TECHNOLOGY ASSESSMENT IN THE HOMEGARDEN SYSTEMS

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DECLARATION

I hereby declare that this thesis entitled **"Technology assessment in the homegarden systems"** 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, associateship, fellowship or other similar title, of any other university or society.

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CERTIFICATE

Certified that this thesis entitled **"Technology assessment in the homegarden systems"** is a record of research work done independently by Mr. Allan Thomas (2000-21-23) under my guidance `and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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Introduction

1. INTRODUCTION

Homegarden is one of the oldest forms of agro-ecosystems present throughout the world. It plays an important role in the economic as well as socio-cultural functions of rural societies. It is a major, unique and very much developed agricultural production system in Kerala - the 'Gods own country' where it forms the basic farming system in all agro-ecological zones. This is a system with high diversity of useful plants and animals per unit area where its interaction through intervention by man results in a unique combination by high levels of productivity, stability and sustainability. Homegardens are operational farm units or farm environment in which crop, livestock, poultry and any other specialized components like sericulture, apiculture and/or fish farming is carried out mainly for the purpose of satisfying farmer's needs. This type of farming enables the farmers to utilise the available land around their house for growing a variety of annuals/seasonal or perennial crops of their best choice based on home requirement and market preferences if surplus is produced subject to the extent of land and resource availability [Kerala State Land Use Board (KSLUB), 1997].

In Kerala, the number of homegardens in a zone could be as many as the number of families in the zone, where the home is always surrounded by a small piece of land, in which, 'poly crop - animal husbandry - specialised component' mix combinations are found which constitutes an ideal and continuous production system making it a dynamic one.

Stemming from the sustainable development discourse, the concept of sustainable agriculture is against 'industrial agriculture' and 'green revolution agriculture' which is gradually becoming the concern of scientists and researchers (Jose, 1992). It is widely believed that homegarden systems are a means to attain high sustainability and a system that is sustainable will be a system that is profitable and environmentally sound [Potash and Phosphate Institute (PPI), 1990]. Owing to the

interaction of a multitude of components, homegarden systems can be considered as one of the complex systems which demands a system approach for its understanding.

Under the shrinking per capita land availability, coupled with the intricacies of the global and market economy, homegarden systems are facing its own challenges. This phenomenon, eventhough challenging, highlights the importance of this production system as the scope of commercial agriculture is decreasing day by day in Kerala as a result of decreasing availability of land for agriculture because of high population density in Kerala. Therefore, a viable production strategy to overcome the disadvantages of land holding size lies in proper planning and maneuvering to the needs of homegarden farmer.

The ever-evolving nature of homegardens make it structurally and functionally complex and quantum of technology involved necessitate scientific research and validation. Research studies on the structural and functional diversities and various technological aspects of homegarden farming system would help in formulating strategies to ensure effective and meaningful programmes for the holistic development of homegardens on a long term sustainable basis. Hence, the present study was taken up with the following specific objectives.

1. To analyse the profile characteristics of homegarden farmers.
2. To identify the structural configuration of homegardens.
3. To identify the cropping system and type of homegardens.
4. To assess the extent of contribution of technology in terms of extent of adoption of technology/scientific practices in homegardens.
5. To establish the relationship of personal characteristics of homegarden farmers with the extent of adoption of technology / scientific practices.
6. To assess the extent of adoption of indigenous practices adopted by homegarden farmers.
7. To identify the technology needs of the homegarden farmers that essentially forms the technology forecast for the homegarden systems.
8. To delineate the dimensions of technology suited for homegardens and
9. To identify the constraints experienced by homegarden farmers.

Scope and importance of the study

Kerala state, which covers only 1.18 per cent of the total land area of India, supports over 3.5 per cent of the country's population. The state has a population density of 819 persons per sq. km. being the highest in India. Because of the high-density population, the size of the farm holding is very small, ranging from 0.02 to 1.00 ha. The farmers of the state usually undertake intensive farming involving a variety of crops on the limited area available in order to obtain food, fuel, fodder, timber and cash from homesteads. The homesteads thus present an excellent example of the basic concept of homegarden systems in Kerala (Nair and Sreedharan, 1986).

Since homegardens are a part of the total agro-eco systems, their development cannot be considered in isolation. Information on the agricultural calendar and seasonality of homegarden crops would enable us to design a species composition which would improve the role of homegardens so that it could fill in the troughs to the lean periods and the seasonability of labour supply and demand, maintaining the dynamic and ever evolving nature of homegardens.

Detailed investigations on the structure and composition of homegardens of Kerala would enable both the extension and research system to formulate research agenda as well as delivery mechanism. Thus, homegarden systems will enable better income generation which will complement educational needs of family members and development of technologies adapted to local situations.

Analysis of the dimensions of food security and additional income generation problem at household levels suggest a broad agenda for possible personal and technological interventions that may be necessary or useful in improving the conditions within which individual households must pursue their own agenda of food security and additional income through the sale of surplus. An attempt to assess the technology needs and factors therein for the system sustainability of homegarden would thus be of relevance.

There has been interplay of several institutions that have led to development of technologies cutting across different crops. Irrespective of the inclusion of crops in homegardens, these technologies have been disseminated by extension systems considering crops in isolation. But, since these crops are only components of a larger system such as a homegarden, the relevance or otherwise of the technologies generated / disseminated need to be thoroughly probed. Technologies that have permeated into the homegardens alone would be relevant to their sustainability. Thus, the identification of such technologies and its dimensions is an important part of the study.

The technology assessment in a whole can serve as a useful feedback to the research system for designing technologies useful to the small and marginal farmers for large-scale recommendation so as to share the benefits of development. It will aid in technology change and improvement in any sphere, increases economic returns and enhance development process of the state.

Limitations of the study

The study was conducted as a part of Doctoral Research work and was restricted to Southern Kerala comprising Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta districts, which makes it difficult to generalise the findings of the study for the entire state. However, all efforts have been made to conduct the study as objective and systematic as possible.

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 objective of study while the third chapter comprises methodology. The fourth and fifth chapters deals with the results and discussion on the results of the study respectively. The final chapter gives the summary and conclusion of the study.

Review of Literature

2. REVIEW OF LITERATURE

A proper conceptual framework for the study based on the ideas and concepts gathered from review of existing literature of both theoretical and empirical nature will facilitate the researcher for planning the study in a comprehensive way. As the studies on the technology assessment in homegarden systems in Kerala was less, the works on homegardens reported from other countries were reviewed to identify and internalise different variables that are relevant to the different areas of present research and to presume probable relationship among them. Hence, the available studies that are directly or indirectly related to the topic of research from various sources are exhaustively reviewed. The literature based on the objectives of the present study are elucidated in this chapter on the following heads.

2.1 HISTORY OF HOMEGARDENS

Homegardens may have originated in prehistoric times when human started dwelling in a place for existence. The history of homegarden thus is as old as civilization. Literature have been reviewed and presented to understand the origin of homegardens.

Homegardens (kitchen, dooryard or backyard gardens) are commonly found in many parts of Indonesia and throughout Southeast Asia, South Asia, Africa, Latin America and the Pacific Islands, as well as in temperate regions (Savonnet, 1959; Fernandes *et al*., 1984; Thaman, 1984; Brierley, 1985; Brownrigg, 1985; Sommers, 1985; Fernandes and Nair, 1986 and Soemarwoto, 1986). The first written record of the homegarden in Indonesia appeared in a Javanese charter of 860 A.D. (Terra, 1954). But the homegarden probably originated 10,000 years or more ago, when hunters and gatherers discarded domestic refuse, containing seeds and other propagules, in the vicinity of their dwellings and then tended and protected the plants that appeared (Hutterer, 1984). It has been suggested that Central Java is the Indonesian center of origin of the homegarden (Terra, 1948, 1954). Because homegardens are cared for primarily by women, they are more likely to be developed among matriarchal societies, typical of Central Java, thirty years ago. In Tegal on the northern coast, for example, a homegarden could not be sold without the consent of the wife. Similarly, well-developed homegardens are found in the matriarchal society of West Sumatra and among the Acehnese of North Sumatra but not among the patriarchal Batak people, also of North Sumatra (Penny and Ginting, 1984).

Homegardens vary in size from less than 100 to several thousand square meters. In the early 19th century, Sir Stamford Raffles reported gardens covering about ten percent of the total area of a district in Java (Raffles, 1817).

Ninez (1984) has pointed out the description of the mythical Garden of Eden in Genesis II was that of a homegarden, containing “every tree that is pleasant to sight and good for food”. Arnold (1987) reported that homegardens had long existed as the principle farming systems on dryland accounting for a substantial proportion of land use, with irrigated rice cultivation forming the other main component of the farming system.

From this very brief sketch there is evidence that homegardening is a very old tradition which may have evolved over a long period of time and is still continuing in the modern times.

2.2 CONCEPT AND IMPORTANCE OF HOMEGARDENS WITH RESPECT TO FARMING AND CROPPING SYSTEMS

Homegarden farming system is a unique production system practised throughout the state, across caste, creed, religion, lingua, ethnic groups and matriarchal and patriarchal settings. It has been referred to in many terms such as homestead, house garden, compound farm, household farm, homestead farming, mixed garden horticulture, forest garden, mixed garden, house compound land etc.

Farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirement of farm and household while preserving the resource base and maintaining a higher environmental quality which could be crop based/tree based and/or animal based (Fernandes and Nair, 1986).

Poerwadarminta (1976) opined that homegardening is a function of raising garden on the residential site and he termed it as '*Pekarangan*'. The Indonesian term *Pekarangan* is derived from the word *Karang*, meaning place of residence.

Lundgren and Raintree (1983) described agroforestry as a collective term for a land use system and technology in which woody perennials, trees (including fruit trees), shrubs, bamboo etc. are deliberately combined on the same land-management unit, with herbaceous crops and animals either in some form of spatial arrangement or temporal sequence. In agroforestry system, there are both ecological and economic interactions among different components.

Homegarden farming system falls under the broad classification of agroforestry. It is determined by the structure of the system, its ecological functions and its continued ability to fulfil the socio-economic needs of the people. Thus Soemarwoto and Soemarwoto (1984) opined that homegarden as an agroforestry system, should ideally combine the ecological functions of forests with those providing the socio-economic needs of the people.

Nair and Sreedharan (1986) evaluated stability, productivity and sustainability of agroforestry homegardens in Kerala, which combines cultivation of tree crops, plantation crops, seasonal and biennials in intimate mixture on the same piece of land. Farm animals, poultry and sometimes fisheries are also components of the system. The system is characterised by optimum utilisation of available resources of land, solar energy and technological inputs and efficient recycling of farm wastes. Jose (1992) reported that homegardens with mixed crop and livestock components recorded the highest productivity followed by those with mixed crop alone.

Salam *et al*. (1992a) opined that the homestead farming system of Kerala is essentially an agroforestry system involving multi-species of annuals and perennials (trees, shrubs, palms, bamboos etc.), which can meet demands of the home.

All the aforesaid literature point out to one direction that homegardens cannot be considered as system with emphasis on individual components alone but as a system of crop mix interaction with other farm components like animal husbandry and other specialised components like sericulture, apiculture, aquaculture, floriculture etc. Thus a need for thorough understanding of farming system is essential in this study.

Cropping system is the crop production activity where the meaningful utilisation of the cropping patterns takes place on a farm through their interaction with farm resources and available technology which determine its make up and that contribute to the homegarden requirement in terms of economy (Desai, 1961).

Farming system is the production activity of the farm or holding. The farming systems of homegardens thus encompass the sum total of all activities of the farm related to crop production and overall prosperity of farm household. It comprises all cropping systems in the farm or holding and their interaction with farm resources, other household enterprises and physical, biological, technological, environmental, socio-economic and cultural factors (Swaminathan, 1979).

The rural Kerala with a predominance of households and intensive production activity in its surrounding makes it necessary to understand the composite

nature of farming systems and cropping systems practised in the homegardens for the comprehensive economic development of rural sector (Babu, 1995).

2.3 DEFINITIONS ON HOMEGARDEN

Homegardens can be expressed or defined in a number of ways owing to the variability and diverse function in the homegarden. Some definitions provided by the scientists and experts are presented in the reviews mentioned below:

Ninez (1984) defined homestead as a sub 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 the 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.

Salam *et al*. (1992b) defined homestead farming as a special type of agricultural production system practised around the home with a 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.

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 the homestead farmer. The extended garden, either wet land 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 play an important role on the performance of the homestead farming, even if the extended garden is at a far away place.

From the foregoing reviews, it may be seen that the intricacies and dynamics of homesteads of Kerala are complex and unique which should be considered holistically while probing into the characteristics of homesteads. It was an interesting feature to note that the extended garden acts as a satellite unit of the homestead. The interaction and interrelation of homegarden and the extended garden is found to be in such a high degree that these two units could be viewed as a single unit.

Encompassing all the above factors, homestead may be operationally defined as a special type of sustainable agricultural production system practised around the home with or without extended garden, where a multi-species of annual and perennial crops along with/without animal husbandry components and other specialised components like aquaculture, sericulture, apiculture, etc. for the purpose of meeting the fundamental requirements of home and also to generate additional income through the sale of surplus to fulfil the requirements of household.

2.4 STRUCTURAL CONFIGURATION OF HOMEGARDENS

Structural configuration of homegardens presents a broad idea on the diversity, species richness, evenness, dominance of species, the changing structure and functions, the cropping and farming system and the type of homegardens. A number of studies and surveys have been conducted all over the world's tropical homegardens revealing the structural diversity of homesteads based on agro-ecological peculiarities and socio-human needs. A few studies are reviewed and presented here.

Agro ecosystem properties, productivity, stability, sustainability and equitability are functions of the structure, processes and history of the agro ecosystem. In particular, they are related to its diversity. It has been argued that diversity in natural ecosystems is a product of environmental stability (May, 1972).

Kimber (1973) found that species diversity and plant density vary from place to place, influenced by ecological and socio-economic factors. Many species are represented by several strains, some partly domesticated. In one river basin in West Java 34 banana varieties were recorded (Abdoellah, 1977). The fruit of some bananas (eg. *ambon* and *susu*) are eaten as dessert or steamed for snacks and others are supplementary staples (eg. *kepok* and *tanduk*). Other varieties are grown for their wrapping leaves (eg. *batu*). But farmers also clearly recognize the long-term importance of this genetic diversity: When asked why an unused tree is found in a garden, they typically respond by saying that they might need it sometime in the future. Homegardens are also a good habitat for small wild animals such as birds, reptiles and amphibians. In a hamlet in West Java, 78 species of birds belonging to 38 families were found, including 13 species that are legally protected [Institute of Ecology (IOE), 1979]. Nevertheless, the importance of the homegarden as a genetic resource has not been widely recognized to date and little inventory work has been done.

Christianity *et al.* (1980) demonstrated the remarkably close resemblance of the light interception curve of a homegarden in West Java with that of the Pasoh forest in Malaysia, as measured by Yoda (1974), which helped in identification of the canopy layers.

Homegardens are typically populated by a wide variety of plants, varying from small herbs to tall trees. In a recent survey, 56 species were found in a single homegarden in a village near Bandung, West Java and in a hamlet of 41 households there were 219 species in the dry season and 272 species in the wet season. In a wider sample of 351 homegardens in the same area, 501 species were recorded in the dry season and 560 in the wet season, with a cumulative total of 602 (Karyono, 1981).

Inspite of the very small average size of the management units, homegardens are characterized by high species diversity and usually 3-4 vertical canopy strata, which result in intimate plant associations. The layered canopy configurations and combination of compatible species are the most conspicuous

characteristics of all homegardens. Contrary to the appearance of random arrangement, the gardens are usually carefully structured systems with every component having a specific place and function. The Javanese pekarangan is a clean and carefully tended system surrounding the house, where plants of different heights and architectural types, though not planted in an orderly manner, optimally occupy the available space both horizontally and vertically (Wiersum, 1982; Soemarwoto and Soemarwoto, 1984). The homegardens in the Pacific Islands present a more clearly defined arrangement of species following the orientation and relief characteristics of the watershed. The West African compound farms (Okafor and Fernandes, 1987) are characterized by a four-layer canopy dominated by a large number of tall indigenous fruit trees. An architectural analysis of the canopy reveals a relatively higher percentage of canopy distribution in the upper strata.

Ewell (1986) reported that the dominance of certain crops on the farm increases the risk of losses due to its specific pests and diseases. Although sometimes a higher number of plant species can lead to an increase of pest losses, the advantage of a species rich polyculture is undoubtedly that the risk of losses is spread among many species.

Fernandes and Nair (1986) gave schematic presentations of the structure of different homegardens from various geographical regions and reported the canopies of most of homegardens consisted two to five layers.

Allen (1990) found that 85 per cent of all homestead of Sigomkeni and 73 per cent in Bhekmkhogi had planted at least one tree in common. Other forms of planting included small wood lots, fruit trees and ornamental wood lots consisted of two introduced wattle species *Acacia mearsii* and *Acacia decurrens*. Most commonly planted fruit trees were Avocado, Banana, and Peach etc. No complex labour or intensive agroforestry practices were observed.

Darwiss (1990) reported that the coconut farming systems adopted by Indonesian small holders could be classified into four types; farmyard culture, polyculture, monoculture and tidal swamp. In the polyculture type system coconuts may be grown with annual, perennial or both types of intercrops. In Java, 78.7 per cent of the coconut small holdings fall within the polyculture pattern and the remaining as monoculture.

Salam *et al*. (1992c) observed that homegardens of Kerala were traditional agroforestry systems in which perennial and annual crops were grown intermingled often without any definite arrangement.

Shehana *et al*. (1992) reported that the spice components helped to enhance the bio resource diversity and on farm resource diversity utilization in homesteads. The crop components were grown in a polyculture that consisted of distinct canopy stratification. Thus crops like coconut, arecanut, jack, mango etc. occupied top most layer. Pepper, cashew, clove, nutmeg, cinnamon etc. second layer. Banana, cassava, yam etc. third layer while ginger, turmeric, pineapple, vegetables etc occupied ground layer. Structural arrangement of components were designed to ensure high degree of natural resource utilization in space and time.

Jensen (1993) pointed out that 0.3 ha sized homegardens in West Java contained about 60 plant species (excluding weeds) of which 39 supplied useful products and those remaining were ornamentals. Tree coverage was 81 per cent and total ground cover, including ground litter and weeds was 99 per cent. The vegetation was multi-layered. Total biomass was estimated as 126 t ha^{-1}, including 4.4 t ha^{-1} of ground litter. Of the total biomass, 95 per cent belonged to tree component; *Cocos nucifera, Syzygium aromaticum* and *Lansium domesticum* alone constituted 75 per cent. The homegarden resembled both in structure and biomass.

Mammen *et al*. (1993) reported about species diversity in homesteads of Kerala. This includes seasonal and annual crops *viz*., vegetables, pulses, tubers, betelvine, pineapple, banana etc. Duration of most of these crops was less than one

year. Perennial crops were the major cash crops which included coconut, arecanut, pepper, coffee, cocoa, nutmeg etc. Tree crops were defined as all trees other than those considered as perennial crops. Most tree crops were grown to obtain fruits for consumption, shade, timber, ornamental purposes, fodder and green manure. Some other trees that provided income through sale of produce are cashew, tamarind, kudampuli etc. Main multi purpose trees retained for their wood and fruit values were jack, mango and the timber trees were teak, rosewood, anjily and ailanthus. Fruit trees were custard apple, guava, narakom and moringa. Polyalthia and chempakom were grouped as ornamental trees, miscellaneous crops included bamboo, fodder grass and plants raised as live fence such as glyricidia and pandanus.

Kumar *et al.* (1994) based on their survey conducted in 17 selected taluks of Kerala reported that there was tremendous variability both in number of trees and shrubs present. All sized holdings also exhibited profound variability in the number of woody species and individuals present. In total 127 woody species were encountered. Floristic diversity was higher in smaller homesteads and decreased with increasing size of holdings. No clear cut-planting pattern was discernible in the homegardens. Trees and shrubs were either scattered throughout the homestead or on farm boundaries.

Wickramasinghe (1994) reported that Kandy gardens which represented-traditional homegardens practised on smallholdings of one hectare in Sri Lanka had varying species diversity with total number of trees and shrubs varying from 65 to as many as 1700 numbers ha^{-1} with a multi-storey configuration, which included different species of fruit trees, medicinal plants and timber species where in components were arranged randomly in space.

Wickramasinghe (1995) analysed the spatial structure of traditional homegardens (not affected by modern intervention) in selected villages of Kandy. He reported that there was a large variation in the spatial arrangement of species. These were primarily linked with priority needs, potential uses and availability of space. The effect of the distance from home to the edge of the homegarden was identified as a

factor contributing to the zonation of homegarden which implied that the match between the variations in priorities of the home and the spatial arrangements of homegardens is strong both socially and economically.

Millat-E-Mustafa *et al.* (1996) in their study on structure and floristics of Bangladesh reported that most perennial species were planted in the border of the homegardens irrespective of farm size and region. Food and fruit producing species dominated near the living quarter and working areas and small plots of annual vegetables and crops separated this part of the garden from the more distant parts favoured for timber species. They also inferred that within regions there were significant differences in species richness associated with farm size, and within each homegarden size category there were significant differences among regions.

2.5 FUNCTIONAL DIVERSITY OF HOMEGARDENS

As altitude increases, the homegardens become smaller, with greater density of plants and plant species and lower diversity. At lower altitudes coconuts and fruit trees predominate, whereas higher up the gardens are mostly devoted to vegetables. Detailed analysis of homegardens reveals well-defined plant associations that reflect a variety of complementary functions and whose design and composition are under the influence of climatic, edaphic and economic factors, as well as cultural and traditional ones (Abdoellah, 1977; Karyono, 1981). Cultural influences can be very important: At the border between Central Java and West Java, where the Javanese and the Sundanese meet, the plant associations of the homegardens of the former are more complex than those of the latter (Abdoellah, 1980). There are also significant differences in the plant categories. Javanese families grow more medicinal plants, whereas the Sundanese grow more vegetables. The Javanese consume considerable quantities of extracts from medicinal plants (the *jamu*) to treat and protect against a variety of diseases and as a way of keeping fit. They are especially important during and after pregnancy. By contrast, the Sundanese are fond of eating

raw vegetables and, because they also like neat gardens, they grow relatively more vegetables and ornamentals.

Homegardens or homestead systems are raised to perform a variety of roles and fulfil various functions of the farm family and the community therein. The functional basis of homesteads has been defined by Nair (1989) as the major function or role of the system, which may be productive eg. production of food, fodder, firewood and so on or protective windbreak, shelter belt, soil conservation and so on. Fernandes and Nair (1986) revealed that multi-storey tree gardens were highly productive, fully sustainable and very practicable systems. The soil fertility maintenance was achieved by combination of inputs, particularly of household waste and a high level of recycling of organic matter and nutrients.

Salam *et al*. (1992a) found that a variety of tree species commonly grown in the homesteads for meeting the food, fodder, fuel and timber requirements of the home and have been effectively utilized to trail pepper. This practice not only enhanced the productivity of the system but also increased the resource efficiency of homesteads.

Shehana *et al*. (1992) pointed out that spice components grown in a polyculture that consisted of distinct canopy stratification, helped to reduce soil temperature inside the microclimate which inturn helped to reduce soil evaporation rate. The litter and crop residues were often left to get accumulated in soil and this was helpful to reduce soil evaporation rate.

Trees are a common component, so much so that to the traveller in the Javanese countryside the villages are not recognizable by the presence of houses but by the dense "forest" that conceals them. According to popular belief, the structure of the homegarden deliberately mimics the natural forest, but in Javanese culture forests have a low social value. Indeed, Javanese feel offended when their homegarden is compared to a forest. In the popular shadow plays, the *Wayang*, forests are depicted as dangerous places where wild animals live and evil spirits reign. Hence forest clearing (*Babad alas*) is looked on as a noble deed and can only be done by men who have

spiritual powers. Today the term *Babad alas* is used in everyday life for the initial activities of praiseworthy projects, such as the creation of a university. The forest structure of a homegarden is, more plausibly, a result of convergent evolution, both natural and artificial selection favoring diversity (Soemarwoto and Conway, 1991).

Jensen (1993) concluded that sustainability of the homegarden was with the medium fertile soil with large nutrient reserves, the large plant biomass directly and indirectly protected the soil against erosion and drying and high species diversity provided a large variation in crop phenology and stability in nutritional supply.

Ravindranath and Somasekhar (1995) found that a high per cent of farmers maintained large diversity of trees, which yield multiple benefits, eg. like karanj (leaf manure, oil seeds and twigs as fuel), neem (leaves as fodder, oil seeds, tinsher, twigs as fuel wood, agricultural implements) and ficus species (leaves as fodder, twigs as fuel and trunk as timber) on their farm.

Sharma (1996) pointed out that there was a long standing tradition of practising coconut based system in Kerala. An important aspect was the presence of more plant cover on the plantation floor, which increased the fixation of nutrients that is cycled within the soil plant system. The vegetative cover maintained reduced soil erosion risks, biotic diversity of species composition, age distribution and trophic levels. It was sustained above the level at which the activities of pests and diseases become an ecological and economic constraint. Previous experience have shown that large scale plantations restore forest coverage and achieve objective of sustainability, increased production which benefit the farmers as well as rural poor.

2.6 COMPONENTS OF HOMEGARDENS

The increasing population, massive industrialization, agricultural transformation, under development, culture and tradition etc. are major crucial factors that have resulted in massive exploitation of natural resources that are necessarily the components of agriculture which aids in the development of a family, society, state

and the nation. Since Kerala state is characterized with high-density population, the size of the farm holding is very small, ranging from 0.02 to 1.00 ha which is most commonly called as homesteads (homegardens). It is therefore necessary that we identify the components of homegarden for its development and improvisation.

Salam and Sreekumar (1990) concluded that in a homegarden of 68 cents of land with cropping component (having multi - tier canopy configuration), live stock component (Jersey cross bred cow and poultry) and irrigation component could meet the home demands as well as educational requirement of seven member family consisting of five children. This was enabled due to the synergistic interaction between these components.

Salam (1991) identified different component interaction of homegarden and suggested a separate kitchen garden as a component of homegarden that was operational in 50 cents of land.

Jose (1992) classified the homegarden components as mixed crops (mixed crops + rubber, mixed crops + livestock and mixed crops + rubber + live stock).

Spices were a major component in the cropping strategy of the homegardens where it occurred 83 per cent in every eight out of ten homegardens (Shehana *et al.*, 1992).

Shehana *et al*. (1994) identified 35 crop components, 22 forestry components and four livestock components in varying intensities in the homegardens of south Kerala.

2.7 NATURE AND TYPE OF FARMING SYSTEMS AND CROPPING PATTERNS IN HOMEGARDENS

The method of utilising the land resource by cropping pattern is said to be method of cropping. Farming practice includes specialised farming, diversified or mixed farming and integrated farming.

In a study on economics of mixed farming, Shastry (1959) found that the percentage of income and yield per acre was high on mixed farming units.

Rajagopalan (1960), in a case study on mixed farming units in Coimbatore concluded that mixed farming leads to increasing employment opportunities and there is a phenomenal development of mixed farming in suburban villages.

Desai (1961) reported that mixed farming with reference to enterprises on the same farm was to their mutual advantage. He found that crop production aided livestock production by supplying the fodder requirement for livestock and rearing livestock resulted in a better utilisation of resources.

Dhondyal (1971) stated that a farm is termed as a mixed farm where at least 20 per cent of its gross receipts are from milch cattle.

Singh (1971) opined that mixed farming is a system of farming under which crop growing is combined with keeping of livestock production.

Sundaresan (1975) defined mixed farming as rearing of livestock as a subsidiary enterprise along with crop farming.

Puttaswamy (1979) stated that small farmers could maintain two or three milch cows and 15 to 24 sheep if sufficient operating capital and good marketing facilities were available.

Mehta *et al*. (1980) inferred that inclusion of dairy activity considerably improved the efficiency of small farms in Punjab.

KAU (1989a) reported that rice based farming system is predominant in low lands and coconut based farming system in uplands. The practice of mixing first and second crop paddy seeds and raising Kootumundakan mixed crop is followed under the situation in certain areas of Palakkad district.

The nature and type of crops in the homestead depend mainly on requirement of the farmer and ranges from purely seasonal to perennial crops. One principal feature is that coconut constitutes the base crop in almost every homestead and it is intermixed with other seasonal, annual and perennial crops (KAU, 1989).

Salam and Sreekumar (1990) opined that mixed farming is a harmonious assembly of crop husbandry and animal husbandry. Mixed farming acts like an ayurvedic treatment to soil ensuring prolonged soil health and consequently the productivity remains sustained.

Singh (1990) opined that mixed farming system involving proper sequence of crops, inclusion of livestock /poultry/fish and recycling crop residues and animal / fish wastes can maintain high level of production on a sustainable basis with only moderate use of external inputs without affecting the quality of environment. Optimum harvesting and stocking practices can similarly restore / maintain forestry and fishery resources in a sustainable system.

Babu and Sreekumar (1991) opined that a vast majority of Indian farmers are practising mixed farming in one form or other. It offers a vast opportunity and challenge.

Storck *et al*. (1991) reported that intercropping of more than two crops is a common practice in Hararghe high lands, while crop rotation is practised less widely. The cropping pattern mainly focused on the provision of food requirement of the family. The land area plays a major role in shaping the household farming system as well as its performance.

Anilkumar (1993) reported that the predominant cropping system of Kerala is coconut based and several farmers are practising sericulture profitably, raising mulberry as an intercrop. Diverse soil and ecological conditions prevailing in Kerala lead to high degree of variability in cropping patterns. Polyculture is the rule in most of the areas. The crop combinations and the crop sequences in the high land, mid land and low land are characteristic.

2.8 ECONOMICS OF HOMEGARDENS

A very few studies have been conducted on economics of homegardens in Kerala. A general review on the economic aspects related to the returns from homegardens, identifying the marketing channels for homegarden produces and the role of middleman in the marketing activities is attempted in this section.

Talib and Singh (1960) indicated that yield and income per acre were high in mixed farming as compared to monocrop farming. It was significantly high in the case of small farmers dwelling unit.

The main expectation from an intercropping system in a perennial plantation crop system is that the overall return from a unit piece of land increased without adversely affecting, either the current or the long- term productivity of the main crop. At the same time, the returns from the additional crop should justify the adoption of intercropping practice and should contribute to the long-term productivity of the system (Liyanage *et al*., 1984).

Das (1988) reported that in the case of multistoried cropping under irrigation in coconut garden the benefit : cost ratio was 1.76 and the internal rate of return higher than 20 per cent and the net present value worth Rs. 32700/-. He also opined that different varieties of cereals, pulses, oil seeds, tubers and rhizomatous crops are relatively more compatible and remunerative intercrops than the other annuals in coconut garden in Kerala.

Balasubramanian *et al*. (1988) after analyzing the existing enterprise combinations of 50 selected garden land farmers of Coimbatore taluk suggested an improved enterprise combination taking into account the requirements of food, fodder and technical, financial and management constraints. The analysis revealed that it is possible to increase the profit realized to an extent of 25 per cent by proper farming system management.

Kandasamy and Chinnaswamy (1988) found that among different mixed farming practices, dairy-based system was more profitable than others. The mean annual net income was Rs.6090/- with per day income of Rs.16.68/-. The next best system was dairy-cum-poultry based farming system, having a mean annual net income of Rs.5899/- with per day income of Rs.16.16/-. Poultry based mixed farming gave only a marginal mean annual net income of Rs.2287/- with a per day income of Rs.6.27/-.

Gerson (1989) reported that women could increase their income through cultivation of indigenous vegetables like *Solanum nigrum* and *Brassica carninata.*

Salam and Sreekumar (1990) concluded that in a homegarden of 68 cents of land with cropping component (having multi - tier canopy configuration), livestock component (Jersey cross bred cow and poultry) and irrigation component could meet the home demands as well as educational requirement of seven member family consisting of five children.

Pasha (1991) described animal husbandry as an important source of income for small and marginal farmers, who have adopted their farming technique in order to maximize production and returns to resources utilization. Unfortunately, different classes have varied degrees of access to common resources giving the richer farmer a better opportunity on diversification.

Babu *et al*. (1992) reported that diversified homestead farming is a deliberate strategy aimed at producing harvests through out the year so that there is always some product of economic value available for household use or cash sale.

Job *et al*. (1993) revealed that by identifying the optimum mix of crops scientifically, the income from coconut based cropping system could be increased substantially.

Marketing channels are the routes through which the produces reach the ultimate consumer.

The review of literatures pertaining to marketing channels is presented in the tabulated form that is given below:

Author	Year	Crops	Marketing channels
Singh and Mann	1971	Fruits	Producer - wholesaler - Retailer - Consumer
Govardhana	1979	Dry chillies	Producer-Trader
Suryaprakash *et al*.	1979	Plantation crops	No unique marketing channels
Ramasamy	1981	Brinjal and Bhindi	Producer - Commission agent - wholesaler - retailer - consumer
John D'silva	1982	Coorg Mandarin orange	Producer - pre harvest contractor – retailer- consumer
Hugar *et al*.	1983	Brinjal	Producer - seller - Commission agent - Retailer - Consumer
Nagaraj *et al*.	1985	Fruits and vegetables	Producer - Commission agent - Retailer - Consumer
Saikia	1986	Vegetables	1. Producer - Wholesaler / Commission agent - Retailer, consumer 2. Producer -Retailer - Consumer
Gill *et al*.	1989	Vegetables	Producer - wholesaler - Retailer - Consumer
Sandhya	1992	Bittergourd Ash gourd	Producer - Commission agent - Wholesaler - Retailer – Consumer
Subrahamanyan	1988	Vegetables	Producer - Commission agent
Wadkar *et al*.	1994	Mango	1. Producer -Consumer 2. Producer -Wholesaler-Commission agent-Retailer - Consumer 3. Producer -Pre-harvest Contractor - Wholesaler-Commission agent-Retailer-Consumer 4. Producer-Cooperative-Consumer
Kumar and Tripathi	1994	Mushroom	1. Producer-Consumer 2. Producer-Retailer-Consumer 3. Producer-Big grower-Retailer-Consumer 4. Producer-Wholesaler-Retailer-Consumer

Mayadevi	1996	Medicinal plants (Kacholam and Koduveli)	1. Producer-Dealer-Ayurvedic medicine manufacturers 2. Producer-Amrutha-Ayurvedic medicine manufacturers 3. Producer-Ayurvedic medicine manufacturers
Thomas	1998	Medicinal plants	1. Producer - Dealer - Ayurvedic medicine manufacturers 2. Producer - Voluntary agencies - Ayurvedic medicine manufacturers 3. Producer - Retail shop dealer - Ayurvedic medicine manufacturers 4. Producers - Ayurvedic medicine manufacturers

2.9 TECHNOLOGY ASSESSMENT IN THE HOMEGARDEN SYSTEMS AND INDEPENDENT VARIABLES SELECTED FOR THE STUDY

Technology assessment in this study aims to understand the different facets of homegarden technologies so as to fulfil the objectives of the study. Reviews related to technology aspects that lead light to the contribution of technology to homegarden farmers by way of its utilization/adoption is very few. Therefore a related detailed review has been conducted and is presented in terms of meaning and definitions on technology, extent of utilisation/adoption of technologies suited to homegardens, relationship of extent of adoption of scientific practices by the homestead farmers and their personal, socio-cultural and techno-economic factors, extent of adoption of indigenous or traditional practices by the homegarden farmers, technology need/ technology forecast for the homegarden systems of the homegarden farmers, delineation of dimensions of technology for homegardens, and constraints as perceived by the homegarden farmer.

2.9.1 Meaning and definitions on technology

Technology is any tool or technique, product or process, physical equipment or method of doing or making (Goldring, 1976). Technology involves the application of science and knowledge to practical use, enabling man to live more

comfortably and securely (Hoda, 1979). Technology is systematic knowledge and action, usually of industrial processes, but, applicable to any recurrent activity (Mc Graw, 1982). The new technology in the context of agriculture means all forms of new farm inputs, practices and services such as fertilizers, insecticides, herbicides, tube-well water, improved farm machines and equipments, agricultural extension services etc (Raju, 1982). Technology is a design for instrumental action that reduces the uncertainity in the cause effect relationship involved in achieving the desired outcome (Rogers, 1982).

Keeping the various definitions in view and considering the peculiar nature of homegarden, technology can be operationally defined as any information which has got some practical utility for the users and which has been tested as feasible, crude, economically viable, socially acceptable and environmentally harmless under user's conditions.

2.9.2 Extent of adoption of scientific practices / technologies suited to homegardens

Rogers (1982) defined adoption process as the mental process an individual passes from first hearing about an innovation to its final adoption.

Sohi and Kherde (1980) reported that most of the small and marginal farmers adopted dairy husbandry practices to a reasonable extent. Majority (95%) of the farmers were practising protective vaccination against contagious diseases, clean watering (85%) to milch animals, pucca animal shelter (61.67%) and own watering system (60%). The least adopted practices were dehorning of young calves (5%), use of improved seeds of fodder crops (8.75%), deworming (18.3%) and castration of young male calves (20%).

Gondi and Gowder (1983) indicated that recommendation involving high cost such as use of fertilizers and plant protection chemicals have been only partially adopted by majority of farmers.

Reddy (1983) indicated that all the respondents had adopted recommended banana variety, good planting material, dug the plots 2-3 times to loosen the soil and to control weeds. Majority of the farmers followed the recommended planting season (98%), spacing (98%), use of sword suckers (93%) and providing supports by propping to prevent lodging (90%). On the other hand, it was observed that relatively very less percentage of farmers had fully adopted key practices like farmyard manure application, split application of fertilizers and plant protection measures.

Mehipal and Kherde (1989) observed that majority of the respondents had medium level of adoption of breeding, feeding, health care management and overall adoption of dairy innovations.

Karwara *et al*. (1991) in their study on comparative adoption of improved technology by female and male-headed scheduled caste families observed that 76 per cent of the female and 70 per cent of the male respondents accepted the improved technology of rice cultivation. It is also evident from the data that 60 per cent of the families headed by women and 48 per cent of the families headed by men adopted the improved package of practices for rice cultivation.

2.9.3 Independent variables selected for the study and its relation ship with extent of adoption of scientific practices by the homegarden farmers

a. Age

Age was operationally defined as the number of years completed by the respondent at the time of investigation.

Jayakrishnan (1984) in a study on adoption of low cost technology among paddy growers found that age had positive and significant relationship with adoption.

Chenniappan (1987) reported positive and significant relationship of age with adoption of improved practices for irrigated cotton.

Krishnamoorthy (1988) found that age had no significant relationship with adoption of seed treatment practices among ragi cultivators.

A study conducted in a village in Faizalabad district, Pakistan, indicated that age was inversely related as a determinant of innovation adoption (Quazi and Iqbal, 1991).

A study conducted by Babu (1995) reported that age of farmers of central Kerala had no relationship with adoption of scientific practices in homesteads

b. Education

Education refers to the extent of non-formal or formal learning possessed by the homegarden farmer.

Jayakrishnan (1984) reported positive and significant relationship between education and adoption of low cost technology among paddy growers.

Rathinasabapathi (1987) reported education had positive and non-significant association between adoption and education.

Sanjeev (1987) reported that there was no significant relationship between education and adoption of improved paddy cultivation practices.

Agarwal and Arora (1989) opined that the educational level was significantly associated with adoption of biogas plants.

Quazi and Iqbal (1991) reported that education was an important determinant of innovation adoption.

c. Occupation

Occupation for this study was operationalised as the main vocation and other vocations that the respondents had at the time of interview.

Jayakrishnan (1984) found that occupation had positive and significant relationship with adoption and low cost technology in paddy cultivation.

Rathinasabapathi (1987) reported non-significant relationship of occupation with extent of adoption of integrated pest management practices in cotton.

Krishnamoorthy (1988) reported that there was no significant relationship between occupation and extent of adoption of scientific practices in irrigated cotton and millets.

d. Family size

This refers to the number of members of either sex living in a household/family dependent on the head of the family.

Verma and Rao (1969) reported that a garden with size based on needs anticipated production and time available will usually result in a well planned, efficient producing home enterprise. Family requirement have a direct relationship to garden size. So, size of family is important in influencing garden size.

e. Irrigation potential

This measured the extent to which the holding was irrigated. This was quantified in terms of availability of irrigation water, which was expressed as physical water scarcity, economic water scarcity and little water scarcity.

Perumal and Mariyappan (1982), Shivaraja (1986) and Chenniappan (1987) reported positive relationship between irrigation index and extent of adoption.

Mann (1989) observed that irrigation index was positively and significantly related with adoption of high yielding varieties of wheat. However, Geethakutty (1993) reported non-significant relationship between irrigation index and adoption.

Babu (1995) reported a significant relationship between irrigation potential and extent of adoption of scientific practices in homegarden.

f. Annual homegarden income

This refers to the total annual earnings of the farmer from farm activities in the homegarden.

Viju (1985) reported positive and significant relationship between annual income and adoption of recommended technologies.

Chenniappan (1987) reported positive and significant relationship between annual income and extent of adoption.

Aziz (1988) established positive and significant relationship between annual income with the adoption of scientific practices on drought management.

Anithakumari (1989) reported that there existed no significant relationship of annual income with the adoption of scientific practices for pulses and oil seeds.

Salam and Sreekumar (1990) concluded that in a homegarden of 68 cents of land with cropping component (having multi - tier canopy configuration), inclusion of live stock component (Jersey cross bred cow and poultry) and irrigation technology could meet the home demands as well as educational requirement of seven member family consisting of five children.

Chandra and Singh (1992) revealed that income from crops contributed significantly to adoption behaviour of tribal farmers of Bihar.

g. Extension contribution

It refers to the extent of help rendered by various extension agencies like Agricultural Department, Commodity Boards, Krishi Vigyan Kendras,

Non-governmental Organisations, Kerala Agricultural University, ICAR Institutes etc. to the homegarden farmers in the form of various extension and educational activities that will help them in better homegarden farming.

Mahadevaswami (1978) inferred that adoption behaviour of small, marginal and big farmers was associated with extension participation.

Shivasankara (1986) reported that there was significant and positive relationship between personal guidance from personnel of different agencies for better farming and extent of adoption.

Suresh (1987) opined that there existed non-significant relationship of extension guidance for better farming with adoption of technology.

Sulaiman (1989) also reported that there was non-significant relationship between personal guidance for better farming and extent of adoption.

h. Market orientation

Market orientation is one of the three subscales of the scale developed by Samantha (1977) for measuring management orientation, which is operationally defined as the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing functions/activities of his farm enterprises.

Market orientation has been defined as the degree to which a farmer is oriented towards the market in terms of demand and price of his produce.

