PARTICIPATORY TECHNOLOGY INTERVENTION AND ITS ASSESSMENT THROUGH ENVIRONMENTAL SCANNING OF HIGH RANGE HOME GARDENS IN IDUKKI DISTRICT: AN ACTION RESEARCH

by

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(2017-21-008)

THESIS

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DECLARATION

I hereby declare that the thesis entitled **"PARTICIPATORY TECHNOLOGY INTERVENTION AND ITS ASSESSMENT THROUGH ENVIRONMENTAL SCANNING OF HIGH RANGE HOME GARDENS IN IDUKKI DISTRICT: AN ACTION RESEARCH"** is a bonafide record of research work done by me during the course of research and the thesis has not been 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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Nithish Babu

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Place: Vellayani

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LIST OF ABBREVIATIONS AND SYMBOLS USED

@	At the rate of
%	Per cent
AICRP	All India Coordinated Research Project
ANOVA	Analysis of variance
B:C	Benefit : Cost
CD	Critical Difference
cm	Centimetre
CY	Court Yard
DAS	Days after sowing
DAT	Days after transplanting
DSI	Disease Severity Index
et al.	and others
EWS	Economic water scarcity
FGD	Focus Group Discussion
Fig.	Figure
FLD	Front Line Demonstration
g	Gram
$g\ L^{-1}$	Gram Per litre
ha	Hectare
ha^{-1}	Per hectare
HG’s	Home gardens
HHG’s	High range home gardens
IUCN	International Union for Conservation of Nature

K	Potassium
KAU	Kerala Agricultural University
kg	Kilogram
kg ha^{-1}	Kilogram per hectare
LAI	Leaf Area Index
LWS / NWS	Little water sacrcity/No water scarcity
Max	Maximum
MAP	Months after planting
Min	Minimum
MR	Mid Region
N	Nitrogen
NS	Non -significant
No.	Number
O	Oxygen
OR	Outer Region
P	Phosphorous
PWS	Physical water scarcity
$Plant^{-1}$	Per Plant
POP	Package of Practice
SO_4	Sulphate
SD	Standard Deviation

SE	Standard Error
Sl.	Serial
sp. or spp.	Species (Singular and Plural)
SZ	Southern Zone
VFPCK	Vegetable And Fruit Promotion Council Keralam
viz.	Namely

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INTRODUCTION

1.

1 INTRODUCTION

Global food production needs to be increased by 70 percentage in order to overcome the growing food demand and cope with the daily caloric requirement of the population in 2050 (FAO, 2013). More interventions are needed as the resources required for the food production like land, water, labour and credit are becoming scarce and extortionate. Home gardening can be taken as a strategy to tackle the problems associated with food production and nutritional security. Home gardens are widely adopted and practiced across the globe by local communities with available resources.

The term home garden is chosen since it emphasized intimate association between the group of people residing in the house and garden (Eyzaguirre and Linares, 2004). Home gardens are unique agro forestry with diversified components and characteristics, but whose biophysical and socioeconomic characters have not been studied sufficiently. These intensive agro forestry ecosystem involving the thoughtful management of multipurpose wood component trees and shrubs grown in close association with herbaceous species including annuals, perennials and seasonal crops along with livestock and all these components are managed with the premises of individual household (Fernandes and Nair, 1986). Home garden come up with a connection between the social and biological linking in the process of cultivated crops and the ecosystem (Hodgkin, 2002).

Multistoried arrangements of crop species and diversity of species prevent the problems arising due to the mono-culturing practices (Nair, 1993). Home gardens also serve as a means to gratify some special functions *viz.*, status symbol, magical values, and religious ceremonies (Arifin *et al*., 2002). Home garden also help to retain greenness and biodiversity by providing services such as shade and pollination also act as wind breaks adding aesthetic value to people of urban areas (Niemela, 1999).

Home garden system of Kerala are representation of typical traditional agro forestry system with complex structure and functions and designed to meet the demand of farm household like food, fodder, fuel wood and timber also serve additional income to the family through the sale of surplus produced (Salam and Sreekumar, 1991). Home garden in Kerala is conditioned by ecological and socioeconomic imperatives. They are need based, intensive and combined multispecies production system around the small dwellings with the objective of efficient utilization of resources along with ecologically viable and sustainable production units. Most of the home garden follows multistory cropping pattern (Shehana *et al.*, 1992). Various type of plants and animal species present in the home gardens do not follow any specific geometry, thus make them difficult to understand the spatial or temporal structure of the home garden.

Home gardens are rich in species diversity which makes them ecologically sound and economically sustainable. Modernization and monoculture practices with focus on the cash crops like rubber is threatening the integrity and continuity of the home garden ecosystem. The farmers in rural areas mainly depends on the home gardens than monoculture to support and stabilize their household food production and nutritional security and thereby increasing the quality of their life.

Ability of a household to attain its full potential of agricultural production depends upon the innovativeness and the rate adoption of new technology. Inaptness of several interventions, outdated economic policies, price and market linked issues are the main reason of low rate of adoption by the farmers. Development of innovativeness is a method consisting of different stages *viz.*, identification of problems, probing of alternate methods and their evaluation and validation (Werner, 1993). Several factors including farmer characteristics, farm structure, and institutional support are determining adoption behavior of the farmers (Mwangi and Kairuki, 2015). Farmers adoption behavior of new technology rely mainly on the interaction between the technology characteristics and other array of conditions including net benefit in terms of cost (Lovinsohn *et al.*, 2013).

Farmers in different agro ecological zones need to access a wide variety of locally validated technologies since the requirement technology is different in different regions (Swanson *et al*., 1997). Different organizations including the state agricultural universities and national institutes of agriculture have rendered immense contributions in the development and spread of new technologies appropriated for various agro-climatic regions in the country. Department of Agriculture and other government and nongovernment agencies related with agriculture had been influential in speedy transfer of technologies to the farming community (Butter and Kolar, 2000).

Idukki is unique when compared to other districts of Kerala in terms of its distinctive landscape and variations in climate in the region of midland and high ranges. The Western Ghats are one among the hotspots in the world with rich flora and fauna. It was observed that the existing agro climatic conditions suitable for the growth of sensitive crop like cardamom has undergone variations due the result of land use modifications. The same situations were there with other dominant crop species in the region (Jha *et al.,* 2000). Studies showed that settlement areas in Idukki hardly occupied 0.73% in 1910 were increased to 30.57% in 1997 (Raju and Kumar, 2006) by depletion of forest land and grass land. The depleted grass land and natural forest areas was used for the buliding of houses, cash crops and infrastructure facilities in the slide slopes without sufficient and proper land management measures resulted in drastic land degradation and the cuurent situation of exhausted land is about 14.12 % of the total geographical area.

Several institutions play massive role in the development of technologies, and effective utilization of this technology is required for employability of the individual and accelerated production (Thomas, 2004). Dissemination of these technologies by extension system is mainly done by crop in isolation and it became remarkable and meaningful when it is evaluated in high ranges.

Hence the present study entitled "Participatory technology intervention and its assessment through environmental scanning of high range home gardens in Idukki district: An Action Research" was taken up with following objectives:

i. To identify the crop dominance cum its technology gaps through environmental scanning of the high range home garden systems.
ii. To conduct action research for assessing the technology adoption through participator technology intervention.
iii. To delineate the dimensions of technologies suited for high range home gardens in order to design the technological forecast for sustainable high range home garden systems.

Scope and importance of the study

Home gardens are a part of the total agro-eco systems, their development cannot be considered in isolation. An exploration on the structure and diversity of high range home gardens of Idukki district would aid in extension and research systems to frame new research ideas based on the dominance of crops. Hence, establishing the crop dominance becomes imperative part of the study.

Irrespective of the inclusion of crops and its technologies in home gardens, these have been disseminated by extension systems considering crops in isolation. Hence, it becomes very important to study home gardens and associated technologies in high ranges where in the agro climatic conditions are unique. So recognition of technologies suitable for highrange homegarden systems, its dimensions and assessing the technology for its adoption becomes an imperative part of the study.

The study is a maiden attempt to conduct a back-of-the envelope analysis of the high range home garden system technologies and its dimensions as perceived by different stakeholders which will contribute towards a technology forecast. The technology forecast can serve as a useful feedback to the research system for designing technologies useful to the rapidly changing agro-eco systems of this fragile and unique farming system that ultimately will help the majority of small and marginal farmers through increased economic returns and enhanced development process of the state.

Limitations of the study

The study was conduted as part of the doctoral research programme and was confined to the Idukki district in Kerala. Hence, the study cannot be generalized for the entire state. Besides, the unique nature of Idukki district *viz.*, undulating topography, large sized home gardens, comparartively large distance between home gardens and unpredictable climate made the research a tedious task. In addition to the aforesaid challenges, the researcher commuted difficulty in enumerating data on crop components for exploring biodiversity of the home gardens due to its ever evolving nature.

However, the researcher made sincere effort to make the research objective, systematic and reliable.

Presentation of thesis

The thesis is divided in to five chapters, of which the first chapter, 'introduction' deals with the relevance of the topic, objectives, prospects and constraints of the study. The second session, 'review of literature' deals with available literature pertaining to the present study and the third session 'methodology" comprises of research design, study location, measurement of independent and other variables, data collection procedure and statistical methods used. Fourth chapter 'results and discussion' comprised of the results obtained from the research along with specific conclusions. The fifth chapter, 'summary' consist of the salient findings of the research work. The references, appendices and abstract of the thesis are given in the end portion of the thesis.

2. REVIEW OF LITERATURE

As the global population is expected to reach over nine billion by 2050, there is a continuous need to increase food production and buffer stock. In this scenario, world nations are eagerly exploring the various strategies to curb the growing food demands of the people and ensure food security. Consequently, much attention is driven towards home gardens as a strategy to enhance household food security and nutrition.

Kerala, often consecrated as the “Mecca of home gardens”, 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 population density, the size of the farm holding is exceedingly small, ranging from 0.02 ha to less than a hectare (Kumar and Nair, 2006). In Kerala, home gardening is an incredibly old tradition that has evolved from the practices of the hunters/gatherers to the modern practices we see today. The home garden systems in Kerala is an excellent example of ecological and socioeconomic imperatives with efficient utilization of resources along with ecologically viable and sustainable production (Shehana *et al.*, 1992).

The literatures collected based on objectives of the study is divided under following subheadings.

2.1. History of home garden

2.2. Definitions of home garden

2.3. Types and characteristics of home gardens

2.4. Home gardens of kerala

2.5. Cropping pattern in the home garden

2.6. Crop dominance in homegarden

2.7. Species composition and diversity profile in homegarden

2.8. Structure of homegarden

2.9. Technology in homegarden

2.10. Crowd sourcing of knowledge and action research through frontline demonstration

2.11. Personal and social charcteristics of highrange homegardens

2.12. Gender role in home garden

2.13. Constraints and solutions in the homegareden system

2.1 HISTORY OF HOME GARDEN

Home gardening is the oldest land use activity next to shifting cultivation. Literature has been reviewed and conferred to identify the evolution of home gardens.

Home gardens, the time- tested models, are evolved through the years of cultural and environmental vagaries. The spontaneous growth of plants near to the dwellings from the leftovers of plant products collected by the ancient people led to the development of home gardens. The first available data of home garden activities dates back to at least 3000 BC, probably in the Neolithic period (Soemarwoto, 1987; Soleri and Cleveland, 1989).

The archaeological evidence from Amazonian regions revealed that the agricultural activities were first concentrated near the human dwellings (Latharp, 1977). Miller and Nair (2006) reviewed the history of Amazonian home gardens and pointed out that the tribal home gardens were composed of fruit plants and other useful plants and it plays a vital role in subsistence agriculture and cultural background of tribal people of Amazon region.

Aftermath of colonial invasion, epidemics and wars hampered the rich tradition of indigenous societies of Amazone, yet the traditional home gardens survived and flourished with exotic fruit crops and cash crops catering to the requirements of farm family (Miller *et al.,* 2006).

Cros Karpati *et al.* (2004) reported that during the socialist period, people were allowed to cultivate the crops near to the homesteads for meeting their domestic needs and was considered as a form of home garden in Hungary.

The home gardens of South Asia was believed to be originated during the period 13000 to 9000 BC in moist tropic regions inhabited by the fisherman community who settled near the fertile river banks (Sauer, 1969). The home gardens were spread to Indonesia, Bangladesh, Philippines, Thailand, Sri Lanka and India with time (Wiersum, 2006).

The home gardens were mostly observed in the matriarchal societies of Indonesia and the size of home gardens may vary from 100 to several thousand square meters and also it occupy about ten per cent of the total land area of a district in Java (Raffles, 1817: Penny and Ginting, 1984). Michon (1983) reported that tree-based home garden systems were present in certain parts of Java in the tenth century AD itself. The home gardens in Java were believed to originate in seventh millennium B.C. (Hutterer, 1984).

The great Indian epics, Ramayana and Mahabharata presumed to have happened in 7000 BC and 4000 BC contains a description of Ashok Vatika, a pre-indicate of modern home gardens (Puri and Nair, 2004).

Randhawa (1980) recorded that the travelers in India already described the home gardens of Kerala with crops *viz.,* coconut, black pepper, ginger, sugarcane and pulses dates back to the fourteenth century itself. He also pointed out that Ibn Battuta, the famous voyager mentioned about the peculiar homesteads of Kerala surrounded with dense vegetation especially in the Malabar Coast of Kerala in his travelogue written during 1325-1354.

2.2. DEFINITIONS OF HOME GARDEN

Home gardens are defined in various ways underscoring the different aspects based on the frame work or emphasis and objectives of the research.

Home gardens are defined as the time tested experimental beds that continue to play a vital role in food security and income generation for the farmer family (Marsh, 1998).

Kumar and Nair (2004) suggested that home gardens are the oldest agricultural land use systems with maximum number of species in a unit area. They also pointed out that there is no standard definition for 'a home garden', but it can be identified as 'an intimate, multi-storey combinations of various trees and crops, sometimes in association with domestic animals, around homesteads' and also suggested that home gardening is mainly concerned with cultivation of vegetables, fruits, and herbs especially for meeting domestic needs.

Generally, home gardens can be defined as the cultivation of a small portion of land which may be around the household or within the walking distance from the home (Odebode, 2006). It can also described as a mixed cropping system which consist of vegetables, fruits, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as an additional source of food and income.

Eyzaguirre and Linares (2010) also defined that home garden as a distinct entity with multi-layered crop canopy and multi-purpose area adjacent to the household that function as a small-scale system for food production retained by the farmer family, and one that comprises of a varied collection of plant and animal species that imitate the natural eco-system.

2.3. TYPES AND CHARACTERISTICS OF HOME GARDENS

Home gardens can be classified differently according to the area we are choosing for gardening. A wide variety of plants can be customized in and around the home in different ways and they are commonly identified as vegetable/kitchen garden, flower garden, tire garden, container garden, greenhouse garden, balcony garden, terrace/rooftop garden and wall/vertical garden (Bleasdale *et al*., 2010).

There is a broad range of literature presenting the different characteristics and role of home gardens. Ninez (1984) differentiated two types of home garden based on the economics of the household *viz.,* subsistence gardens and budget garden. He also pointed out that home gardens can be classified in to tropical and temperate based on the ecology.

Ninez (1984) has also listed characteristics of a typical home garden food production system based on 15-type specific characters and presents the development of home gardens across the world.

Mitchell and Hanstad (2004) have identified five important characters of home gardens as situated near household, owns a rich biodiversitythat includes rare species, main source of family consumption and income, occupy a small area and a production system that the poor can easily handle.

Home gardens generally raised on marginal land are not suitable for field crops or forage cultivation because of their size, topography, and location (Hoogerbrugge and Fresco, 1993). The specific size of home garden may differ from homestead to homestead and usually, it will be less than the size of the arable land owned. Introduction of new innovative techniques has made home gardening possible even for the families that have little land or no land at all (Ranasinghe, 2009). Home gardens may be limited by physical demarcations like live fences or hedges, fences ditches or boundaries established through mutual understandings.

