvesting activity. The average time they spend in the home garden is 6-8 hours/week while men spend four to five hours a week. From the results it is clear that majority of the farmers are government or private employees so they don't find a lot of time to spend in farming activities.

It was observed that a majority (77.79%) of the women were involved in dried-branch collection. The study revealed that 44.44% of the women participate in decision-making in selecting species, which was congruent with the findings of Gurusamy *et al.,* (1990).

Use of family labor, especially women labor in the production process not only ensures lowering of production costs (Rugalema *et al*., 1994; Benjamin *et al*., 2001), but also satisfies a wide range of domestic needs more economically and effortlessly than through local markets (Soemarwoto and Conway, 1991).

These gender roles categorizations and the study in general demonstrates a number of important conclusions: (1) women are mostly involved in home garden management-related activities (2) women are interested in conserving home gardens because they are more directly involved with the substantial benefits as food security, income, health care, and environmental benefits (3) women were found to be more aware of home-garden conservation. This should serve as an eye opener for all development functionaries. It may be noticed that women involve in major practices and operations related to agro biodiversity conservation.

5.8 CONSTRAINTS FACED BY HOMESTEAD FARMERS IN AGRO BIODIVERSITY CONSERVATION

From this study it came out that the most important constraint faced by homestead farmers is the unavailability of water because water plays an important role in the welfare of societies through its widespread linkages. Water needs are complexly linked with daily life and can be an obstacle to economic growth. Even though the household consumption constitutes only eight per cent of the total water usage, the value of water for household purposes is reckoned much higher than its value for industrial use and farming. As per studies conducted by Central Ground Water Board, only 48 per cent of the ground water sources in Kerala has been exploited (KSPB, 2003).

The second most important constraint faced by homestead farmers is unavailability of labour and high cost of labour. 95.56 per cent of respondents expressed this. Most of the labourers are engaged in other works in which they can earn more money compared to the farming activity such as Mahatma Gandhi employment guarantee scheme,(MGNREGS) etc and this might be the reason for their low interest in strenuous agricultural work.

The third most important constraint was lack of time in managing the homestead farm. This study showed that most of the farmers were job holders because of which they did not have enough time to manage their home gardens.

The fourth most important constraint was more dependency on high yielding varieties. Traditional varieties require more management practices and their cost effectiveness is not very good so farmers opt for HYV’s. Most of the departments that are supplying seeds provide exotic varieties as the farmers are not getting the

desired planting materials. Thus they ultimately depend on the high yielding varieties. From the results it is clear that farmers are not getting preferred selection of seedlings and also desired planting material. With the advent of the high-yielding variety (HYV) programme in Kerala, most of the paddy lands (81% coverage according to the KSPB, 2003) were also dedicated to modern varieties; consequently, cultivation of a vast majority of the distinctive landraces have vanished (Kumar, 2005).

Other constraints shown in the table 20 are minor as the constraint index of such constraints is very low.

5.9 THREATS AND CHALLENGES TO AGRO BIODIVERSITY CONSERVATION ROLE OF THE HOMESTEADS FELT BY EXPERTS

From this study it is clear that in the view of experts the major threat to homestead based agro biodiversity conservation is unsustainable human activity which was expressed by 100 per cent of the respondents. The main reason behind this must be due to development of urban-lifestyles in the rural area and due to introduction of cash crops in order to achieve high profits. Farmers of the new age are highly profit-oriented, so they generally do not bother about the perishing traditional species. This is supported from this study because the next threat to agro biodiversity conservation is large scale introduction of cash crop monoculture, particularly rubber, which has been detrimental to the stock of flora in the home gardens. Due to the introduction of rubber it is impossible to grow other crops.

Land-use changes, and in particular agricultural intensification, affect the biodiversity of managed landscapes. Indeed, a large proportion of the Kerala home gardens have been converted into small-scale plantations of coconut and rubber or cropping systems consisting of fewer crops due to commercialization and

fragmentation of land holdings (Kumar and Nair, 2004). Coincidentally, many local varieties of mango (*Mangifera indica*), jackfruit (*Artocapus heterophyllus*) and other traditional fruit/vegetable crops, which were once abundant in the Kerala home gardens, are now thought to be extinct (Santhakumar, 1996; Kumar and Nair, 2004). It is also confirmed from this study that the fourth most important threat is fragmentation of land holdings i.e. by 86.67 per cents of respondents.