Sajeevachandran (1989) reported that there was a positive and significant relationship between market orientation and adoption of scientific practices in pepper.

Thomas (1998) reported that market orientation was significantly related to the knowledge and adoption of medicinal plants.

i. Rational orientation

This was operationalised as the extent of rationality and scientific belief of a homegarden farmer in relation to the different scientific recommendations applicable to homegarden enterprises.

Rajendran (1992) reported that there was a positive and significant relation between rational orientations of schedule caste farming families to the extent of adoption.

j. Knowledge on scientific practices in homegardens

The level of knowledge of homegarden farmers determines the extent of adoption of scientific practices that is the determinant for technology assessment. With this view studies on knowledge level of the homestead farmers were reviewed.

Uma (1980) found that knowledge level of trained mahila mandal members was significantly high as a result of training with respect to nutrition and homegardening in Dharwad District.

Jayakrishnan (1984) also reported that paddy growers had medium level of knowledge on low cost technology.

Krishnamoorthy (1984) reported that the farmers had medium level of knowledge on dry land technology.

Sagar (1989) reported that majority of respondents had medium level of knowledge about recommended practices of paddy cultivation.

Thomas (1998) reported that majority of farmers had medium to high level of knowledge on medicinal values of the crop they cultivate and it had no relationship with the level of education they possess.

k. Evaluative perception on the sustainability of farming and cropping systems in homegardens

There were very few specific studies on evaluative perception of homegarden farmers in relation to the appropriateness of farming systems and cropping patterns. Hence, studies conducted in other areas, which were indirectly connected with present study, were summarized under the following heads

i. Sustainability

The evaluative perception of homestead farmers in relation to sustainability of farming systems and cropping patterns in homegardens varies from individual to individual. The purpose of perception is to help individual to cope with the world by assigning meaning to it, which can stand the test of subsequent experiences (Toch and Maclean, 1970) Sustainable agriculture has emerged in United States of America as the most agreed term to synthesize a variety of concepts and perspectives, associated with agricultural practices. United States Agricultural Department defined sustainable agriculture as a management system for renewable resources including soil, wild life, forests, crops, fish, livestock, plant genetic resources and ecosystems to provide food, income and livelihood for current and future generations and that maintains or improves the economic productivity and ecosystem services of these resources (Singh, 1990).

Jambulingam and Fernandes (1986) reported that farmers in Tamil Nadu integrated numerous species of multi-purpose trees and shrubs (MPTS) in close association with agricultural crops. These woody perennials are better able to cope with poor growing conditions and thereby increasing integration on farmlands, which represented a strategy to minimize the risk of crop failure. They also observed that the productivity of these traditionally managed systems could be considerably improved by scientific interventions or application of technology.

Soemarwoto (1987) opined that while it is relatively easy to increase yield and income, there are difficult problems in achieving long term sustainability of the homegardens. These difficulties are both in the biophysical and in the socio-economic

realm. It is recommended that these problems should be looked into and research to seek appropriate solutions should be stimulated.

Odoval and Aluma (1990), in their study of traditional homegarden systems in Southern Uganda, opined that the system which is operated on a sustained yield basis, retaining, managing animals and crops, various trees and shrubs and crops in order to minimize production of a variety of products.

Rathinam (1991) opined that inter, mixed or multi-species cropping must be followed in coconut garden to sustain income and generate employment.

Salam *et al*. (1991) conducted a study to develop a homestead model suitable for a 0.20 hectare holding in the coastal uplands of South Kerala under rainfed conditions and found that the crop-livestock components selected in the model interacts synergistically to increase the productivity and to generate more returns. The model developed is capable to maintain soil health and to ensure environment safety.

Butler (1992) opined that sustainable agriculture requires the balancing of a variety of goals. This means that often no single side can be maximized, since optimisation might totally produce the achievements of one of the goals of sustainability. In sustainable agriculture farmer shifts from being users of technology to a producer of technology and maker of its impacts.

ii. Influence of homestead farming on quality of life- food, nutritional and medicare aspects

Homestead farming has a high significance from the point of view of household food security and family health status. Homestead farmers place high value on the social, aesthetic and habitat functions of homegarden. Farmers have their own perception about the components of their homesteads. Homestead farmers value the components of their homesteads not only as a source of income and subsistence, but also for their role in improving habitat quality and conservation of soil and water resources and aesthetic value.

Davidson (1990) reported that benefits of household gardens include low input requirements, environmental protection, accessible nutrient supply and food provision during the time of agricultural disruption.

Ganesan *et al*. (1991) on a study on duck-cum-fish culture in rice farming system, found that an additional 114 man-days of employment were generated by introducing mixed farming system.

Babu *et al*. (1992) reported that inclusion of plants with some medicinal value would also help the immediate medicare needs of the family.

iii. Utilization of resources

Homesteads of Kerala are predominantly coconut based where mixed cropping is the common practice. The farming systems and cropping pattern adopted in homesteads help the farmer to exploit the available resources to the maximum level possible, where recycling of resources is the thumb rule.

Homestead farms with a multitude of crops presenting a multi-tier canopy configuration ensures a high level of exploitation of environmental resources. Top-most canopy is occupied by coconuts, the second layer by arecanut, pepper, jack, tamarind and mango, the third layer is occupied by banana, tapioca and fruit plants and the lowermost layer of canopy consists of tuber crops, vegetables and guinea grass. The boundaries are live-fenced with glyricidia (Salam and Sreekumar, 1990).

Anilkumar *et al*. (1990) opined that multiple cropping system helps to augment income from coconut holding. Agronomic research on different forms of multiple cropping system on coconut based cropping of Kerala revealed the scope for taking up multiple cropping in coconut garden with compatible crops.

Bavappa (1991) reported that annuals or seasonal crops or intercrops and perennials, mixed crops in coconut palm, form a multistoried cropping system which

utilizes 75 per cent of land and solar energy and top 30 cm of soil surface not utilized by the coconut palm. He also reported that the air space utilization was 31 per cent and biomass production was also sustained.

Roy (1991) reported that multipurpose trees and shrubs provide food, fuel wood, timber, foliage fodder, green manure and fertilizer. Homestead agro forestry (multiple combinations of various agro forestry components) has a very high potential for increasing production.

Babu *et al.* (1992) opined that diversity in homestead farming is a well planned strategy in terms of pest and disease management, risk aversion and efficient use of natural resources such as light, water, soil and nutrients.

Save and Sanghavi (1993) reported that the products from the natural farming have longer shelf life, high digestibility and palatability.

iv. Economic aspects

In areas far from towns, homegardens function primarily as subsistence systems and may produce over 15 percent of the total food requirement. Perennials in homegardens possess the potential to generate or add income of the homegarden farmers. Income generation is a major function in the areas surrounding Jakarta, in the main fruit production centers, and in tourist areas. In such situations, income from homegardens is usually higher than from rice fields. For example, income from homegardens is 20 times higher in the tourist area of Lembang, West Java (Soemarwoto and Christianity, 1985).

v. Environmental facets

Neher (1992) defined sustainable agriculture as a system, which contains three equally important components namely, environmental quality, ecological soundness, plant and animal productivity and socio economic viability.

The study conducted by IOE (1979) revealed that homegarden respondents when asked why an unused tree is found in a garden, they typically responded by saying that they might need it sometime in the future and it protects the environment. Homegardens are also a good habitat for small wild animals such as birds, reptiles and amphibians. In a hamlet in West Java, 78 species of birds belonging to 38 families were found, including 13 species that are legally protected.

The functional basis of homesteads has been defined by Nair (1989) as the major function or role of the system, which may be productive or protective in nature. The tree crops in homestead can act as windbreaks, shelterbelts and help in soil conservation and so on. Environment is well taken care of by this system.

2.9.4 Extent of adoption of indigenous or traditional practices by the homegarden farmers

The farmers through concerted efforts in their farms develop indigenous practices by trial and error that is a process of informal research. Indigenous knowledge is highly localized and restricted and is passed on by word of mouth from generation to generation.

Michon *et al*. (1983) stated that fish pond-mud and green manure were commonly used in croplands. Villagers regulate or modify the functioning and dynamics of each plant and animal with in the system.

Altieri (1987) reported that predative nature of ducks, fishes, frogs and snakes were traditionally employed to control insects in paddy cultivation.

Perumal and Chandramouleeswaran (1988) reported that the reason expressed for continued adoption of indigenous practices were, “cost and maintenance cheap”, “operation simple” and “handling was easy”.

Wang (1988) defined indigenous knowledge as a sum total of knowledge and practices, which are based on people's accumulated experiences in dealing with situation and problems in various aspects of life and such knowledge and practices are special to a particular culture.

Kanagasabhapathy (1991) reported the scientific rationale of using neemcake dissolved in cow's urine and using tobacco leaf extract for controlling cotton bollworms among the farmers practising dry land agriculture.

Sprinkling of diluted cow dung slurry to hasten germination of paddy seed, soaking sprouted seeds in cow dung to dispense with or minimise farm yard manure application and using of cloth-bit torches at the earhead emergence stage to serve as light trap were extensively practised in specific locations (KAU, 1989).

Waters (1991) described the cultivation and livestock management practices of small cultivators using indigenous knowledge, in order to understand the complexity of mixed farming system. He observed that the agricultural knowledge of the cultivators was sufficient to support sustainable agriculture and urged the private/voluntary organisations as well as Government to their policies.

Balakrishnan (1992) enumerated a number of indigenous practices on dry land agriculture and opined that many of the indigenous practices were low cost, easy to practice and environmental friendly. He also reported that the indigenous practices were labour saving and some of them improved quality and shelf life of the produce.

Butler (1992) opined that in sustainable agriculture farmer shifts from being user of technology to a producer of technology and maker of its impacts.

Joseph *et al*. (1993) reported that the practice of applying common salt to coconut is based on the grower's belief that it reduces barren nuts. It was also observed that in rocky laterite soils addition of common salt to pits before planting coconut seedlings soften the laterite bed and held easy penetration of tender roots. They also reported that common salt made the trees more tolerant to leaf blight disease.

Based on the above reviews, indigenous practice is operationalised as the knowledge/practice which is based on people's accumulated experience and intuition in dealing with situations and problems in various aspects of life or a modern technology imported and adopted to suit indigenous conditions.

2.9.5 Technology needs for the homegarden systems

Getahun *et al*. (1977) lamented that the peasants have not been given the opportunity to actively participate both in the conceptual identification of their basic problems and to contribute to generation of appropriate technologies to meet their fundamental needs. The efficiency of any research set up must be determined by the extent to which technology can be applied for development (Liwenga, 1977). The ultimate objective of research in agriculture, animal or veterinary sciences is to develop technologies that are suitable for users. Evolving new technology is an endeavour in the direction of increasing production efficiency (Swaminathan. 1979). In most developing countries the innovation system dealing with production technologies for farmers functions with the least efficiency (Sharma and Qureshi, 1982).

The rapid technology progress and the increased rate of obsolescence of technologies necessitate technology forecasting for any planning process. Technology need can be defined as a probabilistic prediction of technological changes in terms of future characteristics of useful machines, systems or procedures and needs of the clients (Rao, 1998).

Salam and Sreekumar (1990) concluded that in a homegarden of 68 cents of land with cropping component (having multi - tier canopy configuration), inclusion of live stock component (Jersey cross bred cow and poultry) and irrigation technology could meet the home demands as well as educational requirement of seven member family consisting of five children.

The above reviews clearly indicate the need for developing need-based technologies for successful adoption especially for homegarden farmers.

2.9.6 Delineation of dimensions of technology for homegardens

Agriculture technology and its diffusion are important factors in developing country's quest for food security and better economy. Till date, agricultural technology has bypassed the needs of small and marginal farmers and concentrated primarily on better-endured regions, commodity intensive production systems and commercial crops. Kerala is no exception to this. Most small-scale farmers in Kerala operate in relatively small but complex farming systems in each agro ecological zone. Farmers in different agro ecological zones need access to a wide variety of locally validated technologies if they are to increase their productivity (Swanson *et al.,* 1997). To have such locally validated technologies it is essential that the dimensions of technology for homegarden systems be identified.

Rajendran (1992) identified 15 dimensions that was related with technology and its feasibility using the mean relevancy score. They were initial cost, income generation potential, regularity of returns, availability of raw materials, availability of supplies and services, time utilization pattern, rapidity of returns, physical compatibility efficiency, profitability, availability, simplicity, viability, suitability and social acceptability.

Muthuraman (1995) in his article on sustainable agriculture has quoted some dimensions of sustainable agriculture identified by Swaminathan covering the social, economical, technological, political and environmental facets of sustainability as technological appropriability, economic feasibility, economic viability, environmental soundness, temporal stability, resource-use-efficiency, local adaptability, social acceptability, social sustainability, political tacitness, administrative manageability, cultural desirability, renewability, equity and productivity.

KAU (2002) identified five dimensions for technology assessment as productivity, adaptability, identity, continuity and security.

Small producers particularly those operating in resource-poor areas and in small holdings (homegarden) have benefited much less from the recent technological break through in agriculture. Identifying the dimensions of technology for homegardens will thus enable the cause for homegardens in the following ways.

a. Future oriented research and development towards need based technology for homegardens.
b. Prevention of import of obsolete technologies intended for homegardens.
c. Shift towards appropriate technology suited for homegarden conditions.
d. Effective technology transfer for homegarden farmers.
e. Leap across generations (continuity) in terms of technology use
f. Rapidity of innovations with an eye to homegardens of Kerala.
g. Trade restrictions on technology generation and dissemination to homegardens

2.10 CONSTRAINTS EXPERIENCED BY HOMEGARDEN FARMERS

Research studies pertaining to the constraints encountered in practising agroforestry and homesteads was thoroughly reviewed. A summarised list of the important constraints experienced by farmers in the utilization of agricultural technologies as identified/reported by the researchers is presented below:

KAU (1989), in the National Agricultural Research Project status report of southern zone identified lack of knowledge on technical aspects and economical aspects of balanced use of fertilisers among farmers and lack of optimum fertilisers schedules for different regions, non availability of manure, high cost of organic manure, farmers not convinced of the benefit of liming and high cost of fertilisers.

Umale *et al.* (1991) reported that most of the farmers were found to be deficient in knowledge about the trees recommended under agroforestry and their cultivation practices. They were also found to be not adopting the recommended technologies of agroforestry to a desired extent. A considerable per cent of the respondents reported that due to incomplete knowledge of recommended technologies

of agroforestry they could not adopt the same. Study revealed that sufficient literature in local language was not available with regard to package of practices of agroforestry. Rai and Shivashankar (1993) conducted a survey on agroforestry practices in Karnataka. According to them, the important constraints due to which people have not taken up agroforestry were:

1. Not enough land (23.6 percent)
2. Lack of technical knowledge about planting trees (18.5 per cent)
3. Lack of water (17.9 per cent)
4. Long gestation period (13.2 per cent) and lowering down of water table by trees

Viswanath *et al.* (1994) reported that the major constraints in tree farming were (a) stray grazing (b) erratic rainfall pattern and lack of proper irrigation facilities (c) non-availability of inputs like superior planting stock (d) lack of finance / capital (e) inadequate marketing infrastructure to take up commercial tree planting of multipurpose tree species and low level of awareness regarding the profitability of several multipurpose tree species.

Michael (1995) reported that the most commonly mentioned constraints were lack of water, lack of planting stock, lack of seedlings and lack of time and interest by farmers as well as lack of experience.

Pawar and Kadam (1995) in his study brought out the constraints faced by the agroforestry growers which were coming in the way of expansion of agroforestry systems. The shortage of seedlings was very acute in case of teak. Non co-operation from the government officials and uneconomical transport facilities were also the obstacles in expansion of the plantation. About 23 per cent of agroforestry growers pointed out the difficulty of inter-culturing in tree plantation. Near about 21 per cent of the plantation growers complained about high mortality of seedlings especially in teak, more than four per cent of growers expressed their dissatisfaction towards the existing marketing structure, 20 per cent reported lack of proper market information. Rigidity of government

rules in respect of disposal of teak wood was very troublesome to about 43 per cent of teak growers. In addition to these constraints the agroforestry growers expressed other constraints such as delayed returns, tree serving as host of pests and diseases.

Patnaik (1996) reported that the major bottlenecks in marketing of homestead produce were lack of market infrastructure, marketing plan, lack of proper planning of produce manufacturing system and produce disposal system. In addition to this the stringent act and rules for removal of forest produce even from the private land holdings and lack of agencies to facilitate the marketing was perhaps the major stumbling blocks.

A general nature of constraints experienced by small and marginal farmers were reviewed and presented below.

Sl No.	Author	Crop	Constraints
1	Palaniswamy (1978)	Flowers	Lack of credit, marketing, storage, transport facilities, non-availability of labour, exploitation of middle men, fluctuation in market price
2	Krishnan (1980)	Apple	Lack of storage, high percentage of losses due to spoilage, inadequate marketing facilities and finance.
3	Seshachar (1980)	Chilli	Lack of knowledge regarding application of farmyard manure, fertilizers and plant protection chemical.
4	Gokulraj (1981)	Tomato	Fluctuating market price, inadequate fund, no technical guidance, lack of knowledge regarding improved practice.
5	Kumbar (1983)	Grapes	Lack of knowledge, lack of finance, lack of irrigation facilities.
6	Chadha (1984)	Grapes	Flower and flower bud drop, cluster tips wilting, pink berry formation, poor bud burst, premature defoliation, poor cane maturity, dead area and trunk splitting.

7	Pillaiar (1985)	Paddy	Lack of intensive extension service, inadequate supply of inputs, lack of knowledge, lack of credit availability
8	Ramanathan *et al*. (1987)	Cassava	Lack of marketing system, high cost of cultivation, non-availability of planting material on time, low cost of tubers of HYV (High yielding variety)
9	Hew (1989)	Cutflower	Shortage of good quality planting material, lack of production and post-harvest handling technology, lack of market innovation and insufficient government support
10	Prakash (1989)	Paddy	Lack of co-operation among farmers, low adoption of HYV and lack of irrigation
11	Sajeevachandran (1989)	Pepper	Inadequate timely supply of inputs, large scale distribution of planting materials affected by quick wilt and slow wilt, high cost of plant protection equipments, high cost of fertilizers, lack of adequate financial support
12	Anantharaman (1991)	Cassava	Uncertainty in resource mobilisation, production and marketing, shortage of labour during peak periods, lack of timely and accurate information
13	John (1991)	Pepper	Lack of assistance of government agency in organizing the farmers and providing proper guidance, lack of knowledge and awareness
14	Pandey (1991)	Cut flower	Green house technology at low price, delay in quarantine and inspection of imported seed and planting material, non- availability of the quality planting materials, lack of infrastructural facilities like cold rooms. AC trucks and cold room facilities at airport, heavy airfreight, no guarantee for cargo space by Air India.

15	Jnanadevan (1993)	Coconut	High labour cost, non-availability of labourers in time, inadequate and timely supply of seedlings, lack of adequate financial assistance and subsidies
16	Singh (1994)	Cut flower	Poor infrastructure, lack of appropriate planting materials, production technology, basic inputs like standard media/growing media and quality packing materials and no proven post-harvest handling technologies to increase shelf life.
17	Sindhu (1995)	Cut flower	Capital-intensive industry requires technologically advanced infra-structure to ensure quality product, lack or insufficient availability of good quality planting materials, lack of technical expertise and lack of transporting facilities.
18	Bose (1998)	Jasmine	Fluctuation of market price, exploitation of middle men, non-availability of credit, inadequate irrigation facilities and lack of storage facility

From the foregoing reviews, it may be seen that the constraints experienced by homegarden farmers of Kerala are complex in nature which should be considered holistically while probing into the characteristics of homgardens.

Materials and Methods

3. METHODOLOGY

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

3.1 RESEARCH DESIGN

'Ex-post-facto' research design was used for conducting this study. 'Ex-post-facto' research design is a systematic inquiry in which the scientist does not have direct control over the independent variables because their manifestations have already occurred or because they are inherently not manipulatable (Kerlinger, 1983). This research design was resorted to in this study, as there was no scope for manipulation of any variables under study.

3.2 LOCALE OF THE STUDY

The study was conducted in the Southern Kerala comprising Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta districts and its geographical area is 8581 km^2 with a total of 20 taluks, 46 development blocks and 249 panchayats. The Southern Kerala is characterised by a comparatively heavy rain fall during South West monsoon and less rainfall during the North – East monsoon period leaving in between a dry spell of six months from December to May.

Owing to the wide variability in the structure and cropping pattern of homegardens in the Southern districts of Kerala, which are predominantly the erst while Travancore state, the area is purposively selected for the study. A multistage random sampling conducted in coconut-based homegarden in Kollam district representing the midlands of South Kerala during 1988-1989 generated considerable evidence to the highly heterogeneous cropping strategy practised in the homegardens of the region (Shehana *et al.,* 1994). The study empirically proved the highly diversified cropping pattern practised in the Kerala homegardens of South Kerala that is evident from the components of homegardens. Because of this wide variability and larger proportion of homegardens in this zone, Kerala Agricultural University has identified Farming System Research Station (FSRS), Sadanandapuram as the centre for homestead research. Further more, it was reported in the book entitled 'agro climatic zone specific research-Indian perspective under NARP (National Agricultural Research Project)' edited by Ghosh (1991) that NARP has provided a special sub project at FSRS, Kottarakkara for indepth study of homestead farming, which indicated the significance of this zone with regard to homegardening. All these factors made the researcher to select the Southern districts of Kerala for the purpose of the study. The maps showing the location of the study are given as Fig. 1.

3.3 SELECTION OF THE RESPONDENTS

The respondent group of the study comprises homegarden farmers, extension personnel and scientists/experts.

a) Selection of homegarden farmers

The objectives set forth in this study seek to throw light into the general structure and function of homegardens and the technology assessment aspects. This address largely the land use practices in homegardens. Hence, the study area was stratified on the basis of agroclimatic zones. Three agroclimatic zones as identified by KAU (1989b) and KSLUB (1997) in the study region was considered for the stratification procedure. However the zone namely, special zone for problem areas

A. Thiruvananthapuram

B. Kollam

C. Pathanamthitta

D. Alappuzha

E. Kerala

Fig 1. Map showing location of the study

presents widely varying land resources with respect to agro climatic nature and its utilisation. Therefore two regions representing two different agroclimatic areas were considered for study from this zone. Thus four agroclimatic regions were selected which represented the different strata of the sampling design. These regions were named after the districts under which they largely fall.

A list of all panchayats in each selected regions viz., Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta was prepared. The panchayats, which were reported to have least importance for homegarden system of cultivation, was eliminated in consultation with the respective Principal Agricultural Officers concerned. From the rest of the panchayats, thirteen panchayats from each stratum were selected by simple random sampling method without replacement. As the data on number of households in each stratum was not available, the number of panchayats selected from each region could not be fixed strictly according to the proportion of the total number of households in the strata. Therefore, and for operational convenience thirteen panchayats were selected from each region which represents the second stage sampling.

A list of farmers with homegardens was prepared from the respective agricultural offices. The household farms which do not, prima-facie, conform to the requirements of a homegarden situation were omitted from the list in consultation with agricultural officer. Four homegardens were randomly selected from each panchayats with the following inclusion criteria.

Criteria	Holding size (cents)
1	Less than 25
2	25-75
3	75-125
4	Greater than 125

Thus four homegardens, each representing the four categories of holding size were selected from 52 panchayats covering the entire region of South Kerala which made a total sample size of 208 homegardens for the study.

b) Selection of extension personnel

All agricultural officers (n = 52) of selected panchayats of the respective districts under study were selected as the respondents under extension personnel for the study.

c) Selection of scientists/experts

The scientists/experts (n = 35) concerned with homegarden systems research belonging to different institutions in the study locale of the region representing ICAR / KAU / Commodity Boards were selected as the scientists/experts respondents for the study.

3.4 OPERATIONALISATION AND MEASUREMENT OF VARIABLES

3.4.1 Operationalisation of variables

Homegardening is a very old tradition that has evolved over a long time from the practices of the hunters/gatherers and continued in the ancient civilizations upto modern times. In the due course of this evolving process of homegardens, from ancient to modern times, the stress on food, nutritional and cultural sustainability has transformed to economic sustainability. Thus it has evolved as a system for the production of subsistence crops for the gardener and family with or without the involvement of cash crops. It is this evolving nature that has brought in significance to the structure of homegarden which is contributed by its cropping and farming systems For example, a prominent structural characteristic that exhibits the dominance of the homegarden is the great diversity of species with many life forms varying from those creeping in the ground, such as sweet potato to tall trees of 10 m like coconut palm, bamboo poles or other multi purpose tree species along with some livestock components, birds or domestic animals. In such a system, the structure and function is very significant and of conspicuous nature. A structurally dominant crop component need not be economically dominant or technology needy whereas a transient crop component which is numerically and economically dominant need not be structurally dominant but technology needy. Hence the interpretation of structure of homegarden is very important and handled with utmost care. In one way it is interpreted that the forest-like structure has been the result of deliberate planning of homegarden to mimic

the forest, which has its own techno-socio-economic implications. In the other way it is believed that population boon and pressure on land where the land itself has become a constraint coupled with the development of a market economy made an effect on the complexity of the homegarden and its resemblance of a forest tends to disappear giving a clear insight to the varying species diversity, species richness and measure for evenness from homegarden to homegarden. Therefore it becomes imperative to study the structural configuration of homegarden that enables us to understand the structure and type of homegarden and also the technology needs in the homegarden.

The structure, type and technology needs of a homegarden are dynamic in nature since it is an evolving system. It is very much dependent on the bio-ecographic positions of the locale coupled with the personal, socio-cultural and techno-economic position of the homegarden respondents of the respective area. Hence, it was important that the structure, type of homegardens and technology needs of the homegarden farmers were to be studied district wise so as to bring about their differences if any, that will enable the authorities concerned to frame strategies and implement them in order to develop the homegarden situation which constitute 70 per cent of the Kerala land area. This will definitely help in the sustainable growth of agriculture in Kerala where land has become the most limiting factor.

A methodology was arrived at to understand the structure and type of homegarden through measuring the species diversity, species richness, measures of evenness and finally the dominance index (structural dominance, numerical dominance and economical dominance) in the districts of Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta. The species diversity and species richness and evenness measures will bring out the structural configuration and the type of homegardens district wise. The measures of evenness and dominance index will enable one to infer out the cropping patterns of homegardens district wise. Further more an economic analysis for the major contributing crops will also lead to the investigation of the components (crop and animal husbandry components) that farmer pay heeds (with respect to their adoption) in homegarden situations. It will help in

further assessing the technology need and the dimensions of technology in the homegarden, which is actually the technology forecast for the homegarden situation. Further analysis of constraints experienced by the farmer will lead to solution by the experts that will enable the homegarden farmers to solve their problems and frame strategies for better homegardening, which is of much relevance to Kerala situation and the essence of this study. This forms the significance of the methodology developed for the study and it is described below under the following headings that fulfils the objective of identifying the structural configuration of homegarden, type of homegarden, extent of adoption of scientific practices/utilisation of agricultural technologies by the homegarden farmers, extent of adoption of indigenous practices by homegarden farmers, technology needs assessment of the homegarden farmers and identifying the dimensions of technology as perceived by the homegarden farmers, agricultural officers and scientists forming the basis of forecast of technology for homegarden and constraints experienced by homegarden farmers.

a. Structural configuration, cropping systems and types of homegardens

Structural configuration of homegardens that leads to the structure, cropping system and type of homegardens was brought out using the concept of species diversity and its measurement.

Species diversity is an approximate proxy for biodiversity. The term biological diversity was first defined by Norse and Mc manus (1980) and its abridged form bio diversity was coined by Walter G. Rosen in the year 1985. Biodiversity has been defined as the totality of genes, species and ecosystems in a region [United Nations Environment Programme (UNEP), 1992].

Sagar and Singh (1999) deliberated that species diversity, which is a rough proxy for biodiversity, characterises community structure and maintains the populations, food chains and nutrient cycles in ecosystem. In addition, human depends on biodiversity for food, medicines and materials for ecological services. A minimum level of biodiversity is required for proper functioning of the ecosystem, below this

where the ecosystem may collapse. Hence, the study on species diversity was essential so as to identify the structure and function of a homegarden ecosystem. Species diversity can be expressed at three levels: alpha diversity (within habitat diversity), beta diversity (inter community diversity) and gamma diversity (entire landscape diversity). Since, objective of the study was to measure the diversity index of homegarden, which represent a habitat, alpha diversity which includes measures of biodiversity, species richness and evenness was selected.

A number of indices have been reported that calculates the biodiversity index. The most widely used indices with its formulae are presented in Table 1.

i. Measure of diversity index

In this study, Shannon-Weiner index of diversity based on information theory (the information content is a measure of the amount of uncertainty) was used to calculate the diversity index of the homegardens. This index was purposively chosen as its measure enables further estimation of measure of evenness which will again help in a better understanding of the structural configuration of homegardens. Also, the whole of a homegarden as a single unit could be considered for the study unlike other cases where usually a portion of the ecosystem is considered by way of further sampling. The formula used for determining the diversity index was

$$H` = -\sum_{i=1}^{s} (p_i \log_2 p_i)$$

Where

H` - Shannon-Wiener diversity index

P^i - A proportion of total sample belonging to i^{th} species

ii. Measure of species richness

Species richness is the first and oldest concept of species diversity, which is nothing but an indicator of the relative wealth of species in a community. It also threw light to the varying structure and functions of homegardens.

Table 1. List of biodiversity indices and its formulae

Sl. No	Name of index	Formulae	Description
1	Fisher's index (Fisher et al., 1943)	$S = \alpha \log_e (1 + N/\alpha)$	s-number of species, N-number of individuals, α-Fisher's Diversity index
2	Simpson's index (Simpson, 1949)	$\lambda = \sum_{i=1}^{s} pi^2$	λ-measure of dominance, s-number of species, pi-proportionate of species 'i' in the sample, D = 1- λ and D-diversity index
3.	Shannon and Wiener index (Shannon and Wiener, 1949)	$H` = -\sum_{i=1}^{s} (p_i \log_2 p_i)$	H`- Shannon and Wiener diversity index, pi-proportion of total sample belonging to i^{th} species, s-number of species, $\log_2 - 3.322 \log_{10}$
4.	McIntosh index (McIntosh, 1967)	$MD = \sqrt{(\sum_{i=1}^{s} n_i^2)}$	n_i, number of individuals in the i^{th} species, s-number of species, MD-McIntosh diversity index

Species richness was calculated using the formula of Margalef (1958).

$$SR = \frac{S - 1}{\log (n)}$$

Where,

SR – Species richness
S – Number of species
n – Total number of species

iii. Measure of Evenness

Measure of evenness or equitability represents the proportionate distribution of individuals among the species. It was calculated using the formula of Pielou (1969) that uses Shannon Weiner formula.

$$E = \frac{H`}{\log (S)}$$

Where,

E - measure of evenness
H` - measure of Shannon Weiner index
S - number of species

The data on diversity index, species richness and evenness were analysed for ascertaining whether it varies between districts, whether it varies depending upon the size of holding and whether it varies within defined regions within a homegarden.

The different districts and size of holdings selected for the study was explained in the locale of study and selection of respondent part in the same chapter. Now, there needs to be an explanation for defined regions in the homegarden. The data enumeration with respect to the crop components in the homegarden was done for three different regions in the homegarden which was explained as ‘Courtyard’, ‘Mid region’, and ‘Outer region’ of the homegarden.

Courtyard was operationally defined as the area that is perceived to be near to the house in the homegarden.

Mid region was operationally defined as the area that is perceived to be falling in between the courtyard and outer region in the homegarden.

Outer region was operationally defined as the area that was perceived to be farther in distance from the house in the homegarden.

Analysis of the data on diversity index, species richness and evenness with respect to these defined regions will give a better idea on the varying structural composition and functional variations within a homegarden.

Analysis of variance using a split plot design was done in completely randomised design for the purpose with districts, size of holdings and regions in homegarden taken as factors. The three different regions share the same land resources and hence they cannot be construed as independent plots. Therefore the regions were taken as a subplot of the 4 x 4 (district x size of holding) main plots for conducting the analysis.

iv. Measure of dominance

The dominance of crops in the homegardens was measured in terms of structural dominance, numerical dominance and economical dominance.

The measure of structural dominance was arrived at by observing promptly the pattern of canopy (configuration) formation, the height of plants, a perception of the root spread of plants and rating it in a 'seven point' scale with 'one' for a crop species with a highly dominating structure over the surrounding individual plants and 'seven' for the least dominating one in the homegardens.

The numerical dominance of a crop is the scale value assigned to that crop in accordance with the numerical strength of the individual plants belonging to the

crops species. A seven point scale with 'one' assigned for the crop with maximum dominance stand and seven for the one with a minimum stand or scarcely distributed stand in the homegarden.

The economic dominance was also worked out using the similar procedures by assigning a rank 'one' in the seven point scale for the most remunerative crops and subsequently the other ranks of two, three, four, five, six and seven for the lesser remunerative crops in the order.

b. Economics of homegardens

Marketing of homegarden produces is of great importance requiring a special status as an integral part of production owing to the availabilities of wide varieties of cherished products from homegardens. Moreover, it is virtually impossible to produce these treasured varieties of horticultural produces especially fruits and vegetables in any other system than that of homegarden system. But owing to its highly perishable nature especially horticultural products, marketing decides the net realizable income from the cultivators.

Marketing activities includes the functioning of various agencies mainly classified as producer, middlemen and consumer who have an individualistic view towards marketing and are concerned with profit alone. Besides, unnecessary attachment of large number of intermediaries results in producers small share in consumer rupee (Lepcha *et al*., 1993). Next, being perishable in nature they have to be sold at the earliest opportunity. Majority of Kerala homegardens are relatively smaller holdings, hence farmers do not possess withholding capacity till a favourable price emerges in the market. Besides, they do not have any bargaining power of deriving the best of their revenue. This situation is further aggravated by the less quantum of marketable produce from homegardens, which ultimately provides traders with an opportunity to exploit the homegarden farmers.

It is a pre requisite for the welfare and well being of the farming community in general and homegarden farmers who possess the major land holding in Kerala, that an efficient marketing system be ensured so that it pays rich dividend to the producers and safeguards the interest of the consumer.

Hence, an attempt has been made to know the contribution of major and dominant homegarden components towards annual homegarden income, the marketing channels identified for the contributing homegarden components and the homegarden farmer's perception on the need of middleman in the marketing of homegarden produces.

i. The contribution of major and dominant homegarden components towards annual homegarden income

Based on the dominance (numerical and economical dominance) of crops and other components a theoretical perspective of the contributing components to the homegarden economy was arrived. The actual amount in rupees received by the homegarden respondent annually from those dominant components was arrived at and subjected to statistical analysis using multiple linear regression model. The results obtained will describe the contributing crops with the extent of contribution to the annual homegarden income.

ii. Identifying the marketing channels for the major contributing homegarden components

Marketing channel is operationally defined as the various channels or routes through which products move from producers to the ultimate consumers.

In this study marketing channel is identified as below.

The homegarden farmers were asked the route or channel through which they marketed their surplus or marketable produce obtained from homegarden. The responses were recorded at the time of interview (as mentioned in the interview schedule - Appendix I) and it was listed out and expressed in terms of percentage.

Thus it was made possible to identify the most common and predominant marketing channel through which the bulk of their produce was marketed.

iii. The need for middleman in marketing the homegarden produces as perceived by the homegarden farmers

Middlemen are operationally defined as the connecting link between the producer and consumer with an individualistic view and profit motive.

In the present study the homegarden respondents were asked to respond whether the respondents felt a need for middlemen in marketing the homegarden produces (mentioned in the interview schedule as Appendix I). The response category 'Yes' or 'No' from the homegarden respondents was awarded with a score of 'One' and 'Zero' respectively. The frequency was worked out and it was expressed as percentage in the results.

c. Technology assessment in the homegarden systems

Technology assessment in the homegardens was made after identifying the dominance (structural, numerical and economical dominance) of crops in the homegardens. It was assessed in terms of adoption study, technology needs assessment and identifying the dimensions of technology suited for homegardens. The methodology adopted is described under the following subheads:

i. Extent of adoption of selected scientific practices by homegarden farmers

The concept of extent of adoption, in the present study, refers to the acceptance of the practice by the homegarden farmer.

A review of the measurement procedure for adoption revealed that there are various measures developed and used for measurement ranging from simple to complex measurement procedures.

Chattopadhyay (1963) used adoption quotient for measuring adoption behaviour. This is a ratio scale that measures behaviour on dimensions of applicability, potentiality, extent, time, consistency and differential nature of innovation.

Since the intricacies of adoption of practices by homegarden farmers were not known and the data on different components of adoption like potentiality, time etc. could not be meaningfully interpreted, it was decided that a simple procedure may be followed to measure the adoption pattern of the respondents as described below, the method developed by Chattopadhyay (1963) and modified and used by Singh and Singh (1967).

$$AQ = \frac{\sum_{i=1}^{n} \frac{e_i}{p_i} \times 100}{N}$$

Where,

AQ= Adoption quotient
ei = Extent of adoption of each practice
pi = Potentiality of adoption of each practice
N = Total number of practices selected.

ii. Extent of adoption of scientific practices in homegardens and its relationship with the personal characteristics of the homegarden farmers

Simple correlation analysis was resorted to find out the relationship of personal characteristics of homegarden farmers with the adoption quotient obtained for each individual homegarden farmers.

iii. Extent of adoption of Indigenous practices by homegarden farmers

The homegarden farmers had developed a number of indigenous practices by virtue of their rich practical experience in the field of agriculture acquired through generations to generations. The respondents were prompted by the researcher with

questions so as to get the response from the homegarden farmers about the indigenous practices followed by them if any.

Thus the major indigenous practices adopted by the respondents were enumerated and the same was expressed in terms of percentage.

iv. Technology needs assessment in the homegarden

After the feedback from the farmers during pilot survey and discussion with experts, the researcher came out with some concrete specification regarding various technology/ scientific operations and the technology needs of farmers were worked out.

The needs assessment was worked out by using score/rank as stated below.

Score/Rank	Criteria
1	Technology not available (most needed)
2	Technology available but not applicable
3	Technology available but not sustainable
4	Technology available, applicable and sustainable

The technology needs of farmers vary according to the crops they cultivate, the managerial levels in which they operate, the deficits in the demand and supply of the crops they raise with reference to the specificities of the land they engages for cultivation and the agronomic norms the plant demands. It was with these perspectives, grouping of technology needs of the farmers were done and classified into the aforesaid broad categories. The categories are so framed and named so as to accommodate all the crops. The technology needs with reference to all these 14 parameters *viz*., variety, planting material, selection of intercrops, spacing, irrigation management technologies, soil amendment technologies, nutrient management technologies, pest management technologies, disease management technologies, homegarden machinery, drainage technologies, storage technologies, processing

technologies and value addition technologies were collected in the above said scale for all the categories of crops raised by the homegarden farmer.

Thus technology needs scores of all the 52 farmers of each of the four districts were tabulated and subjected to statistical analysis. The scores assigned being in ordinal scale, the non-parametric test of analysis of variance (Kruskal - Wallis test) was administered.

In order of assessing the need disparities between the different districts, Kruskal - Wallis test was again employed for obtaining the results.

v. Identifying the dimensions of technology in the homegardens

Based on the review of literature and detailed discussion with experts, a list of dimensions that appeared to be related with homegarden technologies was prepared. The list of attributes/dimensions was subjected to examination by the homegarden respondents, agricultural officers and scientists/experts. They were asked to examine the dimensions critically and also to include additional attributes/dimensions if found necessary. The judges were requested to rate the relevancy of each dimension on a 11-point continuum ranging from most relevant to least relevant with the weightages of 'zero' to 10 respectively. The response from all the homegarden respondents, 52 agricultural officers and 35 scientists / experts were collected.

The selection of the final dimensions of technology in homegardens was based on 'cluster analysis' of the data collected.

Cluster analysis or pattern analysis or typology analysis is the procedure by which the entities are objectively grouped together on the basis of their nearness (natural association) based on their proximity values and means.

d. Constraints experienced by homegarden farmers

Based on discussion with farmers, scientists, experts in agriculture and also through relevant review of literature, some of the constraints faced by homestead farmers were identified. A list containing twenty-six such constraints was included in the final interview schedule. The list was open ended by which the constraints experienced by the homegarden farmers at the time of interview were added.

The response to each constraint was obtained on a four-point continuum namely, most important, important, less important and least important, with the score 'four', 'three', 'two' and 'one' respectively. Mean rank cumulative index for each constraint was worked out and the constraints were ranked and catalogued under different subheads.

3.4.2 Measurement of Independent Variables

In order to assess the influence of the profile characteristics of the homegarden respondent for meeting the objectives of the study, the characteristics of the homegarden 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 50 judges comprising extension scientists and homegarden experts (Appendix-II). They were asked to examine the variables critically and to rate the relevancy of each variable on a five-point continuum ranging from most relevant, more relevant, relevant, less relevant and least relevant with weightages of five, four, three, two and one respectively. Out of 50 judges only 32 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 responded. Those variables garnering a score more than the mean score was selected for the study. The variables with the mean relevancy scores are presented in Appendix II.

The independent variables thus selected for the study were age, education, occupation, family size, irrigation potential, annual income from homegarden, extension contribution, market orientation, rational orientation, knowledge of homegarden farmers on scientific practices/technology and evaluative perception of homestead farmers in relation to sustainability of the homegarden.

The selected 11 independent variables and their measurement for study are presented in Table 2.

Table 2. Independent variables and measurement scales / scores used

Sl. No.	Independent variables	Measurement and scoring procedures developed or adopted by
1	Age	Scoring procedure developed for the study
2	Education	Menon (1995)
3	Occupation	Scoring procedure developed for the study
4	Family size	Scoring procedure developed for the study
5	Irrigation potential	Scoring procedure developed for the study
6	Annual income from homegarden	Scoring procedure developed for the study
7	Extension contribution	Scoring procedure developed for the study
8	Market orientation	Samantha (1977)
9	Rational orientation	Jeteley (1977)
10	Knowledge	Test developed for the study
11	Evaluative perception	Arbitrary scale developed for the study

a) Age

Age was operationally defined as the number of years completed by the respondent at the time of investigation.

This was measured as the total number of years completed by the head of the homegarden at the time of interview and was classified based on census classification method.

The classification was done as stated below:

Age category	Years
Young	< 35
Middle aged	35 - 45
Aged	> 45

b) Education

In this study education is operationalised as the extent of non-formal or formal learning possessed by the homegarden respondent.

The scoring procedure adopted by Menon (1995) was used for the study and was as follows.