The decisions related to the home garden system includes selection of crops, harvesting, management and so forth. Such decisions mostly depend on the consumption and income generation needs of the household (Cai *et al*., 2004). Wiresum (2006) noticed that the socioeconomic status of the household plays an important role in the structure, composition, the intensity of cultivation and diversity of home gardens. Kabir *et al*. (2016) also opined that the strong predictors of home garden vegetation characteristics are the size of landholdings, income, homestead size and time spent.

Each home garden is unique in their structure, function, appearance, and composition since they depend on the natural ecology of the location and available family resources including family labour, skills, preference, and enthusiasm of the family (Asfaw, 2002). Home gardens in Kerala are also combined with livestock rearing, where the different components interact synergistically to sustain productivity. Such evolution of home gardens in Kerala represents the wisdom and insight of farmers in response to the shrinking of arable lands (Kumar and Nair, 2004).

A study on the structure and dynamics of home gardens in Kerala revealed the presense of four different types of home gardens which includes traditional home gardens, adapted traditional home gardens, incipient modern home gardens and modern home gardens (Peyre *et al.*, 2006). Chandrasekara and Baiju (2009) investigated on the home gardens of Kerala classified the home gardens to old mixed-species home gardens, new mixed-species home gardens, old single-species home garden and new single-species home gardens and also suggested that Kerala home gardens were shifting from mixed cropping systems to single cash crop dominant agroecosystems.

2.4. HOME GARDENS OF KERALA

Kerala, the Gods own country, bequeathed with rich biodiversity and tradition is often sanctified as the heaven of home gardens. Home gardens of Kerala have long been considered as important multipurpose agroforestry systems that ensure environmental and socioeconomic sustainability. Home garden systems are the prime source of nutrition and income for many households of Kerala, thus contributing to the food and nutritional security of the state. It was considered as low input agricultural production systems which exhibit structural and temporal resemblance with tropical home gardens (Jose and Shanmugaratnam, 1993). However, the home gardens of Kerala, once renowned for its rich biodiversity was in an ill-fated status owing to the anthropogenic activities and socio-economic pressure (Kumar and Nair, 2004).

A study on the structural and functional dynamics of home gardens in Kerala revealed that four development stages were observed along a gradient from traditional to modern home gardens. About 50 per cent of the home gardens still followed the traditional features, while 33 per cent integrated modern methods. The new trends exhibited by home gardens include a gradual shift to cash crops, a decline in multipurpose tree crops and over dominance of ornamental plants. Furthermore, structural homogenization and overuse of external inputs create a negative impact on the sustainability of home gardens in Kerala (Peyre *et al*., 2006).

A study conducted on the homestead farms of Southern Kerala revealed that the home gardens were repositories of plant biodiversity and were under the threat of monoculture of crops like rubber (Regeena, 2007). Chandrashekara (2009) surveyed on the distribution and diversity of fruit trees in the coffee-based home gardens of Kerala revealed a higher diversity of fruit trees in the homesteads of high range regions which denoted that the traditional features of the home gardens were still conserved in certain home gardens of Kerala. The incorporation of tree species provides shade, firewood, timber, soil fertility, fencing and edible fruits along with ensuring ecological sustainability in the home gardens.

Chundamannil and Krishnankutty (2010) investigated on the extent of medicinal plant cultivation in the home gardens of Kerala and reported that the growing demand of medicinal crops and reduction in the accessibility of forest produce led to the incorporation of more medicinal plants in home gardens.

A study conducted in the 45 homesteads of Thrissur district revealed that coconut-based homesteads were the predominant one followed by banana-based home gardens. The species diversity was influenced by the size of the holding and highest species diversity was documented in small landholdings and also in the home gardens situated in low elevation regions (Krishnapriya, 2011).

An investigation on the structure and biodiversity of homesteads in Kerala revealed that the home gardens exhibited a unique structural configuration and as considered as the dominant agro ecosystems of Kerala. The highest biodiversity was recorded in the home gardens of Wayanad district and the least was noted in Thiruvananthapuram and suggested that geographical factors contributed to the variation in biodiversity (Thomas and Kurian, 2013).

The floristic diversity and related ethno botanical information were documented from the home gardens of the Cherpu block in Thrissur and the study revealed that the traditional home gardens were maintained as such with higher species diversity and offered multiple ecosystem services. The reduced interference of plantation crops and monoculture in this region promotes the maintenance of higher biodiversity in home gardens which in turn ensures nutritional security and increased carbon sinks (Vijayan and Gopakumar, 2015).

Kunhamu *et al.* (2015) analyzed the floristic diversity of per urban homesteads of Trivandrum district reported that the rich biodiversity of home gardens were dwindling and the dependence of people on home gardens for livelihood security was also diminishing which pointed to the ill-starred impact of urbanization.

2.4.1. Home gardens in high ranges

Home gardens being a vital part of total agro ecosystems, their development cannot be considered in isolation. Hence, the reviews depicting the home garden situation of the Idukki districts are described here.

Idukki district has a distinctive landscape with midland area towards the west and highland area towards the east. It experiences a moderate climate in the midland areas and the temperature here varies between 21 and 31 degree Celsius, with minimal seasonal variation. In the highlands or high ranges, the temperature varies between 13^0C and 25^0C during winter. This makes this district unique with distinct temperature differences when compared to other districts of Kerala.

It was observed that the Western Ghats of Kerala have been settled by landless immigrants for more than forty years. Natural forests and cardamom have been mostly replaced by smallholder cultivation. In the initial three years of clearing the forest canopy, cassava and other annuals were cultivated predominantly. Gradually black pepper dominant cropping pattern along with other perennials became prominent after 5-15 years of the clearing. A highly mixed home garden became most common on sites, 15-20 years after the forest canopy was removed (Moench, 1991).

Sustenance of sensitive crop like cardamom has changed due to the impact of medications on land use systems in the region (Jha *et al.*, 2000). Many studies showed that the settlement areas in Idukki especially that of Udumbanchola that occupied narrowly 0.73 per cent in 1910 were increased to 30.57 per cent in 1997 (Raju and Kumar, 2006) by conversion of forest lands, grassland, and cardamom plantations. Due to the degradtion of natural forest ecosytems by the creation of houses, cash crops and infrastructure facilities, combined with the absence of sufficient land management measures in the side slopes resulted in severe land degradation and the present status of degraded lands is about 14.12 % of the total geographical area.

It was reported by Ramachandran and Reddy (2017) that vast areas of forest decline were posing severe implications and consequences in the agrarian scenario of Idukki district including the Western Ghats.

Herbs in Idukki were primarily acquired through home cultivation, with a few uncommonly used ones limited to the forest. Almost all families were engaged in home garden activities but the biodiversity and extent to which medicinal plants were integrated into the home landscape vary greatly. The possession of traditional knowledge has improved the household self-sufficiency, health, and ecological conservation of essential species for future generations (Gaunt, 2015).

High ranges are rich in species diversity and are unique in their agro climatic conditions. So, an assessment of technology forecast in this unique system makes the picture of homestead in high ranges clearer and more transparent.

2.5. CROPPING PATTERN IN THE HOME GARDEN

Home gardens are popularly known worldwide as an epitome of a sustainable agroforestry system (Torquebiau, 1992). Home gardens are a unique land-use system involving deliberate management of multipurpose trees and shrubs in an intimate association with herbaceous plants and livestock in the vicinity of a household. It involves the traditional land use activities around a homestead where different kinds of plant species are maintained by members of the household and the products are primarily used for household consumption (Shrestha *et al*., 2001). Kumar and Nair (2004) suggested that food crops, medicinal plants, ornamentals, fruit trees, multipurpose trees and fodder crops are found in abundance in the home gardens.

The crop combinations that follow home gardens of a region are determined by specific needs and preferences of the household and nutritional requirements besides the socioeconomic and ecological factors (Christanty *et al.,* 1986; Vogl *et al*., 2002). Based on the nature and types of the component used, tropical home gardens can be classified into the agrosilvopastoral system and agrisilvicultural system. Agrosilvopastoral system consists of herbaceous crops, woody perennials, and animals, while agrisilvicultural system represents only the first two components. However, home gardens are not static in nature, they are adaptive in accordance with the changes in the rural and livelihood conditions (Wiersum, 2006).

Beyane *et al.* (2018) conducted a study related to home garden dynamics in Southern Ethiopia and observed a shift from food-oriented *enset*-based to cash crop oriented *khat*-based systems and enset-livestock systems combined food and cash crop oriented enset- cereal-vegetable systems.

2.6. CROP DOMINANCE IN HOME GARDENS

A key assumption in the home garden studies was as with higher species diversity the socio-economical sustainability of the system exhibited a manifold upsurge. The traditional home gardens are undergoing different conversion processes linked to socioeconomic changes. Modernization processes in the home gardens have led to a reduction in tree/ shrub diversity, an escalation in the cash crops and ornamental plants has resulted in gradual homogenization of home garden structure and higher use of external inputs (Peyre *et al.,* 2006).

In general, food and fruit-producing species dominated in a garden adjacent to human dwellings and small plots of annual vegetable crops occupy these region and timber species were located at the outer region of home garden. Medicinal and ornamental species are exclusively cultivated in small areas or plots adjoining the house, and vegetables are in areas near to the kitchen. It needs to be clarified that such vegetable and ornamental gardens, may not have agroforestry implications; but they all usually suits well into a land-use system surrounding the home in a relatively small area of land (often less than 0.5 ha), and the whole unit is referred to as ‘home garden’(Kumar and Nair, 2004).

The enset-coffee home garden agroforestry systems were practiced early in the Southern Nations Nationalities and Peoples Regional State (SNNPRS) of Ethiopia. Gradually, enset was replaced by maize and coffee and was replaced by financially appealing cash crops such as khat and pineapple (Abebe *et al.,* 2010). Invasion of exotic and ornamental species was reported in the traditional home gardens of the Nuba Mountains in Sudan. They have been increasingly subjected to the introduction of exotic species which have become dominant and indicated a trend towards the loss of traditional plants species and farming practices (Wiehle *et al*., 2014). A study conducted in South West Uganda pointed out that the food commodities were the most dominant crops in the home gardens while highest species diversity was documented in medicinal plants followed by fruits and vegetables (Whitney, 2017).

Pandey *et al*. (2007) conducted a study to evaluate the crop dominance in different regions of Andaman revealed that the dominance of spice crops was noted in the home gardens of South Andaman whereas North Andaman recorded with mango and citrus as the predominant crops. The parts of Little Andaman occupied with pineapple and vegetable crops depicted that crop species differed in different parts of Andamans.

Sahoo (2009) analyzed the traditional home gardens of northeast India and identified seven major plant use categories. They recorded vegetables as the dominant crops followed by medicinal and spices in herbs groups. In shrub categiory, it was vegetable followed by medicinal and miscellaneous species. However, in the tree group dominant category were fruits species followed by multipurpose and timber tree. On comparing the entire home gardens, vegetables (32%) were the major constituent in home garden followed by fruits and medicinal plants.

Barbhuiya *et al.* (2015) analyzed the home gardens in Mizoram and recorded that medicinal plants were the predominant crop group followed by food crops, ornamentals, woody plants and spice crops.

Niyas *et al.* (2016) investigated on the structural and functional dynamics of urban and peri-urban homesteads of Kerala and identified that fruit crops were the predominant crop in urban areas of Thrissur followed by ornamentals whereas peri-urban regions were dominated by fruit crops followed by woody plants and medicinal plants.

2.7. SPECIES COMPOSITION AND DIVERSITY PROFILE IN HOME GARDENS

Home gardens are regarded as traditional forms of land-use common in tropical regions of the world and are illustrious examples of species diversity in cultivated and managed plant communities. Biological diversity (Biodiversity) is often used as a synonym for species diversity. The important role of biodiversity in sustaining food production and protecting human and ecosystem health is now universally recognized, and land use systems that promote and improve biodiversity are considered to be quite desirable from that perspective. The species diversity in home gardens mostly depends on the climate, altitude, cultural factors, socioeconomic factors and nearness to markets. The diversity and density of species usually increase with rainfall and elevation (Rao and Rajeswara, 2006).

Home gardens are magnificent examples of species diversity in cultivated and managed plant communities. Watson and Eyzaguirre (2002) opined that several landraces and cultivars including rare and endangered species have been conserved in the home gardens.

The variations observed in the species richness from place to place could be attributed to the income difference, altitude, personal preference of species, soil type and home garden size. Ewuketu *et al*. (2014) conducted a study on plant diversity in Jabithenan District, North-Western Ethiopia identified about 69 species from 48 studied home gardens. A study conducted in northern Ethiopia revealed that 80 per cent of the surveyed households were practicing home garden agroforestry system and recorded with 22 plant species belonging to 15 families in the sampled home gardens (Beyane *et al*., 2018).

Gautam *et al.* (2008) analyzed the crop dominance of home gardens in Nepal identified that the most specious rich group was the vegetable followed by fodder, fruits and spices. They also pointed out that the species diversity exhibited a positive correlation with size of the gardens. Whitney *et al.* (2017) evaluated the crop diversity in home gardens of Uganda revealed that a total of 209 species with a Shannon's diversity index of 1.65, species richness of 25 and Pielou's index of 0.53 which denoted the higher species diversity in the region.

A study on diversity profile of 408 home gardens of Bangladesh was carried out and the results revealed a higher biodiversity with 419 plants under 109 families, of which six plants belongs to IUCN Red List category. The study also suggested that serious efforts should be invented to conserve the rare plant genetic resources in the study area (Kabir and Web, 2008).

Such variable and discrete accounts of species diversity have been reported from other parts of India as well. About 122 species were identified from home gardens in Barak valley of Assam (Das and Das, 2005), while a high figure of 294 species were recorded from the upper Assam (Devi and Das, 2012). Sharma *et al*. (2014) surveyed 100 home gardens in urban areas of Raipur, Chhattisgarh, and opined that home gardens influence ex situ conservation and are repositories of many rare medicinal and endangered plant species and recorded about 168 rare species of medicinal plants. Vibhuti *et al.* (2018) documented a total of 111 plant species under 55 families from home gardens in Central Himalaya and also recorded the maximum number of species diversity in home gardens located in medium altitude region.

Farm size is the factor influencing the species richness within the area. Kumar *et al*. (1994) conveyed that floristic diversity (measured by the number of species per unit land area) in Kerala was greater in small gardens (<0.4 ha size) (Simpson's diversity index, D = 0.61) than in medium (0.4 to 2.0 ha, D = 0.44) and large (>2 ha, D= 0.46) garden, and also reported that the diversity profile of the home gardens were also influenced by the religious or cultural beliefs, customs, and taboos of the villagers.

Thomas and Kurian (2013) conducted a study on structural aspects and biodiversity of homesteads in Kerala and reported that the highest diversity was recorded in outer regions of home gardens followed by mid regions and courtyards. The higher biodiversity index of outer regions was owing to the factors such as planting of non-commodity trees and regeneration of neglected seed lots and the lowest diversity at courtyards was due to the plastering or interlocking of courtyard region.

Ajeesh *et al*. (2015) reported structural and functional features of the peri-urban home gardens of southern Kerala where 90 home gardens with 30 each belonging to three holding size classes viz. large (> 0.08 ha), medium (0.040.08 ha) and small (0-0.04 ha) were surveyed from Neyyatinkara Municipality area, Trivandrum. A total of 95 species were noted belonging to 80 genera and 35 families with Shannon's diversity index of 3.77, 3.23 and 3.87 for large, medium, and small home gardens respectively and respective value for Simpsons Dominance Index was 0.92, 0.89 and 0.81.