Traditionally, the home gardens allowed product diversification for domestic consumption, besides generating cash income (Kumar and Nair, 2004). Today, however, farmers rely more and more on commercial crops to meet the family's rising expectations and growing income needs. Changes in the society and the new aspirations of people also influence the choice of trees in the home gardens (e.g. planting fast growing multipurpose trees).

Based on the above discussion it can be concluded that unsustainable human activity, mono- cropping, increasing urbanization which causes encroachment of the rural areas for urban creeds, ''modern'' varieties which replace local landraces in large scale and changes in land use patterns due to change in life style were the major constraints in homestead based agro biodiversity conservation.

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSIONS

Homestead farming is a traditional practice of multiple and mixed cropping in small holdings in Kerala. Home gardens are living gene banks and reservoirs of plant genetic resources that preserve landraces, obsolete cultivars, rare species and endangered species and species neglected in larger ecosystems. Home garden is one of the components of agro biodiversity.

Home gardens, with their diversified agricultural crops and trees, fulfill the basic needs of the local population. In addition, the multistoried arrangements of plants and relatively high species diversities prevent the environmental degradation that is commonly associated with monocultures. The biodiversity of Kerala homesteads has declined drastically during the last four to five decades. Majority of the homesteads face the threat of fragmentation. Thus, it is most important that biodiversity of the homesteads be conserved.

Relying on biodiversity may not increase the short-term economic benefits generated from agriculture. However, biodiversity will improve the stability of the system, improve the quality and diversity of commodities available for home consumption, improve the ability of the farmer to make resilient dwelling unit, and reduce fluctuations in cash income. Even though the predominant farming system in the state is homestead farming system, their role and contribution to agro biodiversity of the state is very less studied. With modernization and urbanization picking up on a large scale, agriculture is pushed to back stage and as a reflection of this, the homesteads are also decline.

Home gardens are largely neglected in national and international agricultural research for several reasons. The significance of this research is that it contributes to a better understanding of the dynamic homesteads of Kerala

farmers in relation to agro biodiversity. The new generation farmers are losing interest on subsistence crops and instead, take up high paying cash crops where ever they can. A life style, largely dependent on nature and utilizing natural products and processes has almost bowed out. In this context, it is highly essential that we document the homesteads and their contribution to agro biodiversity. There present study is taken up to throw light on these aspects as far as possible with the following specific objectives:

Specific objectives of the study are:

- To inventory the components of agro biodiversity in homesteads.
- To examine the farming mechanisms to conserve biodiversity using farmer participatory methods.
- To study gender equity in conserving agro biodiversity and its role in maintaining the ecosystem services of homesteads.
- To identify the present and future threats of agro biodiversity conservation.

The study was conducted during the year 2011 in Thrissur district comprising Thrikkur, Pananchery and Adat panchayats consisting a sample size of 45 homegardens using random sampling technique representing three three regions *viz.* high elevation lands, medium elevation lands and low elevation lands.

The variables in the study were awareness of homestead based agro biodiversity and perception about ecosystem services of homesteads, gender roles in agro biodiversity conservation, constraints faced by the homestead farmers in agro biodiversity conservation and future threats and challenges felt by the experts in homestead based agro biodiversity.

The characteristic variable selected for the study were Age, education, occupation, farm size, monthly income, farming experience, family size, information source utilization and innovativeness. The characteristics variables were quantified using existing scales or following established procedures.

In order to assess the diversity in homesteads two biodiversity indices were used in this study namely Margalef's index (1958) and Shannon-Wiener Index (1985). Margalef's index formula was used to measure the species richness and Shannon-Wiener Index was used to measure diversity of homestead.

The data were collected by conducting personal interviews with homegarden farmers, using well- structured and pre-tested interview schedule developed for this study.

Percentage analysis, correlation analysis, frequency percentage, Margalef Index and Shannon-Weiner Index was employed in interpreting the results.

The salient findings of the study are furnished below.

1. More than three fourth of the farmers were in aged category.
2. Almost 75 per cent of the farmers had educational level from high school to collegiate level.
3. More than one third of the sampled farmers had agriculture alone as occupation whereas more than two third of farmers had 'agriculture + private' or 'agriculture + government' as occupation.
4. About three fourth of the respondents (71.11%) generated a monthly income of more than Rs 10,000/- and nearly one fourth of the respondents (24.44%) generated a monthly income ranging from Rs 5,000 to Rs 10,000/-.