Category	Score
Illiterate	0
Can read and write	1

One score was added to every successful completion of formal schooling.

c) Occupation

Occupation was operationalised as the main vocation and other additional vocations that the respondents were possessing at the time of interview. The scoring procedure developed for the study is as described below.

Category of occupation	Score
Agriculture alone	1
Agriculture + private business	2
Agriculture + Government	3

The maximum and minimum score that could be attained by the respondent was ‘three’ and ‘one’ respectively.

d) Family size

This refers to the number of members of either sex living in a household/family dependent on the head of the family.

This was measured in numbers.

e) Irrigation potential

This was operationally defined as the extent to which irrigation water was available in the holding and the extent of area irrigated.

It was quantified in terms of availability of irrigation water for irrigating the homegarden and the scoring procedure developed for the study is as stated below. Terms of physical water scarcity, economic water scarcity and little water scarcity with scores of 1, 2 and 3 respectively.

Irrigation potential category	score
Physical water scarcity	1
Economic water scarcity	2
Little water scarcity	3

The score obtained by the respondent was taken as his score for irrigation potential. The maximum and minimum score that could be attained by the respondent was ‘three’ and ‘one’ respectively.

Physical water scarcity refers to the perception of farmer that the water available in the homegarden is not enough for irrigation purpose.

Economic water scarcity refers to the perception of farmer that the water available in the homegarden is to be used very judiciously inorder to meet the irrigation requirements in the homegarden.

Little water scarcity refers to the perception of farmer that the water is abundantly available in the homegarden.

f) Annual income from homegarden

This refers to the total annual earnings from the farm activities in the homegarden.

This was measured in terms of rupees per year as expressed by the homegarden farmer.

g) Extension contribution

It refers to the extent of contribution of technology in the homegardens as perceived by the homegarden farmers in the locality.

The respondent's perception on the contribution of technology by different extension agencies was scored in a three point continuum with scores of 'three', 'two' and 'one' respectively for 'very adequate', 'adequate' and 'not adequate' category of response. The responses for extension contribution from various agencies as expressed by homegarden farmers were collected as given in interview schedule (Appendix-I). By summing up the scores obtained by the farmer in all the category of responses, the extent of contribution from various institutes as perceived by the homegarden respondents were finally made.

The maximum and minimum score that could be attained by a respondent was '12' and '4' respectively.

h) Market orientation

Market orientation is one of the three subscales of the scale developed by Samantha (1977) for measuring management orientation, which is defined as the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing functions/activities of his farm enterprises.

Market orientation was measured using the sub-scale, which consisted of six statements, three positive and three negative statements (interview schedule - Appendix I). In the case of positive statements, a score of 'one' was given for agreement and 'zero' for disagreement. For negative statement, the pattern was reversed. The total score obtained by the respondent was taken as his score for market orientation.

The maximum and minimum score that could be attained by the respondent was ‘six’ and ‘zero’ respectively.

i) Rational orientation

This was operationalised as the extent of rationality and scientific belief of a homegarden respondent in relation to the different scientific recommendations of an enterprise. The procedure developed by Jeteley (1977) and adopted by Selvanayagam (1986) was used for measuring rational orientation of a farmer.

The question ‘what do you feel about the increased improvement in your life’? was posed to the respondent which was rated based on the response as follows:

Response category	Score
Belief in stars and not in scientific recommendations	1
Belief in stars and scientific recommendations	2
Belief only in scientific recommendations	3

The score obtained by the respondent was taken as the rational orientation score of the respondent. The maximum and minimum score that could be attained by the respondent was ‘three’ and ‘one’ respectively.

j) Knowledge of homegarden farmers on scientific practices/technology

Different researchers had defined and measured knowledge level by developing and standardising the items that reflect the knowledge level of the respondents.

Bloom *et al.* (1955) defined knowledge test as those behaviours and tests situations, which emphasised remembering either by recognition or recall of ideas, materials or phenomena.

Noll (1957) defined a standardised knowledge test as one that has been carefully constructed by experts, according to the acceptable objectives or purposes and procedures for administering, scoring and interpreting scores, which are specified in detail so that the results should be comparable.

In the present study, knowledge is operationally defined as the respondents awareness and understanding about the different scientific practices in the recommended package of practices. In the present study the method of 'Teacher made test' was employed for the measurement of general knowledge about scientific practices on homegarden components of the homegarden respondent by using the following steps.

The knowledge items on various technologies/scientific practices of homegarden components (crop and livestock component) to be known by the homegarden respondents were prepared in consultation with agricultural experts and field extension functionaries. This process was supplemented with review of literature from the Package of Practices Recommendations of KAU (2003).

On the basis of this, a set of knowledge questions prepared (70 questions) was further given to a panel of experts of related disciplines for their comments and suggestions. Based on the criticism and suggestions made by the experts, the knowledge statements were modified and new statements were added. Finally 35 questions pertaining to the technologies/ scientific practices on homegarden components (crop components and live stock components) were selected after judges rating for administering to the respondents of the study as given in the interview schedule (Appendix - I).

The questions selected to measure the knowledge level of the identified technologies/scientific practices were explained to the homegarden respondents and their responses were collected. Each correct answer was given 'one score' and zero for 'incorrect answer'. The maximum and minimum scores were 35 and zero respectively.

The summation of scores for the correct answers over all the items for a particular respondent indicated his level of knowledge on the scientific practices in homegardens. The mean values of the individual knowledge scores obtained by 52 respondents from each district (thus a total of 208 homegarden respondents) were computed and the respondents were grouped into low and high categories of knowledge level.

k) Evaluative perception of homegarden farmers in relation to sustainability of the cropping pattern and farming system in homegardens

The evaluative perception of homegarden farmers in relation to sustainability of farming systems and cropping patterns in homegardens varies from individual to individual. The purpose of perception is to help individual to cope with the world by assigning meaning to it, which can stand the test of subsequent experiences (Toch and Maclean, 1970)

Evaluative perception of homegarden farmers on the sustainability of farming system and cropping patterns was measured using an arbitrary scale developed for the purpose. The scale was considered as an arbitrary one since the various procedures of standardisation by estimating reliability and validity of the scale were not attempted in the present study.

Based on the relevant review of literature and discussion with experts of Department of Agriculture and Kerala Agricultural University, items related to sustainability of farming systems and cropping patterns adopted by homegarden farmers were identified under five major heads namely environmental facets, sustainability, quality of life- food, nutritional and medicare security, utilization of resources and economic aspects.

Environmental facets refer to the overall consideration given to the environment by the homegarden farmer when agricultural production and allied activity is pursued by maintaining the cleanliness of the environment and preserving the same for the future generation.

Sustainability of homegarden refers to successful management of renewable resources for homegardening to satisfy the changing needs of members of farm family like improved productivity, providing food, income and livelihood for current and future generations while maintaining or improving the quality of homegarden environment and conserving the natural resources of homegardens.

Utilisation of resources refers to the effective use and management of homegarden resources through which maximum utility attained from the use of homegarden inputs.

Economic aspects refer to the degree to which the overall economic improvement of the homegarden farmer is brought about as a result of adoption of technology/scientific practices in homegarden farming systems and cropping patterns.
Quality of life- food, nutritional and medicare security refers to the degree to which the standard of living, nutritional, medical and aesthetic aspects of the household would be influenced by the adoption of farming systems and cropping patterns that varies widely from homegarden to homegarden.

Evaluative perception of homegarden farmers on sustainability of farming systems and cropping patterns in the homegarden is thus operationally defined as the respondent's meaningful sensation about the worth and efficiency of homegarden farming systems and cropping patterns in terms of environment, quality of life-food, nutritional, medicare and aesthetic aspects, resource/technology utilisation and economic aspects.

The perception of homegarden farmers on these items was measured on a four-point continuum varying from most important to least important with scores 'four' to 'one' respectively as given in the interview schedule (Appendix-I).

The scores for the evaluative perception of a homegarden farmer on each item were summed up to get the overall perception score for an individual respondent. The maximum and minimum scores were 124 and 31 respectively.

The mean values of the evaluative perception scores obtained by 52 respondents from each district (thus a total of 208 homegarden respondents) were computed and the respondents were grouped into low and high categories.

3.5 DATA COLLECTION PROCEDURE

The data were collected using a well-structured interview schedule prepared for the purpose (Appendix I). 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 homegarden farmers by the investigator and responses recorded at the time of interview. The data collection was done during June, July, August, September, October, November and December 2003 by directly interviewing the homegarden farmers, by the researcher.

3.6 STATISTICAL TOOLS USED IN THE STUDY

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

3.6.1 Mean

The respondents were grouped into categories with reference to the means of the independent variables. After grouping the respondents into categories, their percentages were worked out.

3.6.2 Percentage Analysis

After grouping the farmers into various categories based on the score on utilization or extent of adoption of agricultural technologies, simple percentage was worked out to find out percentage distribution of the farmers. It was also used to interpret the results of independent variables selected for the study.

3.6.3 Kruskal Wallis One-way Analysis of Variance by Ranks

This non-parametric test was used to compare the different regions with respect to the perception of the determinants of feasibility and utilization of the different technologies/scientific practices.

3.6.4 Analysis of Variance

The analysis of variance was used to assess the significant difference in structure of homegardens in terms of different districts, regions within the homegarden, different holding sizes and on interaction effect based on the alpha diversity measurements (diversity index, species richness and evenness) and dominance index.

3.6.5 Correlation Analysis

Correlation coefficient was worked out to measure the degree of relationship between independent variables and extent of adoption of scientific practices.

3.6.6 Multiple Linear Regression Analysis

Multiple linear regression analysis was carried out to find the relative contribution of each of the selected homegarden components (crop and live stock components) on annual homegarden income.

3.6.7 Cluster Analysis

Cluster analysis or pattern analysis is the procedure used for objectively grouping the dimensions of technology in homegardens on the basis of their nearness and importance. The nearness and importance of the dimensions of technology was inferred in terms of the proximity measure and mean values obtained from cluster analysis.

Results

4. RESULTS

The findings of the present study are presented in this chapter under the following heads.

4.1 Distribution of the respondents based on their personal, socio-cultural and techno-economic factors

4.2 Structural configuration, cropping patterns and type of home gardens

4.3 Economics of homegardens

4.4 Technology assessment in the homegardens

4.5 Constraints experienced by homegarden farmers

4.1 DISTRIBUTION OF THE RESPONDENTS BASED ON THEIR PERSONAL, SOCIO-CULTURAL AND TECHNO-ECONOMIC FACTORS

4.1.1 Age

Table 3. Distribution of the respondents based on their age

n=208

Category (Years)	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<35	1	1.92	2	3.85	5	9.62	2	3.85	10	4.81
35-45	10	19.23	13	25.00	5	9.62	10	19.23	38	18.27
>45	41	78.85	37	71.15	42	80.76	40	76.92	160	76.92

It is evident from the Table 3 and Fig. 2 that more than three fourth of the sampled farmers were in aged category where as, middle and young age category were less respectively 18.27 and 4.81 per cent.

Viewing the district wise distribution Alappuzha, Thiruvananthapuram and Pathanamthitta were having more than three fourth of the farmers under aged category and Kollam district was having 71.15 per cent under aged category. Whereas the middle and young aged category was about one fifth of the sample taken in the district of Thiruvananthapuram, Kollam and Pathanamthitta. In Alappuzha it was less than one fifth of the sampled farmer.

Hence it was inferred that more than three fourth of the farmers were in aged category.

4.1.2 Education

Table 4. Distribution of the respondents based on their education

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Middle	7	13.46	11	21.15	7	13.46	10	19.23	35	16.83
High School	20	38.46	18	34.62	20	38.46	14	26.92	72	34.61
Collegiate	25	48.08	23	44.23	25	48.08	28	53.85	101	48.55

The educational status of the farmers presented in Table 4 and Fig. 2 projects that all farmers were under the literate category of which more than 80 per cent of the farmers were having the educational qualification ranging from high school to collegiate level.

The district wise distribution is also reflecting the total sample that more than the 80 per cent of farmers of Thiruvananthapuram and Alappuzha had educational level from high school to collegiate education and Pathanamthitta and Kollam were having more than 75 per cent under this category.

Hence it is inferred that more than 80 per cent of the farmer had education level from high school to collegiate level and Thiruvananthapuram had maximum number of homegarden farmers (80%) attaining high school to collegiate level of education.

4.1.3 Occupation

Table 5. Distribution of the respondents based on their occupation

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agriculture alone	20	38.46	21	40.38	11	21.15	22	42.31	74	35.58
Agriculture + Private	16	30.77	12	23.08	23	44.23	15	28.85	66	31.73
Agriculture + Government	16	30.77	19	36.54	18	34.62	15	28.85	68	32.69

The occupational category of farmers were almost evenly distributed among three categories each with one third of total sampled farmers vide Table 5 and Fig. 2.

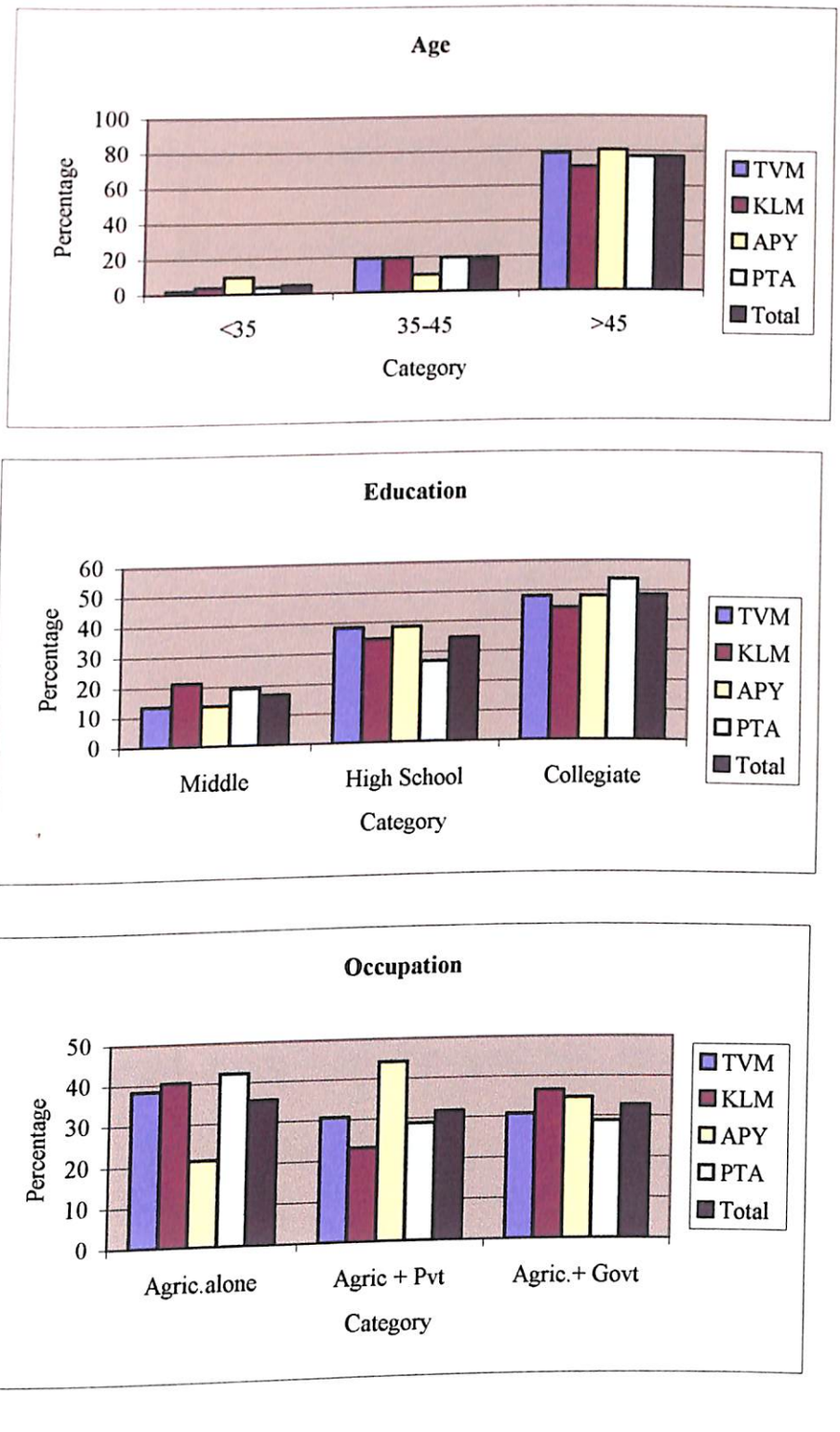


Fig. 2. Distribution of respondents based on their independent variables

Whereas, in the district wise distribution of farmers under occupational category, nearly 44 per cent under Alappuzha had agricultural and private occupation, 42 per cent under Pathanamthitta had agriculture as the sole occupation followed by Kollam with 40 per cent and Thiruvananthapuram with 38 per cent.

Hence it is inferred that more than one third (35.58%) of the sampled farmers had agriculture alone as occupation whereas more than two third (64.42%) of farmers had 'agriculture + private' or 'agriculture + government' as occupation.

4.1.4 Family Size

Table 6. Distribution of the respondents based on their family size

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
3-4	45	86.54	40	76.92	34	65.38	38	73.08	157	75.48
5-6	7	13.46	12	23.08	18	34.62	14	26.92	51	24.52

It is evident from the Table 6 and Fig. 2 that more than three fourth of the sampled farmers (75.48%) were having the family size with 3-4 members.

Similar case was noted in the district wise analysis where 86.54 per cent of the respondents in Thiruvananthapuram district had 3-4 members followed by Kollam with 76.92 per cent, Pathanamthitta with 73.08 per cent and Alappuzha with 65.38 per cent.

Hence it could be inferred that three fourth of the sample respondents had a family size with 3-4 members.

4.1.5 Irrigation potential

Table 7. Distribution of the homegarden based on its irrigation potential

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Physical water Scarcity	2	3.85	6	11.54	2	3.85	4	7.69	14	6.73
Economic water scarcity	13	25.00	13	25.00	14	26.92	13	25.00	53	25.48
Little water scarcity	37	71.15	33	63.46	36	69.23	35	67.31	141	67.79

A perusal of Table 7 and Fig. 2 revealed that more than two third of the sample had an irrigation potential in the category of "little water scarcity" followed by "economic water scarcity" (25.48%) and only 6.73 per cent belonged to the category of physical water scarcity"

The district wise distribution shows that about one fourth (71.15%) of Thiruvananthapuram homegardens had little water scarcity followed by Alappuzha (69.23%), Pathanamthitta (67.31%) and Kollam (63.46%). One fourth (25.00%) of homegardens of Pathanamthitta, Kollam and Thiruvananthapuram were in the category of "Economic water scarcity".

Hence it could be concluded that more than two third (67.79%) of the homegardens fell in the category of "little water scarcity".

4.1.6 Annual homegarden income

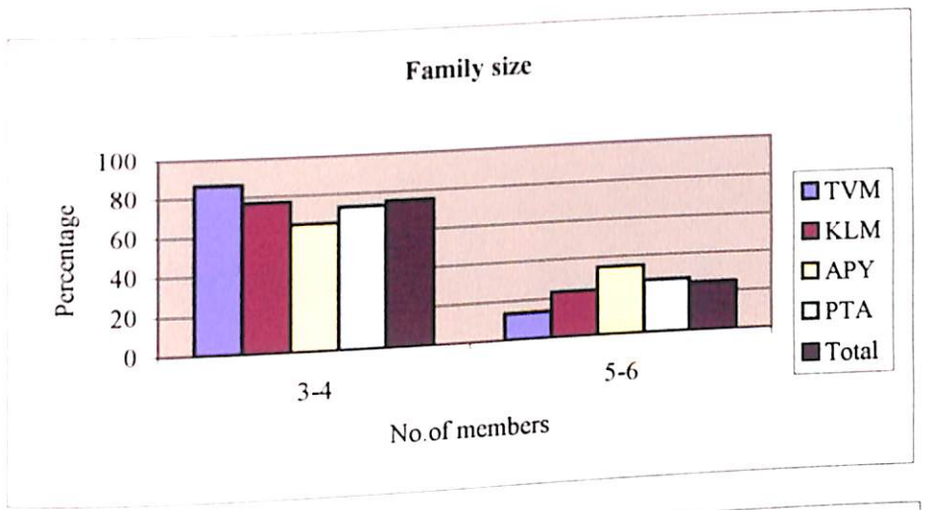
Table 8. Distribution of the respondents based on their annual homegarden income

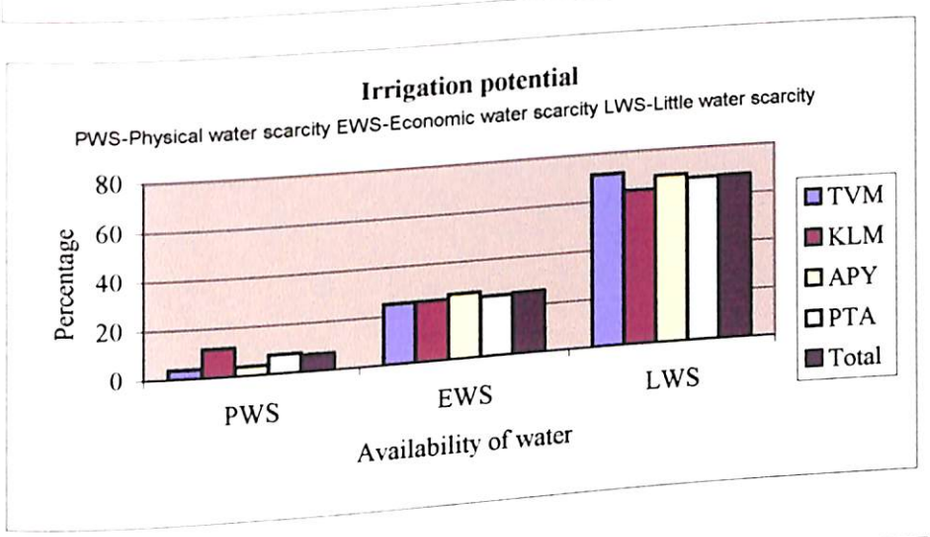
n=208

Category (Rs.)	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<25000	20	38.46	15	28.85	28	53.85	15	28.85	78	37.50
25000-100000	22	42.31	30	57.69	23	44.23	35	67.31	110	52.88
>100000	10	19.23	7	13.46	1	1.92	2	3.85	20	9.62

It is evident from Table 8 and Fig. 2 that more than half of the sampled respondents (52.88%) had an annual homegarden income in the category of Rs.25,000/- to Rs.1,00,000/- followed by more than one third (37.50%) respondents with an income of less than Rs.25,000/-. Only 9.62 per cent of the total sample received an annual homegarden income of more than Rs.1,00,000/-.

District wise interpretation shows that more than two third (67.31%) of the respondents of Pathanamthitta received an annual share of Rs.25,000/- to Rs.1,00,000/- where as more than half the sample of Alappuzha district (53.85%) had





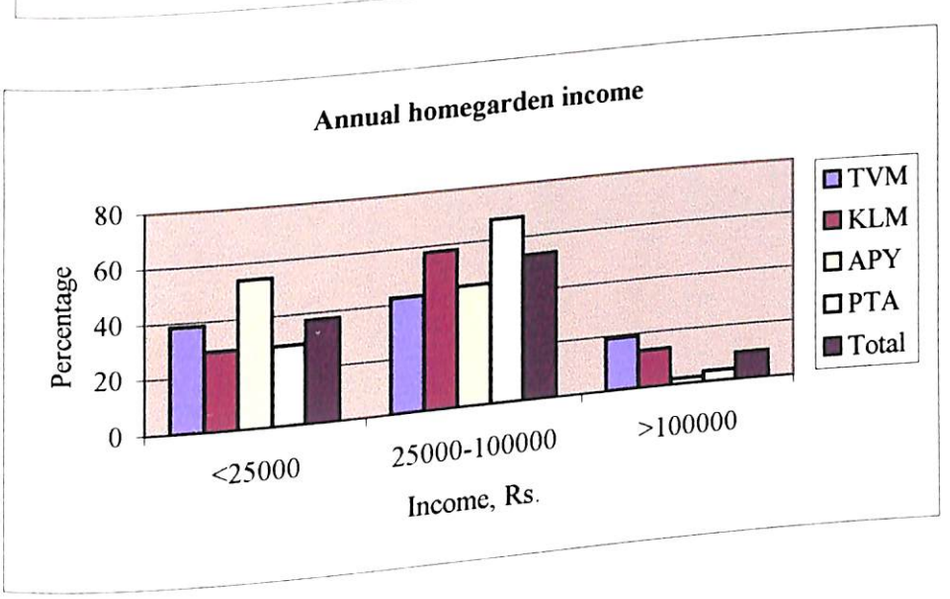


Fig. 2. Distribution of respondents based on their independent variables (continued...)

an annual income of less than Rs.25,000/-. It was also observed that almost one fifth (19.23%) of respondents from Thiruvananthapuram district received an annual income of more than one lakh from the homegardens.

Hence it could be inferred that more than half the sample respondents (52.88%) generated an annual homegarden income ranging from Rs.25,000/- to Rs.1,00,000/-.

4.1.7 Extension contribution

Table 9. Extent of extension contribution towards homegardens by different extension agencies as expressed by homegarden farmers

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agri Department	30	57.69	35	67.31	40	76.92	30	57.69	135	64.90
KAU	13	25.00	8	15.38	8	15.38	10	19.23	39	18.75
Commodity Boards	6	11.54	0	0.00	4	7.69	12	23.08	22	10.59
ICAR	0	0.00	6	11.54	0	0.00	0	0.00	6	2.88
Others	3	5.77	3	5.77	0	0.00	0	0.00	6	2.88

The extension contribution made by the various extension agencies as expressed by the homegarden farmers presented in the Table 9 and Fig. 2 projects that near to two third (64.90%) of the contribution was from agricultural department followed by Kerala Agricultural University (18.75%), commodity boards (10.58%), ICAR and others (2.88%) each.

District wise analysis of homegarden farmers perception on extension contribution showed that agricultural department contributed to the maximum for all the districts, where the extension contribution for Alappuzha district was more than three fourth (76.92%) followed by Kollam (67.31%) and Pathanamthitta and Alappuzha with 57.69 per cent each. Also it was noted that extension contribution from Kerala Agricultural University was one fourth (25.00%) in Thiruvananthapuram district followed by 19.23 per cent in Pathanamthitta district and 15.38 per cent in Alappuzha and Kollam district respectively. A distinct finding was that the

homegarden respondents from Pathanamthitta felt that 23.08 per cent of the extension contribution came from commodity boards.

Hence it could be inferred that almost 84.00 per cent of the extension contribution came from State Department of Agriculture and Kerala Agricultural University as expressed by the homegarden farmers.

4.1.8 Market orientation

Table 10. Distribution of the respondents based on their market orientation

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<3	6	11.54	26	50.00	8	15.38	5	9.62	45	21.63
>3	46	88.46	26	50.00	44	84.62	47	90.38	163	78.37

The market orientation of the total respondent sample was high with more than three fourth (78.37%) falling in the category of greater than three score vide Table 10 and Fig. 2. It was the case of different districts except that of Kollam where the market orientation was equal (50% each) for high and low category.

Hence it was inferred that more than three fourth of the total respondents (78.37%) had a higher level of market orientation.

4.1.9 Rational orientation

Table 11. Distribution of the respondents based on their rational orientation

n=208

Category (Belief)	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Religion	0	0.00	1	1.92	0	0.00	0	0.00	1	0.48
Religion +Science	4	7.69	6	11.54	5	9.62	4	7.69	19	9.14
Science	48	92.31	45	86.54	47	90.38	48	92.31	188	90.38

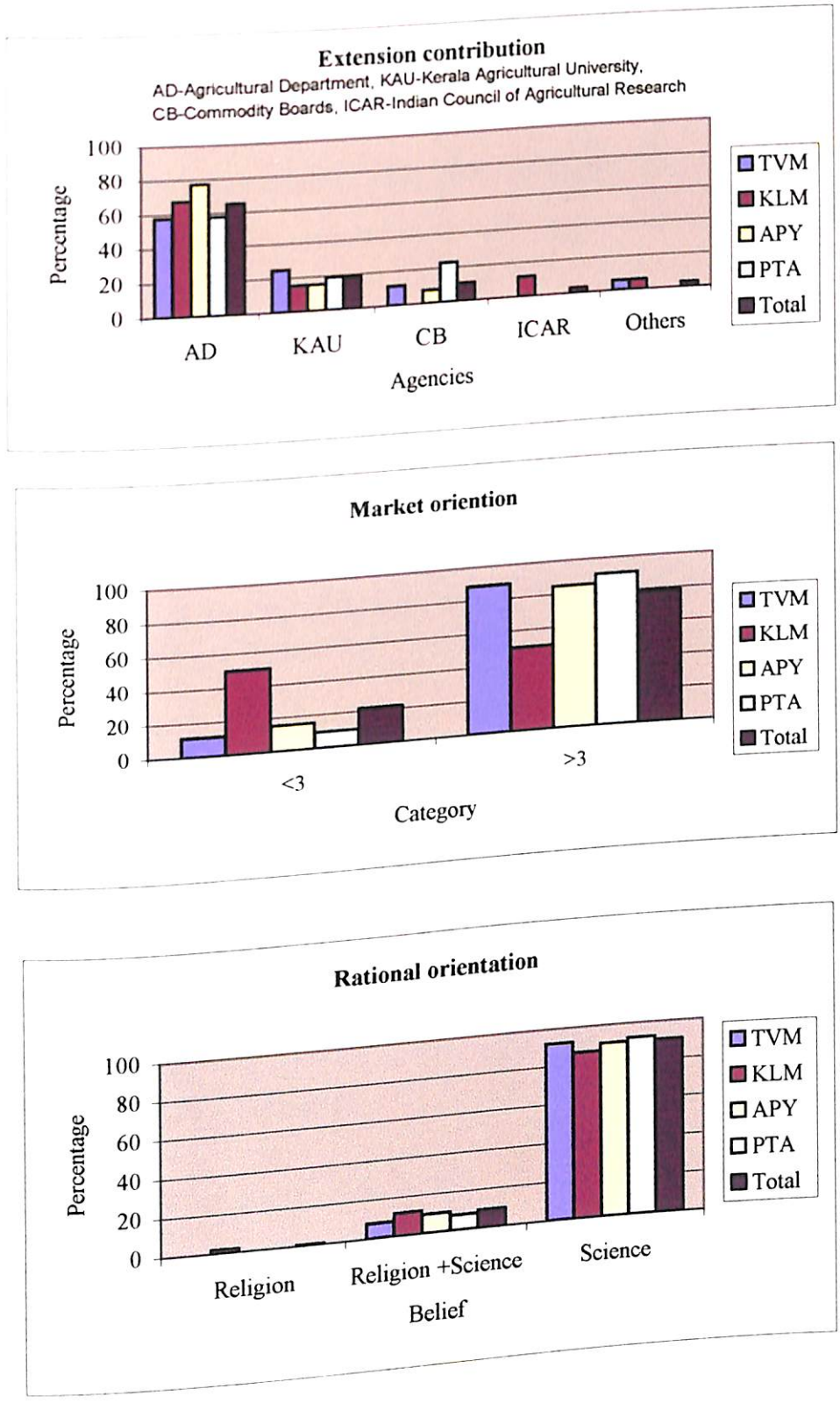


Fig. 2. Distribution of respondents based on their independent variables (continued...)

It was evident from the Table 11 and Fig. 2 that more than 90.00 per cent of the sampled farmers had belief on services rather than belief on religion or religion and science together.

District wise interpretation also showed the same result where the rational orientation was high as 90.38 per cent for Thiruvananthapuram, Alappuzha and Pathanamthitta districts.

Hence it was inferred that more than 90 per cent of the sampled farmers had high level of rational orientation.

4.1.10 Knowledge

Table 12. Distribution of the respondents based on their knowledge level on the scientific practices/technology in homegardens

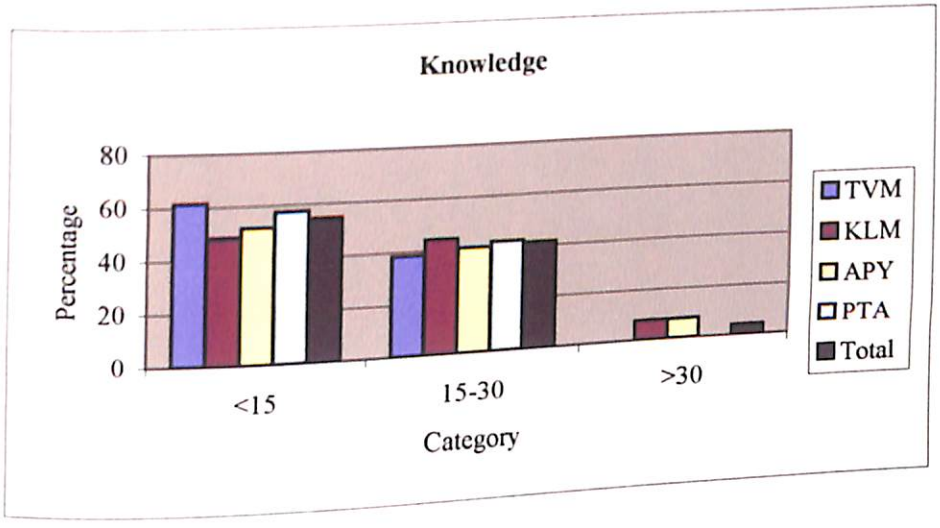
n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<15	32	61.54	25	48.08	27	51.92	30	57.69	114	54.81
15-30	20	38.46	23	44.23	21	40.38	22	42.31	86	41.35
>30	0	0.00	4	7.69	4	7.69	0	0.00	8	3.84

The knowledge level of the farmers presented in Table 12 and Fig. 2 projects that more than 50 per cent (54.81%) are under low category followed by 41.35 per cent under medium category.

The district wise distribution is also reflecting the total sample, that more than three fifth (61.54%) of farmers in Thiruvananthapuram district had low knowledge level followed by Pathanamthitta (57.69%), Alappuzha (51.92%) and Kollam (48.08%). It also revealed that more than two fifth of the respondents from Kollam (44.23%), Pathanamthitta (42.31%) and Alappuzha (40.38%), fell under the medium category of knowledge level.

Hence it is inferred that majority of the respondents (96.60%) had low to medium level of knowledge on the scientific practices in homegarden.



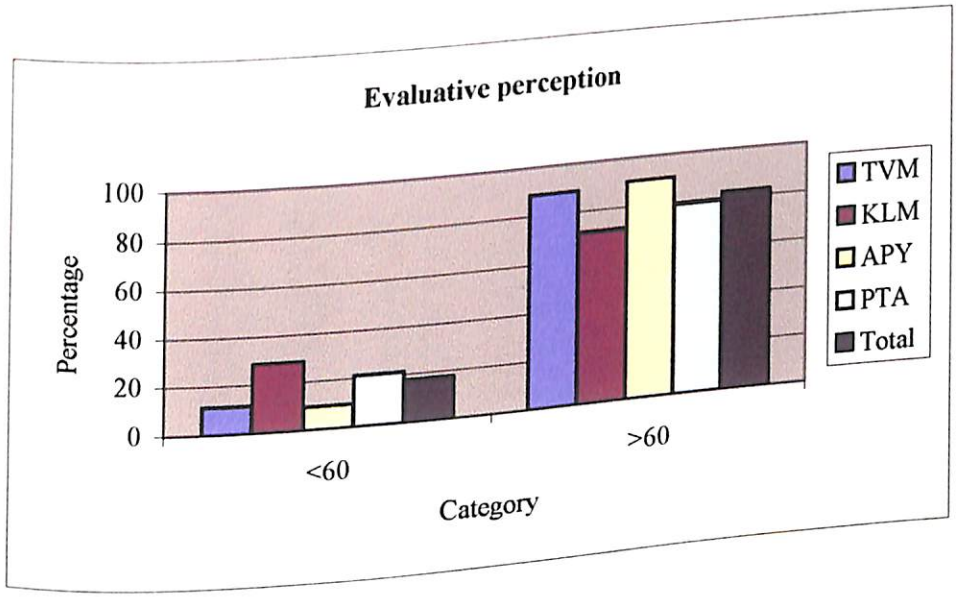


Fig. 2. Distribution of respondents based on their independent variables (continued...)

4.1.11 Evaluative perception

Table 13. Distribution of the respondents based on their evaluative perception on the sustainability of cropping and farming systems in homegardens

n=208

Category	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<60	6	11.54	15	28.85	5	9.62	11	21.15	37	17.79
>60	46	88.46	37	71.15	47	90.38	41	78.85	171	82.21

A perusal of the Table 13 and Fig. 2 revealed that more than three fourth (82.21%) of the sampled respondents fell in the high category of evaluative perception. The same was observed in case of different districts where the evaluative perception on the cropping and farming systems was high for Alappuzha district (90.38%) followed by Thiruvananthapuram (88.46%), Pathanamthitta (78.85%) and Kollam (71.15%) respectively.

Hence it is inferred that 82.21 per cent of the sampled homegarden respondents had high evaluative perception on the sustainability of cropping and farming systems in the homegarden.

4.2 STRUCTURAL CONFIGURATION, CROPPING SYSTEM AND TYPE OF HOME GARDENS

The structural configuration, cropping system and type of homegardens are well deduced in terms of the measure of diversity index, species richness, evenness and dominance index that was worked out in the study. These results are well explained under each sub heads.

4.2.1 The Measure of Diversity Index

The bio diversity of homegardens was calculated using Shannon-Wiener index and the results obtained after analysis are illustrated below.

Table 14. The diversity index of homegardens in districts in relation to holding size

Holding size(H) / District(D)	<25 cents	25-75 cents	75-125 cents	>125 cents	Mean
TVM	1.580	1.364	1.708	1.790	1.611
KLM	1.685	1.611	1.691	1.817	1.701
ALP	1.411	1.479	1.351	1.402	1.409
PTA	1.324	1.542	1.466	1.464	1.449
Mean	1.501	1.498	1.554	1.618	
F	F_{DH} 0.785^{NS}	F_D 4.452**	F_H 0.766^{NS}		
CD	$_{DH}$ 0.36	$_D$ 0.18	$_H$ 0.18		
SE	0.13	0.065	0.065		

NS - Non significant ** - Significant at 1 per cent level

A critical analysis of diversity index presented in Table 14 reveals very interesting results.

District wise analysis reveals that Kollam district tops as far as diversity is concerned. Thiruvananthapuram district is second in the order followed by Pathanamthitta. Alappuzha recorded the least. The results were also statistically significant with the top two districts being on par with each other. Thiruvananthapuram and Kollam districts, which include both coastal and mid land regions account for higher biodiversity index in comparison with Alappuzha, which is predominantly coastal, and Pathanamthitta that comprises mid and highland regions. The means of the diversity index of different holding sizes did not differ significantly revealing that the biodiversity of small holding and large holding are more or less same. Neither, did the means of the interaction between districts nor holding size differ indicating that the biodiversity index was not influenced by the holding size irrespective of the districts.

Hence it was inferred that the homegardens of Kollam had the highest biodiversity wherein Alappuzha recorded the least. Also, the biodiversity index was not influenced by the holding size irrespective of the districts.

Table 15. The diversity index of homegardens in relation to the different regions in each district

Region(S) / District (D)	Courtyard	Mid region	Outer region
TVM	1.040	2.150	1.642
KLM	1.784	1.995	1.324
ALP	0.608	1.905	1.714
PTA	1.148	1.865	1.334
Mean	1.145	1.979	1.563
F	F_{DS} 11.778** F_S -69.446**		
CD	$_{DS}$ 0.278 $_S$ 0.139		
SE	0.1 0.050		

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

The similarities and differences of biodiversity index within various regions of home garden presented in Table 15 point to glaring differences that are explicit.

The mid region in case of all districts had the highest biodiversity. The mid region of Thiruvananthapuram district recorded the highest biodiversity index. The gradation in the pattern of index for Thiruvananthapuram, Alappuzha and Pathanamthitta were the same with mid region followed by outer region recording the higher diversity. On the other hand the mid region was followed by courtyard in case of Kollam district and the differences were also not significant. What must be inferred from this is that, in Kollam district, the biodiversity that exist in the courtyards made the big difference placing it on top in case of the averages of the district. The highest diversity index in the case of outer region of the homegardens was in case of Alappuzha district followed by Thiruvananthapuram, which were at par. The least was observed in Kollam district. Analysis of the index of the courtyard showed that Kollam district not only accounted for highest diversity but also was way ahead in comparison to other districts. Alappuzha on the other hand recorded the least.

Hence it was inferred that of all the differences observed the big difference is recorded at the courtyard level and this contributed to the variations in the mean biodiversity between districts.

Table 16. The diversity index in different regions of homegardens in relation to holding size

Region (S) / Holding size(H)	Courtyard	Mid region	Outer region
<25 cents	1.037	2.003	1.450
25-75 cents	1.160	1.644	1.432
75-125 cents	1.035	2.074	1.552
>125 cents	1.342	1.967	1.570
F_{HS} (6.576)	1.907^{NS}	2.231^{NS}	2.014^{NS}
CD	0.278	0.180	0.174
SE	0.1	0.03	0.07

NS - Non significant

Classification of biodiversity index in different regions of homegarden of the four holding sizes is presented in Table 16.

A perusal of the data again point to the mid region showing the maximum biodiversity index. Within this region, holdings of 75-125 cents recorded the maximum index. Whereas in the case of outer region and courtyards holding size of more than 125 cents were observed to show the highest index. The data in all the cases were not significant.

Hence it was inferred that midregions in homegardens of 75 to 125 cents holding size recorded the maximum diversity index.

Table 17. The diversity index in different regions of homegardens of different holding size in all the four districts

Districts / Holding size + region	TVM	KLM	ALP	PTA
<25 cents + CY	0.750	1.712	0.497	1.189
<25 cents + MR	2.222	1.882	2.102	1.809
<25 cents + OR	1.768	1.460	1.634	0.975
25-75 cents + CY	1.046	1.735	0.852	1.032
25-75 cents + MR	1.650	2.030	1.866	2.032
25-75 cents + OR	1.396	1.068	1.702	1.562
75-125 cents + CY	0.917	1.765	0.318	1.139
75-125 cents + MR	2.528	2.033	1.946	1.792
75-125 cents + OR	1.681	1.274	1.788	1.467
>125 cents + CY	1.449	1.925	0.765	1.231
>125 cents + MR	2.200	2.033	1.707	1.828
> 125 cents + OR	1.722	1.492	1.734	1.332
F (18.576)	0.972^{NS}			
CD	0.556			
SE	0.201			

NS - Non significant

Results of the biodiversity index in different regions of different holding size of all the four districts are presented in Table 17.