The study on functional diversity of urban and peri-urban home gardens of Kerala revealed that about 76 plant species were recorded from the peri-urban homesteads in Malappuram whereas comparatively lower diversity of 51 plants were documented from the urban homesteads of Thrissur. The home gardens in peri-urban region also exhibited a higher Simpson's dominance index and Shannon Index values *viz.*, 0.73-0.84 and 2.72 - 3.37 respectively. The urban homesteads recorded a Shannon Index of 1.53 - 2.03 and a Simpson's dominance index of from 1.53 - 2.03 which highlighted the decline in species diversity as a result of urbanization and associated socio-economic changes in the state (Niyas *et al.*, 2016).

A study conducted by George and Christopher (2020) disclosed that a total of 182 plants in 160 genera under 67 families were documented from the tribal home gardens of Attappady in Palakkad district with Shannon's diversity index ranged from 1.05 - 2.18. The highest diversity index was noted in the home gardens of Muduga (2.18) as it located in high rainfall area and also due to the proximity of settlements near non-tribal communities that influences the species diversity of the region.

2.8 STRUCTURE OF HOME GARDENS

A diverse range of plant and animal species are present in home gardens. Presence of this large number of species on the same land, mostly not following any specific geometry, makes it strenuous to understand the temporal /spatial architecture of home gardens.

The structural components of home gardens are orchestrated in such a way that a unique micro-zonal arrangement with precise vertical or horizontal stratification that cannot be separated from the whole system (Nair and Sreedharan, 1986).

A three-layered structural configuration was present in the home gardens of Andamans and were composed of palm, fruit, spice, and forest trees. The top storey (12–16 m) was always occupied by arecanut, coconut and forest trees. Trees like mango, jackfruit, neem, tamarind and *Ceiba* sp., formed the second storey (4.50–9.50 m) whereas spices like nutmeg and cinnamon, and fruit trees like papaya and lemon occupied the base storey (Pandey *et al.*, 2007).

Most of the home garden in Kerala follows a unique pattern with multistory cropping pattern. The upper layer of crop canopy was dominated by perennial crops *viz.,* coconut, arecanut, jackfruit, mango, cashew, tamarind and forest trees whereas the second layer was occupied by the spice crops *viz.,* pepper, clove, nutmeg and cinnamon The third layer of the crop canopy was dominated by banana, cassava, yam, and the crops such as ginger, turmeric, pineapple, vegetables, and guinea grass contributed to the ground layer (Shehana *et al.*, 1992).

2.8.1 Horizontal and vertical integration in home gardens

Many reports indicated the occurrence of distinct horizontal zones in the home gardens and their location, size and plant species composition reflect deliberate management strategies executed on the regions (Mendez *et al*., 2001).

One of the most distinguishing features of home gardens, especially in humid tropical lowlands is the multi-tiered canopy structure. Predictably, the vertical stratification ensures a gradient in light and relative humidity, which creates different niches for enabling various species groups to exploit them. The shade tolerant crops constitute the lower stratum, shade intolerant trees the top layer, and species with varying degrees of shade tolerance in the intermediate strata.

The species composition varies with an increase in the size of home gardens. In the studies conducted, home gardens showed a distinct horizontal structure arrangements zone between perennial plants and annual crops. It was noticed that in the middle of the gardens, vegetables, cereal crops, and fruit trees were typical features of most of the gardens. Horizontal structure of the species declined as one goes from the first to the fourth quadrat or out of the garden. As in the case of functional groups distribution in the gardens, most woody species were observed in the fourth quadrant whereas fruits and vegetables were frequently noticed in the second quadrat and cereal crops, pulse and spices were recorded in quadrat one. Vertical structure of the home garden reflected the species degree of specialization and complexity. Vertical stratification of the studied home gardens can be categorized into four major strata; upper storey (>10m), main canopy (5-10m), shrub layer (1-5m) and bottom layer <1m (Beyene *et al*., 2018).

Albuquerque *et al.* (2005) evaluated the structure of home gardens in Brazil identified a three layered stratum, of which the bottom layer extend to 1-3 m comprised of medicinal and fruit plants together with forage crop. The second stratum (3-7m) was occupied with multipurpose plants whereas the upper strata (7-12m) encompasses of woody perennials.

Zimik *et al.* (2012) reported five vertical strata such as emergent, canopy, understorey, shrub and herb in the studied home gardens of Assam and four vertical strata in the home gardens of Arunachal Pradesh, based on the average height of the plant species. Barbhuiya *et al.* (2015) reported that home gardens of Mizoram exhibited a three or four layered strata of plants which includes an uppermost canopy with woody perennials, a second stratum with annual and perennial plants and a third stratum with medicinal plants and other shrubby plants. The ground layer was occupied by the plants with less than 20 cm height and were mostly vegetables.

A study conducted in home gardens of War Khasi Community of Meghalaya identified four conspicuous strata *viz.,* A, B, C and D. The strata A or canopy layer was located at a height of > 15 m and usually occupied with woody perennial crops. The second layer (B strata or sub canopy layer) composed of medium sized trees of height ranged from 8-15m whereas the third layer also known as C strata or under canopy characterized with small tree species with a height of >8m and the bottom layer includes herbs and shrubs (<2m height) (Tynsong and Tiwari, 2010).

George and Christopher (2020) investigated the structural configuration of tribal home gardens in the Attappady region of Kerala. The analysis on structural configuration revealed the existence of two types of home gardens *viz.,* two-layered and four-layered vertical canopy strata. The top layer (10-15m) was dominated by areacanut, jackfruit, *Albizia* sp, *Ceiba* sp. and *Gmelina* sp whereas the second layer was occupied with plants *viz.*, coconut, neem, citrus etc. which reach up to a height of 5-10 m and these two layers contributed to the maximum diversity in tribal home gardens. The third layer has the height of 2-5 m and dominated by *Hibiscus* sp., tapioca, papaya, banana and the base layer (<1m) was occupied with ornamentals, vegetables and medicinal plants.

2.9. TECHNOLOGY IN HOME GARDEN

Technology can be defined as any tool or techniques, product or process physical equipment or method of doing or making something (Goldring, 1976).

Technology in the context of agriculture includes all forms of new farm inputs, practices, and services such as insecticides, herbicides, fertilizers, tube-well water, improved farm machines and equipment and agricultural extension services (Raju, 1982).

According to a certain sector of farmers, technology provides knowledge on how to cultivate and practice a crop successfully. Success in farming can be obtained by knowing how to apply fertilizer, control pests, and take care of the plant for its better growth. Another group of farmers opined that technology refers to knowledge regarding what crop varieties and what kind of fertilizers that are suitable for the soil (Chi and Yamada, 2002).

Technology has an unquestionable role in our day-to-day life. This is due to the fact that life without technology is meaningless in today's dynamic world. The various definitions pointed towards the fact that technology brings together tools that enable creation, use and exchange of information, and also played a significant role in performing as well as solving many issues related to human wellbeing.

2.9.1. Extent of adoption of technology in home gardens

Adoption is defined in different ways by various authors. Loevinsohn *et al.* (2013) defines adoption as the process integration of a new technology/ practices into an existing practice and is usually proceeded after a period of 'trying' and some degree of adaptation.

Adoption can be defined as a mental process that an individual passes from first hearing about an innovation to its final product (Rogers, 1982). Adoption can also be defined based on factors such as frequency and rate of adoption. The rate of adoption can be defined as the relative speed with which the farmers adopted new technology and the frequency of adoption was defined as the intensity of adoption of novel technology within the stipulated period (Bonabana, 2002).

The adoption of technology among farmers in the homestead depends on several factors. The ability of the people in understanding new tecchiques and gaining skills clearly depends on the receptivity of the people. Considering several factors, it was found that the low literacy rate resulted in comparatively low receptivity among the rural women of Jessore area of Bangladesh. Technology adoption rate was recorded higher in educated rural women than non-educated women. About 21 per cent among the educated and 14 per cent among the non-educated women adopted new seed technology. When the education level is increased, the technology adoption rate is also increased (Paul and Sadullah, 1994).

Access to extension services was found to be a major aspect of technology adoption. Extension agents inform the existence, effective use, and benefits of the innovation to farmers. They also perform as a link between the innovators (Researchers) of the technology and users of that technology. This helps to decrease transaction cost experienced when progressing the information on the new technology into a diversified group of farmers (Genius *et al*., 2010).

The training and visit (T&V) system of Agriculture development department was found to be the most relevant source of information to the farmers along with adequate intervention from the government in the provision of credit facilities and subsidy on storage inputs which can ultimately aid in an enhanced rate of adoption (Abiodun *et al.,* 2000).

Nwaobiala (2018) conducted a study to identify the adoption rate of farming practices of cassava and intercrop technologies by the farmers in Nigeria. The results showed that the rate of adoption was 86 per cent which denotes the high rate of adoption of cassava farming techniques. However, the rate of adoption of intercrop technologies was less and should be promoted through awareness programs to farmers.

Aurangozeb (2019) conducted a study among the rural women in Rangpur Dinazpur Rural Service (RDRS) in Bangladesh for evaluating the adoption of technology in homestead farming. The extent of adoption in integrated farming technologies varied depending upon the nature of the technology, availability of inputs, technical know-how and also other characteristics like age, annual income, education, contact with extension media, cosmopoliteness, innovativeness and aspiration.

Karwara *et al*. (1991) analyzed the comparative adoption of improved technology by female and male headed scheduled caste families and observed that 76 per cent of female and 70 per cent of male respondents accepted improved technology for rice cultivation. Daberkow and Mc Bride (2003) identified farm size and location as having a positive impact on the rate of adoption of technology. The larger the farm the higher the rate of adoption.

An investigation on the adoption techniques of cardamom farmers in Idukki districts of Kerala revealed that most of them were diverting into modified organic production techniques such as use of farmers selection varieties with organic plant protection techniques and beekeeping for increasing the pollination percentage (Gills *et al*., 2013).

2.9.2 Determinants of agricultural technology adoption

The farmer's decision about the adoption of new technology depended on the interaction between the technical characteristics and another array of circumstances and conditions (Loevinsohn *et al.*, 2013). The decision of the farmers for using an innovation are the results of a comparison of the net benefit in terms of cost. While analyzing the economic analysis of the technology adoption behavior of the farmer, it was found to be related with personal characteristics, endowments, imperfect information, risk, uncertainty, institutional constraints, input availability, and infrastructure (Rogers, 2003).

Namara *et al*. (1991) broadly categorized the determinants of adoption of technology into farmer characteristics, farm structure, institutional characteristics, and managerial structure. Wabbi (2002) opined that categorization is purely based on the current technology being investigated, the location, and the preference of researcher, or the differing needs of the clients.

Uaiene *et al.* (2009) opined that social network and learning are also coming under the categories of factors determining technology adoption. The determinant of agricultural technology adoption can be grouped into three categories such as economic, institutional and social factors. (Akudugu *et al.,* 2012). Lavison (2013) generally grouped the factors that influence technology adoption into social, economic, and physical categories. Mwangi and Kairuki (2015) categorized the factors of technology adoption into technology factors, institutional factors, and household-specific factors.

2.9.3 Technology dissemination in home gardens

Technology components are intentionally incorporated in the home garden system to make them more complex in an evolving system.

Thomas and Kishore (2016) reported that maximum technology need was required for under-exploited horticultural tree crops like mango, jack and beverage crops. The technology needs for homegarden farmers were recorded as value addition, processing and storage facilities.

Ravikishore *et al.* (2017) conducted a study related with technological, economical and socio-cultural dimensions to the specialized components in home gardens and the results showed a variation in priorities between the specialized home garden farmers and traditional farmers. Agricultural Officers and Scientists had reported that dimensions which ranked highest were initial cost, continuing cost, income generation potential, skilled labour requirement and local resource utilization and the lowest ranks were for commercialization, infrastructure development, family labour, decision making style and communicability.

Sreelakshmi and Thomas (2018) reported that technology dissemination in Kerala depends upon the efficiency of the Extension System. Effect of different techno-socio-economic dimensions would have contributed to specializations in the home garden system such as aquaculture, sericulture, floriculture, and animal husbandry.

2.9.4. Technology gap in home gardens

Farmers may obtain information and technology through technology transfer. Technology transfer can be defined as the general process of passing information and skills from the generators of knowledge or information such as research laboratories and universities to clients such as farmers (Valera and Plopino, 1987). Farmer's adoption and bringing them to action with further diffusion is the outcome of new technology transfer. But the reaching and adoption of technology by the farmers face some barriers.

However, the majority of smallholder farmers depends on traditional methods of cultivation and production and this led to a decreased level of productivity. For instance, more than 70 per cent of the maize production in the majority of developing countries is from smallholders who practice traditional methods of production. These farmers obtain very low crop yields because they use only local varieties with low potential yield, and depends primarily on rain-fed cultivation with limited dependence on irrigation. To make things worse, pest control is not adequate and little or no fertilizers are used (Muzari *et al.*, 2012). This has triggered much attention on the need to increase productivity and sustainability in agriculture globally. Even though technologies are available everywhere, they are not reaching the field in its maximum potential. It indicates the technology gap existing and need for efficient technology transfer.

Lazaro *et al.* (1993) reported that farmers are afraid of using new technologies in the larger field because they overestimate the loss in yield caused by insects rather than the actual loss. There was a lot of reason for the non-adoption of technologies by farmers.

Chi and Yamada (2002) have listed the following reasons. Farmers did not trust the new inventions and were worried about the low yield. Due to lack of proper education, old age farmers never believe in technologies and they continued to follow traditional practices, use their practices such as high seed rate, direct broadcasting and spraying of pesticide and chemicals for prevention of insect occurrence.

Access to credit and policies was gender-biased and also need hectic procedures, as a result of which farmers are unable to adopt high cost technologies (Muzari *et al*., 2013).

Makokha *et al*. (2001) reported that high cost as a hindrance for the adoption of technology. In his study related with determinants of fertilizer and manure use in maize production in Kenya, he could notice that high cost of labour and other inputs along with the unavailability of demanded packages and untimely delivery were the main constraints faced by the farmers. Adoption of improved storage structures for grains and pulses such as hermetic containers, cold treatment, chemical application was relatively low due to lack of adequate awareness and knowledge of use of these technologies, unavailability and high cost of technologies.

2.10 CROWDSOURCING OF KNOWLEDGE AND ACTION RESEARCH THROUGH FRONTLINE DEMONSTARTION

Crowd sourcing is considered as a method to collect informations from a larger group of people. In scientific research, crowd sourcing plays a very important role by furnishing relevant details to understand the cuurent scenario and to yield relevant conclusions on scientific aspects (Franzoni and Sauermann, 2014). Sometimes, participatory appraisals were also considered as an alternative form of crowd sourcing that enables better interaction between farmers and researchers that led to better understanding on field problems and also dissemination of knowledge (van Etten, 2011). Recently, Beza *et al.* (2017) recorded crowdsourcing as an alternative method of obtaining field data to conduct yield gap analysis along with sophisticated remote sensing methods. In agriculture field, crowd sourcing enable the farmer to point out the actual field issues and also aid the researcher to formulate the soultions according to the needs of farmer.

Due to lack of proper mechanisms, there is no way to ensure the application of research findings to the practical situations. Majority of the social science studies are practiced in isolation from the situations happening in the society. In this juncture, action research plays an important role in the intervention of research and real-life situations. Action research has been utilized by different researchers in specific situations and applications in different ways such as action research in the organization, participatory action research in community development, action research in education and farmers participatory research generation (Cilliers *et al.,* 2017).

Action research is also known as Participatory Action Research (PAR) and community-based study. Mc Cutcheon and Jung (1990) defined action research as a systematic inquiry with collaborative, collective, self-reflective, critical, and taken by the participants in the inquiry. Chambers (1991) identified it as a continuum between development research and action in the search for new and applicable knowledge. It includes action science, action learning, and cooperative enquiry (Lingard *et al*., 2008). Kumar (2002) defined action research as an approach of study with a focus on both the action and research, aimed at bringing a change in community, environment, organization or program.