5. More than three fourth of the sampled farmers had a family size with 3-4 members.
6. More than three fourth of the respondents had a farming experience of more than 10 years.
7. Most of the respondents had high level of information source utilization.
8. Most of the respondents were having high innovativeness i.e. more than 40 per cent.
9. More than 55 per cent of the respondents were having medium level of awareness about agro biodiversity.
10. More than 65 per cent of the respondents were having medium level of perception about ecosystem services of homestead.
11. Low elevation lands region recorded the highest richness of species. This was followed by highland and midland in which only slight difference was there.
12. Low elevation lands homesteads are having high species diversity with mean index of 1.56 followed by high elevation lands and medium elevation lands with only slight difference.
13. There was inverse relationship between area and species diversity
14. Out of 10 independent variables, three variables namely education, information source utilization and innovativeness were positively and significantly related with awareness about agro biodiversity of the homesteads at 1 per cent level of significance.
15. Out of 10 independent variables, three variables namely education, information source utilization and innovativeness were positively and significantly related with perception of the stakeholders about the ecosystem services of the homesteads at 1 per cent level of significance.
16. Most of the activities are undertaken by women farmers in agro biodiversity conservation.

17. The constraints analysis revealed that the major ones identified were unavailability of water (100), unavailability of labour and high cost of labour (95.56), lack of time in managing the homestead farming (88.89) and depending more on high yielding varieties (77.78).
18. The most important threat to agro biodiversity conservation was unsustainable human activity (100). Second most important threat is large scale introduction of cash crops and also mono-cropping (96.67 per cent).

To conclude, in general, the results that analyses the conservation of agro bio diversity in homesteads were mainly maintained by the women farmers. It is also found the species richness and diversity was varying from region to region.

SUGGESTIONS FOR FUTURE LINE OF WORK

- Agro biodiversity studies on a state wide basis including all agro-climatic zones.
- Scientific studies on ideal components for maximizing agro-biodiversity conservation in homesteads.
- Interactions and inter relations among the different components of agro-biodiversity.
- Awareness creation about the important role of home gardens and need for their conservation.
- Development of technology packages in tune with homestead based agro-biodiversity conservation.

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APPENDICES

APPENDIX-I

INTERVIEW SCHEDULE

Sl.no: Area:

Date: Survey no:

PART-A

1. Name of the farmer:

2. Age :

3. Address :

4. Religion/Caste :

5. Education : Illiterate/Read Only/Can Read and Write/Primary School/Middle School/High School/College

6. Occupation : Agriculture alone/Agriculture+Private business/Agriculture+Government

7. Farm Size : Area in cents

a. wet land :

b. dry land :

c total :

8. Monthly Income :

(a) on farm income:

(b) off farm income:

(c) total

9. Farming Experience:

For how many years have been engaged in farming?

10. Information Sources:

(a) Mass media

Sl.no.	Source	Most often	Often	Sometime	Rarely
1	Internet				
2	Television				
3	Radio				
4	Movies				
5	Farm magazine				
6	News paper				
7	Others(specify)				

(b) Interpersonal Sources

Sl.No.	Source	Most often	Often	Sometime	Rarely
1	Agricultural Assistant				
2	Agricultural officer				
3	University scientist				
4	Input agencies				
5	Any other(specify)				

(c) Personal localite sources

Sl.No.	Source	Most often	Often	Sometime	Rarely
1	Friends				
2	Neighbours				
3	Relatives				
4	Any other(specify)				

11. Innovativeness

(a) Have you cultivated HYV's of any cultivated crop? Yes/no

(b) Do you collect information regarding new practices from the research stations/universities? Yes/no

(c) As soon as you get information regarding new agricultural practice, will you take immediate decision to put into use? Yes/no

(d) Do you practice any improved recommendations after getting necessary information without any delay? Yes/no

12. Family Structure and Characteristics:

Sl. No	Name	R/n with head	Sex	Age	Education	Employment			
						P	Income/year	S	Income/year

PART-B

Agro biodiversity Components:

Based on Spatial

(a) Courtyard region:

S no:	**Crop species**	**No: of sp/area**	**Age**	**Use**

(b) Mid region

S no:	Crop species	No: of sp/area	Age	use

(c) Outer region

S. no:	Crop species	No: of sp/area	Age	Use

Based on temporal

(a) During one year how many crop species are raised?