In all districts and in all the different size of holdings the mid regions accounts for the highest diversity index. The sole exception being in the case of Alappuzha and that too only in the highest size of holding where in the outer region recorded a slightly higher index than the mid region. The results in all the regions were not significant.

Hence, it was inferred that the results of biodiversity index of different regions in homegardens of different holding size in all the four districts reinforces the finding presented in Table 16.

Table 18. The total diversity index of homegardens in all the four districts

Holding size(H) / District (D)	<25 cents	25-75 cents	75-125 cents	>125 cents	Mean (D)
TVM	2.6934	2.104	2.838	2.754	2.597
KLM	2.777	2.614	2.898	3.070	2.840
ALP	2.902	2.743	2.856	2.630	2.783
PTA	2.546	2.754	2.692	2.499	2.623
Mean (H)	2.730	2.554	2.821	2.738	
F	F_{DH} -0.9714^{NS}	F_D 1.2969^{NS}	F_H -1.1578^{NS}		
CD	0.5795	0.2897	0.2897		
SE	0.209	0.105	0.105		

NS - Non significant

The data on the total diversity index of the districts which is a cumulative of all the three regions (courtyard region, mid region and outer region) is presented in Table 18.

The mean of the total diversity index of different districts revealed a different trend. Though Kollam recorded the highest diversity index it was only slightly higher than Alappuzha followed by Pathanamthitta. Thiruvananthapuram recorded the least.

The maximum index with respect to holding size was recorded in case of 75-125 cents, followed by the highest size of holding.

Hence it was inferred that the interaction effects were reflection of the size of holdings. Though distinct differences were recorded, in none of the cases the result was significant.

4.2.2 The measure of species richness

Species richness which actually depicts the relative abundance of a species within a homegarden is presented in Table 19 to 22.

Table 19. The species richness of different districts in relation to the holding size

Holding size (H) / District (D)	<25 cents	25-75 cents	75-125 cents	>125 cents	Mean
TVM	1.734	3.938	3.982	2.700	3.089
KLM	2.996	2.848	3.047	2.044	2.734
ALP	1.208	1.882	3.165	2.898	2.288
PTA	1.625	2.739	2.246	2.542	2.538
Mean	1.891	2.852	3.36	2.546	
F	F_D 8.759**	F_H 28.334**	F_{DH} 7.272**		
CD	0.32	0.32	0.64		
SE	0.115	0.115	0.231		

** - Significant at 1 per cent level

The results of species richness in homegarden of different districts in relation to the holding size are presented in Table 19.

Thiruvananthapuram district in general recorded the highest richness of species. This was followed by Kollam and Pathanamthitta which were at par.

With respect to the size of holding, the maximum richness was observed in the group 75-125 cents followed by 25-75 cents and the least was observed in the small holding size. The results were also statistically significant.

Interaction effects in the class 75-125 cents of Thiruvananthapuram district recorded the highest value which was also superior to all other categories. This was also followed by the same category of Alappuzha and Kollam and the below 25 cents of Kollam which were all at par with each other.

Hence it was inferred that homegardens of Thiruvananthapuram recorded the highest species richness and in case of holding size it was highest in the group 75 to 125 cents holding size.

Table 20. The species richness in relation to the different regions of homegardens in each district

Region (S) / District (D)	Courtyard	Mid region	Outer region
TVM	3.060	3.209	2.997
KLM	2.701	2.878	2.622
ALP	2.115	2.358	2.391
PTA	2.575	2.326	2.714
Mean	2.613	2.693	2.681
F	F_S 0.182^{NS} F_{DS} 0.668^{NS}		
CD	0.282		
SE	0.102		

NS - Non significant

The species richness in defined regions of a homegarden of various districts are presented in Table 20.

In general maximum species richness in all the three defined regions was the highest in Thiruvananthapuram district. This was followed by Pathanamthitta in the case of outer region, Kollam in case of mid and courtyard region.

The mean values of species richness were more or less same in case of courtyard, mid region and outer region. Results in all the cases were not significant.

Hence it was inferred that maximum species richness in all the three defined regions in homegardens was the highest in Thiruvananthapuram district.

Table 21. The species richness in different regions of homegardens in relation to holding size

Region (S) / Holding size (H)	Courtyard	Mid region	Outer regions
<25cents	1.687	2.323	1.662
25-75cents	2.163	2.749	3.644
75-125cents	3.647	3.434	2.999
>125cents	2.954	2.264	2.419
F	F_{HS} 7.497**		
CD	0.564		
SE	0.203		

** - Significant at 1 per cent level

The data on species richness in various regions of homegardens of different holding sizes given in Table 21, revealed that the maximum values were in the courtyard region of the class 75-125 cents. This was followed by the outer region in case of 25-75 cents and mid region in the case of 75-125 cents holding size.

Hence it was inferred from the results that the means of above combinations were significantly superior to the means of the other interactions.

Table 22. The species richness in different regions of different holding size in all the four districts

Districts / Holding size + region	TVM	KLM	ALP	PTA
<25 cents + CY	1.867	2.081	1.664	1.136
<25 cents + MR	1.746	4.129	1.551	1.868
<25 cents + OR	1.590	2.779	0.409	1.872
25-75 cents + CY	2.770	3.184	0.554	2.142
24-75 cents + MR	3.870	2.352	2.196	2.583
24-75 cents + OR	5.180	3.008	2.895	3.493
75-125 cents + CY	4.490	3.694	3.312	3.049
75-125 cents + MR	4.460	3.097	3.198	2.980
75-125 cents + OR	3.000	2.349	3.984	3.662
>125 cents + CY	3.117	1.849	3.928	3.926
>125 cents + MR	2.764	1.934	2.488	1.872
> 125 cents + OR	2.218	2.354	3.277	1.828
F (18.576)	3.0**			
CD	1.127			
SE	0.407			

** - Significant at 1 per cent level

A split up of the species richness in different regions and holding size of homegardens of various districts are presented in Table 22.

From the data it can be inferred that outer region of 25-75 cents of Thiruvananthapuram district recorded highest species richness which was followed by the courtyard region and mid region of 75-125 cents holding of same district and mid region of less than 25 cents of Kollam district which were at par with each other.

Species richness varied with the region and size of holdings in different districts. In Thiruvananthapuram the outer region of 25-75 cents holding size followed by the courtyard and mid region recorded the highest value, whereas in Kollam district the mid region of less than 25 cents, followed by the courtyard region of 75-125 cents and 25-75 cents recorded the highest values.

In Alappuzha district the outer region of 75-125 cents followed by courtyard of above 125 cents recorded the highest species richness whereas in Pathanamthitta the order was just the vice versa.

Hence it was inferred that the outer regions of 25 to 75 cents homegardens of Thiruvanantapuram district recorded the highest species richness which was followed by the courtyard and midregions of 75 to 125 cents holdings of same district.

Generalising the results it may be concluded that Thiruvananthapuram district showed highest species richness. There were no much differences within regions and the species richness shown in case of different regions in different holding size. This was more a reflection of species richness observed at the district level particularly Thiruvananthapuram district.

4.2.3 Measure of evenness in homegardens

The evenness which is the measure of the proportionate spread of the individuals within a species in the homegarden are presented from Tables 23 to 26 .

Table 23. The measures of evenness of homegardens of different districts in relation to the holding size

Holding size (H) / District (D)	<25 cents	25-75 cents	75-125 cents	>125 cents	Mean
TVM	0.5955	0.7273	0.5443	0.6015	0.617
KLM	0.7414	0.6438	0.6615	0.6590	0.675
ALP	0.5930	0.6770	0.5082	0.5100	0.572
PTA	0.6623	0.6513	0.5840	0.6553	0.638
Mean	0.648	0.675	0.575	0.606	
F	F_{DH} 1.575^{NS}	F_D 4.54**	F_H 4.708**		
CD	0.113	0.0571	0.057		
SE	0.041	0.02	0.02		

NS - Non significant ** - Significant at 1 per cent level

District wise analysis of the measures of evenness presented in Table 23 revealed that Kollam followed by Pathanamthitta recorded maximum evenness and the results were statistically significant.

Within the four categories of holdings sizes, 25-75 cents category recorded maximum mean values followed by the less than 25 cents, which was significantly superior, and statistically at par with.

The less than 25 cents group in Kollam district followed by 25-75 cents group in Thiruvananthapuram recorded the maximum evenness, however the results were not significant.

Hence it was inferred that the measures of evenness was highest for Kollam and among the four categories of holding size, 25 to 75 cents recorded maximum mean values.

Table 24. The measures of evenness in relation to the different regions of homegardens in each district

Region (S) / District (D)	Courtyard	Mid region	Outer region	Mean
TVM	0.5774	0.6200	0.6540	0.617
KLM	0.7410	0.7212	0.5674	0.676
ALP	0.3245	0.6874	0.7040	0.572
PTA	0.6848	0.6990	0.5310	0.638
Mean	0.582	0.682	0.614	
F	F_{DS} 14.888**	F_S 8.531**		
CD	0.097	0.049		
SE	0.035	0.018		

** - Significant at 1 per cent level

Results illustrating the measure of evenness of homegardens in relation to the different regions in each district is presented in Table 24.

Evenness observed in different regions (courtyard, mid region and outer region) showed the relative superiority of the mid region followed by the outer region. Within a region the courtyard of Kollam and the mid region of Kollam followed by the

outer region of Alappuzha showed maximum evenness, which were also significantly superior.

The results revealed an interesting trend as the values of evenness was almost uniformly spread in the mid region where the total variations between the highest and lowest values of all the districts fell within a minimal value of 0.1. Maximum difference in evenness was observed in the courtyard regions while the lowest was observed in Alappuzha district and highest in Kollam district and the variability was as high as 0.4.

Hence it was inferred that mean values of evenness was highest in the mid region and in case of districts, it was for Kollam.

Table 25. The measures of evenness in different regions of homegarden in relation to holding size

Region (S) / Holding size (H)	Courtyard	Mid region	Outer region	Mean
<25 cents	0.5199	0.7182	0.7061	0.648
25-75 cents	0.6878	0.6992	0.6373	0.675
75-125 cents	0.5191	0.6361	0.5683	0.575
>125 cents	0.6006	0.6744	0.5443	0.606
Mean	0.582	0.682	0.614	
F	F_{HS} 2.91**			
CD	0.097			
SE	0.035			

** - Significant at 1 per cent level

A cross analysis of the value of evenness in different regions of different holdings sizes presented in Table 25 revealed that mid region followed by the outer region of less than 25 cents followed by the mid region of the 25-75 cents recorded maximum values. They were also significantly superior.

Minimal variations in the evenness were observed in the mid region followed by that in the outer region. Maximum evenness was recorded in the courtyard.

Hence it was inferred that the measures of evenness was highest in the mid regions of homegardens for all categories of holding size.

Table 26. The measures of evenness of homegardens in different regions of different holding size in all the four districts

Districts / Region + Holding size	TVM	KLM	ALP	PTA
<25 cents + CY	0.4086	0.6718	0.3568	0.6424
<25 cents + MR	0.6508	0.8086	0.6931	0.7202
<25 cents + OR	0.7271	0.7438	0.7294	0.6243
25-75 cents + CY	0.7118	0.7894	0.5845	0.6653
25-75 cents + MR	0.7155	0.6987	0.7330	0.6495
25-75 cents + OR	0.7547	0.4432	0.7125	0.6389
75-125 cents + CY	0.5219	0.7478	0.1831	0.6235
75-125 cents + MR	0.4776	0.7144	0.6435	0.7089
75-125 cents + OR	0.6335	0.5224	0.6978	0.4195
>125 cents + CY	0.6672	0.7537	0.1734	0.8081
>125 cents + MR	0.6378	0.6632	0.68	0.7167
> 125 cents + OR	0.4995	0.5601	0.6765	0.441
F (18.576)	1.708**			
CD	0.194			
SE	0.07			

NS - Non significant

From the data presented in Table 26 it can be inferred that there is significant difference between mean values of evenness of the combination of different regions, holding sizes and districts.

The mid region of the less than 25 cents in Kollam district followed by the courtyard of above 125 cents of Pathanamthitta district recorded the highest values of evenness.

In general the 25-75 cents in Thiruvananthapuram and Alappuzha districts, the less than 25 cents in Kollam district and the mid regions and courtyard of the four groups in Pathanamthitta recorded maximum evenness.

It may be concluded that Kollam and Pathanamthitta districts in general showed the highest evenness. The 25-75 cents followed by the lower values of holding size recorded higher evenness. The mid region of the four districts in general showed

higher evenness with minimal variation in case of both districts and holding size. Differential pattern was observed in the evenness with respect to combinations of regions, holding sizes and districts. Very explicit observations were recorded with relatively low evenness in the courtyard of Alappuzha and outer regions of the large holdings in Pathanamthitta.

4.2.4 The Dominance Index (Structural, numerical and economical) of crops in homegardens

The dominance index was worked out to bring out empirically the dominant crops (structurally, numerically and economically) in homegardens which will give a better understanding of the cropping system and type of homegardens. The results obtained are presented in Tables 27 and 28.

The dominance of crops derived from the seven point ordinal scale was individually ranked for its structural, numerical and economical dominance. The rank means of dominance of the above three aspects are presented in Table 27.

A scrutiny of the data revealed that the dominance of crops primarily varied with the districts. Thiruvananthapuram, which had the maximum dominance rating among the four districts, was individually analysed to fix the dominant crops.

The mean of ranked scores revealed that rubber, coconut, betelvine, ginger, vegetables (cucurbits), pepper, banana, tapioca, arecanut and mango were the most dominant crops in the order. The extent of biodiversity of the selected homegardens is presented in Appendix- III.

Analysis of the dominance rating of Kollam district revealed that rubber followed by coconut, ginger, betelvine, bush jasmine, banana, pepper, tapioca and arecanut. The crop resource inventory, which gives an idea of diversity index of the district, is presented in Appendix- IV.

Table 27. The structural, numerical and economical dominance together in the different districts

District / Crops	TVM	KLM	ALP	PTA	Mean
Coconut	1.609	1.767	1.801	2.674	1.96
Arecanut	3.636	3.429	3.160	3.938	3.54
Tapioca	3.439	3.278	3.436	2.835	3.25
Yams	4.184	4.344	3.943	4.444	4.23
Banana	3.433	3.208	2.658	3.241	3.14
Vegetables	2.976	3.361	2.540	2.528	2.85
Rubber	1.208	1.412	3.667	1.191	1.87
Jack	4.296	4.333	7.000	4.100	4.93
Mango	3.647	3.812	3.952	3.890	3.83
Vanilla	7.000	6.167	4.833	4.333	5.58
Ginger	2.800	2.808	3.889	2.750	3.06
Pepper	3.048	3.217	2.963	2.861	3.02
Teak	4.778	7.000	4.533	4.380	5.17
Mahagony	5.330	7.000	4.333	4.333	5.25
Coffee	6.444	4.222	4.000	3.889	4.64
Pineapple	7.000	4.333	4.833	7.000	4.96
Betelvine	2.333	2.833	7.000	3.000	3.79
Mulberry	7.000	7.000	7.000	1.333	5.58
Nutmeg	7.000	4.600	4.800	5.000	5.35
Seelanthi	7.000	4.778	5.000	7.000	5.94
Bamboo	7.000	3.667	4.330	7.000	5.50
Rice	7.000	7.000	1.556	7.000	5.64
Sapota	7.000	7.000	2.667	7.000	5.92
Cashew	3.833	4.333	4.833	7.000	5.00
Glyricedia	4.000	7.00	4.000	7.000	5.50
Erythrina	4.500	7.000	5.000	7.000	5.88
Anjili	5.000	7.000	5.000	7.000	6.00
Zera rubber	7.000	4.333	5.667	7.000	6.00
Anthurium/Orchid	7.000	7.000	3.000	7.000	6.00
Bush Jasmine	7.000	3.000	7.000	7.000	6.00
Arrowroot	4.600	4.167	7.000	7.000	5.71
Cocoa	6.300	7.000	7.000	7.000	6.83
Mean	4.953	4.731	4.450	4.856	
F		F district 2.65* 3.256	F crop 12.055** 31.256	Fcrop-dist 3.4652** 93.256	
CD		0.3715	1.0507	2.10	
SE		0.134	0.379	0.758	

* Significant at 1 per cent level

** Significant at 5 per cent level

Similar analysis of the Alappuzha district revealed that rice, coconut, banana, vegetables, sapota, pepper, anthurium and orchids, arecanut and tapioca in the order of sequence are the most dominant crops. The biodiversity of the homegardens are presented as Appendix-V.

Analysis of the dominance pattern of Pathanamthitta district revealed that rubber, mulberry, coconut, vegetables, ginger, tapioca, pepper, banana, coffee and arecanut are the most dominant of the crops. The crop resource inventory, which gives an idea of diversity index of district, is presented in Appendix- VI.

Averaging out the dominance pattern of the four districts collectively rubber, coconut, vegetables, pepper, ginger, banana, tapioca, arecanut, betelvine and mango in the order of sequence are the 10 most dominant crops of homegardens of the study of the sampled area.

The split wise dominance pattern that is structural, numerical and economical dominance and the means of crops are presented in Table 28. Individually each index reveals a definite pattern.

Structural dominance rating clearly depicts the structurally dominant crops. Structural configuration of identified homegardens clearly indicates the structurally dominant crops. This need not necessarily imply that they are only stout and tall perennials. On the contrary crops that contribute to a sizeable chunk of total biomass of an ecosystem are termed as structurally dominant. The delineation of the crops based on their structural dominance is presented in Table 28. Coconut is the most structurally dominant crop followed by rubber, arecanut, mango, mahagony, teak, banana, jack, betel vine and vegetable (cucurbits) in the decreasing order of importance. Other structurally dominant crops of lesser importance are also listed.

Likewise the numerical and economical dominance rating gives a clear picture of the numerical and economically important or dominating crops.

Table 28. The crops those are structurally, numerically and economically dominant

Crops / region	Structural	Numerical	Economical	Mean	F	CD
Coconut	1.3597	2.8345	1.694	1.963	0.9178	
Arecanut	2.4188	3.9644	4.2386	3.541	1.477	
Tapioca	4.5524	1.932	3.2562	3.247	2.635	
Yams	5.5361	3.1695	3.9808	4.229	2.22	
Banana	3.7781	2.5927	3.0344	3.135	0.55	
Vegetables	4.4565	1.9345	2.1629	2.851	2.986	
Rubber	1.685	1.8622	2.0607	1.869	0.054	
Jack	3.8694	5.5333	5.3944	4.932	1.308	
Mango	2.737	4.4234	4.3146	3.825	1.367	
Vanilla	5.375	4.375	7.00	5.583	2.6942	
Ginger	4.625	1.7272	2.8327	3.062	3.283*	
Pepper	5.5978	3.0706	2.3978	3.022	0.5553	
Teak	3.6697	5.5409	6.3125	5.174	2.835	
Mahagony	3.25	5.5	7.0	5.25	5.468	
Coffee	4.5	4.75	4.6667	4.639	0.0248	
Pineapple	6.25	4.0089	4.6161	4.958	2.0622	0.3958
Betelvine	4.375	3.1875	3.8125	3.8125	3.792	0.543
Mulberry	5.75	5.5	5.5	5.583	0.0319	
Nutmeg	4.85	5.65	5.55	5.35	0.2916	
Seelanthi	4.9479	5.8854	7.0	5.944	1.619	
Bamboo	4.5	5.0	7.0	5.5	2.686	
Rice	5.75	5.5	5.6675	5.639	0.0248	
Sapota	5.75	6.0	6.0	5.917	0.0319	
Cashew	4.0625	5.7292	5.2083	5.00	1.116	
Glyricedia	5.25	4.25	7.0	5.5	2.974	
Erythrina	4.875	5.75	7.0	5.875	1.751	
Anjili	4.95	6.05	7.0	6.0	1.616	
Zera rubber	4.75	6.25	7.0	6.0	2.014	
Anthurium/Orchid	6.5	5.75	5.75	6.0	0.288	
Bush Jasmine	6.25	6.0	5.75	6.0	0.0959	
Arrowroot	7.5	4.5	5.125	5.708	3.845	
Cocoa	6.25	7.0	7.25	6.833	0.4157	
Mean	4.624	4.538	5.080			
F crop (31.256)	7.975**			4.17*		
CD	1.29169			0.395		
SE	0.466			0.143		

* Significant at 1 per cent level

** Significant at 5 per cent level

In the present study, the relevance is more towards the mean of three dominance, which again was ranked. The 10 most dominant crops in the order of dominance were the same as those presented in Table 27 again reconfirming the results.

Hence it was inferred from the results that minor or subtle differences observed at the level of species richness and evenness was observed at the level of the number of components of a particular species and the localization or evenness of a particular region in the homegarden.

4.2.5 Type of Homegardens

The structural configuration in terms of species diversity, species richness, evenness and measure of dominance would definitely throw light into the presence of different components in the homegardens. Based on the different homegarden components, the type of homegarden can be deduced.

Homegardens represents a subsistence land-use system where interaction and intimate association of different crop components within homegardens (crop-tree-animal mix combine) are intensively facilitated and managed by family labour so as not only to meet the food production but also to generate additional income. The results of distribution of homegarden based on farming system adopted in the homegarden in the study area is illustrated in Table 29 which brings into light the type of homegardens.

The “homegarden primary structure” is invariably present in all the homegardens as it represents an array of crop tree mix combine.

It is evident from the results that crop-animal husbandry component combination was a predominant type in homegardens from the sampled populations where livestock crop interaction was noticed in less than half of (44.23%) the total sampled respondents and followed by 28.36 per cent of crop-poultry interaction of which crop–hen was the dominant type of interaction system.

Table 29. Distribution of homegardens based on farming system adopted in homegardens

Sl. No.	Farming systems	TVM (n=52)		KLM (n=52)		APY (n=52)		PTA (n=52)		Total (N=208)	
		No.	%	No.	%	No.	%	No.	%	No.	%
	HOMEGARDEN PRIMARY STRUCTURE +										
A.	Animal husbandry components										
	1. Livestock	20	38.46	23	44.23	25	48.08	24	46.15	92	44.23
	2. Hen	13	25.00	17	32.69	14	26.92	10	19.23	54	25.96
	3. Duck	0	0	0	0	2	3.85	0	0	2	0.96
	4. Love birds	1	1.92	0	0	2	3.85	0	0	3	1.44
B.	Specialised components										
	1. Sericulture	0	0	0	0	3	5.77	2	3.85	5	2.40
	2. Apiculture	1	1.92	0	0	0	0	0	0	1	0.48
	3. Aquaculture	0	0	0	0	6	11.54	1	1.92	7	3.36
	4. Nursery	0	0	0	0	1	1.92	1	1.92	2	0.96
	5. Floriculture	3	5.77	2	3.85	0	0	1	1.92	6	2.88
	6. Terrace gardens	4	7.69	1	1.92	2	3.85	0	0	7	3.36
	7. Eco-tourist homegarden	0	0	0	0	1	1.92	0	0	1	0.48
C.	Socio-cultural components										
	1. Kudumbakshethram	0	0	1	1.92	3	5.77	1	1.92	5	2.40
	2. Sacred Groves (Kavu, Sarpakavu)	0	0	0	0	2	3.85	0	0	2	0.96

In case of specialized components or specialized homegardens as it could be seen, 3.36 per cent of the respondents of the total sample were deriving additional income or products for homegarden uses through inclusion of enterprises like aquaculture and terrace gardens in the homegardens followed by 2.88 per cent in floriculture, 2.40 per cent in sericulture and less than one per cent in nursery and apiculture respectively. Likewise homegardens with religious ingredients like the presence of *Kudumbakshetram* or *Sacred groves* (*Kavu*) in one part of the homegarden land was also noticed.

A district wise analysis also shows similar results or homegarden primary structure-livestock interaction in homegardens of all the districts. But it was different in terms of occurrence of specialized components. Aquaculture units (11.54%) followed by sericulture (5.77%) was dominating in Alappuzha homegardens. Presence of terrace gardens and eco-tourist homegardens in lesser proportion added colour to its specialization. In case of Thiruvananthapuram 7.69 per cent respondents resorted to terrace gardening and 5.77 per cent of homegardens had floriculture to add to its specialization followed by 1.92 per cent of apiculture. Floriculture was a specialized component in 3.85 per cent of the homegardens in Kollam district. In Pathanamthitta district 3.85 per cent of homegardens had sericulture as a specialized enterprise followed by 1.92 per cent each of homegardens with aquaculture, nursery and floriculture units.

It was very interesting to note that specialization in terms of religious belief still existed in Kerala homegardens and it was more in Alappuzha district where 9.62 per cent homegardens had *Kudumbakshetram* or *Kavu* (sacred grove) whereas the percentage of occurrence of the same was similar in case of Kollam and Pathanamthitta districts. No such structures were found in Thiruvananthapuram district.

Hence it could be inferred that the homegardens not only had primary homegarden structure but also possessed some sort of specialization through inclusion of components as already stated in Table 29.

4.3 ECONOMICS OF HOMEGARDENS

The economics of homegardens was studied with a view to assess the contribution of homegarden components towards homegarden income, the marketing channels identified for the contributing homegarden components and the homegarden farmers perception on the need of middleman in the marketing of homegarden produces. These are presented in detail under the following subheads.

4.3.1 The Contribution of Homegarden Components Towards Annual Homegarden Income

Though ten dominant crops were identified it became imperative to make a fair assessment of the more dominant of the identified dominance in terms of numerical and economical dominance, which had a natural relationship. All structural dominance identified need not necessarily be an overall dominant species. The data of multiple linear regression analysis for each district to identify the most economically contributing crops towards homegarden income are presented from Tables 30 to 33 and Fig. 3. The homegarden components like livestock and poultry, aquaculture, sericulture, apiculture etc. were also considered as contributing components to the homegarden of which livestock was identified as a dominantly contributing component to the annual homegarden income that was included for the economic analysis.

Table 30. The contribution of major and dominant homegarden components towards annual homegarden income in Thiruvananthapuram district

Sl. No.	Crops	Standard Error	Standardised coefficient 'ß'	t
1	Arecanut	3.164	-0.030	0.219
2	Banana	1.505	0.352	1.101
3	Coconut	0.856	0.124	0.428
4	Livestock	0.224	0.351	5.710**
5	Pepper	0.581	0.159	1.892
6	Rubber	0.124	0.315	5.161**
7	Tapioca	0.411	0.333	2.307*
8	Vegetables	1.792	0.058	0.454

R^2 - 0.852 F - 30.956** Adj R^2 - 0.825

The results of linear regression analysis between homegarden income and their contributing components (crop and livestock) in Thiruvananthapuram district are presented in Table 30 and Fig. 3a.

A high R^2 value of 0.852 with highly significant 'F' value (30.956) indicated that more than 85.20 per cent of the variation in the homegarden income could be explained from the eight variables of the selected components (crop and livestock) contributing to the homegarden income.

Table 30 revealed that only three homegarden components out of eight were significantly contributing to the annual homegarden income. They were income from livestock, rubber and tapioca.

The results indicated that an increase of three units of livestock, rubber and tapioca would increase one unit of homegarden income independently.

Hence it is inferred that out of eight major and dominant components of homegarden, three components *viz*., livestock, rubber and tapioca were significantly contributing to the annual homegarden income in Thiruvananthapuram district.

Table 31. The contribution of major and dominant homegarden components towards annual homegarden income in Kollam district

Sl. No.	Crops	Standard Error	Standardised coefficient 'ß'	t
1	Arecanut	0.860	-0.023	0.470
2	Banana	0.747	0.077	1.251
3	Coconut	0.217	0.318	6.004**
4	Livestock	0.088	0.554	12.837**
5	Pepper	0.201	0.219	4.732**
6	Rubber	0.056	0.762	17.547**
7	Tapioca	0.653	0.096	1.482
8	Vegetables	1.277	0.043	0.883
R^2 -	0.939	F - 70.932**	Adj R^2 -	0.926

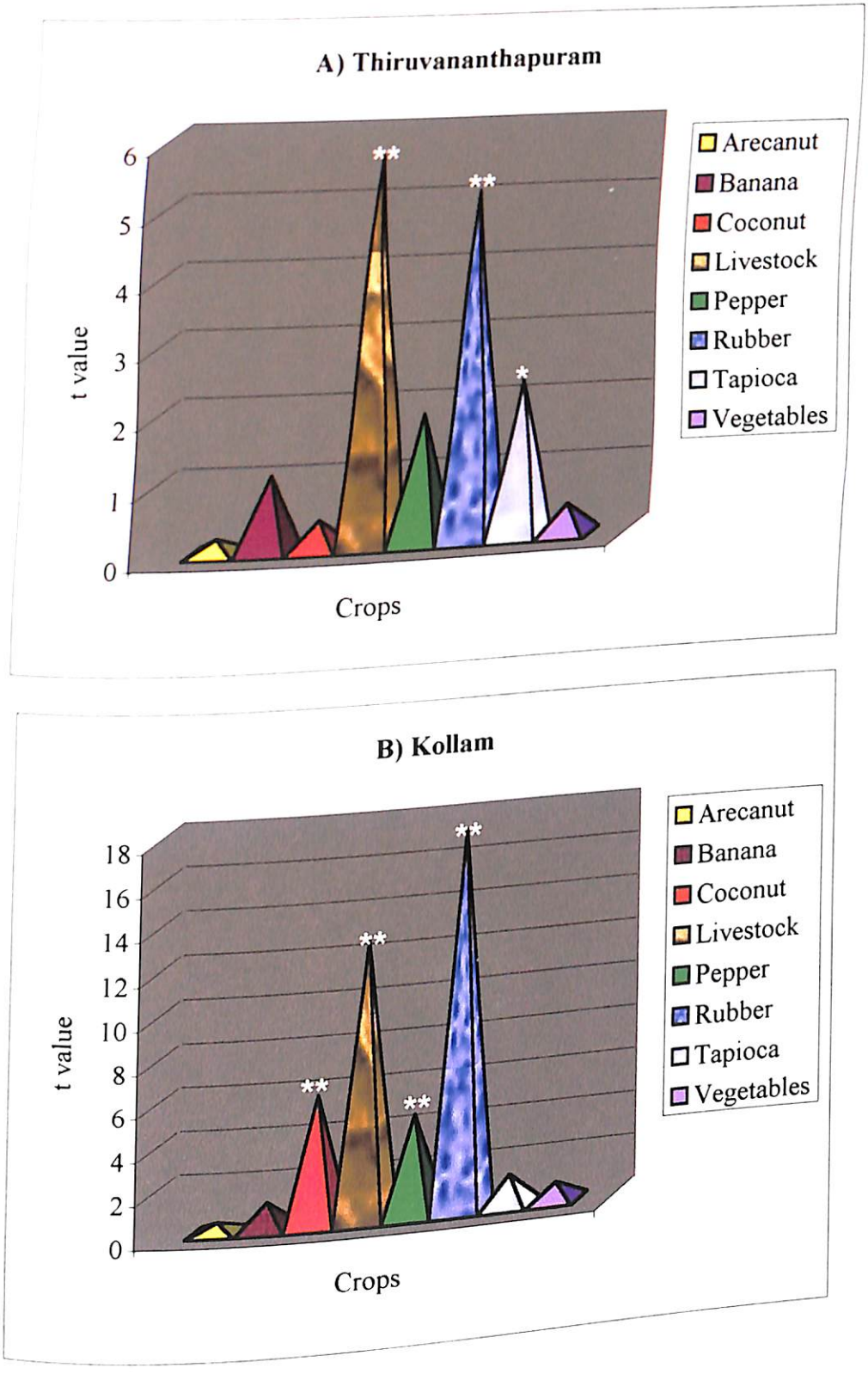


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Fig. 3. The contribution of major and dominant components towards annual homegarden income in the districts of study

The results of multiple regression analysis between homegarden income of the respondents and the contributing major and dominant homegarden components are presented in Table 31 and Fig. 3b.

A careful perusal of the Table shows that a high R^2 value of 0.939 with highly significant F value (70.932) indicated that more than 93.90 per cent of the variation in homegarden income of the homegarden farmers could be explained by the different crop/farm components taken together and independently.

The results indicated that an increase in two units of annual homegarden income could be achieved with three units increase of rubber and two units of livestock, three units of coconut and five units of pepper could increase one unit of annual homegarden income.

Hence it was inferred that out of eight components four components were significantly contributing to the annual homegarden income in Kollam district. They were rubber, livestock, coconut and pepper.

Table 32. The contribution of major and dominant homegarden components towards annual homegarden income in Alappuzha district

Sl. No.	Crops	Standard Error	Standardised coefficient 'ß'	t
1	Arecanut	0.360	0.217	3.988**
2	Banana	0.727	0.013	0.221
3	Coconut	0.125	0.463	7.595**
4	Livestock	0.074	0.624	12.427**
5	Pepper	0.620	0.060	1.273
6	Tapioca	1.234	0.223	4.427**
7	Vegetable	0.051	0.081	1.623
R^2 -	0.905	F -	59.648**	Adj R^2 - 0.890

The results of multiple regression analysis between annual homegarden income of farmers and their major and dominant homegarden components are presented in Table 32 and Fig. 3c.

A high R^2 value of 0.905 with a significant high 'F' value (59.648) indicated that more the 90.50 per cent of the variation in the annual homegarden income could be explained by the selected homegarden income.

Table revealed that except three crop components (pepper, vegetables and banana) in Alappuzha district, all other components were seen to contribute to the homegarden income. They were livestock, coconut, tapioca, arecanut and pepper.

The results indicated that an increase in two units of annual homegarden income could be achieved through a corresponding increase in three units of livestock, five units of coconut, nine units of tapioca and ten units of arecanut in the homegardens respectively and independently.

Hence it was inferred that four out of seven major and dominant homegarden components *viz*., livestock, coconut, tapioca and arecanut were significantly contributing to the annual homegarden income in Alappuzha district.

Table 33. The contribution of major and dominant homegarden components towards annual homegarden income in Pathanamthitta district

Sl. No.	Crops	Standard Error	Standardised coefficient 'ß'	t
1	Arecanut	1.322	0.024	0.515
2	Banana	0.596	0.045	1.323
3	Coconut	0.217	0.316	8.741**
4	Livestock	0.052	0.570	19.386**
5	Pepper	0.721	0.058	1.156
6	Rubber	0.037	0.847	27.415**
7	Tapioca	0.645	0.047	1.691
R^2 -	0.969	F -	197.440**	Adj R^2 - 0.964

The results of multiple regression analysis between annual homegarden income and their contributing factors (crop components) are presented in Table 33 and Fig. 3d.

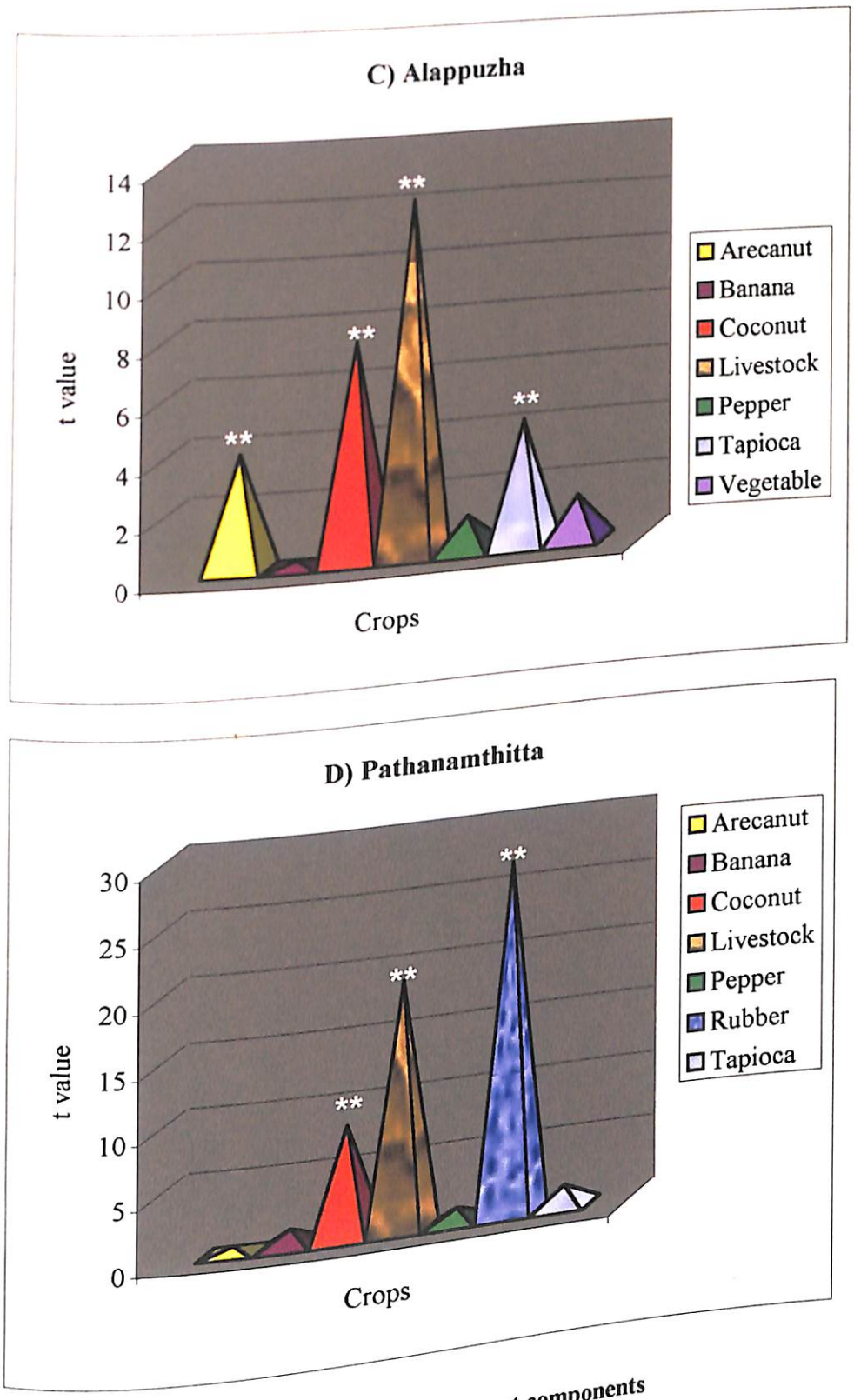


Fig. 3. The contribution of major and dominant components towards annual homegarden income in the districts of study (continued…)

A very high R^2 value (0.969) with a significantly high F value indicated that more than 96.90 per cent of the variation in the homegarden income could be explained by the selected crops together.

Table revealed that three components out of seven components namely rubber, livestock and coconut were the major components contributing to the annual homegarden income.

The results indicated that an increase in two units of annual homegarden income could be achieved through a corresponding increase in two units of rubber, four units of livestock and six units of coconut respectively and independently.

Hence it was inferred that out of the seven major and dominant components in homegardens of Pathanamthitta district, three components *viz*., rubber, livestock and coconut were contributing to the annual homegarden income.

4.3.2 Identifying the marketing channels for the contributing homegarden components

Marketing channels are the routes or channels through which the products move from producers to the ultimate consumers. Identifying the marketing channels would enable to understand the marketing efficiency, the intermediaries involved in marketing of homegarden products. The results identifying the different marketing channels for the major dominant and economically contributing homegarden components are summarized and presented in Table 34.

A detail perusal of the Table 34 gives a clear set of marketing channels for the products of homegarden. It also presents a fact that role of middle men is dominating in the marketing of various products from homegarden. In this study middlemen is occurring in different forms like that of milker in case of marketing of milk, harvester in case of coconut and arecanut, commission agents in case of almost all the other crops except in case of rubber growers in marketing of rubber sheet. This proves that middleman has a role in marketing of homegarden produce.

Table 34. The marketing channels identified for the contributing homegarden components

Products of homegarden	Marketing channels	TVM		KLM		APY		PTA		Total	
		No.	%	No	%	No	%	No	%	No	%
		n=26		n=23		n=27		n=17		n=93	
Milk	Producer – consumer	17	65.38	13	56.52	8	39.63	6	35.28	38	40.86
	Producer – Itinerant consumer	3	11.54	2	8.70	7	35.93	2	11.76	14	15.05
	Producer – Milker – consumer	5	19.23	5	21.74	11	40.74	3	17.65	24	25.80
	Producer – Milk marketing Society – Milma – Consumer	1	3.85	3	13.04	1	3.70	6	35.29	11	11.83
		n=8		n=16		n=3		n=32		n=59	
Rubber	Producer – Wholesaler – Manufacturers	2	25.00	2	12.50	0	0	6	18.75	10	16.95
	Producer –Rubber societies – Manufacturers	4	50.00	8	50.00	3	100	18	56.25	33	55.93
	Producer – Large rubber growers – wholesalers – Manufacturers	2	25.00	6	37.50	0	0	8	25.00	16	27.12
		n=31		n=36		n=41		n=26		n=134	
Coconut	Producer – Retailer – Consumer	3	9.58	11	30.56	17	41.46	6	23.08	37	27.61
	Producer – Wholesaler – Retailer – Consumer	9	29.03	7	19.44	11	26.83	4	15.38	31	23.13
	Producer – Co-operative society – Consumer	0	0	0	0	8	19.51	0	0	8	5.97
	Producer – Harvester – Retailer – Consumer	7	22.58	12	33.33	3	7.32	16	61.54	38	28.36
	Producer – Middleman – Wholesaler – Retailer – Consumer	12	38.71	6	16.67	2	4.88	0	0	20	14.93
		n=16		n=28		n=36		n=11		n=91	
Arecanut	Producer – Local Market Dealer – Consumer	10	62.50	8	28.57	14	38.89	2	18.18	34	37.36
	Producer – Retailer – Consumer	0	0	6	21.43	6	16.67	0	0	12	13.19
	Producer – Harvester – Retailer – Consumer	6	37.50	12	42.86	16	44.44	9	81.82	43	47.25
	Producer – Middleman – Wholesaler – Retailer – Consumer	0	0	2	7.14	0	0	0	0	2	2.20

Table 34. Continued…

		n=10		n=21		n=12		n=10		n=53	
Tapioca	Producer – Local Market Dealer – Consumer	0	0	4	19.05	3	25.00	2	20.00	9	16.98
	Producer – Middleman – Consumer	2	20.00	3	14.29	0	0	0	0	5	9.43
	Producer – Itinerant Dealer – Wholesaler – Retailer – Consumer	6	60.00	8	38.10	9	75.00	8	80.00	31	58.49
	Producer – Middleman – Wholesaler – Retailer – Consumer	2	20.00	6	28.57	0	0	0	0	8	15.09
		n=22		n=18		n=12		n=16		n=68	
Pepper	Producer – Local Market Dealer – Consumer	10	45.45	8	44.44	9	75	7	43.75	34	50.00
	Producer – Middleman – Wholesaler – Consumer	4	18.18	3	16.67	2	16.67	6	37.5	15	22.06
	Producer – Middleman – Wholesaler – Retailer – Consumer	8	36.37	7	38.89	1	8.33	3	18.75	19	27.94

Hence it is inferred that more than one marketing channels existed for every homegarden components or produce under study.