Briggs (1984) classified the participatory action research based on the interaction between farmer and researcher as a contract, consultative, collaborative, and collegiate. The participatory action research can contribute better fit in different areas which are complex, diverse and risk-prone and in an environment like rainfed tropics, hinterlands, hills and swamps which are difficult to reproduce or replicate in the research stations. During the adaptive stage of research, technology can be adjusted to a specific set of environment, enabling the farmers to incorporate technology which better suits their livelihood. In certain areas of research like agroforestry, crop management, germplasm improvement and soil and water conservation, farmer participation has been inclusive and yielded better results.

Farmers participatory research also known as participatory technology development and was developed by the agricultural researchers and international rural developers over the time as a method for traditional transfer of technology or as a top-down approach to agricultural research and extension work (Ciliers, 1999).

Selener (1992) opined that participatory technical development originated from farming system research with a focus on the farmer’s participation in technology generation, evaluation and testing to increase the agriculture production sustainably. He also added the major assumptions underlying for technology development as an emphasis on farmers indigenous knowledge, farmers capacity for experimentation and interdisciplinary collaboration between researchers and farmers.

Tufail *et al*. (2017) described the development of forage through farmer participatory research for the sustainability of smallholders in the Pakistan, by using an innovative strategy of establishing village – based forage seed enterprise of the crop berseem. Likewise, Sulifoa and Cox (2020) stated a participatory action research project in conservation agriculture in Samoa. The farmers and extension professionals were interviewed through eight key informant interviews, 107 semi-structured interviews and a ranking exercise. The program was implemented with the aid of policy makers and researchers in the region.

Thamban *et al.* (2014) conducted a farmer's participatory action research to identify the extent of adoption of soil and water conservation measures in coconut farmers of Kasargode district in Kerala. The impact was assessed by matrix method and the results showed that simple and low investment technologies were adopted and were contributed to the enhancement of yield in coconut.

2.11. PERSONAL AND SOCIAL CHARACTERISTICS OF HIGH RANGE HOME GARDENS

2.11.1. Age

A study conducted in Pakistan recorded that age and determinant of innovation adoption were inversely correlated (Quazi and Iqbal, 1991). Farmers' perception on the technological development is only on the benefit from adopting it, with advancement in the age of farmers, it will require lot of time and hence reduced interest (Caswell *et al*., 2001).

Despite perhaps greater years of experience, older farmers were often reluctant to adopt new technologies and practices. Gillespie *et al.* (2004). Adoption of hybrid seed in homesteads of southern Malawi is negatively related with the age (Chirwa, 2011)

Van den Berg (2013) reported that there was no significant relationship between farmer age and adoption of technology of the irrigation scheme. Farid *et al. (*2015) stated that adoption of farm practices is not determined by the age of the respondents.

Age increases farming experience also increases, so adoption technology is directly influenced by age Reeba (2015). A Study conducted in Nainatal district of Kumaun Himalaya indicated that Age of rural women play an important role in adoption or rejection of a cultivation practice (Bargail and Vibhuti, 2015).

2.11.2. Education

Educated farmers shows more interests in attaining training programs and timely interact with the agricultural experts for finding solutions to their farm related problems (Singh, 2000).

Narayanamoorthy (2000) and Wadud and White (2000) did not noticed any significant impact of education of the farmers with productivity and efficiency of farm activities.

Ekwe and Nwachukwu (2006) reported that the educational qualifications of farmers aid in better understanding of technologies and facilitate adoption of new technologies. Rahman (2008) hypothesized that farmers having level of education indisputably adopt new and modern technologies for increasing their profitability.

Amponsah *et al.* (2013) stated that farmers with higher levels of education qualifications are more interested in adopting newly-introduced technologies than those with lower education. The intensity and nature of farmer's education accelerates the technology adoption because through education farmers attain a better understanding about the trend and instructions for the implementation Namara *et al*. (2013).

Education of the famers and adoption of technology are not having any significant relation Reeba (2015). The decision-making process is generally decentralized among the selected family and the educated adult member actively participated in the process of decision making.

Paltasingh *et al.* (2017) found that education have significant role on the adoption of modern rice varieties and thereby farm productivity. Education gives the farmers exposure to modern agricultural development (Singh and Sahoo, 2019).

2.11.3. Land area

Das and Das (2005) in their study reported that with the increase in land area more variation in species composition was noticed.

Essakimuthu (2015) recorded that majority of the respondents possessed land holding of size less than one hectare (92.49 per cent), 7.05 per cent of the respondents possessed land holding between one to two hectares, 0.46 per cent of the respondents possess land holding of more than two hectares and none of them possess land holding of more than four hectares

Sebastian (2015) reported that 49 per cent of the home garden farmers of Thiruvananthapuram district had an area less than 1 acre and 28 per cent had an area in between 1-2 acres and 23 per cent had an area above 2 acres.

2.11.4. Annual income

A study by Odebode (2006) from Southern Nigeria states reported that tree crops and livestock components included in the home garden contribute to more than 60 percentage of the household income.

Annual income of the respondents exhibited a positive correlation with the rate of adoption of new technologies in select enterprises (Singha *et al.* 2012). Farm income and non-farm income can also reflect the financial capability of a farmer in buying external inputs Amponsah *et al*. (2013).

Krishnan (2013) in his study on specialized home garden revealed that 67 percent of the respondents had an annual home garden income less than Rs. 2,84,000.

2.11.5. Market orientation

Market orientation is considered as the management ability of a farmer to scientific farm management practices *viz.,* execution of new techniques, production and marketing functions of his farm enterprises (Samantha, 1977).

Thomas (1998) studied the technology adoption of medicinal plants in Kerala and recorded that the adoption of technology was positively correlatied with the market orientation.

Jaganathan (2004) conducted a study to identify the relationship of market orientation and attitude of the respondents towards organic farming practices revealed that, about 55 per cent of respondents had medium level of market orientation which underscores that market orientation and attitude of respondents exhibited a positive correlation.

The specialized home garden farmers have a positive attitude that will lead to higher market orientation due to the diversity in the products available to the home gardens (Krishnan, 2013). Market orientation and mechanism is always influencing the adoption behavior of a farmer and scaling up of a technology (Mootleb, 2018).

2.11.6. Extension contact

Activities of extension officer along with frequent visits from authorities and membership of farmer organizations were found to be effective for adoption of recommended crop management practices in paddy cultivation (Mendis and Udosmade, 2005).

Anderson and Feder (2007) opined that access to extension services directly affect the adoption nature of farmers along with welfare by reducing the gap between actual yield and potential yield. A farmer having contact with extension agents is expected to be more familiar, more flexible and more knowledgeable about the use of new and improved agricultural innovations. This variable is expected to be positively related to technology adoption (Tiamiyu, 2009).

With the influence of extension services, farmers are more exposed to interactions with the extension personnel of the department of agriculture and receive scientific guidance to access production and management practices from different sources which lead to high level of adoption level in their farming systems

Singha *et al.* (2012). Mandryk *et al*. (2014) reported that agricultural extension services make farmers enough for taking strategic decision about their farms.

Wossen *et al*. (2015) reported that proper exposure of farmers to extension service intensifies the adoption of modern agricultural technologies by minimizing supply-side constraints that appears due to information market inefficiencies.

Al-Zahrani *et al.* (2016) emphasised the importance and significant potential and capacity of Agricultural extension services to make farmers more efficient and educate, enhance crop yield and employ modern technology and for improving efficient use of natural resources like land and water.

Agricultural policy makers, extension agents and researchers should have the capacity to predict the extent to which farmers will follow and adopt a new technology and practices (Llewellyn and Brown, 2020).

2.11. 7. Rational orientation

Davis and Warshaw (1992) reported that technology acceptance models make use of predictors that are purely cognitive, linking the acceptance and usage of a new intervention to belief, perception and attitude. Rajendran (1992) found positive and significant impact of rationale orientation among scheduled caste families with the extent of adoption.

Extent of adoptions of home garden farmers has no relation with their rational orientation (Thomas, 2004). More than 50 percentage of the studied home garden farmers had belief on science and religion at a time rather than belief on science or religion individually (Krishnan, 2013).

Vecchio *et al.* (2020) conducted a study among Italian farmers for adoption of precision farming tools and stated that most of the farmers were rationally oriented towards the results.

2.11.8. Irrigation potential

Babu (1995) recorded that extent of adoption of new technologies in homegarden exhibited a positive correlation with irrigation potential.

About 50 per cent of the selected home gardens included in the category of little or no water scarcity (Krishnan, 2013). According to Reeba (2015), there was no correlation between the extent of adoption of new technology and irrigation potential.

2.11.9. Innovativeness

Technology adoption behavior of the farmers is not significantly related with the innovativeness (Manjula, 1999). Diederen *et al*. (2003) opined that structural characteristics like farm size, market position, age and education of the farmers are the determining factors for a farmer to become either innovator or adopter of technology. Goswami *et al*. (2010) stated that scientific fish culture practices of farmers are directly influenced by the innovativeness of fish farmers. New innovative technologies in litchi farming are not shows any positive impact on the resource poor farmers of Southern China (Li *et al*., 2019).

2.11.10. Economic motivation

There exists a positive relationship between technology adoption behavior of farmers and economic motivation (Talukdar and Sontaki, 2005; Singha *et al.*, 2012).

Goswami *et al.* (2010) stated that the economic motivation of fish farmers had significant positive impact with their scientific fish cultivation practices.

Singh *et al.* (2012) reported that economic motivation was one of the important elements on adoption of technology of rice and vegetable cultivation, dairy farming and fisheries.

2.12. GENDER ROLE IN HOME GARDEN

Home gardens utilize the family labour including women in the farming activities which reduces the cost of cultivation and also act as a source for sustainable family income (Rugalema *et al*., 1994; Soemarwoto and Conway, 1991; Benjamin *et al*., 2001). Though women are actively participating in home garden activities, their involvement tends to be determined by socio-cultural norms. In most of the scenarios, the contribution of women in the household is massive, but this does not support the argument of considering home gardening as a predominantly female activity (Mitchell and Hanstad, 2004)

There is a clear demarcation between men and women in home garden activities including the selection of plant resource components, domesticating wild species, and managing home garden activities. A study conducted on home gardens in Peru, indicated that women exhibited more preference to produce food for household consumption while men gardeners mainly focus on income generating cash crops for marketing (Ninez, 1985). The degree of involvement of women and their responsibilities varies across cultures including land preparation, planting, weeding, harvesting, and marketing (Talukder *et al*., 2000).

In some cultures, women are the sole caretaker of home garden, while in some part, they play a more or less supportive role. The involvement of women was significantly higher (72.0 - 95.0%) than that of men in all the practices except in lopping activity was observed in the Murong indigenous community in Bangladesh (Das and Mohiuddin, 2012).

Moreno-black *et al*. (1996) analyzed the gender role in home gardens of Northeastern Thailand revealed that the rural women were the backbone of homegarden systems, as most of the activities of the home gardens. Howard (2006) in his case study analysis of 13 home gardens from South America revealed that women are the lead managers of home gardens across the region. These activities are indispensable and suits very well with their day-to-day domestic activities and motif of employment along with their cultural and aesthetic values.

Vogl and Vogl (2003) investigated on the characteristics and management of home gardens managed by organic and inorganic ways in Austria reported that women act as innovators of new farming practices, custodians of sustainable agriculture and protectors of plant genetic resources.

In a study conducted in Senegal for evaluating the food and nutritional roles of home gardening, it was found that the homegardens plays a major role in improving the income, social status as well as increased the good food habits among women than that of food consumption and nutrition (Brun *et al.*, 1989).

Among the home gardens of tribal community of Kerala (Attappady) men were concentrated on daily wage works and women in the community were actively engaged in the management of home gardens. The younger women were more enthusiastic about ornamental plants whereas a thorough knowledge of wild plants was exhibited by elder women in the interior hamlets of the village (George and Christopher, 2020)

2.13. CONSTRAINTS AND SOLUTIONS IN THE HOME GARDEN SYSTEM

The homegardens around the globe experienced several constraints and the ecologists were concerned about the extinction of home gardens as it was failed to address in the policymaking and also due to the menace of commercialization of traditional home gardens (Kumar and Nair, 2004).

Hoogerbrugge and Fresco (1993) opined the key constraints to the home gardening that includes inaccessibility to suitable and sufficient land to initiate a home garden along with lack of ownership and right to use the land. The other constraints were lack of access to capital or credit, access to seed, planting material and water, ineffective extension and advisory services, access to labour and market.

As due to the migration of rural people to urban areas in search of better livelihood in the last decades, led to impoverishment of traditial home gardens of Spain (Agelet *et al.*, 2000).

Ashokan and Kumar (1997) found that Kerala home gardens have been dominated by cashcrops *viz.,* coconut and rubber or some other cropping system comprising of a limited number of crops. Nair (2006) opined that the farmers in peri-urban centers are attracted by the power of economics and they were on the verge of converting their home gardens into commercial crops that can fetch a better market price.

As per Andrews and Kannan (2016), the major constraints in the home garden system was the size of land given to the agricultural laborers. The lands possessed by the agricultural laborers were too small to produce enough for the sustenance of the family or income generation. Land use changes took place in the villages rapidly and indigenous homemade commodities like vegetables, fruits and spices failed to fetch good prices in the market.

Kumar (2015) said that home gardens s a testing ground of many innovations and today’s home gardening is as a result of such continuous innovations and improvisation.

Home garden system helps in the conservation of crop diversity, decrease the dependence and stresse on the natural forests by being the source of food, timber, fuel wood, medicinal plants, and fodder (Kumar, 2015). So, research on all aspects of home gardens is more than a necessity.

Benjamin *et al*. (2001) opined that understanding of the nutrient, energy and water balance in the home garden is critical for providing a scientific basis for better management and design of the system to allow systematic use of resources, to reduce energy loss and to improve the production.

Kumar and Nair (2004) said that with relatively more managerial inputs and cautious selection of components for the home garden mostly will help to retain benefits of both traditional and commercial farming systems.

The home gardens can considered as a reservoir of rare plants and a play a vital role in germplasm conservation (Coomes and Ban, 2004). Hence, the home gardens can be recognized as an integral part of the larger agricultural ecosystem that provide nutrional security along with socio-economic benefits and ecosysyem conservation.

METHODOLOGY

3. METHODOLOGY

This chapter deals with a concise protayal of the methods that were used for meeting the objectives mentioned in this study. The methodology adopted in the present study is described below.

3.1 Research design

3.2 Locale of the study

3.3 Selection of the respondents

3.4 Operationalization and measurement of the variables

3.4.1 Structural configuration in terms of dominance biodiversity profile of crops in the high range home gardens

3.4.2 Technology needs assessment

3.4.3 Extent of horizontal and vertical crop diversification in high range home gardens

3.4.4 Front line demonstration in high range home garden systems

3.4.5 Crowdsourcing and percentage adoption of crop production and protection practices in different crop based home gardens

3.4.6 Dimensions of technology suited for high range home gardens

3.4. 7 Distribution of the respondents based on their personal, socio-cultural and techno-economic factors

3.4.8 Gender roles in high range home gardens

3.4.9 Constraints experienced by high range home garden farmers

3.4.10 Suggestions for refinement as perceived by home garden farmers and extension personnels

3.5 Data collection procedure

3.6 Statistical tools used in the study

3.1. RESEARCH DESIGN

‘Ex-post-facto’, ‘explorative’ and ‘action’ research designs were used for conducting this study. ‘Ex-post-facto’ research design is an organized investigation in which the researcher does not have direct control over the independent variables as they are not able to manipulate (Kerlinger, 1983). This particular research design was adopted to in this study, as there was no scope for manipulation of any variables under study. Since the researcher had to probe for crop resource and specialized components in the home gardens, explorative design too was used for the study. Home gardens are also a venue for integration different components, both plants and animals and it is a cafeteria of many different biotic and abiotic entities that require technologies. There is need of enquiry into the application of technologies and whether farmers apply appropriate knowledge and skills. This will enable the extensionists to identify the action required to improve upon the existing situation of the home gardens. This calls for action research.