(b) What the crops that

(c) are grown and how many species?

Based on scalar

Crop	**variety**
Banana	
Coconut	
Pepper	
Vegetables	
Fruits	
Arecanut	
Any other(specify)	

3. AWARENESS ABOUT HOMESTEAD BASED AGRO BIODIVERSITY

1. Agro biodiversity promotes food security yes/no
2. Agro biodiversity helps in maximizing effective use of resources yes/no
3. Agro biodiversity improves human nutrition and provides sources of local remedies yes/no
4. Agro biodiversity does not helps to maintain soil health yes/no
5. Agro biodiversity does not helps in the nutrient cycling yes/no
6. Agro biodiversity does not ensure better utilization and conservation of water.yes/no

2. PERCEPTION ABOUT THE ECOSYSTEM SERVICES OF THE HOMESTEADS

Sl.No.	STATEMENTS	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	Homestead biodiversity promotes pollination, encourages pollinators					
2	Homesteads are multipurpose generators of goods, timber and fuels					
3	Better diversity helps in soil formation.					
4	Agro biodiversity does not helps in natural hazard regulation					
5	Agro biodiversity does not helps in recharge of ground water					
6	Plant species grown traditionally in homesteads are not rich in photochemicals which have health promoting effects.					

Gender roles in agro biodiversity conservation

Gender roles	MEN	WOMEN
1.Kitchen garden		
2.hedge of green manure crop		
3 Digging holes		
4 purning		
5 Planting species		
6 Watering		
7 Fertilizing		
8 Weeding		
9 Fencing		
10 Seed selection		
11 Mulching		
12 Pest control		
13 Burning of dried waste		

What are the constraints faced by you in agro biodiversity conservation?

Sl. No.	Constraint	Mark
1	Unavailability of water	
2	Unavailability of labour	
3	High cost of labour	
4	Unavailability of desired planting material	
5	Depending more on high yielding varieties	
6	Preferential selection of seedlings by farmers	
7	Lack of knowledge about agro biodiversity programme	
8	Low level of awareness on agro biodiversity	
9	Deep rooting habits of certain trees which affects the yield of agricultural crops	
10	Uncertainty about the produce from the trees	
11	Lack of time in managing the homestead farming	
12	Growing of certain trees results in depletion of soil nutrients	

APPENDIX -II

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF AGRICULTURAL EXTENSION

COLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

Dr.Jayasree Krishnankutty **Vellanikkara**

Associate Professor **10-02-2010**

Dear Sir/Madam,

Miss Krishna Priya. N, M.Sc student of this department is undertaking a study titled **Homestead based agro biodiversity conservation – a farmer participatory study** under my guidance for her research work. As part of the study she has to measure 'awareness about agro biodiversity by the homestead farmers' and 'perception of the stakeholders about the ecosystem services of the homesteads'

Considering your rich experience in the field, you have been identified as a judge for rating the relevancy of the items identified under each dimension. Kindly rate the items by putting a tick (√) mark against the appropriate column in the five point continuum provided. Kindly add other items you feel appropriate under the variables and rate them accordingly. You may also rearrange the statements according to the suitability.

Please return the completed schedule to the researcher at your earliest convenience.

Thanking you,

Yours sincerely,

Jayasree Krishnankutty

AWARENESS ABOUT HOMESTEAD BASED AGRO BIODIVERSITY

Sl.No.	STATEMENTS	MR	R	MLR	LR	LEA.R
1	Agro biodiversity helps to enhance economic returns.					
2	It brings about better genetic diversity by way of a variety of species, cultivars and hybrids.					
3	Agro biodiversity supports the agro ecosystems like agricultural.					
4	Agro biodiversity supports the agro ecosystems like pastoral.					
5	Agro biodiversity supports the agro ecosystems like forest.					
6	Agro biodiversity supports the agro ecosystems like aqua culture.					
7	Local knowledge and culture are the integral parts of agro biodiversity management.					
8	Agro biodiversity is combinations of species are hard to find in any other farming system.					
9	Agro biodiversity helps to maintain the relationship between biodiversity and agriculture.					
10	Agro biodiversity promotes food security.					