4.3.3 The need for middleman in marketing the homegarden produces as perceived by the homegarden farmers

Marketing of surplus of homegarden products obtained from crop component and animal husbandry components contribute to the main or additional income generated by the homegarden farmers. Marketing activities includes the function of main agencies like producer, middle- man and consumer. The results of the usefulness or role of middleman as perceived by the homegardens farmers are presented in Table 35.

Table 35. The need for middleman in marketing the homegarden produces as perceived by the homegarden farmers

Response	TVM		KLM		APY		PTA		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Yes	36	69.23	29	55.77	31	59.62	17	32.69	113	54.33
No	16	30.77	23	44.23	21	40.38	35	67.31	95	45.67

The table points out to very interesting results.

More than half the respondents (54.33%) felt that middleman were useful and essential in the marketing of homegarden produce. However, 45.67 per cent felt that middleman should be avoided from the marketing activities.

A district wise analysis showed that the respondents from Thiruvananthapuram, Alappuzha and Kollam preferred to have middleman for marketing their produce. Homegarden farmers from Thiruvananthapuram ranked first with more than two third of the homegarden farmers (69.23%) feeling the need for middleman followed by 59.62 per cent of Alappuzha homegardens and 55.77 per cent of Kollam homegarden respondents. The homegardens of Pathanamthitta district showed a conspicuous difference to that of the respondents from the other three districts of study wherein more than two third of the homegarden respondents

(67.31%) felt that there was no need for middle men in the marketing of their homegarden produce.

Hence it was inferred that except in case of Pathanamthitta district majority of the respondents from other district preferred and liked the use of middle man in the marketing of homegarden produces.

4.4 TECHNOLOGY ASSESSMENT IN THE HOMEGARDENS

The results for technology assessment was made in terms of adoption study, technology needs assessment study and identification of dimensions of technology for homegardens that will throw a light into the different aspects of technology requisite/technology forecast in the homegarden situation.

4.4.1 Technology Adoption

The results of the adoption study is presented in terms of the distribution of the respondents based on the extent of adoption of scientific practices/technology in homegardens, the relationship of extent of adoption of scientific practices/technologies by the respondents and their independent variables and the extent of adoption of indigenous practices in the homegardens. The results are presented under the following subheads.

a. Distribution of the respondents based on the extent of adoption of scientific practices in homegardens

The results of the distribution of the homegarden farmers based on the extent of adoption is presented and described under Table 36 which will enable to bring out the percentage of respondents who are high, medium or low adopters of scientific practices / technology in homegardens.

Table 36. Distribution of the respondents based on the extent of adoption of scientific practices in homegarden

n = 160

Sl. No.	Category	Class limits	No.	%
1	Low (Mean – standard deviation)	<21.02	28	17.50
2	Medium (Between mean and standard deviation)	21.02-50.58	108	67.50
3	High (Mean + standard deviation)	>50.58	24	15

Mean = 35.80 S.D. = 14.78

The Table 36 and Fig. 4 depict the distribution of homegarden farmers based on the extent of adoption of selected scientific practices in homegarden.

A perusal of Table 36 revealed that majority of the homegarden farmers fell under medium category (67.50%) followed by 17.5 per cent of respondents in low category and 15 per cent in high category.

Hence it was inferred that more than one third of the homegarden respondents fell under medium category of adoption.

b. Extent of adoption of scientific practices by the respondents and their independent variables

The results of simple correlation analysis, was taken into consideration for analyzing the influence of independent variables on the extent of scientific practices/technology by homegarden farmers.

Table 37. Correlation between extent of adoption of scientific practices / technology by the respondents and the independent variables

Variable	Independent variable	r
X_1	Age	0.045
X_2	Education	0.150*
X_3	Occupation	0.007
X_4	Family size	0.051
X_5	Irrigation potential	0.025
X_6	Annual homegarden income	0.275**
X_7	Extension contribution	0.154*
X_8	Market orientation	0.135*
X_9	Rational orientation	0.064
X_{10}	Knowledge	0.137*
X_{11}	Evaluative preparation	0.100

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

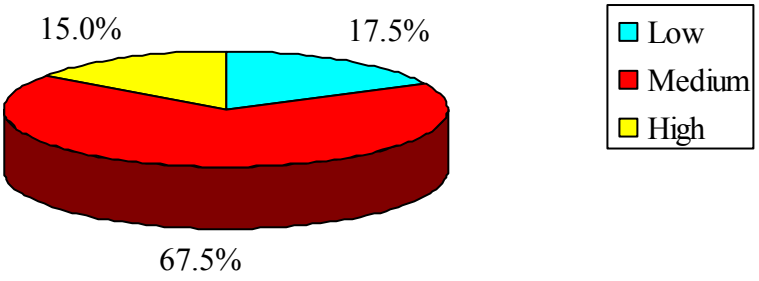
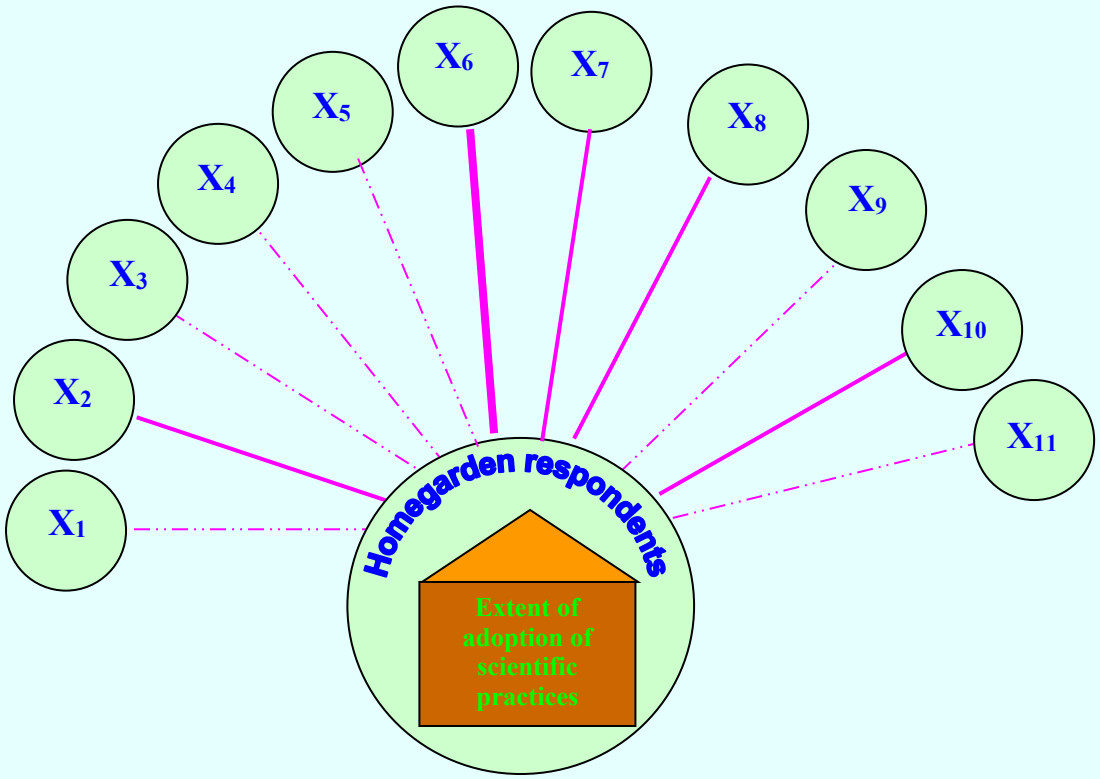


Fig. 4. Extent of adoption of scientific practices by homegarden farmers in percentage



Non-significant

Significant at 1% level

Significant at 5% level

X_1 - Age
X_2 - Education
X_3 - Occupation
X_4 - Family size
X_5 - Irrigation potential
X_6 - Annual homegarden income
X_7 - Extension contribution
X_8 - Market orientation
X_9 - Rational orientation
X_{10} - Knowledge
X_{11} - Evaluative perception

Fig. 5. Extent of adoption and its relationship with independent variables

The results of correlation analysis are presented in Table 37 and Fig. 5 Correlation analysis revealed that out of 11 independent variables, five variables namely education, annual homegarden income, extension contribution, market orientation and knowledge of farmers on homegarden technologies, were positively and significantly related with extent of adoption of scientific practices/technologies irrespective of crop/practices etc at five per cent level of probability except annual homegarden income which was significant at one per cent level of probability.

Hence it is inferred that all the above five variables are directly influencing the adoption of scientific practices/ technologies in homegardens.

c. Extent of adoption of indigenous practices in the homegardens

Homegarden farmers based on their rich experience and intuition had developed certain practices of their own due to their strong belief in it with or without considering the scientific rationale behind the same. The indigenous practices adopted by farmers are presented in Table 38 (Appendix - VII).

It was observed from the table that a total of 54 indigenous practices were followed in the homegardens of the sampled population. A maximum of 14 indigenous practices were recorded for both rice and vegetables followed by coconut (9), livestock and poultry (6), banana and spices (4 each) and tubers (3).

A detailed analysis showed that a maximum of 29.81 per cent of the respondents removed the inflorescence of the banana soon after its full emergence for improved size and maturity. The practice of burning the waste from coconut tree in its basin was the next dominant practice followed by farmers in coconut (28.36%). Smearing cow dung and ash solution on banana suckers before sowing (26.93%) followed by packing of banana bunches with dry banana leaves (25.48) were the next prominent indigenous practices followed by the homegarden farmers.

Storage of tapioca in the moist soil for increasing its shelf life and milking the cow in fixed time (20.19% each) was the next major indigenous practices followed in the homegarden. This was followed by indigenous practices like detecting the functional eye of coconut by floating it in water (19.71%), burial of pseudostem of banana in the coconut palm basins (16.83%), tapping of coconut for toddy purpose (16.35%), drying the vegetable pods for seeds of vegetables for 4-6 days to decrease excess moisture and increase shelf life and preventing from attack of storage pest (15.86%), using of kerosene-bamboo gum against rats in tuber and yams plots (15.38%), sun drying under the pandals of cucurbits to enhance fruit set, reducing pest attack and increasing fertility (14.90%), drying of red chillies by placing a bunch of crow feathers at the four corners or tying it at the top of the drying area for scaring of birds (12.50%), mixing of edible cowpea seeds with a little mustard oil for safe storage and keeping the land for vegetable cultivation after land preparation activities for three days to eliminate weed growth and resting stages of insects and pathogens (11.06% each). The rest of the indigenous practices are practised by less than or equal to 10 per cent of homegarden farmers as described in Table 38. The total 'n' exceeded 208 numbers because multiple responses of the respondents were taken into consideration.

4.4.2 Technology needs assessment in the homegardens for crops in each district

The results for technology needs assessment was made for knowing the category of crops that needed technology for homegarden farmers in their district (Table 39) and technology need for each category of crops with respect to their practices in each district (Tables 40 to 43 in Appendix- VIII).

a. Technology needs of crops in different districts

Table 39. Technology needs of crops in different districts

Sl. No.	District / Crop	TVM	KLM	ALP	PTA
1	Vegetables	81.500	115.813	135.833	88.318
2	Tubers	129.121	116.087	133.047	144.217
3	Coconut	141.673	130.847	159.510	140.192
4	Spices	183.848	178.125	189.890	182.262
5	Beverages	90.167	38.765	32.790	95.600
6	Fruits	85.355	89.068	88.580	83.453
7	Fruit trees	33.788	37.481	50.670	34.920
8	Under and unexploited horticultural tree crops	14.375	15.375	22.770	13.880
9	Rubber	183.813	183.971	203.160	214.680
10	Cashew	37.250	48.250	69.000	33.143
	Chi	157.711	172.0416	187.3327	191.3079
	C.V.	41.26915	48.886	41.60251	47.76447

From Table 39, it is evident that the highest needs for technology (or the low technology availability) was recorded for under and unexploited horticultural tree crops, which was on par with that of fruit trees (mango and jack) and beverages in Alappuzha district. The lowest need of technology was for rubber and was on par with that of spices. The need for technology of remaining crops in the decreasing order of need was for cashew, fruits (banana and pineapple), tuber, vegetable and coconut.

For homegarden farmers in Kollam district higher need for technology was again recorded for under and unexploited horticultural tree crops and was on par with that of fruit trees, beverages and cashew. High availability of technology (low need for technology) was recorded for rubber and was on par with that of spices. The technology needs of other crops in the decreasing order of needs were for fruits (banana and pineapple), vegetables, tubers and coconut.

The technology needs for homegarden farmers of Pathanamthitta was also highest in case of under and unexploited horticultural tree crops, which was on par with that of cashew and fruit trees. The lowest technology need was for rubber that

was on par with that of spices. The technology need for other crops as expressed by the homegarden farmers of Pathanamthitta in the decreasing order of needs was for crops like fruits (pineapple/banana), vegetables, beverages, coconut and tubers.

The highest technology need of homegarden farmers of Thiruvananthapuram district was recorded for under and unexploited horticultural tree crops that were on par with that of fruit trees (mango and jack) and cashew. The lowest need of technology was recorded for spices crops, which was on par with rubber. The need for other crops in the decreasing order of need was for vegetables, fruits (banana/pineapple), beverages, tubers and coconut.

b. Technology needs specific for crop categories with respect to scientific practices in Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta districts

A detailed perusal of Tables 40 to 43 (Appendix- VIII) indicates that there is significant difference in need for technology among different crops in different districts.

i. Vegetable crops

The highest technology needs reported by the homegarden farmers of Thiruvananthapuram district was for value addition, processing and storage technology, which was on par with homegarden machinery. The lowest technology needs or the highest technology availability was for irrigation management, soil amendment, nutrient management, pest management and drainage technology, which was on par with planting material, spacing, variety and disease management. In between these categories comes the technology needs for selection of intercrops.

Similar pattern of technology needs of homegarden farmers of Thiruvananthapuram district was observed for the homegarden farmers of Kollam, Alappuzha and Pathanamthitta districts with an exception in case of homegarden farmers of Alappuzha district. In addition to high technology needs for storage, processing and value addition, technology needs for drainage was felt very important by the homegarden farmers of Alappuzha district.

ii. Tubers

The highest technology needs for tuber crops in Thiruvananthapuram district was for value addition. The lowest technology needs or highest technology availability reported by homegarden farmers was for variety, planting material, soil amendment and nutrient management, which was on par with drainage technology, spacing and storage technology. The technology needs of other practices in the decreasing order of importance are homegarden machinery, processing, disease management, pest management, irrigation management and selection of intercrops.

A similar pattern of technology needs was observed for the homegarden farmers of Kollam and Pathanamthitta districts except for suitable processing technology and homegarden machinery which was felt to be a highly needed technology requirement for the homegarden farmers of Kollam and Pathanamthitta.

In case of homegarden farmers of Alappuzha district the highest needs of technology or lowest availability of technology was reported for value addition and drainage technology and was on par with that of processing. The lowest need of technology was for variety, planting material, soil amendment and nutrient management and was on par with that of spacing and storage technology. The need of technology or lack of technology of other practices, recorded in the decreasing order of importance was for homegarden machinery, disease management, pest management, irrigation management and selection of intercrop.

iii. Coconut

The technology needs of homegarden farmers of all the four districts of study for coconut were following a similar pattern except in case of drainage technology which was a felt need by the homegarden farmers of Alappuzha district.

In general for all the four districts of study, the highest need is for value addition and processing technology. The lowest need is for variety, technology for selection of planting material, soil amendment technology, nutrient management

technology, drainage technology and storage technologies. The need for technology in other areas is for homegarden suited machineries, pest and disease management technology, spacing, irrigation management technology and selection of intercrops.

iv. Spices

The highest technology needs for homegarden farmers of Thiruvananthapuram and Kollam districts for spices crops was reported for value addition technology. In case of homegarden farmers of Pathanamthitta district highest needs for technology was reported for homegarden machinery whereas the highest needs for technologies in Alappuzha district was reported for drainage technology and was on par with that of homegarden machinery, value addition and pest management. The lowest technology needs reported by the homegarden farmers of all the four districts of study was of similar nature. The lowest technology needs was for variety, planting material selection, irrigation management, soil amendment, nutrient management, disease management, spacing and selection of intercrops.

v. Beverages

The highest technology needs for homegarden farmers in case of beverage crops in Thiruvananthapuram districts was for value addition which was on par with all other technology needs like varieties, planting material selection, selection of intercrops, soil amendment, nutrient management, homegarden machinery, disease management, storage, processing and pest management technologies.

Unlike for homegarden farmers of Thiruvananthapuram district, except that of value addition technology all other technology needs fell under low technology needs category for the homegarden farmers of Kollam district.

The technology needs of homegarden farmers of Pathanamthitta district was similar to that of Kollam district except for processing technology that was on par with the need for value addition technology.

In Alappuzha district, the homegarden farmers felt that there was a high need for technologies like homegarden suited machineries, drainage technology, storage, processing and value addition technologies. The rest followed a similar pattern as that of Kollam and Pathanamthitta homegarden farmers.

vi. Fruits (banana and pineapple)

The highest technology needs reported by homegarden farmers of Thiruvananthapuram district for fruit crop was for storage, processing and value addition. The lowest technology need was reported by the respondents for technologies on soil amendments, which was on par with that of variety, planting material, nutrient management, disease management, drainage technology and pest management. The technology need of other practices in the decreasing order was for homegarden machinery, selection of intercrops, irrigation management and spacing.

Similar results were observed in case of Kollam, Alappuzha and Pathanamthitta districts with an exception in case of Alappuzha where drainage technology was the highest need for the homegarden farmers and it was on par with that of storage, processing and value addition technologies.

vii. Fruit trees (Mango and Jack)

The highest technology needs for homegarden farmers of Thiruvananthapuram and Pathanamthitta was of similar nature, which, was reported for processing and value addition technologies. In case of Kollam and Alappuzha district highest technology needs was reported for storage, processing and value addition.

The lowest technology needs of homegarden farmers of Thiruvananthapuram was for variety, planting material selection and drainage technology, which was on par with that of nutrient management, disease management and irrigation management technologies. In case of homegarden farmers of Kollam district, similar results were noticed except for nutrient management, disease management and planting material selection which fell under the category of other

technology needs that were felt more important by the homegarden farmers. The needs of technologies in the decreasing order of need were for selection of intercrops, spacing, disease management, soil amendment, nutrient management, homegarden machinery and pest management technologies. A similar result was found for Alappuzha and Pathanamthitta district respectively.

viii. Under and unexploited horticultural tree crops

The district wise analysis for the under and unexploited horticultural tree crops showed a more or less similar pattern in technology needs.

Highest technology needs for the under and unexploited horticultural tree crops in Thiruvananthapuram was for storage technologies and variety, which was on par with that of homegarden machinery, processing, value addition and drainage technologies. Lowest technology need was for planting material, which was on par with that of selection of intercrops, soil amendments, nutrient management, pest management, disease management, spacing and irrigation management.

In case of Kollam homegarden farmers there was a noted difference where the farmers felt high need for suitable intercropping technologies.

ix. Rubber

Higher technology needs was reported for value addition by the homegarden farmers of Thiruvananthapuram district. Lowest technology needs was for variety, planting material, spacing, soil amendment, nutrient management, homegarden machinery, drainage technology, storage and processing. The technology need of other practices in the decreasing order of need was for selection of intercrop, pest management, irrigation management and disease management.

Except in case of Alappuzha district the results were the same in case of all other districts of study. In Alappuzha district the highest needs of technology was reported for irrigation management which was on par with the needs for soil amendment technologies.

x. Cashew

The highest technology needs reported by the homegarden farmers of Thiruvananthapuram district was for value addition, storage and homegarden machinery, which were on par with spacing and processing. Lowest need for technology was for variety, soil amendment and drainage technologies, which was on par with that of planting material and nutrient management. The technology needs of other practices in the decreasing order of need were for irrigation management, pest management, disease management and selection of intercrops.

Technology needs for the homegarden farmers of Kollam, Alappuzha and Pathanamthitta followed a more or less similar pattern to that of homegarden farmers of Thiruvananthapuram.

xi. Rice

Homegardens with rice cultivation was found in Alappuzha district and hence the technology needs assessment was done only for Alappuzha district. The highest needs for technology were for value addition and selection of intercrop and were on par with that of disease management, spacing and drainage technologies. The lowest need for technologies were for variety, planting material, irrigation management, soil amendments, nutrient management, disease management and processing and was on par with that of storage and pest management technologies.

Generalising the results, it was interesting to note that the technology needs of farmers for different crop categories were recorded maximum for value addition, processing and storage unlike the perceived traditional requirements. Hence it could be concluded that farmers had definite technology needs with respect to different crop categories, different practices and it also varied in terms of districts.

4.4.3 The dimensions of technology in homegarden systems perceived to be important by the homegarden farmers, Agricultural officers and Scientists

The dimensions of technology in homegarden systems perceived to be important by the farmers of all the districts, the agricultural officers in the area of study and scientists / experts of subject matter related to homegarden are dealt separately and presented under the following heads.

a. The important dimensions of technology in homegarden systems as expressed by the homegarden farmers

Forty-eight dimensions of technology under each category for the homegarden farmers were used for hierarchial clustering. The dendrogram analysis using average linkage method is given in Fig. 6a

Grouping was done at 12.5 point rescaled distance cluster combine. It was seen that the 48 dimensions segregated itself into four cluster groups and it is presented in Table 44.

Table 44. The important dimensions of technology in homegarden systems as expressed by the homegarden farmers

Cluster No.	Dimensions	Total No.
I	TC8, TC11, SC1, SC2, SC3, PS1, DM1, DM3	8
II	TM2, TM3, TC1, TC3, TC4, TC7, TC9, TC10, TC12, TC13, EN1, EN3, PS2, HR4, DM2	15
III	EC1, EC2, EC3, EC6, TM1, TM4, TC2, TC5, TC14, TC15, EN2, EN4, EN5, PS3, PS5, HR4	16
IV	EC4, TC6, EN6, PS4, PS6, PS7, HR1, HR2, HR3	9

From Table 44, it was observed that cluster number III was the largest, holding 16 dimensions followed by cluster II with 15 dimensions, cluster IV with 9 dimensions and cluster I with eight dimensions. On careful examination of the association and mean values of the different dimensions it was evident that the dimensions in cluster III, IV and I were perceived to be more important by the homegarden respondents than that of cluster II where the means of its dimensions

were relatively low. Thus it could be inferred that 33 dimensions were seen to be important from farmer's point of view. They were initial cost, continuing cost, income generation potential, regularity of returns and employment generation potential under economic dimensions. The homegarden respondents rated sustainability and rapidity of returns under temporal dimensions with high importance. Under technical dimensions the most important dimensions as per the farmers say was efficiency, profitability, suitability, local resource utilisation, followed by communicability, decrease in discomfort, and observability in the order. Resource recycling capacity, availability of raw materials, availability of supplies and services were clustered together in group III with closer association and infrastructural development in cluster IV under environment dimensions indicates that all these dimensions were important for the homegarden farmers. Under psychological dimensions goal orientation in cluster I followed by attitude and level of satisfaction in cluster III and perceived social status, scientific orientation and perception of technology in order were rated to be as important dimensions as perceived by the homegarden farmers themselves. Record keeping dimension and Extension officers influences were rated to be high under decision-making dimensions. Family labour, hired labour and physical labour requirement were falling in the same cluster group IV of human resource dimension where the means of the dimension clearly showed that the most important was family labour.

Hence it could be inferred that the homegarden respondents rated a total of 33 dimensions as important dimensions of technology for homegardens.

b. The important dimensions of technology in homegarden systems as expressed by the Agricultural Officers

The forty eight dimensions that were rated by the farmers were administered to the agricultural officers for hierarchial clustering. The dendrogram results are presented in Fig. 6b.

When the grouping was attempted at 12.5 rescaled distance cluster combine the 48 dimensions got segregated into three clusters as illustrated in Table 45.

Table 45. The important dimensions of technology in homegarden systems as expressed by the agricultural officers

Cluster No.	Dimensions	Total No.
I	EC 5, TM 2, TC 1, TC 2, TC 3, TC 4, TC 6, TC 8, TC 9, TC 12, TC 13, EN 1, EN 3, EN 6, PS 4, DM 2	16
II	EC 4, TM 3, TC 14, PS 2, HR 2, HR 3	6
III	EC 1, EC 2, EC 3, EC 6, TM 1, TM 4, TC 5, TC 7, TC 10, TC 11, TC 15, EN 2, EN 4, EN 5, SC 1, SC 2, SC 3, PS 1, PS 3, PS 5, PS 6, PS 7, DM 1, DM 3, HR 1, HR 4	26

The agricultural officers rated five out of 15 technical dimensions important and they were profitability, availability, simplicity, observability and local resource utilization. It was observed that three of the six environmental dimensions were felt important for technology in homegarden and were having closer associations. They were resource-recycling capacity, availability of raw materials and availability of supplies and services. All the three socio-cultural dimensions were felt important by the agricultural officers with respect to technology in homegarden. Likewise in case of psychological dimensions except that of aspirations and perceived social status all other dimensions were equally important for the farmers according to the opinion of agricultural officers. Record keeping dimension and extension officers influences were rated to be highly important under decision making dimensions and finally in case of human resource dimensions two dimensions namely family labour and skilled labour requirement were found to be more important dimensions for homegarden farmers in the opinion of agricultural officers. Thus to conclude, a total of 26 out of 48 dimensions were perceived to be important dimensions of technology in the homegarden as rated by the agricultural officers.

c. The important dimensions of technology in homegarden systems as expressed by the Scientists

It was interesting to note from the Fig. 6c that the forty eight dimensions of study clearly clustered into two definite clusters when grouping was done at 12.5 rescaled distance cluster combines and the data are presented in Table 46.

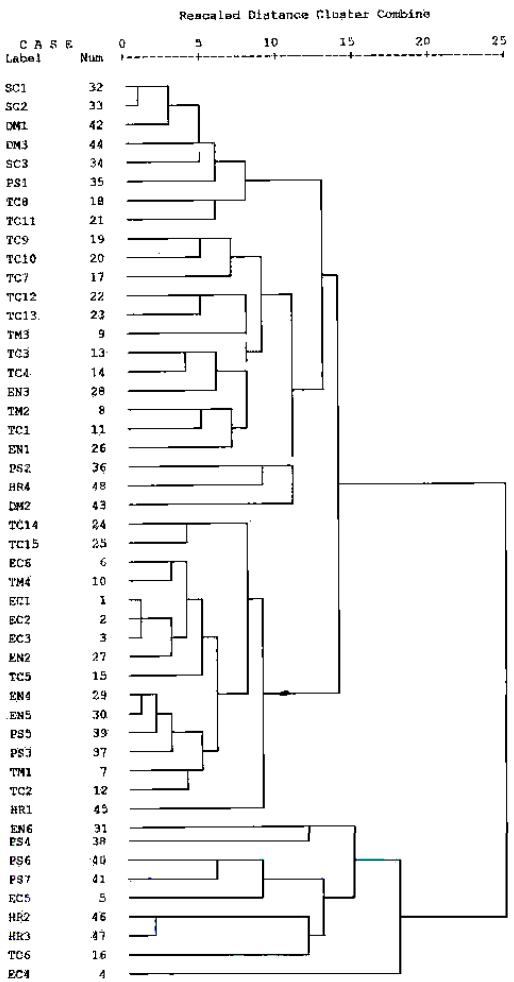


Fig. 6a. Homegarden farmers

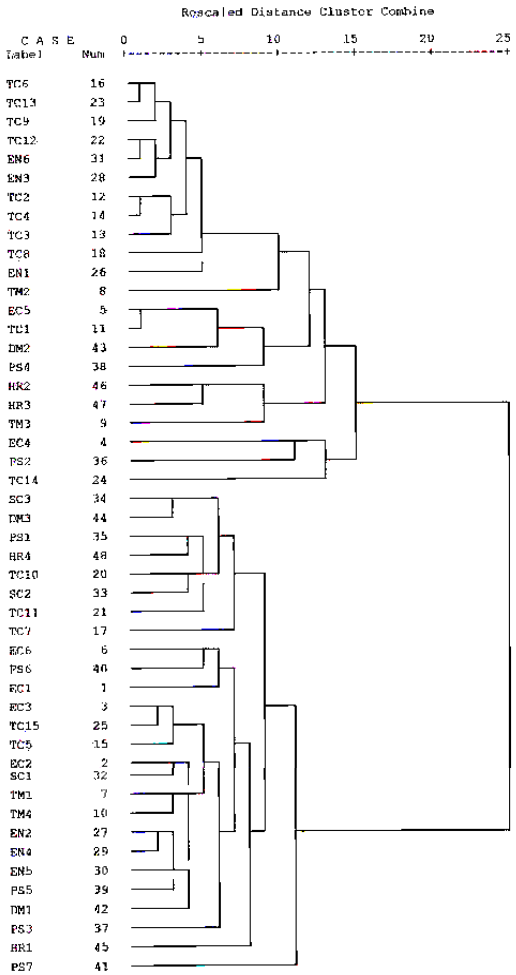


Fig. 6b. Agricultural Officers

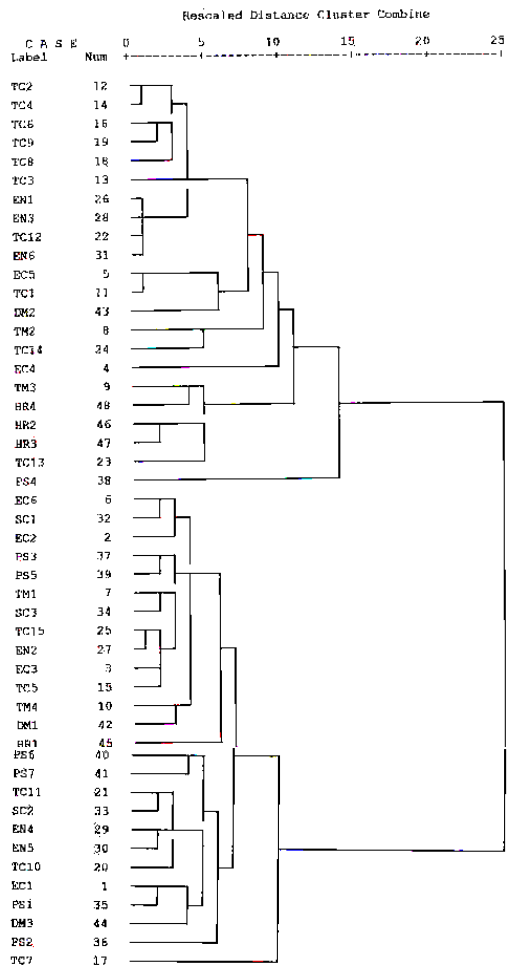


Fig. 6c. Scientists

Fig. 6. Dendrogram using average linkage for identifying the important dimensions of technology for homegardens as perceived by a) homegarden farmers, b) agricultural officers and c) scientists

Table 46. The important dimensions of technology in homegarden systems as expressed by the scientists

Cluster No.	Dimensions	Total No.
I	EC 4, EC 5, TM 2, TM 3, TC 1, TC 2, TC 3, TC 4, TC 6, TC 8, TC 9, TC 12, TC 13, TC 14, EN 1, EN 3, EN 6, PS 4, DM 2, HR 2, HR 3, HR 4	22
II	EC 1, EC 2, EC 3, EC 6, TM 1, TM 4, TC 6, TC 7, TC 10, TC 11, TC 15, EN 2, EN 4, EN 5, SC 1, SC 2, SC 3, PS 1, PS 2, PS 3, PS 5, PS 6, PS 7, DM 1, DM 3, HR 1	26

From the table it was observed that cluster II was the largest, holding 26 dimensions followed by cluster I with sixteen dimensions and cluster II with only 6 dimensions.

From a careful analysis of the cluster group it was interesting to note that all the dimensions falling in cluster II was rated with higher importance than that of dimensions in cluster I

The cluster group II had dimensions that were rated with higher importance and all the category of major dimensions occurred in the cluster namely, economic dimension, temporal dimension, technical dimensions, environmental dimensions, sociocultural dimensions, psychological dimensions, decision making dimensions and human resource dimensions.

Hence from the Table 46 it could be inferred that initial cost, continuing cost, income generation potential and regularity of returns were the most relevant in economic dimensions as per the say of the agricultural scientists. In case of temporal dimensions sustainability followed by time utilization pattern and rapidity of returns were rated of high relevance by the respondents.

A perusal of Table 46 revealed that 26 out of 48 dimensions were clustered in group two and the rest in group one. Good association was observed in both the groups but the superior dimensions were all clustered together in group two and it was

the similar pattern as noticed in case of cluster III of agricultural officers rating except for the case where skilled labour requirement under human resource dimension was not considered an important dimension and aspirations of farmers under psychological dimension which was considered important according to the scientist community.

Hence from the above three Tables 44, 45 and 46 it could be inferred that there are common dimensions under different categories which can be construed as the most important dimension of technology for the homegarden farmers. These dimension that came to be common for all the three respondent groups are presented in Fig. 7.

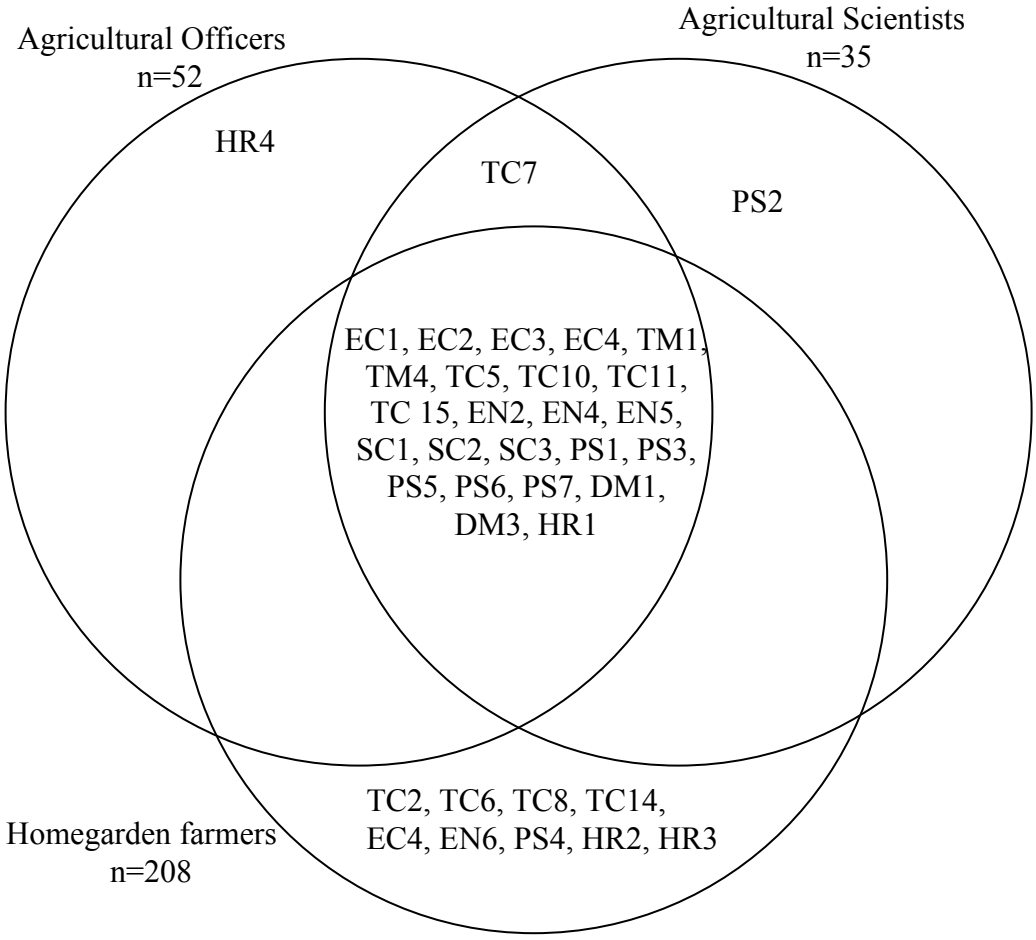


Fig. 7. Perception of homegarden farmers, agricultural officers and scientists on technology dimensions of homegardens

Thus the dimensions of technology for homegarden farmers identified were

(1) Economical dimensions

1) Initial cost
2) Continuous cost
3) Income generation potential
4) Regularity of returns

(2) Temporal dimensions

1) Sustainability
2) Rapidity of returns
3) Availability of supplies and services

(3) Technical dimensions

1) Profitability
2) Simplicity
3) Observability
4) Local resource utilization

(4) Environmental dimensions

1) Resource recycling capacity
2) Availability of raw materials

(5) Socio-cultural dimensions

1) Social acceptability
2) Social approval
3) Cultural compatibility

(6) Psychological dimensions

1) Goal orientation
2) Attitude
3) Level of satisfaction
4) Scientific orientation
5) Perception of technology

(7) Decision making dimension

1) Record keeping

2) Extension officer's influence

(8) Human resource dimension

1) Family labour

The operationalisation of dimensions of technology for homegardens is presented in Appendix- IX.

4.5 CONSTRAINTS EXPERIENCED BY HOMEGARDEN FARMERS.

The data revealed that there are significant differences between the different constraints identified by the homegarden farmers and the rank means are presented in Table 47.

A perusal of Table 47 shows that the most important constraints faced by the homegarden farmer was "surplus but insufficient for marketing" which is on par with low price of produce, high labour cost, lack of markets for products of homegarden, lack of extension service, inadequacy of capital, poor economic status of homegarden farmer, non-availability of supply and services, lack of knowledge about technology, non-availability of labour, prohibitive cost of inputs, lack of homegarden suited implements, lack of technology available of homegardens, poor storage facilities for homegarden produce, non-availability of credits, lack of motivational factors, lack of time in homegarden activities, uneconomic holdings, lack of knowledge in post harvest handling, poor transportation facilities, lack of processing implements and lack of post harvest implements. The constraints that were of least importance for the homegarden farmers were lack of quality irrigation water followed by interrupted power supply, trade unionism and lastly the non-availability of implements.

Table 47. Constraints experienced by homegarden farmers

Sl. No.	Constraints	Rank means	Rank over class	Rank over total
A	**Marketing constraints**			
1	Surplus but insufficient for marketing	79.12	1	1
2	Low price of produce	77.00	2	2
3	Lack of markets for products of homegarden	71.50	3	4
B	**Economic constraints**			
4	High labour cost	75.37	1	3
5	Prohibitive cost of inputs	53.37	2	11
6	Non availability of credit	47.12	3	15
C	**Personal constraints**			
7	Lack of extension service and assistance	70.37	1	5
8	Inadequacy of capital	62.62	2	6
9	Poor economic status of homegarden farmers	61.75	3	7
10	Lack of knowledge about technology	60.00	4	9
11	Lack of motivational factors	46.75	5	16
12	Lack of time in homegarden activity	45.37	6	17
13	Lack of knowledge in post harvest handling	44.50	7	19
D	**Physical constraints**			
14	Non availability of supplies and services	60.62	1	8
15	Non availability of labour	57.25	2	10
16	Uneconomic holdings	44.87	3	18
17	Poor transportation facilities	42.00	4	20
18	Interrupted power supply	26.00	5	25
19	Scarcity of quality irrigation water	25.25	6	26
20	Non availability of implements	36.25	7	23
E	**Technological constraints**			
21	Lack of homegarden suited implements	52.37	1	12
22	Lack of technology suited for homegarden	51.25	2	13
23	Poor storage facilities	50.50	3	14
24	Lack of processing implements	41.50	4	21
25	Lack of post harvest implements	37.87	5	22
F	**Political constraints**			
26	Trade unionism	35.37	1	24

Discussion

5. DISCUSSION

The results generated in the study can only be discussed under broad subheadings as each result is linked with one another. A broad attempt to discuss the results is being made under the following major sub headings.

5.1 Distribution of the respondents based on their personal, socio-cultural and techno-economic factors

5.2 Structural configuration, cropping patterns and type of homegardens

5.3 Economics of homegardens

5.4 Relationship between the extent of adoption of scientific practices by the respondents and their personal, socio-cultural and techno-economic factors.

5.5 Indigenous practices adopted by homegarden respondents

5.6 Technology needs assessment in the homegarden

5.7 Identifying the dimensions of technology in the homegardens

5.8 Constraints experienced by homegarden respondents

5.1 DISTRIBUTION OF THE RESPONDENTS BASED ON THEIR PERSONAL, SOCIO-CULTURAL AND TECHNO-ECONOMIC FACTORS

Age, education, occupation, family size, irrigation potential, annual homegarden income, extension contribution, market orientation, rational orientation, knowledge of scientific practices in homegardening and evaluative perception on the sustainability of cropping and farming system in the homegardens were the independent variables selected for the study. The results of the categorization of the respondents based on the independent variable was done district wise as well as in total. Each of the independent variables selected for this study had to be discussed as it had its own significance.

Majority of the homegarden respondents belonged to the aged category. This was because the elder most in the home is often considered to be the head of the

homegarden. The higher level of education among the homegarden respondents was attributed due to the well developed educational system prevailing in the state as well as the high level of literacy owned by the people in the districts of study. Occupational classification revealed that majority of the homegarden farmers considered homegardening as an additional source of income generation and they used their free time getting involved in the homegarden activities. This was well supported by the findings in this study where majority of homegarden farmers were involved in government job or private business / job. The average members of a family in the study area were below four clearly highlighting the shift towards nuclear family concept. Thus the physical involvement of family members in homegardening activities over years may get diminished and they might just resort to supervisory role. The finding of this study was in conformity to the results of Babu (1995). Almost all the houses possessed well or other irrigation structures and majority of the respondents reported shortage of irrigation water if any only during summer season. The irrigation potential was believed to be high by the respondents owing to the nature of irrigation of homegardens. Most of the homegarden tree crops were nurtured in rainfed conditions and only crops that were interventionally adopted (immediate cash yielding crops) were irrigated. Hence the homegarden farmers perceived high rate of irrigation potential in the homegardens. The extension contribution in general as evident from the results was not satisfactory for majority of the crops except for crops like rubber, vanilla or high value crops. The extension contribution was fairly good for the rubber growers when compared to that of other agricultural crops because agencies such as Rubber Board had a very good and efficient monitory cum evaluation system when compared to that of krishibhavans where timely incentives and help in the form of subsidies and inputs was given to growers who cultivated it as per the recommended practices of the rubber board. The market orientation of homegarden respondents was high as the homegarden generated better additional returns (in terms of rapidity and regularity) from the products obtained from the homegardens. The diversity in the products available to the homegarden makes it necessary for the homegarden farmers to look with positive attitude that will reflect in terms of even higher market orientation. Rational orientation of the homegardens respondents was very high.