3.2. LOCALE OF THE STUDY

The study was conducted in the Idukki district of Kerala where the specialized home garden systems are in vogue. Owing to the wide uniqueness of high range home garden agro forestry ecosystem and its variability in the structure and cropping pattern of the home garden systems, Idukki district was deliberately selected for the study. The map showing the study area and points of intervention are given as Fig.1.

3.3. SELECTION OF RESPONDENTS

The respondents of the study comprised of farmers, agricultural officers and scientists. However, the respondent categories of agricultural officers and

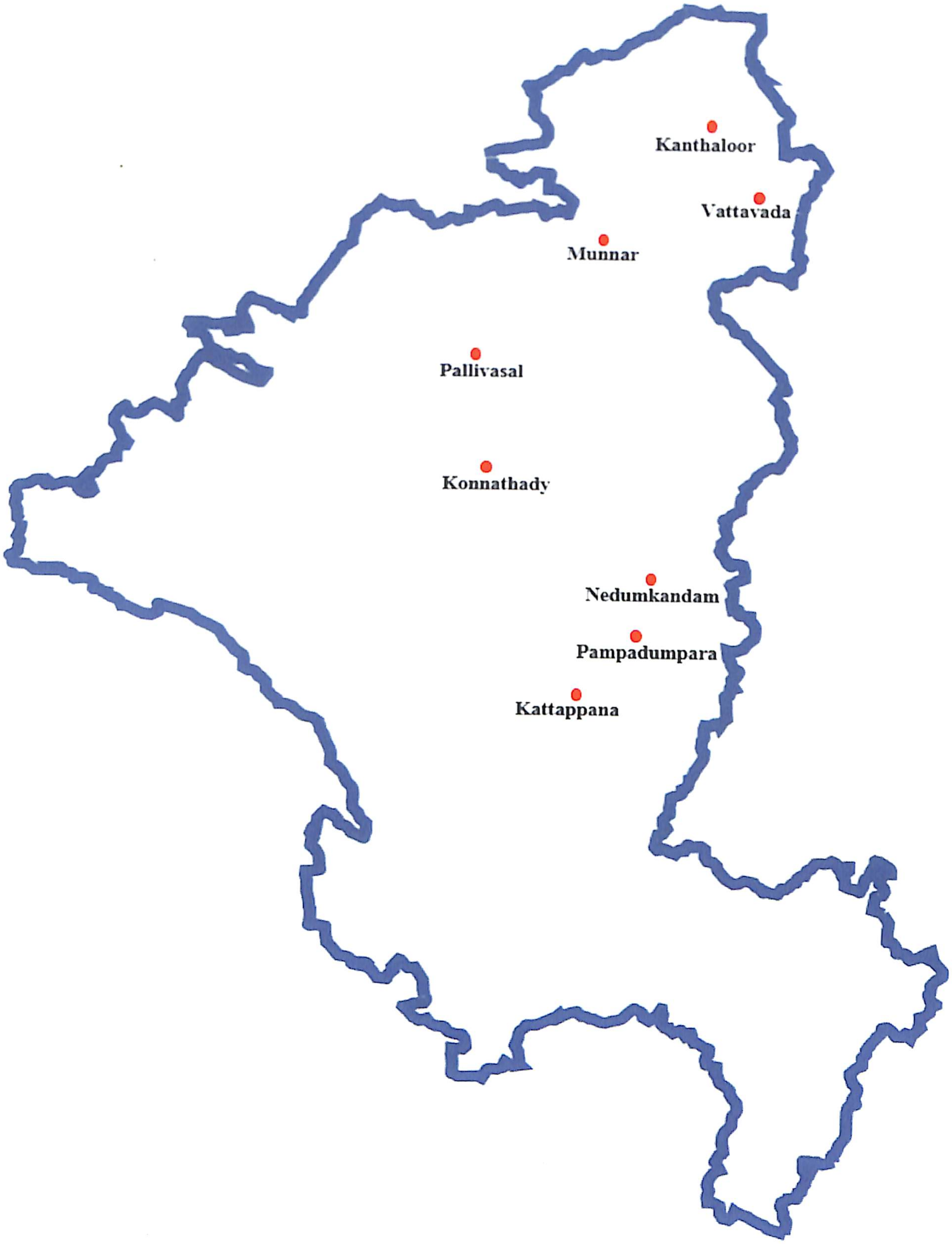


Fig. 1. Map showing the point of intervention

scientists were confined to the study related to identification and delineating of technology dimensions in high range home gardens.

a. Selection of farmers

The study area was stratified according to different agro ecological units as mentioned in the study report conducted by Kerala Agricultural University and State Planning Board. There are 50 panchayaths in 8 blocks of Idukki district. Eight panchayaths with maximum number of functional home gardens was selected that covered all the 4 agro ecological units (strata) as mentioned below:

A list of all panchayats in each stratum was prepared and two panchayats was selected from each stratum by Simple Random Sampling without replacement with maximum number of functional home gardens. In each selected panchayat, the Krishibhavan was contacted in order to identify the different broader types of home- garden system in the panchayat so that atleast one home garden will be selected from each type of home garden system. It was envisaged to cover a minimum of 120 farmer respondents for the study.

Thus a total of 120 high range home gardens and its farmer respondents from 8 panchayats covering the four agro ecological units of Idukki districts were the farmer respondents for the study.

b) Agricultural Officers and Scientists

A minimum of 25 Agricultural Officers and 25 Scientist concerned with home garden research belonging to different institutions in Kerala (ICAR/KAU/Commodity Boards) were the respondents of the study. This category of respondents was only meant for the study related to identification and delineation of the technology dimensions in high range home gardens.

Thus a total of 170 respondents were covered under the study that comprised of 120 home garden farmers and 50 extension professionals. In addition to the sample respondents, 120 home gardens were selected for data enumeration with special reference to study on crop biodiversity and crop dominance of home gardens.

3.4. OPERATIONALIZATION AND MEASUREMENT OF THE VARIABLES

Properties or characteristics of the concept are variables and the process of transforming abstract concepts into computable variables and indicators is known as operationalization. Operationalization strictly defines variables into measurable factors and allows them to be measured, empirically and quantitatively.

3.4.1. Structural Configuration in terms of dominance biodiversity profile of crops in the high range home gardens

Kerala Home gardens presents a typial traditional agroforestry system with crop-animal mix combination designed to meet the household food, fodder, fuel, wood and timber requirement and generate supplementary income through the sale of surplus. In the process of development of home gardens, components of farming are either assimilated horizontally or vertically. Both commodity and non commodity crops are integrated understanding the canopy configuration and root spread of existing crops thus helping home gardens to form their own shapes baded on different tiers or hierarchies. This leads to the significance of understanding and studying structural configuration in terms of dominance biodiversity profile of home gardens.

3.4.1.1. Numerical and economical dominant crops in high range home gardens

The dominance of crops in the high range home gardens was measured in terms of numerical and economic dominance.

Numerical dominance was measured by using a seven-point scale as suggested by Thomas (2004). The crop with maximum dominance was assigned with the rank score ‘one’ and subsequent scores were given to other crops based on its dominance. A rank score of ‘seven’ was ascribed to the crop with the lowest dominance. The rank score was assigned based on the numerical strength of plants that belonged to each crop species.

Economic dominance was also calculated based on a seven-point scale with the similar rank score as done for numerical dominance which was based on the returns obtained from each crop as perceived by the farmer of the respective home garden under survey. The highest rank score of 1 was assigned to the crop with most remunerative crop and a rank score of 7 was assigned to the least remunerative crop.

3.4.1.2. Diversity Profile of High Range Home gardens in Kerala

A total of fifteen home gardens were selected from each panchayat and the plant components were recorded for the assessment of biodiversity. Each home garden was divided into the courtyard/Backyard (CY/BY), mid-region (MR) and outer region (OR) for the comparison of biodiversity with reference to the different regions in a home garden.

The courtyard/backyard region is the immediate surroundings of the home whereas mid region is defined as the area situated in between the courtyard region and outer region. The outer region is the area located at a distance from the home.

The crops were categorized into different groups based on their use as vegetables, spices, plantation crops, beverages, fruits, tubers, medicinal plants, ornamentals and multipurpose trees and the total count of plants were recorded. The identification of plant species was done with the help of scientists in the relevant fields.

To compare the biodiversity of different home gardens, Shannon-Weiner index of diversity was used and the formulae for the same is given below:

$H = -\Sigma\, P_i \log (P_i)$, where, $P_i = n_i/N$ (n_i = number of individuals of a species, N = total number of individuals of all species).

3.4.2. Technology needs assessment

Based on the information gathered from the pilot survey and further discussions with the experts, parameters identified under technology categories *viz*., production, protection and post-harvest technology were identified and the technology needs of the farmers were identified. The scoring method for analysing the technology needs under different criteria was adopted from the study conducted by Thomas (2004).

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

The technology needs of the farmers may vary with the crop and locality. So the technology needs of different crops were assessed separately. The technology needs of the farmers were broadly classified into three categories *viz.,* production, protection and post-harvest technology. The various parameters belong to any of these aforementioned categories were documented as per the score chart. The technology need scores of all the 120 home garden farmers from were tabulated and analyzed.

3.4.3. Extent of Horizontal and Vertical Crop Diversification in High Range Home gardens

Agriculture diversification means adding a new plant species or a diverese animal breed to an existing farm or non-farm system (Ali, 2005).

Horizontal diversification can be referred to as the addition of more crops to the existing cropping system. Vertical diversification is mostly concerned with the use of any crop species, which could be refined to different value-added products. In this study, the horizontal and vertical diversification was measured as given below.

The horizontal diversification was calculated based on the number of levels of crops observed in each of the home gardens with special emphasis to the numeric and economic dominance. The results obtained was expressed in terms of average levels of inclusions in each of the home garden systems. The findings of the study were portrayed in terms of the mean score obtained for each home garden system.

The vertical diversification was calculated based on the number of levels of economically dominant crops (seven most economically dominant crops as already computed) subjected to the levels of value addition until it reaches the market. The findings were expressed in terms of the mean score obtained for each of the economically dominant crops in different home gardens.

3.4.4. Front Line Demonstration in high range home garden systems

Front Line Demonstrations (FLDs) is a unique method to offer a direct interface between researcher and farmers. Here, the scientists are directly involved in the planning, implementation and monitoring of the demonstrations for the technologies developed by the research and development systems in the country. It helps in getting direct feedback from the farmers' field about the crops and the technology being demonstrated in particular.

3.4.4.1. Front Line Demonstration of production practices of banana

An exploration through transect was undertaken in banana based home garden of Idukki district of Kerala during December 2018 to September 2019 to understand the constraints faced by farmers and to project the impact of scientifically proven technologies for maximizing yield in banana. An appraisal of the current situation pointed out that the major challenges faced by the banana farmers were poor yield and the frequent incursion of pest and diseases. A solution to the existing problems was the adoption of scientific farming practices that leads to the potential yield in banana. So, in order to demonstrate the importance of scientific technologies, an experiment was conducted with farmer participation at the selected agro ecological unit following the recommendations put forward by the Kerala Agricultural University - Package of Practices recommendations.

A total of 15 respondents were selected from the area. Out of this, 10 respondents were allowed to carry out their normal farming practices while the remaining five respondents were selected to adopt the Package of Practices recommendation under the researcher's guidance. Healthy disease free planting materials of nendran variety were collected. Paring and pralinage operations were carried out before main field planting. Planting operations and nutrient applications were done according to the POP recommendations at timely intervals starting from the date of planting. Regular monitoring of fields was done to aid in early detection of pest and disease incidence which in turn would leads to appropriate adoption of crop management practices. In order to compare the impact of the adoption of management practices following POP recommendation with that of farmers practices, observations on various crop growth and yield parameters were recorded from the experimental plots at three months after planting, at bunch emergence and harvest stages (Annjoe, 2017; Sai, 2017).

3.4.4.1.1. Biometric characters selected for observations

Plant height

The plant height was measured from base of the plant to the base of the unopened leaf and represented in meters.

Girth of pseudo stem

It was measured at 20cm height of the pseudo stem from the base and represented in centimeters.

Number of leaves

The total number of leaves present in the plant were recorded.

Leaf area

The leaf area was calculated by multiplying the total length and width of leaf with a constant 0.8 and represented in m^2 as suggested by Murray (1960).

Leaf area index

Leaf area index was determined as per the formula developed by Watson (1952).

LAI=Total leaf area of the plant/ area occupied by the plant.

3.4.4.1.2 Yield Characters

Bunch weight

The total weight of the bunch up to the first scar of peduncle was recorded and represented in kilogram.

The cost benefit analysis was conducted for the selected farmers and the BC ratio was recorded and compared.

3.4.4.2. Front Line Demonstration on management of foot-rot disease in black pepper

To identify the constraints faced by the pepper farmers of Idukki district, focused group discussions were carried out with the support of the state agriculture department and local self-government bodies. A critical analysis of the current scenario revealed that the incidence of quick wilt disease was a menace to the pepper cultivation in Idukki.

Owing to the needs of pepper farmers, an experiment was conducted at Idukki district in the year 2018-2019 to ascertain the impact of KAU recommendations for the effective management of quick wilt disease of pepper.

The experimental site was a 10 year old pepper plantation with a total of 200 vines. Plots with similar disease severity indices were selected for conducting the experiments. KAU recommendations were practiced in one plot (POP, 2018) whereas the other plot was allowed to follow the farmer's practices. A plot was selected as control where no management operations were adopted.

Disease severity index of the plots was calculated using the scoring method developed by Ali *et al.* (1996) before the starting of experiments in May 2018. Observations were taken from ten randomly selected vines from each plot.

Observations on the impact of practices on management of quick wilt disease of pepper were assessed three months after the application of each treatment using the same scoring method on September 2018 and January 2019.

Disease severity index (DSI)

Type of Symptom	Level of disease severity and rating			
	1-25%(I)	25-50% (II)	50-75% (III)	75-100 (IV)
A-Foliar infection	1	1.25	1.5	1.75
B- Spike infection	2	2.25	2.5	2.75
C- Yellowing	3	3.25	3.5	3.75
D- Defoliation	4	4.25	4.5	4.75
E - Collar infection ; wilting	5	5.25	5.5	5.75

Average Disease Severity Index (DSI) /vine = (nA+nB+nC+nD+nE) / N

Where nA, nB, nC, nD and nE are sum of the disease severity for the respective symptom expressed in different levels (i.e. I, II, III and IV).

N = Total number of vines treated with a particular treatment

The percentage of disease reduction over control was calculated by using the formula:

$$\text{Per cent of disease reduction over control} = \frac{\text{(DSI of control-DSI of treatment)}}{\text{DSI of control}} \times 100$$

3.4.4.3. Front Line Demonstration on management of cardamom thrips

The preliminary investigations on the problems confronted by the cardamom farmers of cardamom based home gardens disclosed that the frequent incursions of the cardamom thrips, *Sciothrips cardamomi* (Thripidae: Thysanoptera) resulted in a negative impact in the yield of the marketable produce. In this context, an experiment was conducted at Idukki district of Kerala during February 2019 to May 2019, to corroborate the effectiveness of POP recommendations of Kerala Agricultural University for the management of cardamom thrips. Fifteen respondents were selected from a particular agro-ecological unit and out of this, 10 respondents were allowed to carry out their normal practices to manage the pest. Five respondents were selected to adopt the Package of Practices recommendation suggested by Kerala Agricultural University.

The spraying was done and observations were made on the capsule damage, before the spray and on 10, 20 and 30 days after application. A total of ten panicles/ clump were selected and the total number of capsules were counted along with the number of capsules exhibiting damage symptoms. Similarly, a total of four such clumps were selected from the different portions in a plot. The methodology followed by Aravind *et al.* (2017) was employed for this study.