11	Women are the best keepers and protectors of agro biodiversity.					
12	Agro biodiversity helps in maximizing effective use of resources.					
13	Agro biodiversity improves human nutrition and provides sources of local remedies.					
14	Agro biodiversity greatly promotes natural soil fertility.					
15	Agro biodiversity helps to maintain soil health.					
16	Agro biodiversity helps in the nutrient cycling.					
17	Agro biodiversity encourages biocontrol agents and natural enemies for crop and livestock pests.					
18	Agro biodiversity promotes cultural and local knowledge of diversity.					
19	It includes the diversity of non harvested species that indirectly support production like pollinators, soil microorganisms and predators					
20	Agro biodiversity promotes diversified products like no other					

	farming system.					
21	Homestead based agro biodiversity leads to sustainability of the farming system.					
22	Agro biodiversity promotes the conservation of ecosystem better species diversity in homesteads leads to sustainability of farming system.					
23	Agro biodiversity helps in pollination and dispersal of seeds.					
24	Homestead based agro biodiversity contributes greatly to a rich micro climate, unlike monoculture.					
25	Agro biodiversity ensures better utilization and conservation of water.					
26	Agro biodiversity leads to sustainability of farming systems.					
27	Agro biodiversity will lead to less profitable farming.					
28	Agro biodiversity is workable only in small scale homestead farms					
29	Agro biodiversity is not a long-term option for subsistence farmers.					

MR- Most relevant LEA.R- Least relevant R- Relevant MLR- More or less relevant LR- Less relevant

PERCEPTION ABOUT THE ECOSYSTEM SERVICES OF THE HOMESTEADS

Sl. No.	**STATEMENTS**	**MR**	**R**	**MLR**	**LR**	**LEA.R**
1	Homestead biodiversity promotes pollination, encourages pollinators.					
2	Homesteads can be considered as one of the best examples of agro biodiversity reserves.					
3	Homestead farming helps to support a number of species of flora and fauna directly.					

4	Homestead cultivation a necessity in the traditional way of living and it was not chosen because of the ecosystem services.					
5	Homesteads are multipurpose generators of goods, timber and fuels.					
6	Better diversity helps in soil formation.					
7	Agro biodiversity promote detoxicification.					
8	Agro biodiversity helps in decomposition of waste.					
9	Agro biodiversity helps in natural hazard regulation					
10	Agro biodiversity helps in recharge of ground water					
11	Argo biodiversity promote better water infiltration.					
	Homesteads help promote					

12	cultural values as well as spiritual and aesthetic values.					
13	Homesteads help in protection of people from the sun's harmful ultraviolet rays.					
14	Homestead farming is not highly superior to any other systems of cultivation in enriching the environment.					
15	Homestead cultivation is too varied and individualistic to be considered as a specialized farming system which serves in recycling and rejuvenation.					
16	Homestead farming will be generally low in production, so farmers cannot be expected to go on with it just for ecosystem benefits.					

17	Homesteads are just random selection of crop and crop species and don't have much to do with environment protection or conservation.					
18	Plant species grown traditionally in homesteads are rich in phytochemicals which have health promoting effects					

MR- Most relevant LEA.R- Least relevant R- Relevant MLR- More or less relevant LR- Less relevant

APPENDIX-III

KERALA AGRICULTURAL UNIVERSITY
DEPARTMENT OF AGRICULTURAL EXTENSION
COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

Dr. Jayasree Krishnankutty
Associate Professor

vellanikkara
22-6-2011

Dear Sir/Madam,

Miss. Krishna Priya N, M.Sc student of this department is undertaking a study entitled **Homestead based agro biodiversity – a farmer participatory study,** under my guidance for her research work. As a part of the study she has to rank the 'threats and challenges to agro biodiversity conservation' of homesteads

Considering your rich experience in the field, you have been identified as a judge for selecting the items under each of the variables. Kindly rate the items putting a tick mark against the most important.

Please return the completed schedule to the researcher at your earliest convenience.

Thanking you in advance, and expecting your valuable co operation

Yours sincerely,

Jayasree Krishnankutty.