The high literacy level, educational level and occupational status would have been reason for the majority of respondents belief in scientific practices rather resorting to religious belief alone. Majority of the respondents fell in the low category of knowledge level on the scientific practices in homegardens. The weak and inefficient extension services from the agricultural department coupled with the reliance of homegarden farmers on indigenous knowledge would have had an influence in the low knowledge level on scientific practices in homegarden farming. A package of practices recommendations developed in the regional languages will definitely help the homegarden farmers to reach a higher level of knowledge. The result was in conformity to the findings of Aravind (1999). Evaluative perception of the respondents on the sustainability of the cropping and farming systems followed in homegardens is dependent upon the actual need of the homegarden farmer. Majority of the homegarden farmer belongs to high-level category of evaluative perception. This was due to the specific interest of the homegarden farmer with respect to their likes and dislikes in selection of crops or other components or further the actual intention in the minds of the homegarden farmer in introducing a new component in the homegarden. The result of a study showed that temporal dimension such as sustainability was rated high by the farmer indicating how much important they attribute to the safety of homegardens not only to their generations but also for their upcoming generations.

The results of the independent variables actually bring out the nature of personal-socio-psychological and economic profile of the homegarden farmers. Proper understanding of these personal characters will enable the strategists to frame programmes for better and successful homegarden farming.

5.2 STRUCTURAL CONFIGURATION, CROPPING PATTERNS AND TYPE OF HOMEGARDENS

The structural configuration, which invariably focuses on the evolving nature and the change in the structure of the homegardens was brought out in the chapter of results of the study. The structural configuration of the homegardens in the study was successfully brought out through measuring the species diversity index,

species richness, measure of evenness and measure of dominance index. Since all these parameters are related to one another, the discussion will have to be made in a holistic point of view. The result obtained is evidently proving the structure, function, cropping pattern or systems and type of homegardens (Plate 1). Hence this part of discussion is presented under the following subheads.

5.2.1 The measure of diversity index

Thiruvananthapuram district followed by Kollam recorded the maximum biodiversity index. Such a result could be argued with respect to the type of homegardens under the districts. Thiruvananthapuram and Kollam represent both coastal and midland regions of agro ecosystems. Pathanamthitta on the other hand represented midland to high ranges and Alappuzha typically a coastal land except for a small tract, which is midland. An introspection into the crop cafeteria of homegardens of Kollam district reveal that a high level of ornamentals and treasured group of domesticated fruit species which stood out distinctly as a specialized courtyard farming of Alappuzha which is mostly sandy except for a small tract, the index was more or less uniform indicating that the extent of area had little influence on the biodiversity. This shows that with the present system, it is worthwhile to make further individual homegarden analysis and to identify homegardens where index and relative income generation is fairly high so that it could be adopted as a system for interventional analysis.

A very special feature observed is that in the two districts with high mean index the biodiversity index was found to increase with holding size. In Pathanamthitta the mid holding size was found to have maximum index. This point to the very basic nature of homegardens, where the biodiversity increment was not to a larger extent the function of size of holdings in Thiruvananthapuram and Kollam. In Pathanamthitta and Alappuzha it was not influenced by the size at all. A major concept of the diversity index of the four districts is this very basic aspects but whether this build up or spread as the case may be remains to be identified as to whether it is deliberate, powerful or simply by chance. As the case look more or less

uniform within a district it should be deemed that the index which is a result of planned diversity build up or generations is more geographic, partially interventional or deliberate and more a specialty of the region. Another factor worth discussing is that mid-region of homegarden contributed to maximum index. This reveals that irrespective of the district and size of holdings the gardens tends to preserve the maximum taxonomically distinct variance within the region. A growing body of experimental evidence persists in the study in ensuing discussion part in species richness and evenness. A second point is a reflection of the complementary exploitation of habitat resulting in more complete capture of resources. In short, the dominance exploiting the resources well and the subordinates and transience exploiting relatively unfavorable microhabitats. Such a complementarity has reported by Campbell *et al.* (1991). A third point is at the management level. As the mid-region was more convenient the gardener could have packed his gardens with more important species towards the centre and then structurally dominant towards the outer periphery, be it accidental or intentional.

Intermediate size of holdings (75-125 cents) revealed maximum diversity index in the study pointing to the fact that wishful thinking and practical application in reality of homegarden is maximum within this operational size. A worthily question put forth by Grines (1997) in his learned review is that 'though subordinate members of the plant community exercises controls on the identity' functional diversity and relative abundance of dominance, the answer of these question in our study is not only yes but the extend to which it takes place depends upon the size of holdings. Certainly the dominance determines the ecosystem properties to a large extend but homegardens of Kerala cannot be considered as a stable hierarchy. Over a long term the subordinates and even transient members can act as filters selecting between different potential structural dominance. The crop cafeteria of homegardens presented in Appendices III to VI reveals this aspect. A split up of the array of crops based on holding size could have been a better indicator. This again confirms another point wherein biodiversity index with high filter effects of subordinates and transience are well expressed.

5.2.2 The measure of Species Richness

The graded patterns of species richness in various districts make the homegardens of each district. Abundance of species richness is observed in mid regions of high holding size in Thiruvananthapuram district where as it is low in mid regions of high holding size in Alappuzha district. Such a type of situation is actually a reflection of the planning and interventions, which gives meaning to various holding size.

While low holding sizes are best exploited in Kollam District, it is the mid followed by highest holding size that is maximum exploited in Thiruvananthapuram district. In case of Alappuzha district on the other hand exploitation of homegardens is best in high holding size and differences are very evident. In Pathanamthitta, the picture is almost the same as in Thiruvananthapuram.

In essence the pattern of species richness varies with the holding size in district with the pattern being almost the same in Thiruvananthapuram and Pathanamthitta. The data reveals very interesting trends which ought to be taken stock by the planners that the holding size in Pathanamthitta, Thiruvananthapuram and Alappuzha are really species poor homegardens or species impoverished, calling for rational consolidation measures for maximum utilization efficiency. What is most important is that it is this (less than 25 cents holding size) which accounts for the numerically higher group of homegardens within each district. Another area, which merits the attention, is in the case of high holding size, which could be still further exploited.

Auditing of the regional aspects of the homegarden revealed that in Thiruvananthapuram and Kollam, the mid-region was species rich, whereas in Pathanamthitta and Alappuzha it was outer region that was species rich, still, more critical observation would reveal in Thiruvananthapuram and Kollam, the courtyards were also fairly species rich. The crop cafeteria of each district, which is presented in Appendix III to VI, reveals the type of crops within each district. In Thiruvananthapuram and Kollam, urbanization and fragmentation of holding size has

had its impact with homegarden farmers domesticating more ornamental and high valued fruit trees. As the contrary in Alappuzha and Pathanamthitta, the homegardens packed most of the species in the outer region. Still further critical analysis reveals that in Alappuzha the water source of conventional homegardens was present in the outer region and this was moreover, packed with perennials particularly agro-forestry tree components in contrast to Pathanamthitta where it comprised horticultural perennials.

Another important social dimension of packing the outer regions with perennial tree crops is primarily a protection of ones own area and secondarily derivation of resources from the neighbouring homegarden. The effect of this social dimension becomes less pronounced in holding sizes, which were uniformly large. Eventhough this was the general case, when the holding sizes are randomly scattered it tends to encroach into the resource use of adjoined homegardens.

A split up of the species richness in different regions of different holdings size revealed that the courtyard of 75-125 cents was maximum species rich. Another feature was that within the holdings size species richness decreased from the courtyard to outer region whereas in the 25-75 cents it increased from courtyard to outer region. This can be only interpreted in terms of wishful thinking and practices of the homegarden farmer. 25-75 cents was within the command and reach of the farmer and so he could reach every part. As the size increased further the homegarden farmer himself began to apportion crops to specific regions so that it is within his hand reach.
A split up of the species richness of different districts with respect to different regions of holdings size revealed that variations were observed within districts. Maximum species richness was observed in the outer region of 75-125 cents holding size in Thiruvananthapuram district followed by the mid-region in less that 25 cents holding size. Species richness in Alappuzha was highest in the outer region of 75-125 cents and in the courtyard of Pathanamthitta with above 125 cents holding size. This reveals the interaction effect. But it is more important to infer that 75-125 cents in case of all regions and districts was more species rich.

5.2.3 Measure of Evenness in Homegardens

Within the four categories of holding size, the maximum evenness was observed in 25-75 cents. Among the districts Kollam ranked highest. The values were more or less similar. The least was recorded in Alappuzha. This reveals that though the biodiversity was highest in 75-125 cents holding size the proportionate spread of species were more confined to 25-75 cents holding size. Logically it may be interpreted that crops with high remunerative yields but few in number were more confined to the higher holding sizes.

With respect to the districts Alappuzha and Thiruvananthapuram recorded lower values. It revealed that the proportionate spread of species in these two districts was less or the comparative occurrence of a species was thinner. In Thiruvananthapuram district the evenness was the highest, which goes hand in hand with the species richness. In short Thiruvananthapuram homegarden not only accounted for the relative abundances of species but also in its maximum spread. This was followed by Pathanamthitta district.

With respect to the regions in a homegarden in a district, the mid region contributed to the maximum evenness followed by outer region. Individual assessment revealed that courtyard of Kollam followed by mid-region of Kollam and outer region of Alappuzha recorded maximum evenness. The most important qualitative aspect was that the least vegetation or the maximum similarity in evenness was observed in mid-region which goes hand with the species richness and bio diversity. This simple point characterises the original imbalance regarding the spread of crops of the four districts where the mean biodiversity, relative abundance and the proportionate spread centered around the mid region except in the case of courtyard of Kollam and outer region of Alappuzha and Thiruvananthapuram which have already been discussed.

The measure of evenness of regions with respect to holding size speaks tall of claim irrespective of districts, the average reveals that under all categories of holding sizes, the mid regions account for maximum evenness.

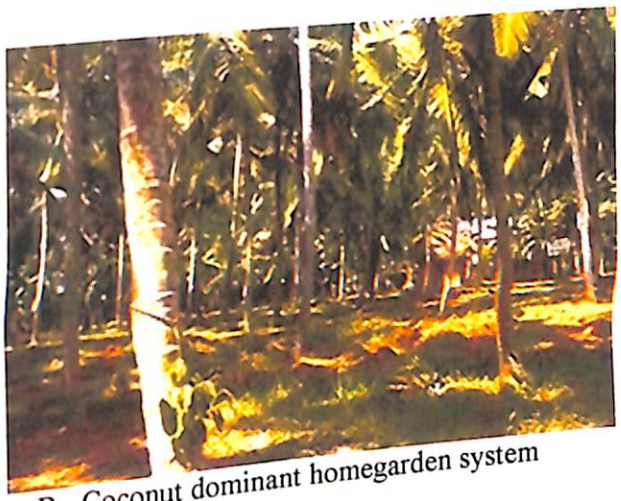
A. Vegetable dominant homegarden systems

B. Coconut-banana homegarden system

C. Tapioca dominant homegarden system

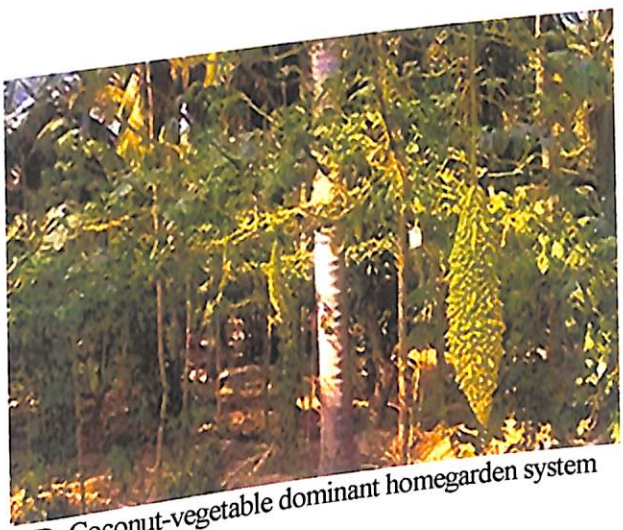
Plate 1. Structural configuration of homegardens (changing structure of homegardens due to dominant crop components)

A. Rubber dominant homegarden system



B. Coconut dominant homegarden system

C. Coconut-yams dominant homegarden system



D. Coconut-vegetable dominant homegarden system

E. Coconut-vanilla dominant homegarden system before planting

F. Coconut-vanilla dominant homegarden system after planting

Plate 1. Structural configuration of homegardens (changing structure of homegardens due to dominant crop components) (continued...)

Generalising the result of measure of evenness in the different regions of different holding size in all four districts could be inferred that less that 25 cents in Kollam district, 25-75 cents in Thiruvananthapuram and Alappuzha districts and mid region and courtyard of four groups of holding size in Pathanamthitta recorded maximum evenness. The result should be explained in the converse direction meaning to say that in the regions, within a homegarden dominance of crops existed. Under such a system the functional properties are more determined by the dominance. Subordinates of co-dominance could also determine the functional properties like in a regenerating ecosystem.

5.2.4 The Dominance Index (Structural, Numerical and Economical) of Crops in Homegardens

The Kerala homegardens present a case of typical dominance – diversity profile. Some species of homegardens habitually dominates and have controlling effects on the fitness of their subordinates (Kurien and Sam, 2004). Planting of banana and pineapple is widely spread in homegardens of Pathanamthitta where rubber and early two year of monocropped rubber is seen. In some parts of Kollam district also this is the case. They further quoted that seedling and vegetative establishment in the early stage is subordinate and follow disturbances that are not determined exclusively by traits such as size and number of propagules, their dispersal, morphology and physiology. They arise through complete interaction with substantive conditions in which contributors to the front cover of homegarden by subordinate plants have both positive and negative effects (Cavers and Harper, 1967) (Canal and Staiyer, 1977); (Bazzaz, 1986); Burk and Grines, 1996).

The speed and completeness with which ecosystem reassembly occurs will depend upon early colonization by dominance and subordinates, delayed arrival or intervention could result in total exclusion of some or few. Species declining homegardens of districts under study could be at different levels beginning from seed formation to reassembly.

Kurien and Sam (2004) in their classic study have reported that a look at the subordinate and transience could give an idea of the progress and/ or impoverishment of homegarden. They further informed that Kerala homegardens are not more food suppliers but are more focused at income and employment generation. They reported the head on impact made by vanilla in Kottayam and adjoining districts of Ernakulam and Idukki as a change towards market driven economy and the addition of stevea, safed musli and medical plant components like insulin plants as an awareness factor. The report mainly focused on Kottayam and Idukki are the two most advanced districts with respect to total literacy of the state and country, the former being as the 'land of letters'.

In this study vanilla was an emerging crop but as they have not reached the bearing phase they lacked prominence but was in a critical stage of transaction to the bearing phase. This means, given the present price trend this will be a crop of the immediate future with respect to numerical and economical dominance.

On the one side addition of species into the homegardens is an indicator of change, but on the more important side it should be conformed that the homegardens are constantly evolving.

The structural configuration, which is often interpreted in terms of structural dominance, can no longer be taken individually. The results generated in this study very explicitly focus on structural dominance in relation to species richness and evenness. Within the broad realness of homegarden a paradigm shift is required wherein focus is not only on the qualitative aspects of mere structure (often referred to as structural dominance) but should account for numerically important and more importantly from the economic aspects. Hence the study though originally was proposed to identify the structural dominance, it became imperative that dominance *perse* had to be categorized from all the major angles namely structural, numerical, and economical, against conventional evaluation and analysis of ecosystem as mentioned above. A paradigm shift became necessary to identify dominance from all

three angles. Here it is to be emphasized that all available literature that exist is based on conventional ecological theory towards the mass ratio hypothesis and against the proposition of species richness and evenness that controls the functions of an ecosystem without much losses of planned biodiversity. This study has not only evaluated the diversity index, species richness and evenness, but as mentioned above has gone to identify species that are structurally, numerically and economically dominant crops in the homegarden ecosystem which ultimately decided what are the important and less important crops. Equally it also exposes crops of less importance or of no consequence to the home.

Based upon the above three parameters of dominance a realistic assessment revealed the type of dominant crops within each district. This formed the basis of all technology requirement that whereof maximum consideration for homegarden farmers.

5.2.5 Type of Homegardens

Homegarden is generally considered as a subsistence production system where the primary function was food production. A global inventory of agroforestry systems being undertaken by ICRAF (International Centre for Research on Agroforestry) since 1982 has gathered and synthesized a substantial body of information on several types of traditional land use systems that can be collectively called homegardens. The results of the study clearly take one to the wishful thinking in interpreting the meaning of homegarden with respect to the components of interaction with the homegarden primary structure. This interaction results in the bio-physical and socio- economic meaning of homegardens. The economic preference and various aspects related to homegarden was clearly visible through the inclusion of specialized components like sericulture, apiculture, aquaculture, floriculture, nursery units etc making way for the homegardens to be categorized as subsistence with subsidiary commercial interest (Plate 2 in Appendix - X). This result is contradictory to the findings of Nair (1969) where the emphasis of the study was highlighted in case of poultry (meat and egg), cattle (milk) and specialized components in relation to its

interaction and association with homegarden primary structure that enabled income generation in homegardens. Such type of specialization will aid the homegarden with continuous production throughout the year that will help in better income generation and also family labour involvement.

The socio-religious importance of homegarden cannot be under estimated as even today structures like *Kudumbakshethrem* and *Kavu* exist in Kerala homegardens as evident from the results of study. Worship of trees and plants has been a documented part of religious factors in India since the hunting-gathering stage. The study revealed the presence of rudraksham, *Santalum album*, *Ficus religiosa*, acacia, bamboo, *Saraca indica*, *Aegle marmelos* which were commonly recognized by devote people in Kerala as strictly religious trees associated with the *Kudumbakshethram* and *Kavu*.

The homegarden farmers also planted some auspices trees that suited their star sign. Chandrakanth *et al*. (1990) reported it was believed to have 27 stars that play an important role in shapening the destiny of people. Their importance begins right from the moment of birth of an individual. Even the name of a person is given in accordance with the star prevalent at the time of his or her birth. As homegardens are representing an agroforestry system and the results from species diversity shows clearly that homegardens are somewhat similar to a forest type system, the star forest system can also be related and established in the concept of homegardens. The stars are located at specific angle on the north-south (0° to 180°) base line. Hence, the tree/plant species as recommended by religious texts are planted at their specified angles as shown in Appendix - XI as reported by Gupta (1980), Iyengar and Seshadri (1980) and Dikshit (1981).

Any how there are a lot of limitations to establish such a system in Kerala homegardens due to many reasons where progressive respondent feel it is merely superstitious. Also Kerala homegarden are today constraint with acute shortage of land resources. Since these are cultural treasures of a society passed on from

generations, it is important that we maintain some of it in the homegarden. Otherwise these crops may turn to be extinct. This cultural tradition could be maintained, if initiative to plant religious trees, which affects ones destiny could be facilitated at unit level or individual homegarden level. The religious organization can play their part in this direction. In such a situation homegardens can become an ideal avenue not only for the purpose of food requirements and income generation but also for preserving and promoting the traditional culture of Kerala.

5.3 ECONOMICS OF HOMEGARDENS

The discussions on the results for the economics of homegardens is presented under the following subheads:

5.3.1 The contribution of major and dominant homegarden components towards annual homegarden income

The results of economic analysis with respect to different contributing components towards annual homegarden income reveals that live stock was uniformly perceived to be contributing in nature to the homegardens of all the districts.

There could be several reasons for this. The primary means for inclusion of livestock unit in a homegarden was due to the fact that they provide all advantages inherent in a mixed farming system. The livestock system not only ensures enterprise diversification but also augment homegarden income by the sale of surplus milk, besides contributing to the homegarden farmers requirements. In this context one has to view the homegarden as a complete, self-reliant unit with respect to the individual requirements of the homegarden farmer.

Apart from the provision of food and nutritional security to the members of farm family, the livestock components facilitate a high degree of organic recycling between the various systems and also minimize the inputs like manures. These results conform to the earlier findings of Salam *et al*. 1991 and Soemarwoto (1986).

Whether intentional or not, inclusion of livestock in majorities of homegardens was due to its efficiency not only economically and ecologically but also biologically. The easiness to selling products like milk or meat after consumption requirements locally, might be another reason for having a livestock unit in the homegardens.

Thus the present study on the major and dominant crop components that were found to contribute economically to homegardens were rubber, coconut, tapioca, pepper and arecanut. However, this does not mean that other crops are not contributing. They contribute to the total income but in lesser proportion. The results clearly reveal that rubber (if present) was the most remunerative of the crop components in homegardens. The occurrence of rubber was predominantly in Pathanamthitta and Kollam districts in this study. The fewer occurrences in other two districts were primarily due to the geographical and land utility constraints for rubber crop in homegardens.

The occurrence and maintenance of rubber in homegardens was due to manifold reasons. The major reason being that the rubber owned land might have been gifted to the generations or as a result of sub division and fragmentation in true economic terms. Since rubber being a profitable perennial crop with regular returns, the household farmers have domesticated the crop with utmost care as they function as the main source of livelihood. Another reason for rubber to be a major crop in the homegardens of Pathanamthitta was due to the congenial conditions prevailing for rubber. The efficient extension activities and technologies such as subsidy for replanting and quality planting material from sources such as “Rubber Board” was another reason for the homegarden farmer’s scientific adoption and better productivity. The efficient contribution was mainly with right and timely advisory service and credit supply as evident from the results of our study of the rubber growers, which was not the case for other crops. The present remunerative price situations were another motivating factor for more number of homegardens switching to this crop. This again has to be explained in terms of various associations at definite internal effects on homegardens.

Coconut base crop was seen in almost all the districts but with less dominance in Pathanamthitta. It was proved to be of income contributing nature with respect to regular returns. In many of the homegardens though coconut was a neglected crop with reference to management as revealed in the study but proved to be a major source of income. Besides, the products of coconut like leaf, leaf peduncle, inflorescence, spathe, dried husk of coconut and coconut shells catered to the fuel and economic requirements of the household.

The contribution of tapioca to the annual homegarden income was also revealed from the result of the study. High profit coupled with minimal attention on management aspects and input was a valid reason for the predominance of this crop. The findings are in agreement to the results of Salam and Sreekumar (1990).

Another major reason as revealed in the study is that this crop was a major crop not only from the dietary habits, but also from the point of consumer preference. The stem and processed tuber also serve as a food for livestock at all times particularly lean periods.

Pepper was a contributing crop to the annual homegarden income. It was generated due to the fact that it is a high value crop. A less quantity obtained can fetch more prices. Shehna *et al.* (1992) reported that spices occurred in every eight out of ten homesteads surveyed and the most common spice component identified was pepper, which was observed in 58 per cent of the homesteads studied. A major reason for the high occurrence can be traced to many multi purpose tree species occurrence in the homegarden, which served as live standards for pepper thus making it a numerically dominant and contributing crop in Kerala homegardens.

The culinary habit of the tract is another reason. Most of the people of Kerala prefer spicy food. Again the spices from Kerala have a premium and find a ready market. When it comes to sale, it serves as a buffer security to homegarden. The crop with its superficial feeding habits fits the spatial and temporal land use making it an ideal component of the crop mix pattern of Kerala homegardens.

The results also revealed that arecanut was also contributing to the annual homegarden income especially in case of Alappuzha district. Arecanut predominantly existed in homegardens and it occurred in association with other tree crops in coconut dominant multi tier cropping systems. This is because Alappuzha is predominantly coastal and other crops fail to come up to its potential best in the sandy tract. Vegetables are now adding to the fortune of the farmer very recently. Only further studies can make it a major player among the crops.

Even though the aforesaid crop components were found out to be more contributing in nature for homegardens, tree crops like mango, jack, cashew, tamarind, teak, mahogany and many other fruit crops were widely grown in the homegardens for meeting the various requirements. They contributed more to the homegarden self-reliance. The contributing nature of the aforesaid components have been attained due to the synergistic interaction among the different components (be it crop, livestock or poultry) in the homegardens making it a sustainable one from all aspects of the requirement of households. Thus the homegardens, which, were originally expected to the function of food security, has now undergone a radical change where a prioritization with income generation has been the prime concern. This is mainly due to the fact that higher income gives the homegarden farmers better access of his entire requirement plus a surplus savings. This is contrary of the reports of Fernandes and Nair (1986).

5.3.2 Identifying the marketing channels for the contributing homegarden components

The results of the study point out to the fact that many routes exist in marketing of the homegarden products that reach the ultimate consumer. The role of harvester and milker in the marketing of the products of homegarden itself is clearly an indication of the eagerness among the homegarden farmers to sell of the products at the earliest to obtain an additional income from various homegarden components. The perishable nature of the products that demands immediate sale could attribute to the

cause of marketing of homegarden products such as milk, coconut, arecanut and highly perishable fruits and vegetables.

The role of middlemen invariably in marketing of almost all the products except that of rubber was an indication of the fact that the marketable products were less in quantity. Hence it could be said that the various marketing channels that exist was invariably important and the mechanism is to be streamlined and regulated so that it pays adequate dividend to the producers and also safeguards the interest of consumers.

5.3.3 The need for middleman in marketing the homegarden produces as perceived by the homegarden farmers

The result of the study revealed that middlemen were necessary for marketing of homegarden products except in the case of Pathanamthitta district. Pathanamthitta homegardens having predominantly a rubber dominant cropping system, coupled with a strong and efficient market system with adequate extension and advisory support from agencies like rubber board, societies and NGO's. This was the reason for their dislike in having middlemen in the marketing activities of homegarden produces.

On the contrary, majority of homegarden respondents of Thiruvananthapuram, Kollam and Alappuzha felt that middlemen were useful and necessary in the marketing of homegarden products. This was primarily attributed to the varying diversity and species composition in the homegardens where animal husbandry components with many crop components contributed to homegarden with different products but in less quantity. In short there was surplus of products but not enough for direct marketing. Hence it became essential that some agencies who could market the products be involved in the marketing activities. Since there was no organised or regulated structure for the purpose, the homegarden respondents had to rely on the middlemen to get their products marketed forgoing some of the actual profit they intend from the products which was often taken by the middlemen as commission. The results of the study are contradictory to the findings of Lepcha *et al*. (1993) and Babu (1995).

Also, homegardens are rich with horticultural components where there is a predominance of fruits and vegetables. It being perishable in nature, they have to be sold at the earliest opportunity. A majority of the homegarden farmers are small farmers, hence do not posses withholding capacity till a favourable price emerges in the market. Due to its less quantity they do not have a bargaining power to derive the best of their resource. This particular situation obviously made the homegarden farmers feel the essentiality and usefulness of middlemen in marketing their homegarden products.

5.4 TECHNOLOGY ASSESSMENT IN THE HOMEGARDENS

The discussions for the results obtained in the study on technology assessment aspects are presented under the subheads given below:

5.4.1 Technology Adoption

a. Extent of adoption of scientific practices by the homegarden farmers

Results revealed that 67.5 per cent, 17.5 per cent and 15.0 per cent fell under medium, low and high adoption categories respectively.

The adoption rate was found to be medium, mostly because the research projects were developed for individual crops but not for a crop-mix pattern that was the prevailing situation. As evident from the study, the homegardens are continuously evolving. Hence, some of the technologies developed had lost its relevance. The university and other supporting research institutions have to accordingly change the research priorities based on the changing conditions with special reference to homegardens. A future insight is also required as newer problems could tend in the passage of time. The need for such futuristic perspective planning had been highlighted in the studies of Babu (1995).

b. Relationship of adoption of scientific practices by respondents and their independent variable

The results revealed that annual homegarden income, extension, contribution, education, market orientation and knowledge level were directly influencing the adoption of scientific practices in homegardens.

Homegardens are evolved with the purpose of serving multitude of functions with food production being not only the primary role but higher income generation leading to more access to all requirements of the garden.

The results of the study clearly highlights the role of structure and function of homegarden crops like coconut, vegetable (cucurbits), pepper, ginger, banana, tapioca and mango that are intended to meet the food requirements of the members of the household and the surplus to be directly marketed for income generations. The dominance of crops like rubber, arecanut and betelvine were solely meant for economic purpose. The occurrence of such economically important crops highlights the high relationship of economic motivation and annual homegarden income to the extent of adoption of scientific practices in homegardens. The extent of extension contribution and economic returns on cash crops like rubber was very high reflecting in the high association of those variables with extent of adoption of scientific practices of the crops in homegardens. The higher educational level of the homegarden farmers could have contributed to the relationship of adoption of scientific practices.

Homegardens represent land use system involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably, livestock and poultry. Within the homegarden unit, the whole crop-tree-animal unit has been intensively managed by family labour. The homegarden families rely on homegardening as a strategy to stabilise their household food security and income against role and uncertainties of monocropping. This strategic planning is more a result of their proven relationship of the aforesaid independent variables with the adoption of scientific practices in their homegardens.

c. Extent of adoption of indigenous practices by the homegarden farmers

The primary function of homegarden, which was originally conceptualised for food production alone, has now changed from it to the concept of food security with income generation as the major function. There can be noted a distinct similarity among the different homegardens with respect to the type and nature of herbaceous crops (which is not structurally dominant) in each district, while there is a definite variability with respect of the woody perennial seen in the homegardens, depending on physical, economical, social, cultural, environmental, ecological factors etc. These or more factors are satisfied by the homegarden farmers based on their vast experience and inhibition to the development of many practices of their own due to their strong belief in it, which is termed as indigenous practices. The high cost effective nature and easiness to practice was the primary reasons for the adoption of indigenous practices by the homegarden farmers.

5.4.2 Technology needs assessment in the homegardens for crops in each district

Technology needs for different categories of crops in the different districts remains the same.

In Alappuzha one of the most important requirements sought for the farmers is an efficient drainage technology. This requirement basically stands from the fact that cultivation in Alappuzha is mainly at or below sea level and flooding and salinity intrusion is a story almost repeating seasonally or annually. Instead of crop wise analysis it would be more relevant if group wise analysis were made.

The high perishable nature of vegetables coupled with the low individual unit area of homegardens makes it necessary not only to have the development of storage technology but also to have infrastructure facilities of storage at homegarden farmers group level. This will enable to store the surplus of produce of each homegarden and also to market produce at required time and in a required lot.

Another area of technology requirement in vegetable is at the level of product development. Similar practice like evolving dehydrated or dried products will enable round the year availability of products and more returns.

If the above are the requirements in the case of vegetables, the story of fruits is no different but the intensity is only more. Fruits are more perishable and hence efficient storage facilities like CA (controlled atmospheric) storage and product development are the need of the hour. Equally efficient trading practices by formation of farmer's group cooperatives and marketing produces to places of non-availability will only enhance returns.

The next area needing attention is training homegarden farmers for product development. Value addition technology wherein better products could be developed is another area of technology needs. This holds very much importance in case of tapioca, coconut, spices and fruit products.

In case of coconut the technology for manufacturing of the products like grated coconut, processed coconut water and coconut milk exist, but can be taken up only at a cooperative effort encompassing many homegardens, as technology is costly. The case is same when it comes to spices. Low cost products like pepper in brine, decorticated pepper, white pepper and dehydrated green pepper can be taken at individual level provided homegarden farmers are trained to develop products satisfying regress international quality standards. On the other hand products like oleoresin and oil extraction of spices require sophisticated machinery technology that are costly. Only group efforts can pay off in this direction. In case of high technology products like spice oils and oleoresin governmental efforts to obtain bulk orders and support the homegarden to cater to the needs of the developed was a felt need of homegarden farmer

Technology need for beverage crops like cocoa and coffee are on a different plain. Though products can be developed, only quality products of

recognized multi-nationals, do really sell. For example, most of the cocoa is purchased by Cadbury and the products are sold, but individual households can produce the same products but there will be difficulty in marketing.

In case of cashew almost the entire cashew apple is going waste. The Kerala Agricultural University itself has patented products on this line, that is yet to reach individual households. Organizing Self Help Groups and particularly women for collection and training them for product development would be the way out.

In case of rubber, farmers still resort to development of rubber sheets. Improvements and requirements at level of latex serving and controlled smoking could result in quality products, which are more paying. Even product development, which involves low cost technologies like rubber bands, gloves, etc. can be thought at group level. Here the felt requirement of the homegarden farmer is technology and financial services.

Another common aspect, which is required, is market analysis and support. Crops of homegardens are mostly horticulture or cash crops. Market intelligence, organizational support and advice are required. Un- exploited and under exploited horticultural tree crops with immense export potential exists in the homegardens. This is one area requiring vital attention.

In general technology needs of the farmers had radically changed from the conventional ones to that of technologies like scientific storage, processing and value addition of homegarden produces. This could be due to the higher social and biophysical standards of homegarden farmers of Kerala.

5.4.3 The dimensions of technology in homegarden systems perceived to be important by the homegarden farmers, Agricultural Officers and Scientists

A large variation was found in the spatial arrangement of species. These were primarily linked with priority needs, potential uses and availability of space. The effect of the distance from home to the edge of the homegarden (referred to as

courtyard, mid region and outer region) was identified as a factor contributing to the zonation of homegardens and variance of structure of homegardens in the study that is evident from the results. This implies that the match between the variation in priorities of the home and the spatial arrangement of the homegarden was strong both socio-economically and bio-physically. This was in conformity to the findings of Wikramasinghe (1995). Hence the study on dimensions of technologies for economical, temporal, technical, environmental, socio-cultural, psychological, decision making and human resource dimensions were to be important for the homegarden farmers, agricultural officers and scientists.

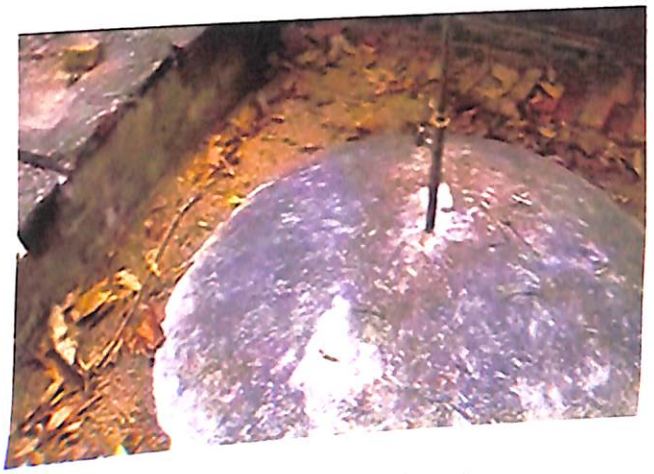
Dimensions of technology suited for homegardens as perceived by the homegarden respondents, agricultural officers and scientists were presented in the results of the study. Twenty-four dimensions out of the 48 dimensions were perceived to be important by all categories of the respondents.

Homegardens being a small unit but with an array of crop-animal-specialised components mix combine made it necessary that initial cost, continuous cost, income generation potential and regularity of returns to be perceived as the important economic dimensions of technology in the homegarden systems. The evolving nature of homegarden demands needs specific technologies taking into account the perennial nature of crops, its gestation period and practices involved in it. The returns obtained from such crop should form the basis of dimensions to be considered while generating and applying a technology in homegarden. All these factors will lead to the requirements of homegardens for low cost technology with involvement of less repairing cost but which generate regular and good income.

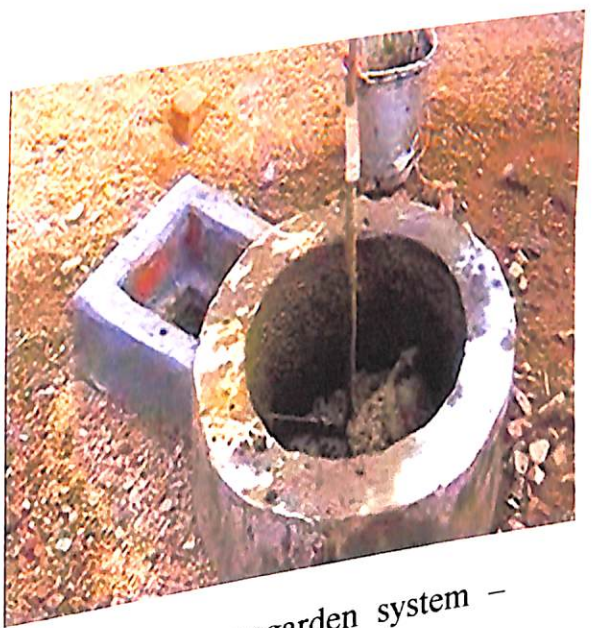
Sustainability and rapidity of returns under temporal dimension; resource recycling capacity, availability of raw materials and availability of supplies and services under environmental dimensions was perceived to be important by all categories of respondents. The homegardens being apparently a climax ecosystem,

where ecological succession is consciously manipulated by human beings, the aforesaid dimensions were perceived to be equally important by all the categories of the respondents. High intensity of vertical and horizontal space use, highly dynamic chronological structure and the capacity to perform essential ecological processes makes homegarden ecosystem a sustainable one through the use of resources and resource recycling (Plate 3). The findings of the study are in conformity to the results of Jose and Shanmugaratnam (1994).

Profitability, simplicity, observability and local resource utilization was perceived to be important dimensions as there is always the potential to increase homegarden food production and income by launching programmes on technical assistance and effective utility of existing resources. Efforts should be made to increase the productivity of land in homegardens because a considerable portion of land is being under-utilised in this farming system. The results of the study reinforce the findings of Dharmasena and Wijeratna (1998). Homegardens presenting a land use system where the different components of homegardens (tree-crop-livestock-specialised component mix) interact and associate should be more as a result of intensive intervention by the family labour. This will enable judicious use of resources, considering the ecological safeness of the homegardens. Also it will help the homegarden farmer to place before the homegarden the dimensions of social approval, social acceptability and cultural compatibility. This was evident from the fact that homegarden respondents had a tendency to use the perennial agroforestry tree crops to the outer region of homegarden facilitating income from it to their own garden but effectively utilizing the resources from the neighbouring homegardens, which brings into light the importance of socio-psychological dimensions. The role of extension officers with respect to exertion of their influence and persisting the need for book keeping (record maintenance) on the activity involved in homegardens should be enforced or seen as their duty in order to make homegarden a meaningful agricultural system.



A. Gober gas production unit utilising the rubber waste from rubber dominant homegarden systems – commonly seen in Pathanamthitta district



B. Gober gas production unit utilising the cowdung in a homegarden system – commonly seen in homegardens with livestock component

Plate 3. Functional diversity of homegardens with special reference to resource use efficiency and resource recycling capacity of different components in homegarden systems

5.5 CONSTRAINTS EXPERIENCED BY HOMEGARDEN FARMERS

Many constraints were reported by the homegarden farmers, of which 'surplus produce but insufficient for marketing was recorded as the most important constraint closely followed by low price of produce, high labour cost and lack of market for homegarden produces.

The very low holding size and variety of products from the same unit of homegarden makes it difficult for the homegarden farmers to find markets for the produce obtained from homegardens. Suitable strategies and plans are necessary for evolving a permanent market for homegarden produce from the part of the concerned authorities.

The initiating of cooperatives or self help groups can be thought of in homegarden situation for collection and marketing of the produce as it has much better potential than in other sectors.

The low price of the homegarden produce was of course natural as the marketing was done for only the surplus of the produce. All the more the lesser quantities of products from homegarden and non-preferential season for the likes of consumers could have been another factor for low price of the homegarden produce.

Non-availability of labour, coupled with other factors in Kerala has a direct influence in high labour cost in the homegardens. The political and social situations prevailing in the state with respect to the work culture also points out to the cause of high labour cost. Even- though family labour is highly involved some physical labour requirement for operations like land preparation, harvesting of produces from coconut, arecanut and other tree crops necessitates the involvement of skilled labour and hence the homegarden farmers are forced to pay high wages for the labour. The results was in accordance with the findings reported by Aravind (1999) and Geethakutty (1993).

Lack of extension services and assistance, poor economic status of farmer and lack of knowledge about technology was also perceived to be important constraints by homegarden farmers. The prospect of homegarden even though high, has not touched the hearts of the homegarden farmers. This was because the extension service and assistance had not reached the homegarden farmers, which resulted in neglected homegardens. The lack of extension service could be attributed due to the less number of staff for an area or the work culture prevailing in the place or state. Further more inadequacy of capital, supplies and services and uneconomic holdings especially for Alappuzha district added to the grievances of the homegarden farmers. Similar findings were reported by Aswathanarayana (1969). Many of the homegarden farmers were of the view that with adequate support in terms of extension services and technology awareness they were willing to take up any enterprise as it eventually helps them in income generation activity. Also better family involvement is assured, that will further help in more cooperation and coordination among the different members of the house hold which will enable the members of homegarden to have a happy life in terms of better understanding and active involvement in all activities of home. Extension service or support system thus should be reoriented to the homegarden situation, as it constitutes the majority or bulk of the Kerala land area.

Summary

6. SUMMARY

Homegarden is one of the oldest forms of agricultural production system that is present in all types of agro-ecological zones in Kerala. This highlights the unique characteristics and importance of this system where the homegarden farmers utilize the available land around their house for poly cropping with a variety of crop components along with or without animal husbandry components or other specialized components of their choice for production of various produces based on their household requirements and surplus production, if any for marketing according to market demand. The primary factor that determines the structural and functional components of homegarden is the extent of contribution of technology, its utilization and technology needs of the homegarden farmers. Thus the structural composition, the functional diversity and technology related aspects of homegardens are very much related and supports the dynamic nature of this ever-evolving system. The farmers have evolved homegardens as a means of subsistence production system, which has today transformed to a means of additional income generation system. This system that has developed over years and still following a dynamic suite, have optimized their production activities that satisfies the biophysical needs and socioeconomic requirements in which they live. Very little effort has been made so far to analyse the structural and functional diversity of homegardens with reference to technology contribution, its utilization and further the technology need that had a void influence in the dynamic nature of Kerala's growth and development. Against this background, the present study was undertaken with the following specific objectives.

1. To analyse the profile characteristics of homegarden farmers.
2. To identify the structural configuration of homegardens.
3. To identify the cropping system and type of homegardens.
4. To assess the extent of contribution of technology in terms of extent of adoption of technology/scientific practices in homegardens.
5. To establish the relationship of personal characteristics of homegarden farmers with the extent of adoption of technology/scientific practices.