The per cent damage was calculated using the formula:

$$\text{Per cent Damage} = \frac{\text{Number of capsules damaged}}{\text{Total number of capsules}} \times 100$$

3.4.4.4. Front Line Demonstration of production practices of cabbage

Based on the information gathered from focused group discussions, the major setback confronted by the cabbage farmers of Idukki district was distinguished as low productivity and uncertainty in the weather parameters. In order to cater to the growing demands of the farmers, the solution left behind was the adoption of scientifically proven technologies. So an experiment was formulated to convince the farmer group regarding the adoption of scientific technologies in Vattavada area of Idukki district.

A total of 15 respondents were selected from the area. Out of this, 10 respondents were allowed to carry out their normal farming practices while the remaining five respondents were selected to adopt the Package of Practices recommendation as proposed by the Kerala Agricultural University to realize to the best of the potential yield. Regular observations on biometric parameters, management practices were done and the yield parameters were recorded from the plots at the time of harvest (Divya, 2013). From each replication, five plants were selected and marked for documenting the observations. The observations were recorded as the average of five plants.

3.4.4.4.1 Biometric Parameters

Plant height

The plant height was measured from base of the plant to the tip of the longest leaf lamina and expressed in centimeters.

Non wrapper leaves per plant

The total number of non-wrapper leaves per plant were recorded.

Gross plant weight

The whole plant weight comprising the head was taken and expressed in kilograms.

Leaf length

The seventh leaf from the top of the plant is selected and the length was measured from base to the apex of leaf lamina and expressed in centimeters.

Leaf breadth

The seventh leaf from top of the plant is selected and the width of the leaf at the widest point was measured and expressed as centimetres.

Leaf size

The leaf length was multiplied with the leaf width and represented in cm^2.

3.4.4.4.2. Head characters

Head depth

It is done by cutting the head into two halves and measuring the length of head from the top to the lowest point of the base and expressed in centimeter.

Head diameter

It is done by cutting the head into two halves and measuring the length of the widest point and represented in centimeters.

3.4.4.4.3. Yield characters

Net head weight

The weight of the head was taken and expressed in grams.

Gross head weight

The weight of the head with leaves and stalk was taken and expressed in grams.

Yield per plot

It is the net weight of heads per plot

Harvest index

It is the ratio of economic yield to biological yield.

The cost benefit analysis was calculated for the selected farmers and the BC ratio was recorded and compared.

3.4.5. Crowd sourcing and percentage adoption of crop production and protection practices in different crop based home gardens

Crowdsourcing in simple term can be operationalized as seeking knowledge, goods, or services from a large body of people. As part of an initial investigation, Focus Group Discussion (FGD) was carried out in selected panchayats of Idukki District in collaboration with the State Agriculture Department and local self-government bodies. A total of fifteen home garden farmers each from banana, black pepper, cardamom and vegetable based home garden were purposively selected for the study, the farmers for the study was selected with the help of the department of agriculture, Kerala and VFPCK (Vegetable and Fruit Promotion Council of Kerala). The focus group discussion was conducted for thirty minutes where the investigation team acted as facilitators and the home garden farmers were asked to point out the major challenges faced in the cultivation of their major crops. They were then asked to rank the major problem confronted during the production and protection aspects of these crops.

The investigation team listened carefully to the presentation of problems made by the home garden farmers and possible solutions to overcome the issues of production and marketing. An appraisal of the current situation pointed out that, the major challenges faced by the banana farmers were in production practices, protection practices in black pepper and cardamom and production practices in vegetable based home gardens. An ultimate solution to the existing problems was the adoption of sustainable scientific farming practices by individual farmers that leads to the potential yield and thereby facilitating remunerative price for the produce. So to demonstrate the importance of scientific technologies, different experiments were conducted, on banana, black pepper, cardamom and vegetable based home gardens as per the recommendations of KAU - Package of practices recommendations.

3.4.5.1. Contracting the farmers for crowdsourcing and action

The first step was contracting the farmers for crowdsourcing and action. A total of fifteen farmers from four different crop based home garden participated in the focus group discussion, among these four banana farmers who were ready to fully cooperate with the investigation team were contracted to adopt the Package of Practices recommendations, where the investigation team gave all the inputs starting from land preparation to harvesting for the contracted farmers. The remaining eleven farmers were asked to follow the packages adopted by the contracted farmers. One lead farmer was selected among the fifteen farmers through socio metric techniques and the role of the lead farmers was to monitor the activities of other farmers. Similar actions were made for black pepper, cardamom and cabbage.

3.4.5.2. Farmer-expert participatory preparation of the checklist

A checklist was prepared for carrying out the cultivation practices in a timely and proper manner with the help of experts in each field considering the opinion of the participating farmers. The checklists were given to all the fifteen farmers and they were asked to record the activities that have been done which were monitored by the lead farmer in the group.

3.4.5.3. Training for the farmers for participatory action and learning

Training programmes were conducted for farmers in different aspects of production and protection practices based on their needs. Further, they were asked to disseminate the technology to the neighboring farmers who are interested in the cultivation of the selected crops. During the training period, discussions were conducted by the research team with the farmers on different varieties suited for the ecological unit. They were briefed upon the merits and demerits, after which farmers were given a free hand to select the variety of their choice from a basketful of opportunities.

Followed by it, selected lead farmers were trained on scientific management of production of banana and cabbage, protection aspects of black pepper and cardamom from temporal and spatial choice to harvesting and marketing of produce. A checklist was created through farmer consultative approach and they were sensitized to document their day to day activities.

The record-keeping was monitored by the lead farmers with regular advisory support from the research team through extension support using social networks.

3.4.6. Dimensions of technology suited for high range home gardens

A list of dimensions associated with home garden technologies were developed based on the suggestions of experts and available literatures. The home garden farmers, scientists and extension personnels were directed to cross examine the dimensions and also suggested to include any other relevant dimensions. The respondents *viz.,* 25 scientists and 25 extension personnals were requested to rate the dimensions in a 9-point continuum varied from least relevant to most relevant with the weightages of ‘zero’ to 9 respectively. The scored value for each dimension were subjected to factor analysis and the dimensions which partake a factor value more than 0.7 were selected for the present study.

Inorder to understand the proximity pattern of the sub dimensions among the major dimensions of technology in home gardens was based on ‘cluster analyses 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.

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

To gauge the impact of profile characteristics of home garden respondent to fulfill the objective of the study, the characteristics of the home garden farmer were identified as explained below:

A list of 25 independent variables associated with the personal and social characters of home garden farmers and important for achieving the objective of the study were identified after a thorough review of literature and discussion with subject matter specialists.

For the critical evaluation and rating of the relevancy of all the identified variables, they were sent to 30 evaluators including extension scientist and home garden experts. The relevancy of the variables was rated in 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 30 assessors, only 25 responded. The criterion of mean relevancy score was used for the selection of final variables, which was got by adding up the weightages obtained by variable and dividing it by the number of judges responded. The variables garnering a score more than the mean score were used for the study.

The variables with the mean relevancy scores are shown in the Appendix II. The independent variables selected for the study were age, education, land area, annual income, market orientation, extension orientation, innovativeness, irrigation potential, economic motivation, and rational orientation.

Sl.No	Independent variables	Measurement
1.	Age	Actual chronological age and classification based on census report, 2011
2.	Education	Basheer (2016)
3.	Land area	in acres
4.	Annual income	Test developed for the study
5.	Market orientation	Samantha (1977).
6.	Extension orientation	Bhaskaran (1979)
7.	Innovativeness	Selvanayagam (1986)
8.	Irrigation potential	Thomas (2004)
9.	Economic motivation	Prasad (1983)
10.	Rational orientation	Jeteley (1977)

3.4.7.1. Age

Age is the total number of years completed by the home garden respondent during the interview period.

It was measured as the total number of years completed by the home garden respondent at the time of the survey and categorized based on the Census report (2011) classification method.

The classification as stated below:

Age category	Years
Young	< 35 years
Middle aged	35-55 years
Old aged	> 55 years

The home garden respondents were sorted into different categories and was expressed in terms of frequency and percentage.

3.4.7.2. Education

In this study education is functionally defined as degree of acceptance of formal learning process by the respondents.

The scoring procedure developed by Basheer (2015) with little modification was used for the study. A score of ‘one’ was added to every completion of formal schooling and the home garden respondents were classified based on their status of education level and expressed as percentage and frequency.

Category	Code
Primary	1-4
Middle	5-7
High School	8-12
Collegiate	>13

3.4.7.3. Land area

Land area is operationally defined as the total area undertaken for farming activities in a home garden system. This was measured in cents. Home garden having a minimum of 25 cents were selected for the study.

Category	**Score**
< or = to 25 - 50 cents	1
51-100 cents	2
101-150 cents	3
151-200 cents	4
>200 cents	5

The home garden respondents were classified into different groups based on the functional land available and expressed as frequency and percentage.

3.4.7.4. Annual income

Annual income refers to the total earning obtained by the home garden respondent from the off - farm and on - farm activities annually. It was calculated in terms of lakhs of rupees per year as expressed by the home garden farmer respondents.

Category **Annual income in Lakhs**	**Score**
<1.0	1
1.0 to 2.0	2
>2.0	3

Home garden respondents were sorted into different groups based on their annual income and expressed as percentage and frequency.

3.4.7.5. Market orientation

Market orientation refers to the one among the subscale of the scale for measuring management orientation that was developed by Samantha (1977).

It can be operationally defined as the extent to which the home garden respondents are oriented towards scientific farm management practices including planning, production and marketing functions/activities of his home garden.

It was measured using the sub-scale consisting of six statements including three positive and three negative statements. A score of 'one' was given for the agreement and 'zero score for disagreement in the case of positive statement. The reverse pattern was followed for negative statement. The sum of the score obtained by the respondent was taken as his score towards market orientation. The maximum score obtained by the respondent was six and the minimum score was zero.

Sl. No	**Statements**	**Response**	
1.	Market is not useful to a farmer	A	DA
2.	A farmer can get good price by eliminating the middleman		
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		

The home garden respondents were grouped into different categories based on their orientation towards the market and the results were expressed as frequency and percentage.

3.4.7.6. Extension orientation

Functionally defined as the extent of contact a home garden respondent had with various extension personals and agencies also his participation in different programs conducted by these agencies.

Extension orientation was measured by taking consideration of both extension contact and participation in the extension activities. A scoring procedure developed by Bhaskaran (1979) was used for this purpose.

The extension contact was computed as follows:

Response	**Score**
Often	2
Frequently	1
Never	0

The values obtained for different extension contact was added to get the total score.

The summing up of score obtained by the home garden respondent for the participation in different extension activities was used for the measurement of extension participation. The scoring procedure used was as follows.

Response	**Score**
Whenever conducted	2
Sometimes	1
Never	0

The total score of the home garden respondent towards extension orientation was acquired by summing up the scores for both extension contact and extension participation. The total score was taken as the criteria for the measurement of extension orientation of the respondents.

Category	Criteria
Low	Mean - SD
Medium	Mean ± SD
High	Mean + SD

With reference to the total score, mean value and standard deviation, the respondents were classified into low, medium and high category based on their extension orientation.

3.4.7.7. Innovativeness

Innovativeness refers to the relative earliness in the adoption of modern technology by the home garden respondent.

Innovativeness of the home garden respondent was measured using the scoring pattern developed by Selvanayagam (1986). The respondent farmers were enquired about their adoption pattern of improved technology or practice in farming. The scoring procedure used was as follows:

		Score
1.	As soon as it is brought to my knowledge	3
2.	After I have seen other farmers tried successfully in the farm	2
3.	I prefer to wait and take my own time	1

The home garden respondents were classified based on their innovativeness behavior as follows and express in terms of frequency and percentage.

Category	Score
High	3
Medium	2
Low	1

3.4.7.8. Irrigation potential

Operationally defined as the extent of availability of irrigation water for a home garden to be irrigated during a complete year.

It was measured in terms of availability of irrigation water for irrigating the home garden and the scoring procedure used is presented as:

Category	Score
Physical water scarcity	1
Economic water scarcity	2
Little or no water scarcity	3

The irrigation potential was counted as the score obtained by the home garden respondent. 'Three' and 'one' were the maximum and minimum score attained by the respondent as irrigation potential.

Physical water scarcity is the condition where the water available in the field is not enough to meet the irrigation requirement.

Economic water scarcity can be mention as the belief of farmer that the available water in the home garden have to be used in an overly cautious way in order to meet the irrigation purposes in the field.

When the water is profusely available in the home garden it can be referred to as little or no water scarcity condition.

3.4.7.9. Economic motivation

Operationalized as the drive of home garden respondent towards the benefit and economic matters.

The economic motivation was measured using Supe's scale and modified by Prasad (1983). Five point continuum of response was used in the scale developed by Supe. In the case of modified scale pattern, a dichotomy of 'yes' or 'no' response was used. The scale comprised of six statement five positive and one negative statement. In the case of positive statement, a score of one was given for 'Yes' response and zero score for 'no' response. The reversed procedure of scoring was used in the case of negative statement.

The economic motivation of a home garden respondent was noted by the summing of the score obtained for each statement. The maximum and minimum score that could be obtained by the respondent were six and zero, respectively.

Category	**Criteria**
Low	Mean - SD
Medium	Mean ± SD
High	Mean + SD

3.4.7.10. Rational orientation

This was operationalized as the degree of rationality and scientific belief of a home garden respondent towards the scientific management practices of the home garden.

The rational orientation of home garden respondent in this study was measured using the procedure developed by Jeteley (1977) and adopted by Thomas (2004) with slight modifications.

The question posed to the respondent was 'what you think about the increased development in your life'? The respondents were then rated based on their response towards the question as follows:

Category	Score
Belief	1
Belief + Science	2
Science	3

The rational orientation of the home garden respondent was taken as the score obtained by the respondents. 'Three' and 'one' were the maximum and minimum score that could be accomplished by the home garden respondent.

3.4.8. Gender roles in high range home gardens

Gender roles can be expressed as the 'normative expectations about the division of labor among the sexes and to gender-related rules about social interactions that exist within a particular cultural–historical context' (Spence, 1985). Gender roles in different home garden system were identified and analyses were carried out using the following procedure.

The major home garden farming practices of different crop based home gardens were prepared. The respondents following each system were asked to point out 'who performed each of the practices in their home garden?' The list of activities of different crop based home garden is appended (Appendix III).

Extent of involvement of men and women in carrying out different home garden practices was developed to categorize the farm activities in terms of gender involvement as male dominant, female dominant and equal participation. The results were worked out by calculating the total number of respondents involved in each practice in different crop based home garden and then calculating the percentage of respondents involved in each activity.

3.4.9. Constraints experienced by high range home garden farmers

After a detailed review of literature, pilot survey and discussion with agricultural officers and scientists, the constraints faced by the home garden farmers were identified. A list containing twelve such constraints were included in the final schedule. It was an open-ended list so that the farmers could add more constraints faced by them at the time of the interview.

The response of the farmers were recorded in a four-point continuum as 'most important', 'important', 'less important', and 'least important' by assigning a score of 'four', 'three', 'two', and 'one' respectively. The constraints were ranked based on the mean cumulative score.

3.4.10. Suggestions for refinement as perceived by home garden farmers and extension personnel's.

The suggestions of farmers were identified through Focus Group Discussions (FGD) and the major strategies were screened and presented after discussing with the subject matter specialists. The frequency and percentage was computed from the responses of the respondents and the strategies were merely ranked in the decreasing order of importance based on the perentage obtained.

3.5. DATA COLLECTION PROCEDURE

The data for the research work was collected by using a well- defined interview schedule. A pilot study was carried out in the non-sample area and the draft interview schedule was modified according to the suggestions. The modified final interview schedule was directly given to the home garden farmers and their responses were recorded. The technical social and economic dimensions were rated by the help of agricultural officers and Scientists.

Focused group discussions were conducted to identify the technology needs and problems as perceived by the farmer and based on that information, action research was planned.