Threats and challenges to homestead based agro biodiversity

Sl. No.	STATEMENTS	Mark
1	Unsustainable human activity is the greatest threat to biodiversity, causing environmental destruction of beneficial habitats, the killing of living organisms, the reduction of genetic diversity and species extinction.	
2	. Replacement of rural areas once used for the production of services (home gardens, wooded areas, living fences, pastures) by monocultures has caused a depletion of local species, primitive varieties and wild relatives.	
3	Changes in land use patterns due to change in life style.	
4	Unavailability of local seed.	
5	‘‘Modern’’ varieties which replace local landraces in large scale	
6	Fragmentation of holdings due to inheritance	
7	Large scale introduction of cash crop mono-cultures, particularly rubber, has been detrimental to the stock of flora in the home gardens	
8	Pressure on land due to public infrastructure.	
9	Increasing urbanization which causes encroachment of the rural areas for urban creeds.	

10	Lack of incentives for farming systems that enhance biodiversity	
11	Lack of knowledge and awareness on the importance of conservation of biodiversity	
12	Environmental stresses (e.g. natural calamities, water scarcity, loss of soil fertility)	
13	Mechanization of agriculture and the consequent specialization of agricultural tasks have lead to an impoverishment of the traditional home garden system	
14	Scarcity of labour	
15	Change in lifestyle and occupational pattern which has reduced family involvement in home garden operations.	

ANY OTHERS PLEASE LIST?

Homestead based agro biodiversity- a farmer participatory study

By

KRISHNA PRIYA N

THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Agriculture
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2011

ABSTRACT

Homestead farming is a traditional practice of multiple and mixed cropping in small holdings in Kerala. Home gardens are an integral part of the livelihood systems, and could contribute to the family food, income and the conservation of biodiversity. Home garden is one of the components of agro biodiversity.

The home garden agro ecosystem is an important system for the maintenance of agro biodiversity beyond its primary function in crop production, household food security and nutrition. It is an important area for effectively implementing programmes geared towards biodiversity conservation, food security and sustainable development.

This study was undertaken in Thrissur, Thrikkur, Pananchery and Adat panchayats were selected representing high elevation lands, medium elevation lands and low elevation lands respectively. From these panchayats 15 homesteads were selected purposively based on farm size making a total sample size of 45.

Inventory of crop and other plants was prepared for 45 homesteads and divided into different categories with the percentage occurrence of each crop. It was noted that 100 per cent occurrence is obtained for coconut crop. Next crop which recorded the highest frequency was banana i.e.97.78

Biodiversity of homesteads of these regions were estimated based on two major biodiversity indices namely Margalef index (1958) and Shannon-Wiener diversity index (1985). Margalef index measures the species richness and Shannon-

Wiener diversity index measures the species diversity. Based on this low elevation lands recorded the highest species richness and species diversity.

The level of awareness about agro biodiversity was assessed. More than 55 per cent of the respondents were having medium level of awareness. The level of perception about ecosystem services of homesteads was also found medium among the respondents.

Positive correlation between farmer's awareness on agro biodiversity was observed for three variables namely education, information source utilization and innovativeness were positively and significantly correlated at 1 per cent level of significance. The correlation analysis for the perception of the stakeholders about the ecosystem services of the homesteads had similar results. Age and occupation had negative correlation.

Gender roles in agro biodiversity confirmed that most of the activities were undertaken by women farmers. Kitchen garden activity which is recorded the highest per cent i.e. 90.

Most important constraint faced by farmers in homestead based agro biodiversity conservation was the unavailability of water. The next important constraint was scarcity of labour and high cost of labour which was expressed by 95.56 percentage of respondents.

Unsustainable human activity was the main threat to homestead based agro biodiversity conservation with the highest frequency of occurrence i.e. 100 per cent.

Second most important threat was large scale introduction of cash crops and mono-cropping (96.67 per cent).

To conclude, variability in home gardens exists within region and between regions and as the size of holding increased, agro-biodiversity was found to decrease. The homesteads surveyed, generally were rich in agro-biodiversity. Women gender contributed more to conserving it.

Plate 1 Preparing a list of home garden farmers

Plate 4 Arecanut highest per cent of occurrence among other crops

Plate 2 Data collection

Plate 5 Chilli highest per cent of occurrence among spices and condiments

Plate 3 Banana highest per cent of occurrence among fruits crops

Plate 6 Farming mechanism for agro-biodiversity conservation (pond)