6. To assess the extent of adoption of indigenous practices followed by farmers in homegardens.
7. To identify the technology needs of the farmers in homegardens that essentially forms the technology forecast for the homegarden systems.
8. To delineate the dimensions of technology suited for homegardens and
9. To identify the constraints experienced by homegarden farmers.

The study was conducted during the year 2003 in the southern zone of Kerala comprising Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta districts covering a sample size of 208 homegardens using multi-stage stratified random sampling technique representing the three major agro climatic zones *viz.* lowland (problem zone), highland and midland.

The variables in this study were structural configuration of homegardens, cropping patterns and type of homegardens, extent of adoption of scientific practices/technology, technology need assessment in the homegarden system, dimensions of technology for homegarden systems and constraints experienced by homegarden farmers.

The characteristic variable selected for the study were age, education, occupation, family size, irrigation potential, annual income from homegarden, extension contribution, market orientation, rational orientation, knowledge of homegarden farmers on scientific practices/technology and evaluative perception of homestead farmers in relation to sustainability of the homegarden.

Structural configuration was assessed based on the diversity index and its measurement. Shannon-Wiener index was used to measure diversity index (Sagar and Singh, 1999), Margalef's (1958) formulae was used to measure the species richness and Pielou (1969) formulae was used to measure the evenness. A dominance index was worked out to identify the structural, numerical and economical dominance of crop components in homegarden. The extent of adoption was measured by the

procedure used by Singh and Singh (1967). The technology needs assessment of homegarden farmers was arrived at using Kruskal Wallis one-way analysis of variance. The dimensions of technology were identified using cluster analysis procedure. A constraint index was worked out for identifying the constraints experienced by homegarden farmers.

The characteristic variables were quantified using already existing scales or following established procedures.

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

Percentage analysis, mean, correlation analysis, multiple linear regression analysis, Analysis of variance (CRD), Kruskal Wallis one way analysis for variance and cluster analysis were 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. More than 80 per cent of the farmers had education 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. More than three fourth of the sampled farmers had a family size with 3-4 members.
5. More than two third of the homegardens fell in the category of “little water scarcity”.
6. More than half the sampled respondents (52.88%) generated an annual homegarden income ranging from Rs. 25,000/- to Rs. 1,00,000/-

7. Almost 84.00 per cent of the extension contribution came from Agricultural Department and Kerala Agricultural University as expressed by the homegarden farmers.
8. More than three fourth of the total respondents (78.37%) had a higher level of market orientation.
9. More than 90.00 per cent of the sampled farmers had belief on science rather than belief on religion or religion and science together.
10. Majority of the respondents (96.60%) had low to medium level of knowledge on the scientific practices in homegarden.
11. More than 80 per cent of the sampled homegarden respondents had high evaluative perception on the sustainability of farming systems and cropping patterns in the homegarden.
12. The structural configuration of the homegardens of Kerala considerably varied. In this study, the means of the diversity index (using Shannon-Wiener diversity index) showed that structural configuration varies between sampled areas of study where Kollam topped in the diversity index. The means of the interaction between different areas of neither study nor holding size differ indicating that the biodiversity was not influenced by the holding size irrespective of the area selected for study. The mid region in homegardens of all the locale of study had the highest biodiversity.
13. Generalising the results of species richness, Thiruvananthapuram showed highest values for species richness. There were not much differences within regions and the species richness shown in case of different regions in different holding sizes were more a reflection of species richness observed at the sample area particularly Thiruvananthapuram.
14. The measure of evenness was highest in Kollam and Pathanamthitta. The 25-75 cents holding size followed by lower values of holding size recorded higher evenness. The mid regions of the four sample areas of study in general showed higher evenness with minimal variations in case of both area wise and holding size. Very explicit observations were recorded, with relatively low evenness in the courtyard of Alappuzha and outer regions of the large holdings in Pathanamthitta.

15. The cropping systems as identified through the measure of dominance index in terms of structural dominance, numerical dominance and economic dominance revealed that the 10 major dominant systems were attributed due to crops like coconut, rubber, arecanut, mango, mahagony, teak, banana, jack, betelvine and cucurbitaceous vegetables.
16. The types of homegardens were delineated based on the added components to homegardens primary structure. The animal husbandry components constituted four types of homegardens due to the addends like, livestock, hen, duck and lovebirds. Six types of homegardens were identified based on specialized components, like sericulture, apiculture, aquaculture, nursery, floriculture and agro-eco-tourism. Two types of homegardens were identified based on the socio-cultural and religions components. They were homegardens with 'Kudumbakshethram' and homegardens with 'Kavu' (Sacred grove).
17. On the economics of homegardens with respect to extent of contribution of major components (crop and livestock) towards annual homegarden income, it was found that livestock, rubber and tapioca were significantly related to annual homegarden income in Thiruvananthapuram whereas in case of Kollam it was rubber, livestock, coconut and pepper. In case of Alappuzha it was livestock, coconut, arecanut and pepper whereas for Pathanamthitta it was rubber, livestock and coconut. The marketing channels identified in the study proved that middlemen in various forms had a role in marketing the homegarden products and there existed more than one marketing channels for the marketing of homegarden products.
18. The technology assessment, which threw light into the extent of contribution/dissemination of technology, proved that only a limited quantity of technology reached the homegardens. This was substantiated by the adoption study where two-third of the homegarden respondents fell only under medium category of adoption and variables such as education, annual homegarden income, extension contribution, market orientation and knowledge level of farmers on technology were directly influencing the adoption of scientific practices/technology in homegardens. It was also found that a total of 54 indigenous practices were followed in the homegardens of the sampled population.

19. The maximum technology need was reported for unexploited and under exploited horticultural tree crop components which was on par with that of fruit tree crops (mango and jack) followed by beverages and cashew irrespective of respondents from all the districts. Also for various categories of crops, it was seen that farmers required more technologies for processing, value addition and storage irrespective of all crop categories and the different areas of study except in case of Alappuzha district where respondents clearly indicated the need for drainage and soil amendment technologies. Homegardens suited technologies/machineries and irrigation technologies were also to be developed as it was reflected in the results of the study.
20. On delineating the dimensions of technology for homegarden farmers as perceived by the farmers, the agricultural officers and the scientists, following 24 dimensions were felt important by all categories of respondents. They were initial cost, continuous cost, income generation potential and regularity of returns under economical dimensions; sustainability and rapidity of returns under temporal dimensions; profitability, simplicity, observability and local resource utilization under technical dimensions; resource recycling capacity, availability of raw materials and availability of supplies and services under environmental dimensions; social acceptability, social approval and cultural compatibility under socio-cultural dimensions; goal orientation, attitude, level of satisfaction, scientific orientation and perception of technology under psychological dimensions; record keeping and extension officer's influence under decision making dimensions and finally family labour under human resource dimensions.
21. The constraint analysis revealed that the major ones identified were 'surplus but insufficient for marketing which was on par with, low price of produce, high labour cost, lack of markets for homegarden products and lack of extension service.

To conclude, in general, the results that analyses the structural configuration of cropping systems and type of homegardens reveals that there was a large variation found in the spatial arrangement of species leading to the structural configuration of homegardens. The measure of species richness, evenness and

dominance illustrated the cropping system and type of homegardens. All these were primarily linked with priority needs, potential uses and availability of space. The techno-socio-economics of the operational unit demonstrated a number of factors affecting the engagement of farmers in designing and improving the whole systems through more technology intervention and its optimal utilization. All these points to the fact that the match between the variations in priorities of the 'homegarden' and the structural configuration and functional diversity of homegardens is strong both, techno-socio economically and biophysically fulfilling the objectives set forth in the technology assessment of homegarden systems.

Suggestions for future research

1. As this study was concentrated only to the Southern parts of Kerala similar studies should be initiated in other parts of the state.

2. Homegarden farming, the predominant farming system prevailing throughout Kerala state may be identified as an exclusive system, which may be considered as a pivotal unit, based on which future development, research and extension programmes have to be planned.

3. Impact of fragmentation of lands on the homegarden systems in Kerala can be a future area of research.

4. The indigenous knowledge on farming practices in homegardens is gained through vast experience that is mostly confined to older generation. The transfer of this knowledge is confined to family members alone and it is transferred to the new generation by the process of oral folklore. Studies on identification, evaluation, rationalisation and documentation of Indigenous Technical Knowledge practices would augur better outlook to researchers for further development of homegardens in a holistic manner.

5. Research activities may be focused to find out appropriate production technology for homegarden farming situation, which would be more valuable to farmers.

6. An evaluative research on the role of different implementing agencies in the popularization of homegarden systems could be taken up to study the extent and nature of extension efforts to popularize homegarden farming.

7. A multidisciplinary research team must explore the prospect of developing farmers practices in homegarden farming systems taking into consideration the variety emporium of components (crop, livestock, specialized components like sericulture, apiculture, aquaculture etc.) in homegardens.

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Appendices

APPENDIX - I

TECHNOLOGY ASSESSMENT IN THE HOMEGARDEN SYSTEMS

Code: Date:

Interview Schedule

1. District: 2. Taluk: 3. Village: 4. Survey number:

6. Address:

6a.Total area of homegarden (in ha): 6b. Infrastructural holding area:

7. Effective homegarden area:

a) Type: Irrigated/ Rainfed/ Gardenland

b) Topography: Level/ Undulating/Gentle slop/Steep

8. Family structure and characteristics:

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

P: Primary S: Secondary

Appendix - I (continued…)

9. MARKET ORIENTATION

Whether the respondent agrees with the following statements?

Sl.No	Statements	A	DA
1	Market is not useful to a farmer		
2	A farmer can get good price by eliminating the middle man		
3	One should sell his produce to the nearest market irrespective of price		
4	One should purchase his inputs from shops where his friends or relatives purchase		
5	One should grow those crops which have more market demand		
6	Co-operatives can help a farmer to get better price for his produce		

10. EXTENSION CONTRIBUTION

Mark the response to the extent /Frequency and Usefulness of extension contribution from different extension agencies the respondent got for better homegarden farming.

Statements	Extent of contribution	How frequently?	How useful?
	VA/A/NA	W/M/Y/O	VU/U/NU
The extent to which you discussed the homegarden farming problems with extension personnel from A) AO's/AA's of agricultural department B) Scientists of Kerala Agricultural University C) Scientists of ICAR institutes D) Personnel of other institutes/ Commodity boards, etc. E) Friends, neighbours and well wishers Others (Please mention)			

Appendix - I (continued…)

11. RATIONAL ORIENTATION

What do you feel about the increased income and improvement in life through homegarden? These may be due to:

(a) Beliefs in stars and not in scientific recommendation

(b) Beliefs in stars and scientific recommendations

(c) Beliefs only in scientific recommendation

12. CREDIT UTILISATION

1. Have you availed any crop loan? (Y/N) (Crop/ other activities, give details)
From private individuals/Co-operative societies/ Commercial banks/ Private banks/ Local money lenders/ Friends and neighbours/ Others specify :

2. Nature of the loan taken

Amount of loan and year Amount repaid Amount outstanding Purpose Source

3. What prompted to divert the fund in case it was not utilised for the purpose?

13. TRAINING ATTENDED

Sl. No.	Name the training	Destination	Agency/ Source	Season	Whether useful?		In which subject matter area do you require training in future?
					Y	N	

Y: Yes N: No

Appendix - I (continued…)

14. INTERRELATIONSHIP OF BELIEF'S AND TABOOS WITH TREES CROPS/LIVESTOCK IN HOMEGARDEN

(a) Is the homegarden situated within proximity of places of worship like temple, church, mosque and oter old structures etc? (Yes/No). If yes, mention the structure.

(b) Is there any relationship between the components in homegardens (be it-tree/crops/live stock etc.) and traditions in the families/beliefs/ location importance/rituals etc. (Yes/No)

If Yes:

Sl. No.	Component (Specify)	What is its importance?	Why is it so?	How long they are practising it?

(C) Is there some problem trees/ plants in the homegarden? If so, name the problems associated with it?

15. IRRIGATION POTENTIAL

a) Whether the home garden is (Irrigated/ Rain fed/Combination)

b) What is the perception of farmer on availability of water in the homegarden (Physical water scarcity/ Economic water scarcity/ Little or no water scarcity)

c) Source of irrigation water (Wells/ Tube wells/ Canals/ Ponds/ River/ Tap/ Others)

d) Capacity or period for which irrigation water is available…….

e) Area irrigated…….

Appendix - I (continued…)

Crops irrigated	Stages of irrigation	Method of irrigation	Frequency of irrigation (AD, 2/W, I/W, 2/M, 1/M)

f) Do you pay for the water used? (Y/N)

If yes, Amount incurred for irrigation purpose (Rs/Month)

Amount incurred for home use (Rs/ Month)

g) Do you adopt any water harvesting method/sustainable water management practices in your homegarden? Yes/ No.

If yes, what is the method practised?

How efficient it is? (Very efficient/ Moderately efficient/ less efficient)

16. DRAINAGE FACILITIES

(a) Whether drainage facilities are available in the home garden (Yes/No):

(b) If Yes:

Then the type of drainage facilities available (Natural or interventional):

(c)If interventional type, specify the type of intervention

(Ridges and furrows/Channels/ Concrete channels/ Topographical utilisation/ Others)

(d) Efficiency as perceived by the home garden farmer:

(Highly efficient/ Moderately efficient/ Not efficient)

(e) Other details of interest:

17. The Crops/inter crops/which preceded the existing inter crop earlier with the yield of the same and income from it.

Sl. No.	Crops/ Inter crops		Yield		Returns	
	Present	Preceding	Present	Preceding	Present	Preceding

Appendix - I (continued…)

18. The Crops/ inter crops/, which are likely to succeed the present crop after its harvest and the probable reason behind the same.

Sl.No	Crops/ Inter crops		Probable reason for the crop chosen to succeed if any.
	Present crops	Succeeding	

19. LIVE STOCK COMPONENTS IN HOME GARDEN

Details of live stock components in homegarden

Sl. No	Name	Breed	No	Age	Present Status	Type of product	Yield	Returns	Product used for Home/ cash/ both
	Livestock Cow Buffalo Goat Pig Elephant Poultry Others								

Also indicate the feeding/vaccination and medicines given for the livestock

Are you satisfied with the returns from Livestock / poultry? Y/N

Appendix - I (continued…)

20. OTHER COMPONENTS

List all other components in the homegarden with the details asked for

Sl. No	Components	Site	Source of infor-mation	Number /Area	Products	Value Rs / year	Uses Home / cash
1 2 3 4 5 6 7	Terrace garden Apiary unit Sericulture unit Aquaculture unit Bio gas unit Composting unit a) Coir pith b) Vermi compost c) Others (specify) Processing units Any other (specify)						

21. What is the approximate investment and returns per year on different components of home garden as perceived by the home garden farmer?

Sl. No	Components	Area coverage	Investment/Year	Returns/year	
				Home	Through sale
1.	Tree				
2.	Crop				
3.	Live stock components				
	Others (Specify)				
	TOTAL				

Appendix - I (continued…)

22. INDIGENOUS TECHNICAL KNOWLEDGE (ITK)

If any indigenous practices (ITK) are followed in the homegarden, mention it with the probable reason

Sl.No	ITK Practices	Probable reason	Effectiveness VE/E/NE

VE: Very Effective **E**: Effective **NE**: Not Effective

23. What is the monetary value of the land encompassing the home garden (in Rupees)?

24. a. The farmer depends on home garden mainly for

(Livelihood /Livelihood + Economy / Economic purpose alone / All the above)

b. Food Security

c. Are they getting adequate food and nutritional security from the homegarden?

Yes/ No

If yes, mention the same with its quantity and nutritional value

Sl. No	Products used	Form in which it is used (Raw/Processed)	Processed form	Availability (Round the year/ Seasonally/ Regular intervals/ Irregularly)	Post harvest processing technology, if any

Appendix - I (continued…)

25. CROP COMPONENTS

a) Details of crop component to identify the structural configuration in the **"Courtyard"** of a homegarden. Mark the components for NE, NR, P, UP, D, SD, T in the crop species column. Perceived use in terms of Food, Fodder, Fuel, Timber, Vegetables, Spices, Medicines, Manure, Cash. Others

Type of canopy arrangement: (Multi-tier:- 6 tier, 5 tier, 4 tier, 3 tier/ 2- tier/ 1-tier)

Whether the homegarden structure is planned/ unplanned?

If planned , since when it has been planned?

If planned or unplanned it's observable structure and rationale behind the same

Sl. No.	Crop/ Species	No of species/ Area	Age	Use	Period of crops/ harvest

NR - Naturally regenerated; NE - Naturally evolved; P - Planned; UP - Unplanned; D - Dominant; SD - Subordinate dominance; T – Transience

b) Details of crop component to identify the structural configuration in the **"Mid-region"** of a homegarden. Mark the components for NE, NR, P, UP, D, SD, T in the crop species column. Perceived use in terms of Food, Fodder, Fuel, Timber, Vegetables, Spices, Medicines, Manure, Cash. Others

Type of canopy arrangement: (Multi-tier:- 6 tier, 5 tier, 4 tier, 3 tier/ 2- tier/ 1-tier)

Whether the homegarden structure is planned/ unplanned?

Appendix - I (continued…)

If planned , since when it has been planned?

If planned or unplanned it's observable structure and rationale behind the same

Sl. No.	Crop/ Species	No of species/ Area	Age	Use	Period of crops/ harvest

NR - Naturally regenerated; NE - Naturally evolved; P - Planned; UP - Unplanned; D - Dominant; SD - Subordinate dominance; T - Transience

c) Details of crop component to identify the structural configuration in the **"outer region"** of a homegarden. Mark the components for NE, NR, P, UP, D, SD, T in the crop species column. Perceived use in terms of Food, Fodder, Fuel, Timber, Vegetables, Spices, Medicines, Manure, Cash. Others

Type of canopy arrangement: (Multi-tier:- 6 tier, 5 tier, 4 tier, 3 tier/ 2- tier/ 1-tier)

Whether the homegarden structure is planned/ unplanned?

If planned , since when it has been planned?

If planned or unplanned it's observable structure and rationale behind the same

Sl. No.	Crop/ Species	No of species/ Area	Age	Use	Period of crops/ harvest

NR - Naturally regenerated; NE - Naturally evolved; P - Planned; UP - Unplanned; D - Dominant; SD - Subordinate dominance; T – Transience

Appendix - I (continued…)

26. TECHNOLOGY ASSESSMENT

Technology				
Variety /Species				
Number of species/ area				
Age				
Season of planting				
Harvesting period				
Seed rate				
Depth of Sowing				
Spacing adopted				
Nutrient management				
Organic manure (Kg/ha)				
Fertiliser (Kg/Plant Or Ha)				
N				
P				
K				
Others				
Method of appln				
Hormone / Micronutrient				
Name				
Quantity				
Method				
Stage				
Purpose				
Pest management				
Name of pest				
Name of pesticides				
Quantity				
Method of application				
Disease management				
Name of disease				
Name of fungicide				
Quantity				
Method				
Weed management				
Name of weed				
Name of weedicide				
Quantity				
Method				
Harvesting technologies				
Name of implement				
Time of harvesting				
Stage of harvesting				
Storage technologies				
Storage structure				
Method of storage				
Others				
Source of technology				
Perceived use of technology (VU/U/NU)				
Technology further needed				
Others (Specify)				
[IPM/IDM/IWM/INM]				

Appendix - I (continued…)

27. CONSTRAINT ANALYSIS

Constraints and solutions as perceived by the farmers in homegardens in the order of importance

Sl. No.	Constraints	MI	I	LI	Li	NI	Perceived solutions
1	Prohibitive cost of inputs						
2	Non availability of labour						
3	High labour cost						
4	Inadequacy of capital						
5	Low price of produce						
6	Uneconomic holding						
7	Lack of technology						
8	Lack of knowledge about technology						
9	Scarcity of quality irrigation water						
10	Non availability of credit						
11	Poor storage facilities						
12	Interrupted power supply						
13	Lack of knowledge on post harvest handling						
14	Non availability of implements						
15	Lack of post harvest implements						
16	Lack of processing implements						
17	Lack of homegarden suited implements						
18	Poor transportation facilities						
19	Lack of extension service and assistance						
20	Non availability of supply and service						
21	Lack of time in homegarden activities						
22	Lack of motivational factors						
23	Poor economic status						
24	Lack of markets for products of homegarden						
25	Surplus but insufficient for marketing						
26	Trade unionism						
	Others (Specify)						

Appendix - I (continued…)

28. SUSTAINABILITY OF HOMEGARDENS

Indicate the extent of evaluative perception on sustainability of farming system and cropping pattern in homegardens

Sl. No.	Statements	Evaluative perception			
		VM	M	L	VL
1	**Environmental** Homestead farming reduces soil, water and atmospheric pollution				
2	Woody perennials crop play an important role in the productivity and sustainability				
3	IPM, IDM, IWM, INM can be effectively utilised in homestead agriculture that will be Eco- friendly practices in the homegarden				
4	Interaction between the crop system and livestock system of a homestead facilitates high degree of organic recycling that maintains soil health and sustainability				
5	Homestead agriculture is ecologically compatible				
6	Cooling effect for home				
7	**Quality of life- food, nutritional , medicare security and aesthetic aspects** Homestead farming provides adequate provision for developing aesthetic aspects of the family members				
8	Homegardens provide the home with round the year food and nutritional security				
9	Homegarden products are much reliable and can be considered as safe products				
10	Homegardens help to meet the immediate medicare needs of the family				
11	Homestead farming provides for risk reducing practices				
12	**Resource utilisation** Catch cropping is more beneficial to the residual soil moisture and nutrients after the major crops				
13	Multi-storied cropping helps to exploit resources effectively				
14	Solar harvesting principles can be effectively implemented in the homesteads				
15	Livestock components in a homestead helps to improve the quality of agricultural produce				
16	In agroforestry homegardens land use systems ensures better resource management				
17	Insitu input generation and utilisation are possible in homegardens				

Appendix - I (continued…)

18	Woody perennials of homestead will dominate the arable crops and will compete for resources				
19	Agroforestry components help to meet requirement of food/fuel				
20	**Economic** Homestead farming provides for year round income				
21	Homestead farming ensures highest returns per year				
22	Homestead farming ensure to optimising production				
23	Live stock components in a homegarden helps minimising the manuring cost of the homesteads				
24	Homestead agriculture helps to reduce cost of cultivation				
25	Integrated farming practices make homestead an economically viable unit				
26	Structural and functional diversity of the components in a homegarden provides for multiple demands of the family				
27	Homestead farming helps to get the farmer engaged in farm throughout the year				
28	Livestock components in a homestead helps to get the farmer engaged in the farm throughout the year				
29	Homestead ensures more family input				
30	Homestead farming ensures reasonable income through sale of surplus so as to purchase unproduceable articles in the farm				
31	Homestead farming provides employment opportunities for labourer etc.				

VM: Very Much **M**: Much **L**: less **VL**: Very less

29. DIMENSIONS FOR TECHNOLOGY IN HOMEGARDENS

The items for judgement are placed in an 11-point continuum ranging from 'No relevance' to 'Maximum relevance'. Indicate your responses to express your judgement on the level of relevance, from the farmers' point of view. You are welcome to suggest new dimensions, if any.

Dimensions	10	9	8	7	6	5	4	3	2	1	0
A. ECONOMICAL DIMENSIONS 1. Initial cost 2. Continuing cost 3. Income generation potential 4. Employment generation potential 5. Commercialization 6. Regularity of returns											

Appendix - I (continued…)

B. TEMPORAL DIMENSIONS											
1. Sustainability											
2. Time saving											
3. Time utilization pattern											
4. Rapidity of returns											
5. Availability of supplies and services											
C. TECHNICAL DIMENSIONS											
1. Physical compatibility											
2. Efficiency											
3. Trialability											
4. Complexity											
5. Profitability											
6. Communicability											
7. Availability											
8. Decrease in discomfort											
9. Flexibility											
10. Simplicity											
11. Observability											
12. Viability											
13. Desirability											
14. Suitability											
15. Local resource utilization											
D.ENVIRONMENTAL DIMENSIONS											
1. Energy saving potential											
2. Resource recycling capacity											
3. Spatial threshold											
4. Availability of raw materials											
5. Infrastructure development											
E.SOCIO-CULTURAL DIMENSIONS											
1. Social acceptability											
2. Social approval											
3. Cultural compatibility											
F. PSYCHO-LOGICAL DIMENSIONS											
1. Goals orientation											
2. Aspirations											
3. Attitudes											
4. Perceived social status											
5. Level of satisfaction											
6. Scientific orientation											
Perceptions of technology											

Appendix - I (continued…)

G. DECISION MAKING DIMENSIONS 1. Record keeping 2. Decision-making style 3. Extension-officers' influence **H. HUMAN RESOURCES DIMENSIONS** 1. family labour 2. hired labour 3. Physical labour requirement 4. Skilled labour requirement Any other dimensions, please specify											

30. Level of knowledge on scientific practices

1. Name a green manure crop supplying nitrogen
2. Which are the important nutrients present in organic manures
3. Name a potassic fertiliser
4. When lime has to be applied?
5. Name a variety of paddy suitable to your locality
6. Give spacing for short duration variety of paddy cultivation
7. Application of fertilisers based on soil test recommendation is always advisable (Yes/No)
8. Apply farm yard manure/compost @5 MT/ha (True/False)
9. Name a disease of rice
10. Name an important pest of rice
11. Name any pesticide that can be used to control rice bug
12. Give control measures for the control of sheath blight disease of paddy
13. Name a green manure crop suitable for coconut gardens
14. Basins should be taken at 1.8m radius around the stem and 25 cm depth (True/False)

Appendix - I (continued…)

15. Apply lime @ 1 Kg/palm (True/False)
16. Irrigate the palm during summer at an interval of 5 to 6 days. (True/False)
17. Name an important pest of coconut.
18. Give control measures for Rhinocerous beetle
19. Mosaic disease is an important problem in pumpkin cultivation (True/False)
20. Give the name of pesticide which is largely used in vegetable cultivation
21. Planting of vegetables in pits during summer season helps in conserving moisture (Yes/No)
22. Panniyoor-1 is to be grown in comparatively open areas
23. Name a suitable standard for growing pepper
24. Name an important pest affecting pepper
25. Name an important disease affecting pepper
26. It is better to feed animals individually according to production and requirement (Yes/No)
27. Good quality roughages save concentrate (True/False)
28. Production ration should be fixed based on milk yield (Yes/No)
29. It is important to feed collustrum to infants (Yes/No)
30. Udders should be disinfected using light disinfectants after milking (Yes/No)
31. Name a variety of broiler chicken
32. RD vaccine should be given at 5 days old (True/False)
33. Pigeon pox vaccine is to be given at 3 to 4 weeks (Yes/No)
34. Birds should be dusted against ectoparasites (Yes/No)
35. Rabbitrry is a profitable enterprise in homesteads (Yes/No)

Added items after pilot study

I) Whether homegarden possess any soil erosion preventing structures? (Yes/No)
If yes, what is the structure?

How efficient it is from farmer's point of view? (Very efficient/Efficient/Not efficient)

2) Study on fences in homegarden

Appendix - I (continued…)

Whether live fence or non-live fences in the homegarden?
If live fences

a) What are the common fencing material (Plant components)
b) The configuration of live fences
c) Why were live fences preferred?
d) The season and period of maintenance of the fence
e) The approximate cost incurred on the construction and maintenance of the fence. (Rs.----------/ year)
f) The perceived uses of live fences in the order of importance

If other than live fences the probable reasons

4) Marketing channels

The marketing channel followed by the respondent in marketing the homegarden produce

List the channels cropwise

The approximate share of producer on the market price.

The approximate share received at each stage of the marketing channel

5) Have you utilised subsidy benefits offered by any agencies for crops /other components in homegarden? (Yes/No)

If yes, mention the purpose with amount as subsidy

APPENDIX - II

The variables with their mean relevancy score

Sl. No.	Independent variables	Mean relevancy score
1	Age	**3.65**
2	Education	**4.35**
3	Occupation	**3.95**
4	Family size	**4.20**
5	Annual homegarden income	**4.50**
6	Homegarden farming experience	2.25
7	Homegarden size	1.95
8	Irrigation potential	**4.05**
9	Availability of homegarden inputs	2.80
10	Market orientation	**3.70**
11	Economic motivation	2.95
12	Rational orientation	**4.40**
13	Extension participation	2.85
14	Extension contribution	**4.75**
15	Innovativeness	2.15
16	Social participation	3.10
17	Labour utilisation	3.15
18	Scientific orientation	2.65
19	Credit utilisation	1.85
20	Economic motivation	3.15
21	Risk orientation	2.15
22	Mass media participation	1.75
23	Knowledge on scientific practices in homegarden farming.	**4.60**
24	Evaluative perception on the sustain-ability of cropping and farming systems in homegardens	**4.25**
	Mean	**3.30**

APPENDIX - III

Tree crop resource inventory- Thiruvananthapuram District

Name of the crop	Botanical name	Family
Cereals		
Rice	*Oryza sativa*	Gramineae
Pulses		
Cowpea	*Vigna unguiculata*	Leguminosae
Tubers		
Tapioca	*Manihot esculenta*	Euphorbiaceae
Sweet potato	*Ipomoea batatas*	Convovulaceae
Colocasia	*Colocasia* spp.	Araceae
Elephant Foot yam	*Amorphophallus campanulatus*	Araceae
Dioscorea	*Dioscorea* spp.	Dioscoreaceae
Fruits		
Banana	*Musa* spp.	Musaceae
Mango	*Mangifera indica*	Anacardiaceae
Jack	*Artocarpus heterophyllus*	Moraceae
Papaya	*Carica papaya*	Caricacea
Pineapple	*Ananas comosus*	Bromeliaceae
Guava	*Psidium guajava*	Myrtacea
Sapota	*Achras sapota*	Sapotacea
Bread fruit	*Artocarpus altilis*	Moraceae
Cashewnut	*Anacardium occidentale*	Anacardiaceae
Lime	*Citrus aurantifolia*	Rutaceae
Custard apple	*Annona squamosa*	Annonaceae
Bullock's heart	*Annona reticulata*	Annonaceae
Pomegranate	*Punica granatum*	Punicaceae
Tamarind	*Tamarindus indica*	Leguminosae
Vegetables		
Brinjal	*Solanum melongena*	Solanaceae
Tomato	*Lycopersicon esculentum*	Solanaceae
Amaranthus	*Amaranthus* spp.	Amaranthaceae
Bhindi (Okra)	*Abelmoschus esculentus*	Malvaceae
Bitter gourd	*Momordica charantia*	Cucurbiataceae
Snake Gourd	*Trichosanthes cucumerina*	Cucurbiataceae
Ash gourd	*Benincasa hispida*	Cucurbiataceae
Cucumber	*Cucumis sativus*	Cucurbiataceae
Drumstick	*Moringa pteriosperma*	Moringaceae
Pumpkin	*Cucurbita pepo*	Cucurbiataceae
Curry leaf	*Murriya koenegii*	Rutaceae

Appendix - III (continued…)

Oil yielding crops		
Coconut	*Cocos nucifera*	Palmae
Spices and condiments		
Pepper	*Piper nigrum*	Piperaceae
Clove	*Syzygium aromaticum*	Myrtacea
Chilli	*Capsicum* spp.	Solanaceae
Nutmeg	*Mysristica Fragrans*	Myristicaceae
Cinnamon	*Cinnamoum zeylanicum*	Lauraceae
Ginger	*Zingiber officinale*	Zingiberaceae
Other crops		
Rubber	*Hevea brasiliensis*	Euphorbiaceae
Arecanut	*Areca catchu*	Palmae
Coffee	*Coffea* spp.	Rubiaceae
Cocoa	*Theobroma cacao*	Sterculiaceae
Betel vine	*Piper betle*	Piperaceae
Fodder		
Napier grass	*Pennistum purpureum*	Gramineae
Guinea grass	*Panicum maximum*	Gramineae
Green manures		
Glyricidia	*Glyricidia maculata*	Leguminosae
Crotalaria	*Crotalaria striata*	Leguminosae
Calapagonium	*Calapogonium muconoides*	Leguminosae
Other tree crops		
Venga	*Pterocarpus marcupium*	Leguminosae
Ayani	*Artocarpus hirsuta*	Moraceae
Ilavu	*Bombax malabaricum*	Bombacacae
Teak	*Tectona grandis*	Verbenaceae
Perumaram	*Ailanthus excelsa*	Simarubacae
Portia tree (seelanthi)	*Thespesia populnea*	Malvaceae
Erythrina	*Erythrina indica*	Leguminosae
Neem tree	*Azadirachta indica*	Meliaceae
Bambo	*Bambusa arundinaea*	Gramineae
Elanji	*Mimusops elengi*	Sapotaceae
Mahagoni	*Swietenia mahogani*	Meliaceae

APPENDIX - IV

Tree crop resource inventory- Kollam District

Name of crop	Botanical name	Family
Cereals		
Rice	*Oryza sativa*	Gramineae
Pulses		
Cowpea	*Vigna unguiculata*	Leguminosae
Tubers		
Tapioca	*Manihot esculenta*	Euphorbiaceae
Sweet potato	*Ipomoea batatas*	Convovulaceae
Colocasia	*Colocasia* spp.	Araceae
Elephat Foot yam	*Amorphophallus campanulatus*	Araceae
Greater Yam	*Dioscorea alata*	Dioscoreaceae
Lesser Yam	*Dioscorea esculenta*	Dioscoreaceae
Arrow root	*Maranta arundinacea*	Marantaceae
Dioscorea	*Dioscorea* spp.	Dioscoreaceae
Fruits		
Banana	*Musa.* spp.	Musaceae
Mango	*Magnifera indica*	Anacardiaceae
Jack	*Artocarpus heterophyllus*	Moraceae
Papaya	*Carica papaya*	Caricacea
Pineapple	*Ananas comosus*	Bromeliaceae
Bilimbi	*Averhoea bilimbi*	Myrtaceae
Guava	*Psidium guajava*	Myrtaceae
Champa	*Syzygium* spp.	Myrtaceae
Lovi lovi	*Flacoutia inermis*	Flacourtiaceae
Sapota	*Achras sapota*	Sapotacea
Bread fruit	*Artocarpus altilis*	Moraceae
Nelli	*Emblica officinalis*	Euphorbiaceae
Date palm	*Phoenix dactylifera*	Palmae
Cashewnut	*Anacardium occidentale*	Anacardiaceae
Lime	*Citrus aurantifolia*	Rutaceae
Custard apple	*Annona squamosa*	Annonaceae
Bullock's heart	*Annona reticulata*	Annonaceae
Garcenia	*Garcenia* spp.	Guttiferae
Pomegranate	*Punica granatum*	Punicaceae
Tamarind	*Tamarindus indica*	Leguminosae
Vegetables		
Brinjal	*Solanum melongena*	Solanaceae
Tomato	*Lycopersicon esculentum*	Solanaceae
Amaranthus	*Amaranthus* spp.	Amaranthaceae
Bhindi (Okra)	*Abelmoschus esculentus*	Malvaceae
Bitter gourd	*Momordica charantia*	Cucurbiataceae
Snake Gourd	*Trichosanthese cucumerina*	Cucurbiataceae

Appendix - IV(continued…)

Ash gourd	*Benincasa hispida*	Cucurbiataceae
Cucumber	*Cucumis sativus*	Cucurbiataceae
Drumstick	*Moringa pteriosperma*	Moringaceae
Chekkurmanis	*Sauropus androgynus*	Euphorbiaceae
Pumpkin	*Cucurbita pepo*	Cucurbiataceae
Curry leaf	*Murriya koenegii*	Rutaceae
Oil yielding crops		
Coconut	*Cocos nucifera*	Palmae
Spices and condiments		
Pepper	*Piper nigrum*	Piperaceae
Clove	*Syzygium aromaticum*	Myrtacea
Chilli	*Capsicum* spp.	Solanaceae
Nutmeg	*Mysristica Fragrans*	Myristicaceae
Cinnamon	*Cinnamoum zeylanicum*	Lauraceae
Ginger	*Zingiber officinale*	Zingiberaceae
Other crops		
Rubber	*Hevea brasiliensis*	Euphorbiaceae
Arecanut	*Areca catchu*	Palmae
Coffee	*Coffea spp.*	Rubiaceae
Cocoa	*Theobroma cacao*	Sterculiaceae
Betel vine	*Piper betle*	Piperaceae
Fodder		
Napier grass	*Pennistum purpureum*	Gramineae
Guinea grass	*Panicum maximum*	Gramineae
Green manures		
Glyricidia	*Glyricidia maculata*	Leguminosae
Crotalaria	*Crotalaria striata*	Leguminosae
Calapagonium	*Calapogonium muconoides*	Leguminosae
Other tree crops		
Kumbi	*Careya arborea*	Lecythidaceae
Venga	*Pterocarpus marcupium*	Leguminosae
Ayani	*Artocarpus hirsuta*	Moraceae
Ilavu	*Bombax malabaricum*	Bombacacae
Ambayam	*Spondias mangifera*	Anacardiaceae
Teak	*Tectona grandis*	Verbenaceae
Perumaram	*Ailanthus excelsa*	Simarubacae
Portia tree (seelanthi)	*Thespesia populnea*	Malvaceae
Erythrina	*Erythrina indica*	Leguminosae
Neem tree	*Azadirachta indica*	Meliaceae
Bamboo	*Bambusa arundinaea*	Gramineae
Mahagoni	Swietenia mahogani	Meliaceae

APPENDIX - V

Tree crop resource inventory- Alappuzha District

Name of crop	Botanical name	Family
Cereals		
Rice	*Oryza sativa*	Gramineae
Pulses		
Cowpea	*Vigna unguiculata*	Leguminosae
Tubers		
Tapioca	*Manihot esculenta*	Euphorbiaceae
Sweet poteto	*Ipomoea batatas*	Convovulaceae
Colocasia	*Colocasia Spp.*	Araceae
Elephat Foot yam	*Amorphophallus campanulatus*	Araceae
Dioscorea	*Dioscorea* spp.	Dioscoreaceae
Fruits		
Banana	*Musa. spp.*	Musaceae
Mango	*Magnifera indica*	Anacardiaceae
Jack	*Artocarpus heterophyllus*	Moraceae
Papaya	*Carica papaya*	Caricacea
Pineapple	*Ananas comosus*	Bromeliaceae
Guava	*Psidium guajava*	Myrtacea
Sapota	*Achras sapota*	Sapotacea
Nelli	*Emblica officinalis*	Euphorbiaceae
Bread fruit	*Artocarpus altilis*	Moraceae
Cashewnut	*Anacardium occidentale*	Anacardiaceae
Lime	*Citrus aurantifolia*	Rutaceae
Custard apple	*Annona squamosa*	Annonaceae
Bullock's heart	*Annona reticulata*	Annonaceae
Pomegranate	*Punica granatum*	Punicaceae
Tamarind	*Tamarindus indica*	Leguminosae
Vegetables		
Brinjal	*Solanum melongena*	Solanaceae
Tomato	*Lycopersicon esculentum*	Solanaceae
Amaranthus	*Amaranthus* spp.	Amaranthaceae
Bhindi(Okra)	*Abelmoschus esculentus*	Malvaceae
Bitter gourd	*Momordica charantia*	Cucurbiataceae
Mullan vellari	*Cucumus* spp.	Cucurbiataceae
Snake Gourd	*Trichosanthese cucumerina*	Cucurbiataceae
Ash gourd	*Benincasa hispida*	Cucurbiataceae
Cucumber	*Cucumis sativus*	Cucurbiataceae
Drumstick	*Moringa pteriosperma*	Moringaceae
Pumpkin	*Cucurbita pepo*	Cucurbiataceae
Curry leaf	*Murriya koenegii*	Rutaceae

Appendix - V (continued…)

Oil yielding crops		
Coconut	*Cocos nucifera*	Palmae
Sesame	*Sesamum indicum*	Pedaliaceae
Spices and condiments		
Pepper	*Piper nigrum*	Piperaceae
Clove	*Syzygium aromaticum*	Myrtacea
Chilli	*Capsicum* spp.	Solanaceae
Nutmeg	*Mysristica Fragrans*	Myristicaceae
Cinnamon	*Cinnamoum zeylanicum*	Lauraceae
Turmeric	*Curcuma domestica*	Zingiberaceae
Ginger	*Zingiber officinale*	Zingiberaceae
Other crops		
Rubber	*Hevea brasiliensis*	Euphorbiaceae
Arecanut	*Areca catchu*	Palmae
Coffee	*Coffea* spp.	Rubiaceae
Cocoa	*Theobroma cacao*	Sterculiaceae
Betel vine	*Piper betle*	Piperaceae
Fodder		
Napier grass	*Pennistum purpureum*	Gramineae
Guinea grass	*Panicum maximum*	Gramineae
Green manures		
Glyricidia	*Glyricidia maculata*	Leguminosae
Crotalaria	*Crotalaria striata*	Leguminosae
Calapagonium	*Calapogonium muconoides*	Leguminosae
Other tree crops		
Kumbi	*Careya arborea*	Lecythidaceae
Venga	*Pterocarpus marcupium*	Leguminosae
Ayani	*Artocarpus hirsuta*	Moraceae
Ilavu	*Bombax malabaricum*	Bombacacae
Ambayam	*Spondias mangifera*	Anacardiaceae
Teak	*Tectona grandis*	Verbenaceae
Perumaram	*Ailanthus excelsa*	Simarubacae
Portia tree (seelanthi)	*Thespesia populnea*	Malvaceae
Erythrina	*Erythrina indica*	Leguminosae
Neem tree	*Azadirachta indica*	Meliaceae
Bamboo	*Bambusa arundinaea*	Gramineae
Elanji	*Mimusops elengi*	Sapotaceae
Mahagoni	*Swietenia mahogani*	Meliaceae