3.6. STATISTICAL TOOLS USED IN THE STUDY

The statistical methods adopted for the present study are described below.

3.6.1. Mean

Based on the means of the independent variables, the respondents were categorized in to different groups.

3.6.2. Percentage Analysis

The farmers were grouped in to various categories based on extent of adoption of agricultural technology and then simple percentage was worked out to find out the percentage distribution of farmers. It was also used to interpret the results of independent variables selected for the study.

3.6.3. Analysis of Variance

The analysis of variance was used to compare the difference exhibited by various home gardens in terms of diversity in different regions of home gardens and crop group wise diversity. The data obtained from the action research was also subjected to ANOVA analysis.

3.6.4. Standard Deviation

Standard deviation is a measure that is to quantify the amount of dispersion of a data set. Standard deviation was used along with mean to categories the respondents based on the extent of adoption.

3.6.5. Correlation Analysis

Correlation analysis was carried out to identify the relationship between the dependent and independent variables of the study. The significance of the correlation coefficient was tested for 5 per cent and 1 per cent levels of significance.

3.6.6 Factor Analysis

Factor analysis is a means to condense large number of variables to fewer numbers of factors. Factor analysis was done to identify the important dimensions that are suitable for high range home gardens.

3.6.7 Cluster Analysis

Cluster analysis is the procedure used for objectively grouping the dimensions of technology in home gardens on the basis of their importance. The importance of the dimensions of technology was inferred and mean values obtained from cluster analysis.

3.6.8. Chi Square

A chi-square test is used to compare the observed results with that of the expected results. The purpose is to determine if a difference between observed data and expected data is due to chance, or if it is due to a relationship between the variables that is studied.

3.7 HYPOTHESIS OF THE STUDY

H1: There exist no particular type of crop dominance (economic and numerical) in the high range home gardens.

H2: There exist no significant difference in the biodiversity of high range home gardens with reference to different region in the home gardens.

H3: There exist very low horizontal and vertical crop diversification in high range home gardens

H4: There exist no significant concurrence between the technology need of the high range home garden farmers on production, protection and value addition aspects.

H5: There exist no preference towards a particular dimension of technology as perceived by home garden farmers, agricultural officers and scientists.

H6: Crowd sourcing has no significant contribution on the adoption of technology by high range home garden farmers.

H7: There exist no improvement in the BC ratio when comparing the farmer practices with that of demo plots while conducting the Front Line Demonstration of production practices in banana and cabbage dominant home gardens

H8: There exist no significant contribution of the characteristics of respondents (independent variable) in the extent of adoption of technology in high range home gardens.

H9: There exist no difference in the gender role with reference to the extent of involvement of men and women in carrying out the different practices in the high range home gardens.

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSIONS

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

4.1. Structural configuration in terms of dominance biodiversity profile of crops in the high range home gardens

4.2. Technology needs assessment

4.3. Extent of horizontal and vertical crop diversification in high range home gardens

4.4. Front line demonstration in high range home garden systems

4.5. Crowd sourcing and percentage adoption of crop production and protection practices in different crop based home gardens

4.6. Dimensions of technology suited for high range home gardens

4.7. Distribution of the home garden farmers based on their personal, socio-cultural and economic factors

4.8. Gender roles in different crop based home gardens.

4.9. Constraints experienced by the home garden farmers

4.10. Suggestions for refinement as perceived by home garden farmers and extension personnels.

4.1. STRUCTURAL CONFIGURATION IN TERMS OF DOMINANCE BIODIVERSITY PROFILE OF CROPS IN THE HIGH RANGE HOME GARDENS

The numerical and economical dominance of crops in home gardens will give a view of the arrangements of crops in home gardens that reflects the structural configuration and the functional dynamics of home gardens.

4.1.1. Numerical and economical dominant crops in high range home gardens

The numerical and economic dominance of crops in different cropping system were worked out using a seven-point continuum with the score range of 1 to 7 where one designated the lowest dominance and seven designated the highest dominance. The result of the numerical and economic dominance of crops in banana, black pepper, cardamom and vegetable based home gardens is presented from Table 1 to 4.

4.1.1.1 Numerical and economical dominant crops in banana based home gardens

The results of the numerical and economic dominant crops, in banana based home gardens is presented Table 1 and Fig 2.

Table 1. Numerical and economical dominant crops in banana based home gardens

Banana based home garden (N=15)				
nk	ɔp	merical minance	ɔnomic minance	al Mean minance
1	ɔber	5.75	6.63	6.19
2	nana	4.88	6.25	5.56
3	ɔioca	7.00	3.40	5.20
4	wpea	6.00	4.33	5.17
5	coa	4.92	4.58	4.75
6	ck pepper	3.92	4.93	4.43
7	all chilly	5.00	3.50	4.25

ɔps=25 (when rated in scale 1-lowest and 7-highest),
x dominance=6.19 Rubber
n dominance=1 Anjili
an dominance 3.51
nean=12 crops; and < mean =13crops

A total of 25 dominant crops were found (Appendix V) in banana based home gardens when worked out in a seven-point ordinal scale. Out of the 25 dominant crops, seven most dominant crops *viz* rubber (6.19) banana (5.56),

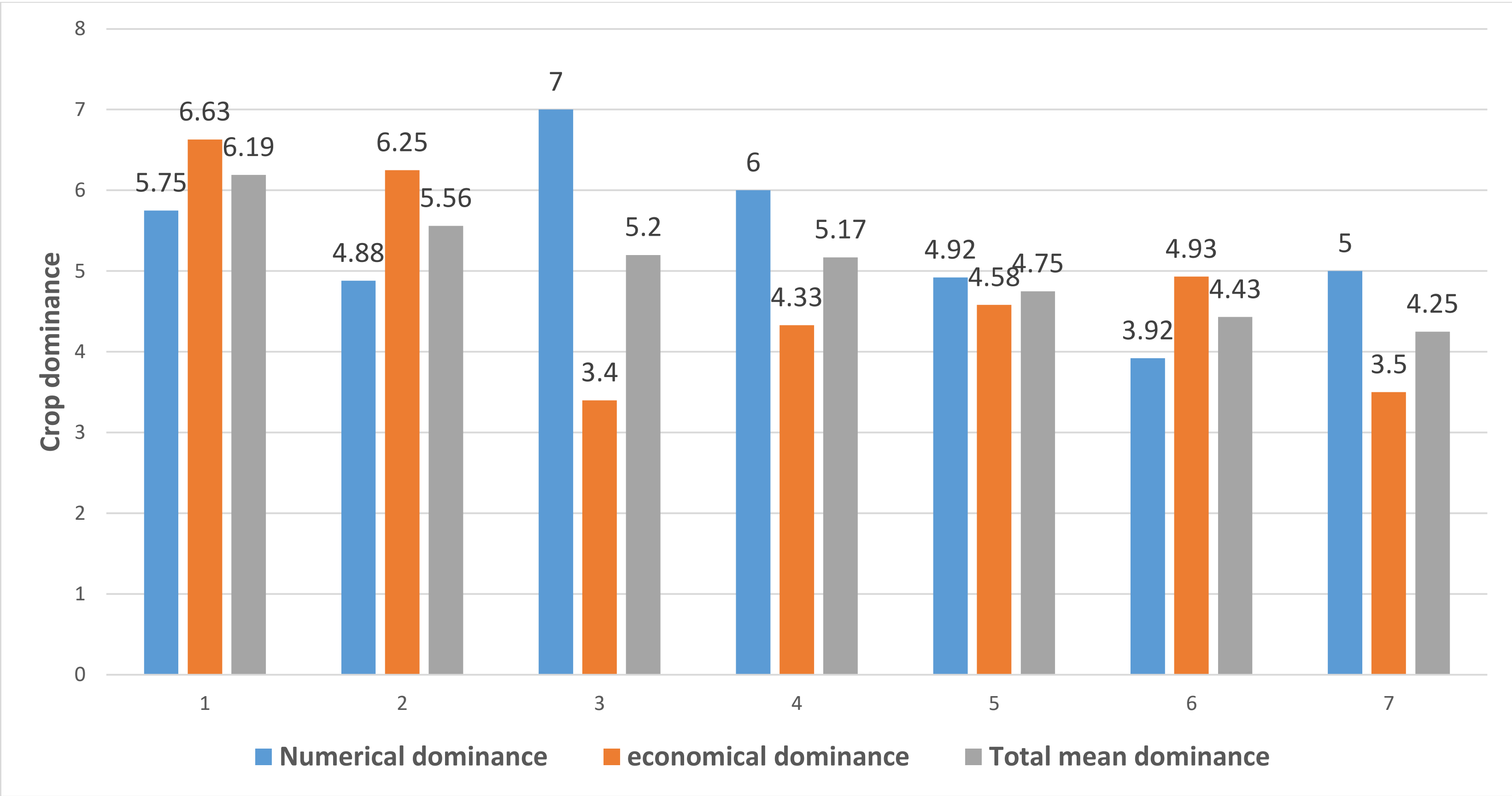


Fig.2 Numerical and economical dominant crops in banana based homegardens

tapioca (5.20), cowpea (5.17), cocoa (4.75), black pepper (4.43) and small chilly (4.25) were numerically and economically dominant.

On analysis of the numerically dominant crops tapioca (7.00) ranked the top position followed by cowpea (6.00), rubber (5.75), small chilly (5.00), cocoa (4.92), Banana (4.88) and black pepper (3.92).

Analyzing the economic dominant crops, rubber (6.63) ranked first followed by banana (6.25), black pepper (4.93), cocoa (4.58), cowpea (4.33), small chilly (3.50) and tapioca (3.40).

4.1.1.2. Numerical and economical dominant crops in black pepper based home gardens

The results of the numerical and economic dominant crops, in black pepper based home gardens is presented Table 2 and Fig 3.

T**able 2. Numerical and economical dominant crops in black pepper based home gardens**

Black pepper based home garden (N=15)				
Rank	Crop	Numerical Dominance	Economic Dominance	Total Mean Dominance
1	Black pep|	6.60	7.00	6.80
2	Rubber	4.86	4.86	4.86
3	Taro	7.00	2.50	4.75
4	Turmeric	3.80	5.00	4.40
5	Cocoa	3.86	4.43	4.14
6	Tapioca	4.00	4.13	4.06
7	Thipalli	6.00	2.00	4.00
Crops=22 (when rated in scale 1-lowest and 7-highest), Max dominance=6.80 Black pepper Min dominance=1.5 Siver Oak Mean dominance 3.54 > mean=10crops; and < mean =12 crops				

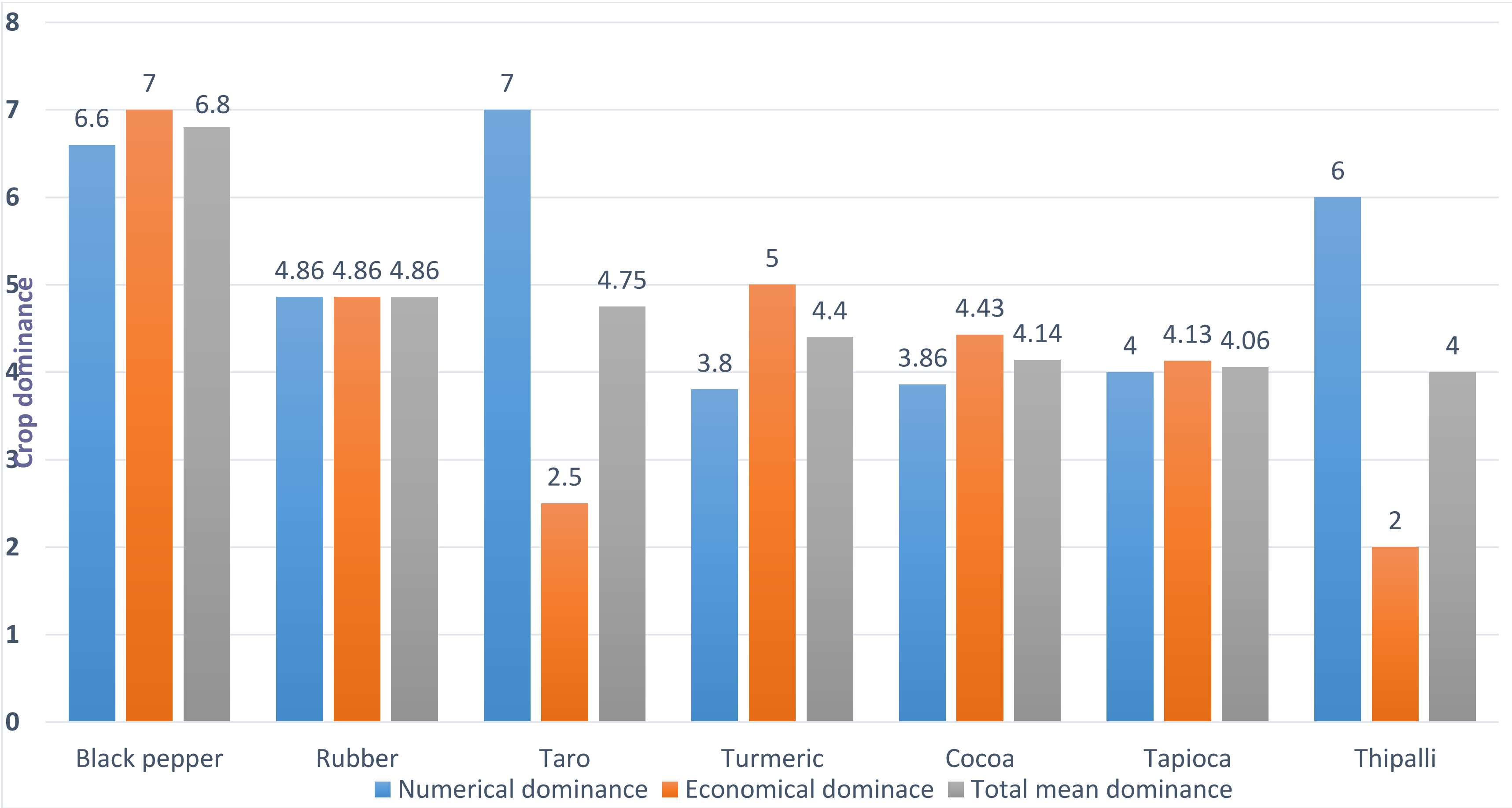


Fig 3. Numerical and economical dominant crops in black pepper based home garden

In black pepper based home gardens, 22 dominant crops were found (Appendix VI) when worked out in a seven point ordinal scale. Out of the 22 dominant crops, seven most dominant crops which were numerically and economically dominant was identified and presented in Table 10.

On analysis of Table 2, the mean ranked score revealed that the black pepper was the dominant crop (6.80) followed by rubber (4.86), taro (4.75), turmeric (4.40), cocoa (4.14), tapioca (4.06) and thippali (4.00).

The result on numerical wise dominance of black pepper based home garden revealed that taro (7.00) was found numerically dominant followed by black pepper (6.60), thippali (6.00), rubber (4.86), tapioca (4.00), cocoa (3.86) and turmeric (3.80).

The economical wise dominance of black pepper based home garden pointed out that black pepper (7.00) was the economically dominant crop followed by turmeric (5.00), rubber (4.86), cocoa (4.43), tapioca (4.13), taro (2.50) and thippali (2.00).

4.1.1.3. Numerical and economical dominant crops in cardamom based home gardens

The results of the numerical and economic dominant crops, in cardamom based home gardens is presented Table 3 and Fig 4.