APPENDIX - VI

Tree crop resource inventory- Pathanamthitta District

Name of crops	Botanical name	Family
Cereals		
Rice	*Oryza sativa*	Gramineae
Pulses		
Cowpea	*Vigna unguiculata*	Leguminosae
Tubers		
Tapioca	*Manihot esculenta*	Euphorbiaceae
Sweet poteto	*Ipomoea batatas*	Convovulaceae
Colocasia	*Colocasia s*pp.	Araceae
Elephat Foot yam	*Amorphophallus campanulatus*	Araceae
Dioscorea	*Dioscorea* spp.	Dioscoreaceae
Fruits		
Banana	*Musa. Spp.*	Musaceae
Mango	*Magnifera indica*	Anacardiaceae
Jack	*Artocarpus heterophyllus*	Moraceae
Miniature Orange	*Citrus sp*	Rutaceae
Papaya	*Carica papaya*	Caricacea
Lovi lovi	*Flacoutia inermis*	Flacourtiaceae
West Indian cherry	Malphigia punicifolia	Malphigiacea
Pomegranate	*Punica granatum*	Punicaceae
Egg fruit	*Leucuna nerrosa*	Sapotaceae
Rambuttan	*Nephelium lappaceum*	Sapindacea
Nelli	*Emblica officinalis*	Euphorbiaceae
Pineapple	*Ananas comosus*	Bromeliaceae
Guava	*Psidium guajava*	Myrtacea
Sapota	*Achras sapota*	Sapotacea
Bread fruit	*Artocarpus altilis*	Moraceae
Champa	*Syzygium* spp.	Myrtaceae
Cashewnut	*Anacardium occidentale*	Anacardiaceae
Lime	*Citrus aurantifolia*	Rutaceae
Bamblimas	*Citrus decumana*	Rutaceae
Custard apple	*Annona squamosa*	Annonaceae
Bullock's heart	*Annona reticulata*	Annonaceae
Pomegranate	*Punica granatum*	Punicaceae
Tamarind	*Tamarindus indica*	Leguminosae
Vegetables		
Little gourd	*Coccinia cordifolia*	Cucurbitaceae
Brinjal	*Solanum melongena*	Solanaceae
Tomato	*Lycopersicon esculentum*	Solanaceae
Amaranthus	*Amaranthus spp.*	Amaranthaceae
Bhindi (Okra)	*Abelmoschus esculentus*	Malvaceae

Appendix - VI (continued…)

Bitter gourd	*Momordica charantia*	Cucurbiataceae
Snake Gourd	*Trichosanthese cucumerina*	Cucurbiataceae
Ash gourd	*Benincasa hispida*	Cucurbiataceae
Cucumber	*Cucumis sativus*	Cucurbiataceae
Chekkurmanis	*Sauropus androgynus*	Euphorbiaceae
Drumstick	*Moringa pteriosperma*	Moringaceae
Pumpkin	*Cucurbita pepo*	Cucurbiataceae
Curry leaf	*Murriya koenegii*	Rutaceae
Oil yielding crops		
Coconut	*Cocos nucifera*	Palmae
Spices and condiments		
Pepper	*Piper nigrum*	Piperaceae
Vanilla	*Vanilla planiflora*	Orchidaceae
Clove	*Syzygium aromaticum*	Myrtacea
Chilli	*Capsicum spp.*	Solanaceae
Allspice	*Pimenta dioica*	Myrtaceae
Nutmeg	*Mysristica Fragrans*	Myristicaceae
Cinnamon	*Cinnamoum zeylanicum*	Lauraceae
Turmeric	*Curcuma domestica*	Zingiberaceae
Ginger	*Zingiber officinale*	Zingiberaceae
Other crops		
Rubber	*Hevea brasiliensis*	Euphorbiaceae
Arecanut	*Areca catchu*	Palmae
Coffee	*Coffea spp.*	Rubiaceae
Mulberry	*Morus alba*	Moraceae
Cocoa	*Theobroma cacao*	Sterculiaceae
Betel vine	*Piper betle*	Piperaceae
Fodder		
Napier grass	*Pennistum purpureum*	Gramineae
Guinea grass	*Panicum maximum*	Gramineae
Green manures		
Glyricidia	*Glyricidia maculata*	Leguminosae
Crotalaria	*Crotalaria striata*	Leguminosae
Calapagonium	*Calapogonium muconoides*	Leguminosae
Other tree crops		
Ayani	*Artocarpus hirsuta*	Moraceae
Ilavu	*Bombax malabaricum*	Bombacacae
Teak	*Tectona grandis*	Verbenaceae
Perumaram	*Ailanthus excelsa*	Simarubacae
Erythrina	*Erythrina indica*	Leguminosae
Neem tree	*Azadirachta indica*	Meliaceae
Bamboo	*Bambusa arundinaea*	Gramineae
Mahagoni	*Swietenia mahogani*	Meliaceae

APPENDIX - VII

Table 38. Extent of adoption of indigenous practices by the homegarden farmers

n = 208

Sl No.	Indigenous practices	No	%
A	COCONUT		
1	The functional eye was detected by floating the nut in water (the portion that comes up when dipped in water is the position of functional eye). Those nuts, which float with stalk portion up will sprout earlier and development of well developed nuts both in terms of endosperm and husk occurs	41	19.71
2	The whole coconut was soaked in water for more than one month after drying in shade so that the fibre became soft and made the emergence of leaf easier. The nuts were sown in slanting position so as to prevent water stagnation in the depression near functional eye that aids in faster and healthy seed germination	16	7.69
3	The coconut seeds were planted with eye portion down for two weeks and then brought back to normal position enabling the embryo to be in full contact with the liquid endosperm till it emerges out so that quality seedlings are obtained with much quicker emergence	42	20.19
4	Pseudostem of banana was buried in the basin of the palm. It increased the organic matter content and water holding capacity. Yield was also seen to be improved. Coconut husks was placed or arranged inside planting pit or basins of the coconut tree. There was yield increase because of increased water holding capacity and supply of some nutrients like potassium.	35	16.83

Appendix VII. Continued…

5	Burn the waste from coconut tree in its basins itself. The practice was found to improve the seed set. It gives potash and decrease incidence of pests and diseases.	59	28.36
6	Use of fresh cows urine in the basins of coconut prevents immature nut fall and use of cow dung supernatant solution against bacterial wilt disease was effective	16	7.69
7	Planting arrowroot in coconut nursery decrease incidence of termites. The root exudates of arrowroot were found to have some repellent effect on termites.	12	5.77
8	Painting of slaked lime on stem against sun scorching especially during the summer months	18	8.65
9	Toddy tapping was found to increase yield of coconut. It gives a rest to the palm and later there will be rejuvenating effect for the palm enabling an increase in yield	34	16.35
B	RICE		
10	Rice for seed purpose was threshed soon after harvest. If threshed soon after harvest the vitality was maintained for long time.	4	1.92
11	Put an egg in water and add common salt till the egg floats. Dip seeds in this water for some time. This will increase spouting. The salt water has got fungicidal property and it will help in the removal of chaffy grains.	2	0.96
12	The rice seeds were dipped in water mixed with cow dung for 6 hours. Then water was drained and seeds were heaped in baskets. Small twigs with leaves of gooseberry was placed over and covered with gunny bags. A weight was placed over this and watered to hasten germination. Seeds absorb nutrients from cow dung and cow dung solution that was found to have some hormones. Gooseberry leaves were believed to generate heat thus helping the emergence of vigorous buds.	2	0.96

Appendix VII. Continued…

13	Add cowpea seeds along with rice seeds when sowing in water less condition (*Podivitha*) at the rate 12 kg/ha. It ensures the availability of green manure and overall yield increase.	2	0.96
14	Use of twigs of Lantana camera to open the galleries of leaf roller	4	1.92
15	Add calotropis as green manure. It can decrease incidence of pest and disease as it has got repellent properties.	4	1.92
16	Employing ducks immediately after rice harvest removes insect pests and weed seeds .	5	2.40
17	Before transplanting the seedlings were uprooted and then heaped. This heaping generates heat and reduces pest incidence. This practice was called '*Kunda koottal'*. It generates heat, which kills eggs and larvae of pests especially of stem borer and case worm.	3	1.44
18	Application of cow dung supernatant solution against bacterial leaf blight in vegetables	2	0.96
19	To decrease damage due to rodents hang white plastic bags and split pseudostem of banana in rice fields. The white colour has got a scaring effect, which wards off rodents.	6	2.88
20	During transplanting, if seedlings were transplanted in a slanting manner, it increases the number of tillers and hence affecting a yield increase	4	1.92
21	Sprinkling of common salt in nursery beds at 2 kg/cent and leaving it for half an hour makes the uprooting of seedlings easier. Deflocculating of soil takes place and hence the soil loosens and it helps for easy uprooting of seedlings.	5	2.40

Appendix VII. Continued…

22	Extract of lemongrass and garlic was used against rice bug	2	0.96
23	Use of waste videotapes as bird scarer in paddy fields.	2	0.96
C	BANANA		
24	Smearing cowdung and ash solution on the banana suckers during storage and before sowing	56	26.93
25	Application of tobacco decoction and soap solution against bunchy top diseases of banana	10	4.81
26	Packing of banana bunches with dry banana leaves gave bunches of better colour and size	53	25.48
27	The inflorescence is removed soon after its full emergence for increase in size of fruits as well as early maturity	62	29.81
D	VEGETABLES		
28	Dry the vegetable pods or seeds for 4-6 days to decrease excess moisture in the seeds to protect from attack of storage pests and fungal diseases.	33	15.86
29	Mix the cowpea seeds for edible purpose with a little mustard oil for a longer shelf life, as it will protect the same from storage pests and diseases	23	11.06
30	Mixing neem leaves with stored seeds ensures its protection as azadiractin has got repellent action against insect pests.	9	4.33
31	Mix the cowpea seeds with ash obtained by burning husk of cowpea. The ash acts as abrasive and kills the storage pests	6	2.88

Appendix VII. Continued…

32	During storage of seeds put some garlic in the container. The pungent smell of garlic acts as repellent and will prevent insect attack.		
33	In case of cucurbitaceous vegetables, land was kept idle for three days after preparation during summer, as it will help to eliminate weed growth and resting stages of insects and pathogens.	23	11.06
34	Cover the bitter gourd for seed purpose with teak leaves. Oily nature of teak leaves repels the raindrops falling and prevents the fruit from rotting. It also prevents the bittergourd from attack of fruit fly.	17	8.17
35	Smoking under *Pandal* of cucurbits enhances fruit set, reduces pest attack and adds fertility to soil.	31	14.90
36	Raise seedlings of bittergourd in jack leaf cones. This helps in proper establishment of crops after transplanting.	4	1.92
37	Chilly seeds was soaked in rice soup (Kangivellam) for an hour and drained. It was then sown and was found to have early and improved germination. Starch helps to retain moisture and provides food for beneficial microorganism.	7	3.36
38	Grow Marigold in chilly plots to reduce disease and pest attacks. Roots of marigold have got some exudates that have got nematicidal property.	12	5.77
39	During drying of red chillies use of crows feather as bird scarer.	26	12.5
40	Tobacco decoction diluted in vep oil and emulsified in soap water used against many of the pests in vegetable.	11	5.29
41	Dried coconut leaves were smeared with jaggerry and insecticides and was used in vegetable plots as bait to attract insects and control them.	7	3.36

Appendix VII. Continued…

E	TUBERS AND YAMS		
42	Use of kerosene – Bamboo gum against rats	32	15.38
43	Planting of amorphophallus in the Malayalam month of Kumbam for getting higher yield	16	7.69
44	Storage of tapioca in the moist soil increased its shelf life.	42	20.19
F	SPICES		
45	Ginger seeds dipped in cowdung slurry and spread over panal leaf were subjected to smoking for some days and stored in panal leaves itself. It enhances sprouting. Cow dung contains some bacteriophages that improve disease resistance. Panal leaves have got insecticidal property	9	4.33
46	Mulching was carried out in ginger plots with leaves of banana and neem. This increases corm size.	11	5.29
47	Dipping pepper for one minute in boiled water and then drying in shade enabled to fetch more price in market. Chlorophyll gets denatured and it gives shining black colour and thus increases market value.	18	8.65
48	Allow pepper vines to move along land to another support without cutting form mother plant. It will help in root establishment at the nodal region of the vine so that the region in contact with soil increases and tolerance increases.	21	10.1
G	LIVESTOCK AND POULTRY		
49	To increase fat content in milk give half-ounce Nallenna/day. Any oil increases fat content in milk	30	14.42

Appendix VII. Continued…

50	Keep the time of milking fixed for getting good milk yield. It was in relation to secretion of the hormone oxytocin	42	20.19
51	Feeding mulberry leaves to cows increase milk yield	10	4.81
52	Green leaf feeding increases milk yield	52	25.0
53	Feeding azolla to poultry/hens will increase the natural colour of the yolk, weight of the egg and overall quality of the egg	16	7.69
54	The birds after hatching out are immediately dipped in water dissolved with turmeric powder to ensure its longevity	14	6.73

* The total ‘n’ exceeded 208 because multiple responses of the respondents were taken into account

APPENDIX - VIII

Table 40. The technology needs for crops with respect to different practices in Thiruvananthapuram district

Crop/ Cultural practices	Variety	Planting material	Selection of intercrop	Spacing	Irrigation manage-ment	Soil amend-ment	Nutrient manage-ment	Pest manage-ment	Disease manage-ment	Home garden machinery	Drainage techn-ology	Storage techn-ology	Proce-ssing	Value addition	Chi^2 (C.V)
Vegetables	102	105.292	68.625	105.292	109.33	109.33	109.33	109.33	89.125	58	109.33	36	36	36	80.329 (38.921)
Tuber	290.5	290.5	194.83	256.88	184.03	290.5	290.5	144.81	139.21	99.21	284.90	235.5	111.14	36.5	254.3261 (60.401)
Coconut	509.5	509.5	413.702	344.72	395.85	509.5	509.5	332.52	263.52	163.17	509.5	509.5	66.27	66.27	550.2676 (80.84)
Spices	424.5	424.5	424.5	424.5	393.93	424.5	409.22	363.37	348.09	355.35	393.93	424.5	378.65	164.7	503.6872 (53.808)
Beverages	394.5	394.5	394.5	394.5	394.5	394.5	394.5	394.5	394.5	394.5	394.5	352.83	394.5	352.83	93.9118 (33.74)
Fruit	457	457	332.66	372.48	370.92	478.31	457	428.31	457	202.16	457	62	62	62	2382.225 (62.644)
Fruit trees	498	498	342.02	145.79	443.96	422.35	476.38	374.44	465.58	208.02	498	122.73	52.46	52.4	3127.661 (57.2)
UUHTC	68	164.25	145.875	127.06	127.06	145	131.66	131.66	131.66	76.97	103.88	68	76.97	76.97	70.4187 (44.91)
Rubber	75	75	19.37	75	32.46	75	75	26.5	32.56	75	75	75	75	5	100.4412 (31.826)
Cashew	87	80.83	46.75	33.75	39.92	87	62.33	40.25	46.75	11.5	87	11.5	36.67	11.5	252.518 (27.603)

UUHTC-Un and under exploited horticultural tree crops

Appendix VIII. Continued…

Table 41. The technology needs for crops with respect to different practices in Kollam district

Crop/ Cultural practices	Variety	Planting material	Selection of intercrop	Spacing	Irrigation manage-ment	Soil amend-ment	Nutrient manage-ment	Pest manage-ment	Disease manage-ment	Home garden machinery	Drainage techn-ology	Storage techn-ology	Proce-ssing	Value addition	Chi^2 (C.V)
Vegetables	73	73	58.75	73	73	73	73	73	62.785	37.375	73	16	16	16	90.7246 (31.826)
Tuber	232	232	152.174	198.478	153.783	232	232	120.261	114.674	74.543	226.413	185.523	78.152	29	205.1919 (53.808)
Coconut	479.5	479.5	389.561	326.316	371.704	479.5	479.5	319.867	245.276	153.663	479.5	479.5	62.806	62.806	517.4835 (78.473)
Spices	412.5	412.5	224.79	365.57	365.57	412.5	412.5	365.57	365.57	298.64	389.04	365.57	365.57	177.86	1572.619 (59.353)
Beverages	411.5	411.5	411.5	394.62	377.44	411.5	411.5	360.85	251.56	223.56	411.5	265.32	348.85	140.03	491.7938 (46.285)
Fruit	403	403	362.43	360.32	375.95	403	403	389.48	375.95	354.11	403	386.70	174.86	44.5	780.5557 (52.629)
Fruit trees	477	477	285.33	319.85	430.81	367	390.71	407	348.42	395.56	477	53.5	53.5	53.5	5404.33 (57.199)
UUHTC	68	164.25	145.88	127.06	127.06	145	131.66	131.66	131.66	76.97	103.88	68	76.97	76.97	70.4518 (44.909)
Rubber	154.5	154.5	47.56	154.5	66.79	154.5	154.5	48.0	110.65	154.5	154.5	154.5	154.5	9.5	202.90 (46.285)
Cashew	47.5	39	30.5	24.5	18.50	47.50	39	24.5	30.50	7.5	47.5	7.5	27.5	7.5	44.980 (22.604)

UUHTC-Un and under exploited horticultural tree crops

Appendix VIII. Continued…

Table 42. The technology need for crops with respect to different practices in Alappuzha district

Crop/ Cultural practices	Variety	Planting material	Selection of intercrop	Spacing	Irrigation manage-ment	Soil amend-ment	Nutrient manage-ment	Pest manage-ment	Disease manage-ment	Home garden machinery	Drainage techn-ology	Storage techn-ology	Proces-sing	Value addition	Chi^2 (C.V)
Rice	58.5	58.5	6.58	23	58.5	58.5	58.5	52.58	58.5	21.17	23	52.58	58.5	6.58	77.9066 (27.60)
Vegetables	137	137	129.97	137	137	137	137	137	132.07	129.97	31.5	31.5	31.5	31.5	197.8943 (43.49)
Tuber	215	215	156	204.48	157.12	215	215	125.55	115.02	105	34.5	189.21	83.62	34.5	199.608 (51.42)
Coconut	512.5	512.5	421.56	347.6	404.41	512.5	512.5	340.07	266.11	168.54	364.66	512.5	64.75	64.75	513.4261 (80.07)
Spices	82.5	82.5	70.83	70.83	82.5	82.5	82.5	41.67	82.5	13.11	11.0	76.67	76.67	33.22	96.32 (33.74)
Beverages	88.12	196	77.21	192.79	189.59	196	157.47	125.41	125.41	65	65	65	65	65	185.7103 (46.28)
Fruit	463	463	388.95	409.45	314.91	463	463	463	463	232.7	83	83	83	83	5693.702 (64.42)
Fruit trees	504.5	504.5	255.67	161.60	289.05	449.88	504.5	477.19	419.53	504.5	504.5	59.5	59.5	595	20155.07 (60.40)
Rubber	492.5	492.5	455.95	236.95	173.41	221	356.14	433.32	492.5	474.5	402.5	402.5	492.5	492.5	2573.357 (52.62)
UUHTC	154	154	51.41	154	66.06	154	154	53.5	110.03	154	53.5	154	154	8.5	195.1737 (44.91)
Cashew	47.5	39	30.50	24.5	18.5	47.5	39	24.5	30.5	7.5	47.5	7.5	27.5	7.5	44.98 (22.60)

UUHTC-Un and under exploited horticultural tree crops

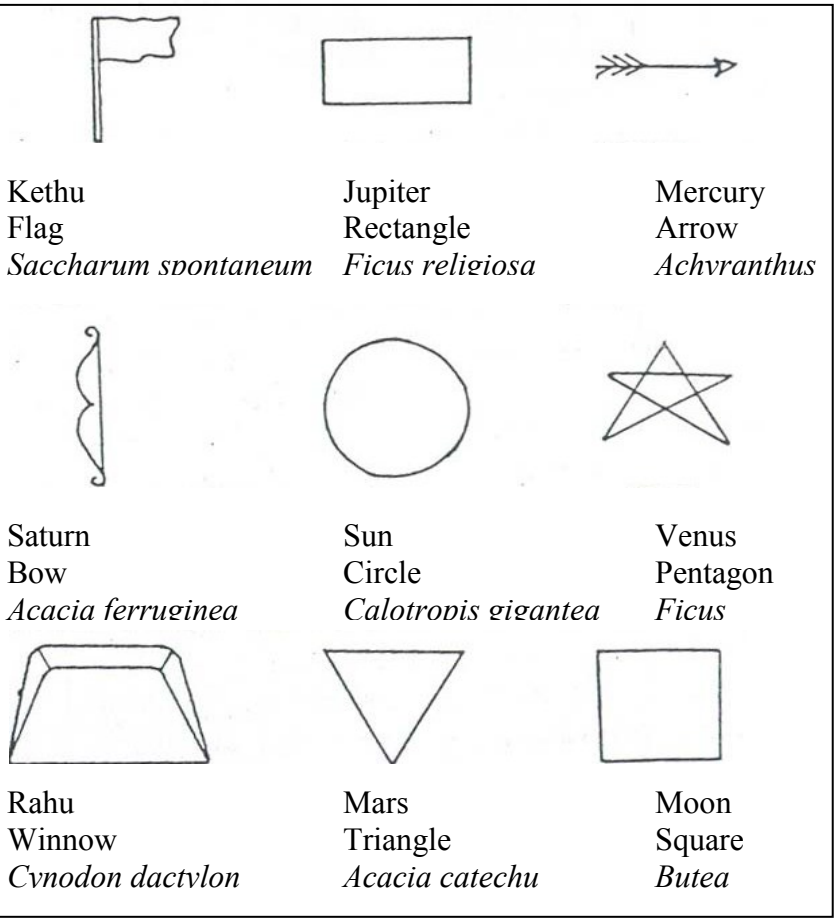
Appendix VIII. Continued…

Table 43. The technology needs for crops with respect to different practices in Pathanamthitta district

Crop/ Cultural practices	Variety	Planting material	Selection of intercrop	Spacing	Irrigation manage-ment	Soil amend-ment	Nutrient manage-ment	Pest manage-ment	Disease manage-ment	Home garden machinery	Drainage techn-ology	Storage techn-ology	Proce-ssing	Value addition	Chi^2 (C.V)
Vegetables	95.27	98.23	61.41	98.23	102.64	102.64	102.64	102.64	80.59	51.09	102.64	29	29	29	90.3685 (37.27)
Tuber	293	293	214	258.5	183.75	293	293	149.25	143.50	64	293	281.5	154.5	33	284.1808 (61.431)
Coconut	509.5	509.5	413.70	344.70	395.85	509.5	509.5	332.52	263.52	163.17	509.5	509.5	66.27	66.27	550.2676 (80.837)
Spices	422.5	422.5	422.5	422.50	422.5	422.5	388.98	305.17	321.93	209.55	422.5	355.45	422.5	369.36	641.7358 (51.423)
Beverages	397	397	397	397	397	397	397	397	397	397	397	359.4	321.6	287.45	114.3375 (35.551)
Fruit	451.28	460.5	322.22	338.53	349.88	451.28	460.5	432.84	460.50	88.31	460.5	63.5	63.5	63.5	2845.583 (63.441)
Fruit trees	494	494	367.84	140.92	393.7	425.84	448.56	436	430.92	263.90	494	317	51.5	51.5	2587.379 (56.092)
UUHTC	72.5	176.15	157.97	136.76	132.59	159.68	137.24	137.24	137.24	83.82	115.29	72.5	81.53	72.5	80.069 (46.29)
Rubber	410.5	410.5	410.5	399.59	370.21	410.5	410.5	248.49	360.13	410.50	400.43	400.43	410.5	41.09	1463.419 (65.389)
Cashew	401	401	401	401	401	401	401	401	401	293.15	344.64	401	347.07	21.07	55.2508 (29.789)

UUHTC-Un and under exploited horticultural tree crops

Appendix - XI (continued…)



Nine planet temple forest. Under the diagram of each planet, the name of the planet, emblem and the name of the plant/tree species representing the planet are listed in that order

Pisces Jupiter *Ficus bengalensis*	Aries Mars *Pterocarpus santalinus*	Tauras Venus *Alstonia scholaris*	Gemini Mercury *Artocarpus heterophyllus*
Aquarius Saturn *Acacia ferruginea*			Cancer Moon *Butea monosperma*
Capricorn Saturn *Dalbergia latifolia*			Leo Sun *Stereospermum chelonoides*
Saggitarius Jupiter *Ficus religiosa*	Scorpio Mars *Acacia catechu*	Libra Venus *Mimusops elangi*	Virgo Mercury *Mangifera indica*

Zodiac forest. In each of the cells, the zodiach sign, name of the controlling planet and the name of the tree species representing the zodiac sign are furnished in that order.

Appendix - IX (continued…)

9. Observability

It is defined as the degree to which the successful results of a technology used in the homegarden can be visually observed by the homegarden farmer.

10. Local resource utilisation

It is defined as the capacity of the technology used in the homegarden to make best use of the available resources of the homegarden for productive purposes.

11. Availability of supply and services

It is defined as the extent of adequate and timely availability of agencies holding the supply and service functions related with a homegarden technology.

12. Resource recycling capacity

It is defined as the extent to which the available resources in a homegarden can be recycled among the existing homegarden components so that the production system can become more productive, dynamic and sustainable

13. Availability of raw material

It is defined as the adequate amount of timely availability of raw material required for the right and efficient use of any homegarden technology.

14. Social acceptability

It is defined as the degree to which a technology for homegarden is considered useful, practical and feasible by the majority of the members of a social system.

15. Social Approval

It is defined as the perception by an individual about the degree to which an homegarden farmer would achieve the approval of others and gains in prestige or esteem by adopting a particular technology.

16. Cultural compatibility

It is defined as the perception by an individual about the degree to which a homegarden farmer would consider the cultural feelings of the place in which a particular technology is been adopted.

APPENDIX - IX

The operationalisation of selected dimensions of technology in homegardens

1. Initial cost

It is defined as the initial investment that covers all the costs of a technology enterprise that has to be accepted for adoption by the homegarden farmers.

2. Continuing cost

It is defined as the cost incurred by the technology for the full period of its use as a part of maintaining the technology that is used in the homegardens.

3. Income generation potential

It is the ability of a technology to generate additional income in the homegardens under the existing conditions.

4. Regularity of returns

It is defined as the capability of a technology to generate returns on a regular basis in the homegardens.

5. Rapidity of returns

It is defined as the temporal ability of technology to ensure immediate or quick returns to the homegarden farmer on use of the technology.

6. Sustainability

It is defined as the degree to which a technology fits in most appropriately with ones homegarden conditions or its environment without causing any problem to his or her surroundings.

7. Profitability

It is defined as the perception by the individual about the amount of money that will be realized as profit for the homegarden as a result of adoption of a technology

8. Simplicity

It is the perception by an individual about the degree to which an innovation is easy to understand and practice in the homegarden.

Appendix - IX (continued…)

17. Goal orientation

It is defined as the extent to which a homegarden farmer achieve a definite prefixed goal on use of a technology in homegardens.

18. Attitude

It is defined as the positive or negative feeling of the homegarden farmer towards a technology that is to be used in homegarden.

19. Level of satisfaction

It is defined as the extent to which the homegarden farmer is happy and satisfied with the output generated in the homegarden as a result of use of a technology.

20. Scientific orientation

It is defined as the extent to which a homegarden farmer is oriented to the use of scientific methods in decision making with respect to the farming activities in his or her homegarden.

21. Perception of technology

It is defined as the clear understanding on selection, organisation and interpretation of a technology to be used by a homegarden farmer in a situation according to prior learning, activities, interest, experiences etc.

22. Extension Officer's influence

It is the perception by an individual about the degree to which an extension officer can influence or persuade the homegarden farmer to use the new scientific practices/methods for better farming in the homegarden.

23. Record keeping dimensions

It is defined as the perception by the homegarden farmer on the importance of maintaining the records on each and every aspects of the technology that is in use in the homegarden.

24. Family Labour

It is defined as the perception by an individual about the extent of family labour involvement or participation in practising a technology in the homegarden.

APPENDIX - X

A. Cattle unit – Pathanamthitta district

B. Goat unit – Kollam district

C. Duck unit - Alappuzha district

Plate 2. Types of homegardens (homegarden primary structure + animal husbandry component)

Appendix - X continued. …

A. Homegarden primary structure + bush jasmine (floriculture unit)

B. Homegarden primary structure + orchids (floriculture unit)

C. Homegarden primary structure + lovebird unit (Alappuzha district)

D. Homegarden primary structure + apiculture unit (Thiruvananthapuram district)

Plate 2. Types of homegardens (continued…)
(homegarden primary structure + specialised components)

A. Homegarden primary structure + terrace garden
(Thiruvananthapuram district)

B. Homegarden in Pathanamthitta with scientific aquaculture unit

C. Homegarden in Alappuzha with fish culture in conventional pond

D. Homegarden primary structure + sericulture unit
(Alappuzha district)

Plate 2. Types of homegardens (continued…)
(homegarden primary structure + specialised components)

A. Homegarden nursery unit

B. Commercial nursery in homegarden

C. Technology components for homegarden farmers through nursery unit

Plate 2. Types of homegardens (continued…)
(homegarden primary structure + commercial nursery unit in Alappuzha district)

A. Thulasithara

B. Sacred grove (Kavu)

C. Sarpakavu

D. *Santalum* spp.

Plate 2. Types of homegardens (continued…)
(homegarden primary structure + religious components)

Appendix - X continued…

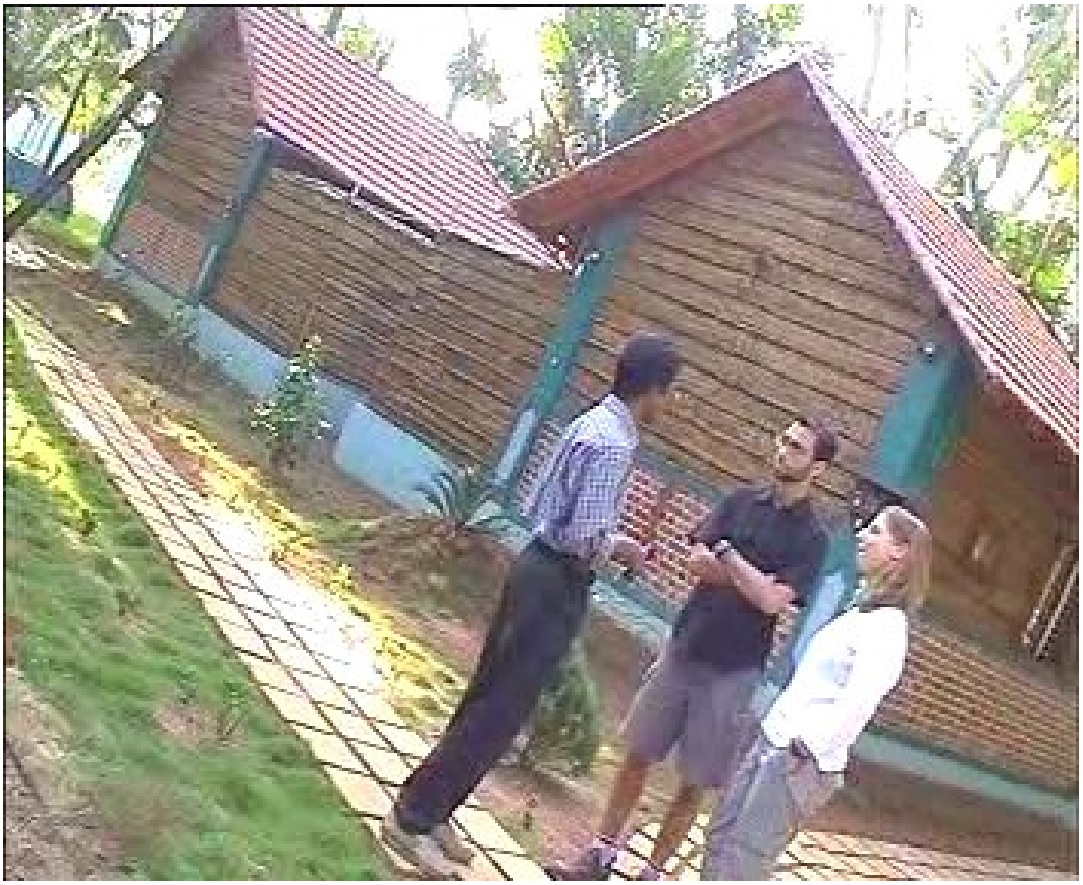
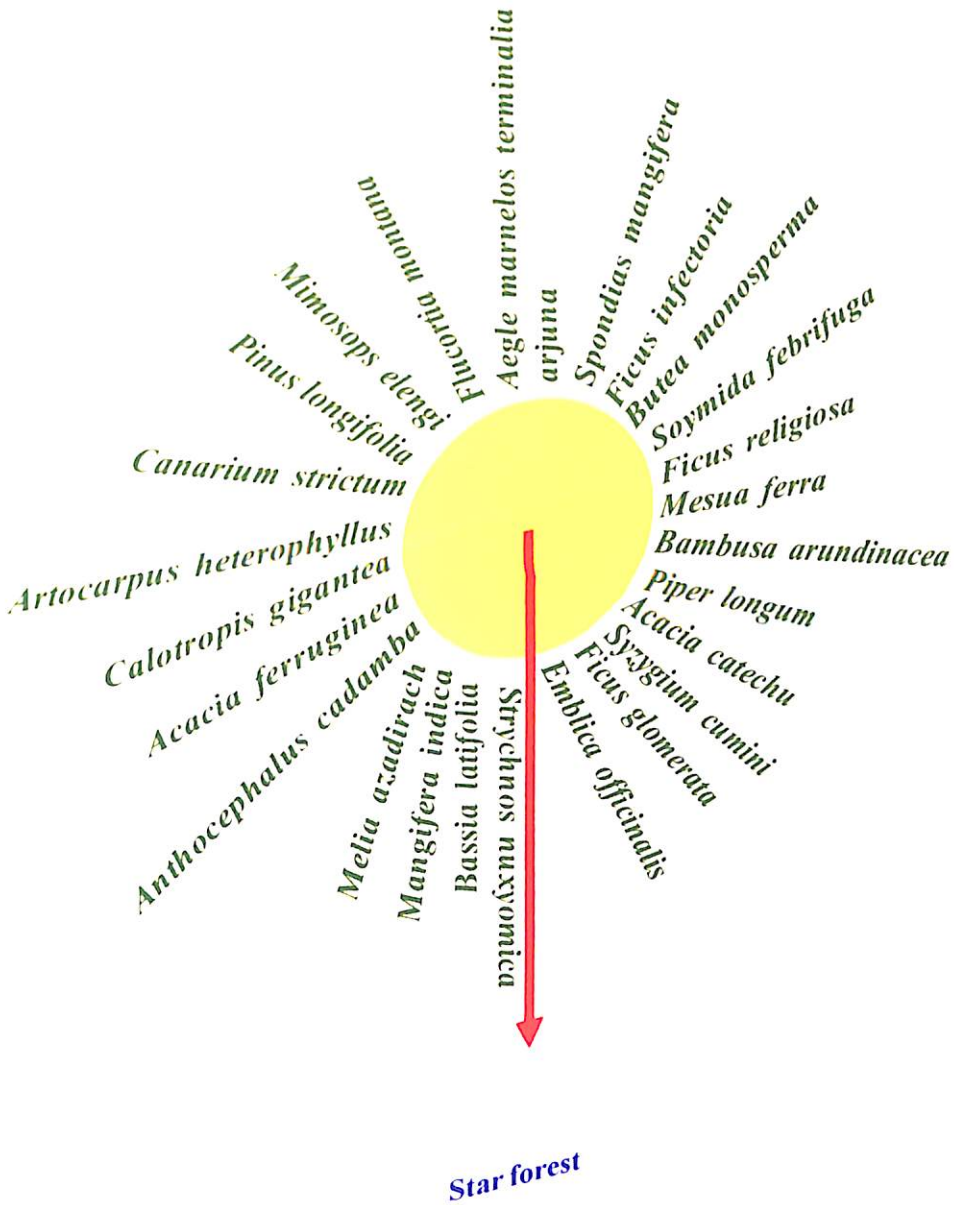


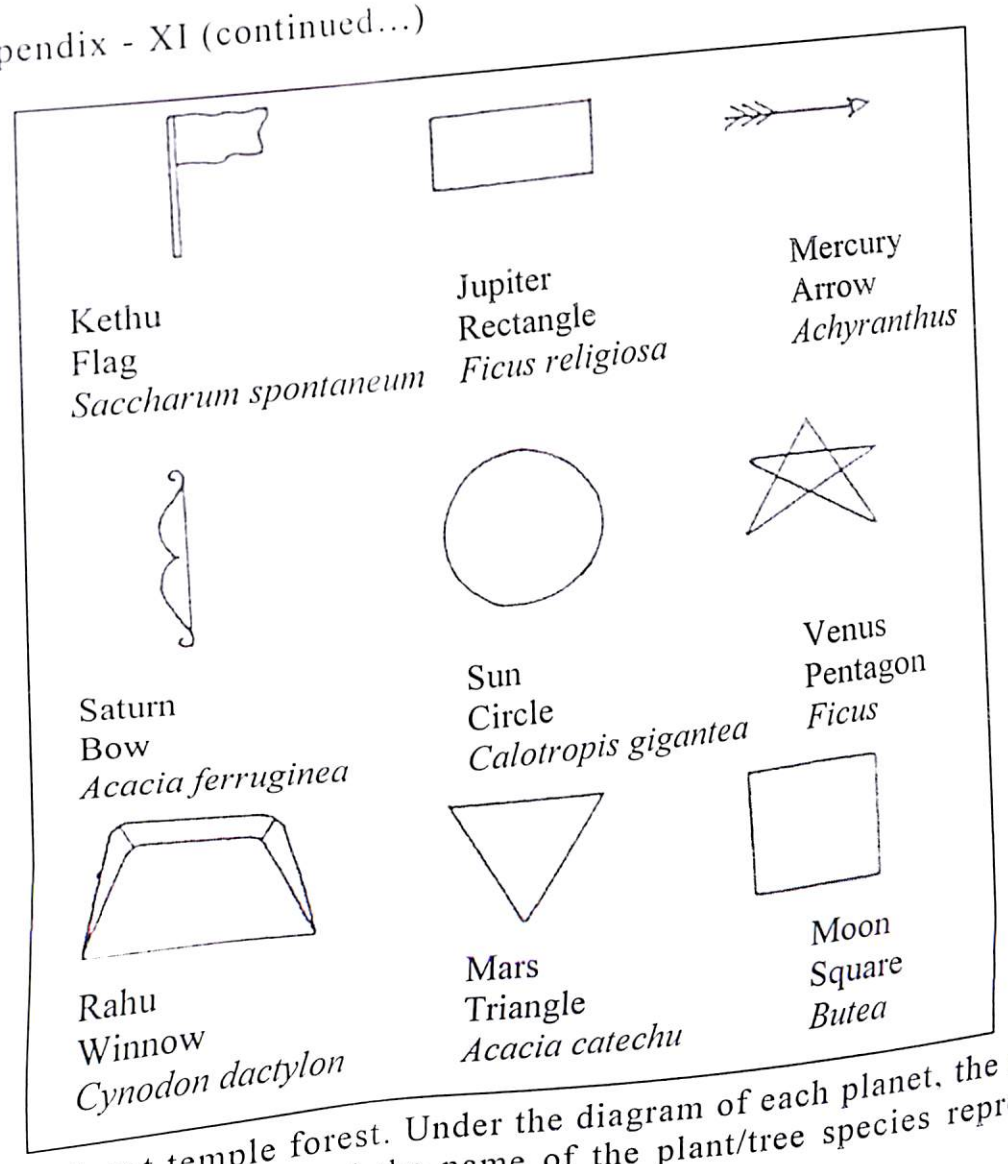
Plate 2. Types of homegardens (continued…)
(homegarden with eco-tourism activity in Alappuzha district)

APPENDIX - XI

Tree plant species and religious beliefs



Appendix - XI (continued...)



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Zodiac forest. In each of the cells, the zodiach sign, name of the controlling planet and the name of the tree species representing the zodiac sign are furnished in that order.

TECHNOLOGY ASSESSMENT IN THE HOMEGARDEN SYSTEMS

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Abstract of the
thesis submitted in partial fulfillment of the requirement
for the degree of

Doctor of Philosophy in Agriculture

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ABSTRACT

Homegardens of Kerala presents a traditional agroforestry system designed to meet the food, fodder, fuel wood and timber requirement of the farm households and to generate supplementary income through the sale of surplus (Salam and Sreekumar, 1991). The homegarden system has its unique structural configuration and cropping patterns. The structural and functional diversity of this farming system makes it a unique one. It is the predominant type of agricultural production system in the state of Kerala (Shehana *et al*., 1994).

This study was undertaken in the Southern Kerala comprising Thiruvananthapuram, Kollam, Alappuzha and Pathanamthitta districts covering a sample size of 208 homegardens using multi-stage stratified random sampling technique which, examines the structural configuration, cropping system, type of homegardens, extent of contribution of dominant homegarden components to the annual homegarden income, marketing channels of major products contributing to the homegarden annual income, extent of adoption of technology/scientific practices, its relationship with the socio-personal characteristic of individual farmers, identifying the technology need of the homegarden farmers, the delineation of dimension of technology suited for homegardens and constraints experienced by homegarden farmers.

The structural configuration, cropping patterns and type of homegardens were identified using the measure of Shannon and Wiener diversity index (Sagar and Singh, 1999), species richness (Margalef, 1958) and measure of evenness (Pielou, 1969). The measure of dominance in terms of structural, numerical and economic dominance was developed for the study. Based on this, ten major dominance systems were observed in homegardens.

Types of homegardens were delineated based on added components to the homegarden primary structure. Six types of specialised homegardens were thus identified based on the additions to primary structure. Two more types were identified based on socio-cultural components in homegardens.

On the economic front of homegardens, the extent of contribution of major components towards annual homegarden income, it was found that livestock, rubber and tapioca in Thiruvananthapuram; rubber, livestock, pepper and coconut in Kollam; livestock, coconut, arecanut and pepper in Alappuzha and rubber, livestock and coconut in Pathanamthitta contributed to a greater extent in terms of annual homegarden income. Marketing channels for the different crops in four districts were also identified and classified.

Technology assessment revealed that a limited quantity of technology reached the homegardens. Only two-third of the respondents fell under medium category of adoption of scientific practices/technology. Factors influencing the adoption of scientific practices were identified as education, annual homegarden income, extension contribution, market orientation and knowledge on technology in homegardens. Fifty-four indigenous practices (ITK practices) were observed to be followed by the homegarden farmers. Maximum technology need was reported for unexploited and under exploited horticultural tree crops which was on par with fruit tree crops (mango and jack) and followed by beverage crops. Processing, value addition and storage requirements were immediate technology needs of the homegarden farmers. Drainage and soil amendment technologies were reported to be important for Alappuzha homegarden farmers. On delineation of dimensions of technologies as perceived by homegarden farmers, agricultural officers and scientists, twenty-four dimensions were felt important by all categories of respondents. Additional nine dimensions perceived by the farmers were found to fall out of the ambit of extension and scientific community revealing that there is a major requirement either overlooked by the scientific/extension system, which is yet to be bridged. The foremost constraint identified was surplus produce but that was insufficient for marketing.

To conclude, primarily a system with dominance has been developed which is again derived from diversity index, species richness, evenness and measure of dominance. Variability in homegardens exists within regions, within and between districts, but was not influenced by holding size. Above all constraints, technology requirement and delineated dimensions of technology was worked out based actual homegarden situation, thus providing a holistic approach to the entire homegarden scenario of the four districts under study.