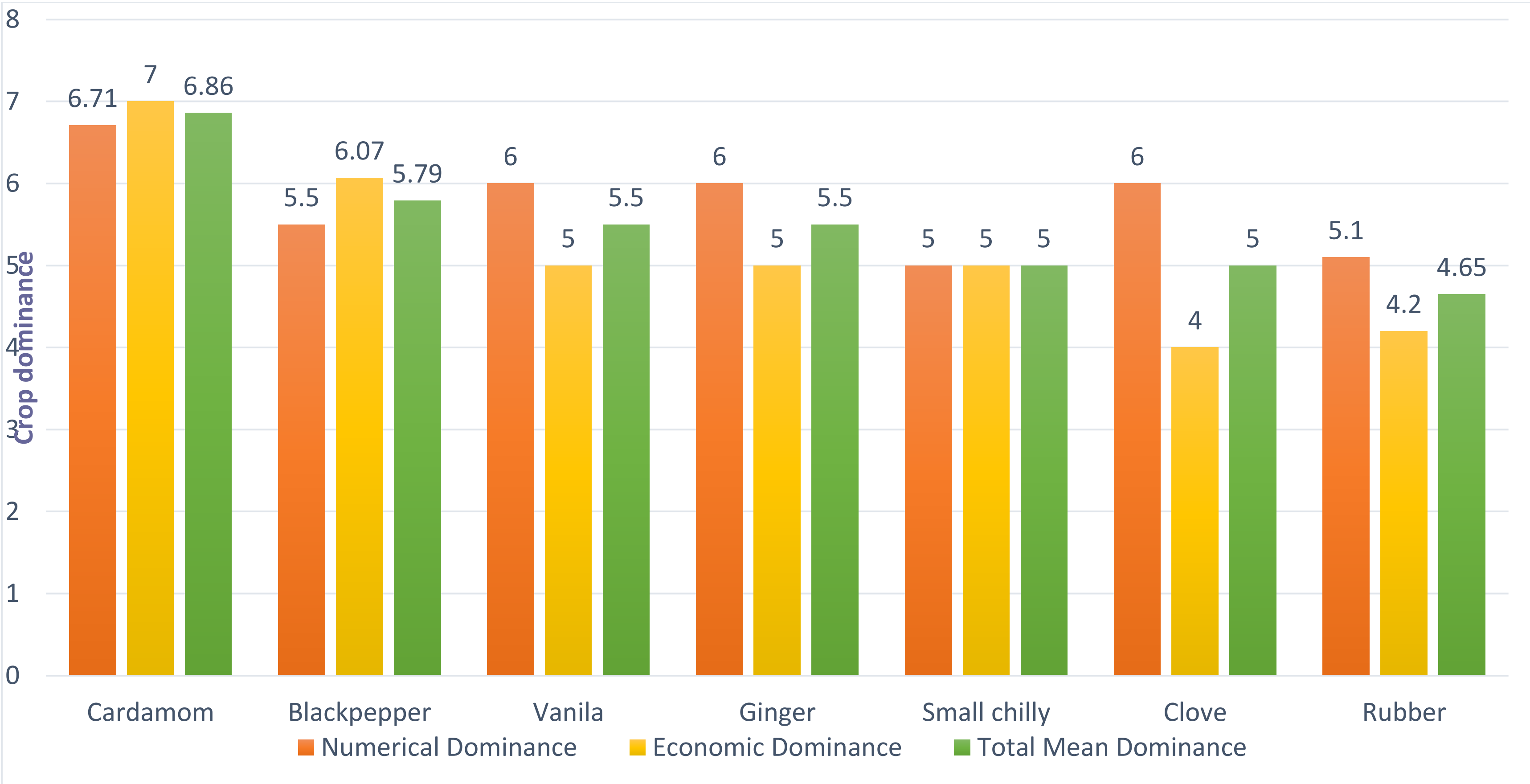


Fig 4. Numerical and economical dominant crops in cardamom based home gardens

Table 3. Numerical and economical dominant crops in cardamom based home gardens

Cardamom based home garden (N=15)				
Rank	Crop	Numerical Dominance	Economic Dominance	Total Mean Dominance
1	Cardamom	6.71	7.00	6.86
2	Blackpepper	5.50	6.07	5.79
3	Vanila	6.00	5.00	5.50
4	Ginger	6.00	5.00	5.50
5	Small chilly	5.00	5.00	5.00
6	Clove	6.00	4.00	5.00
7	Rubber	5.10	4.20	4.65
Crops=23 (when rated in scale 1-lowest and 7-highest), Max dominance=6.86 cardamom Min dominance=1.49 taro Mean dominance 3.56 > mean=9 crops; and < mean =14 crops				

In cardamom based home garden 23 dominant crops were found (Appendix VII) when worked out in a seven point ordinal scale, out of the 23 dominant crops seven most dominant crops which were numerically and economically dominant is presented in Table 3. On assessment of Table 3, the mean ranked score revealed that cardamom (6.86) was the dominant crop followed by black pepper (5.79), vanilla (5.50), ginger (5.50), small chilly (5.00), clove (5.00) and rubber (4.65).

The numerical dominance of cardamom based home garden revealed that cardamom (6.71) was found numerically dominant followed by vanilla (6.00), ginger (6.00), clove (6.00), black pepper (5.50), rubber (5.10), and small chilly (5.00).

From the table on the economic dominance of cardamom-based home garden it was inferred that cardamom (7.00) was the economically dominant crop followed by black pepper (6.07), vanilla (5.00), ginger (5.00) and small chilly (5.00), clove (4.20) and rubber (3.00).

It was obvious that certain cropping system do have its monopoly both numerically and economically due to the unique characteristics of that cropping system and cardamom is such one crop that fits only for high range subtropical climate situations.

4.1.1.4 Numerical and economical dominant crops in vegetable based home gardens inclusive of strawberry

The results of the numerical and economic dominant crops, in vegetable based home gardens is presented Table 4 and Fig 5.

Table 4. Numerical and economical dominant crops in vegetables based home gardens inclusive of strawberry.

Cabbage based home garden (N=15)				
Rank	Crop	Numerical Dominance	Economic Dominance	Total Mean Dominance
1	Cabbage	6.27	6.47	6.37
2	Strawberry	6.17	6.33	6.25
3	Potato	5.33	4.67	5.00
4	Carrot	4.43	5.00	4.71
5	Beans	4.00	5.00	4.50
6	Butter beans	3.38	5.13	4.25
7	Coriander	4.43	3.86	4.14
	Crops=37 (when rated in scale 1-lowest and 7-highest), Max dominance=6.37 cabbage Min dominance=1 maize Mean dominance 3.05 > mean=15 crops; and < mean =22 crops			

A total of 37 dominant crops were found (Appendix VIII) in vegetable-based home gardens when rated in a seven-point ordinal scale. Out of the 37 dominant crops seven most dominant crops which were numerically and economically dominant is presented in Table 4. On screening of Table 4, the mean

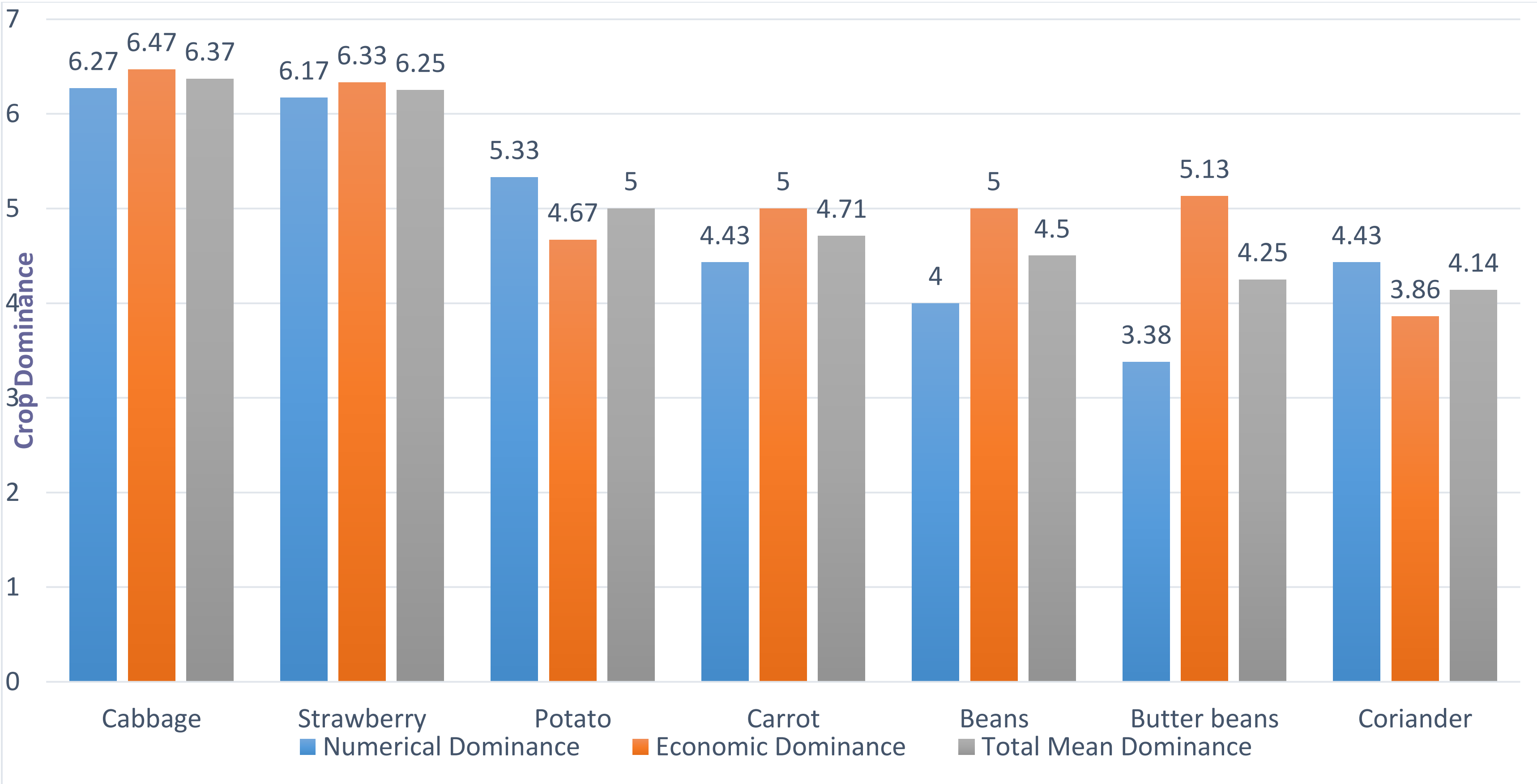


Fig 5. Numerical and economical dominant crops in vegetable based home gardens

ranked score revealed that cabbage (6.37) was found to be the most dominant crop followed by strawberry (6.25), potato (5.00), carrot (4.71), beans (4.50), clove butter beans (4.25) and coriander (4.14).

The numerical dominance of vegetable-based home garden revealed that cabbage (6.27) was found numerically dominant followed by strawberry (6.17), potato (5.33), carrot (4.43), beans (4.00), butter beans (3.38), and coriander (4.43).

On analyzing the economic dominance of vegetable based home garden it can be inferred that cabbage (6.47) was found economically dominant followed by strawberry (6.33), carrot (5.00), beans (5.00), butter beans (5.13), potato (4.67) and coriander (3.86).

The results of Table 1 revealed that wherever rubber existed it was economically dominant crop, however rubber being a cash crop, banana was considered as the dominant crop because focus was on food crop. It was interesting to know that the high dominance of crop mentioned in the table were as a result of possibility of intercropping with both vegetables and tubers, owing to the regular income and concern of food as well as nutritional security of the farm families.

The results of Table 2 revealed that black pepper was economically dominant crop in pepper-based home gardens. It is solely due to the economic interest of the farmer. The black pepper always holds a relatively good price over other crops owing to the market potential of the same. The high dominance of rubber in the home garden made an assured income to the farmers. The crops like taro, turmeric, cocoa and thipali were the major crops that were intercropped in pepper-based home garden and these crops often fetches good price in the market.

The results of Table 3 points to the fact that cardamom based home garden basically follow a spice-based cropping system. It was obvious that certain cropping system do have its monopoly both numerically and economically due to the unique characteristics of that cropping system and cardamom is such one crop that fits only for high range subtropical climate situations. The dominant crops that were presented in the table shows that majority of the crops in the cardamom-based home garden were spice crops that fetched high price in the market this shows the economic motivation of the farmers.

Table 4 clearly showed that vegetable-based home gardens of Idukki district have a peculiar type of vegetable configuration. Even though the land area is limited, multiple type of vegetables such as cabbage, potato, beans, butterbeans, coriander are undertaken in these small areas, which not only act as an income source but also helps in, minimization of risk.

The results clearly indicates that numerically dominant crops need not be the economic dominant crop always and the results are in conformity with the observation made by Thomas (2004) who reported that studies on dominance and biodiversity characterization will throw light to such observations, that there is a need for establishing whether numerical dominance has an influence over economic dominance.

4.1.2. Diversity profile of high range home gardens in Kerala

Home gardens in Kerala are small land units for miscellaneous crop production, usually within the homestead without rural urban divide which play an important role in the upkeep of livelihoods of communities. It also helps in conservation of biological diversity. Home gardens are vital component of subsistence living and an archive for diverse plant species with both coomodity and non commodity crops of mixed life cycles. The number of crop species and species composition found in home gardens may be attributed to techno-socio-economic and psychological conditions of home garden farmers. Hence, profiling the high range home garden biodiversity becomes essential.

4.1.2.1. Crop wise diversity index in the different regions of banana dominant home gardens

The crop wise diversity indexes of banana dominant home gardens are depicted in Table 5 and Fig 6.

Table 5. Crop wise diversity index in the different regions of banana dominant home gardens (N=15)

Crops	Veg	Tub	Fru	Pla	Spi	Med	Orn	MPTS	For
Mean total	0.529	0.405	1.339	1.175	1.425	0.197	0.709	0.721	0.054
SD	0.377	0.209	0.326	0.396	0.315	0.161	0.448	0.280	0.115
SE	0.097	0.054	0.084	0.102	0.081	0.042	0.116	0.072	0.030
F value	37.700								
CD (0.01)	0.292**								

The crop wise diversity indexes of banana-based home gardens are presented in Table 5 and it was observed that the highest mean diversity was recorded in spices (1.425) and was on par with the fruit crops (1.339). The plantation crops were recorded as the third dominant crop in the banana-based home gardens with a diversity index of 1.175 which was on par with fruit crops.

The diversity index of all other crops was significantly lower than that of spices, plantation and fruit crops. The range of diversity index values for different crops varied from 0.054 (fodder) to 1.425 (spices). The lowest diversity index was noted with forage crops which were on par with the medicinal plants (0.197).

The lowest mean biodiversity index of forage crop was owing to the absence of large livestock farms in the region and also sufficient food sources were available for the livestock from the surroundings as it possesses rich biodiversity of plants.

The diversity index of medicinal plants was found to be lower in high range home gardens of Idukki. A study conducted on the home gardens of Idukki district revealed that cultivation of medicinal plants was diminishing in the region owing to the increased reliance on the allopathic medicines (Gaunt, 2015).

4.1.2.1.1. Region wise and total diversity index of each banana dominant home gardens and relationship between its area and total diversity index

The results of region wise and total diversity index of each banana dominant home gardens and relationship between its area and total diversity index is presented in Table 6 and Fig 7.

Table 6. Region wise and total diversity index of each banana dominant home gardens and relationship between its area and total diversity index

(N=15)

HGS	CY	MR	OR	Mean Total DI	Area(acre)
1	2.718	2.362	2.609	2.563	4.000
2	2.736	2.755	0.883	2.125	1.500
3	2.398	2.325	0.930	1.884	2.250
4	1.745	2.418	1.230	1.798	1.250
5	2.772	2.666	2.050	2.496	3.000
6	2.891	2.492	1.237	2.207	3.000
7	2.838	2.137	1.836	2.271	2.000
8	2.227	2.289	1.998	2.171	1.500
9	2.089	1.953	1.704	1.915	1.250
10	2.582	2.300	0.970	1.951	2.300
11	2.811	2.321	2.563	2.565	1.500
12	2.983	1.742	1.025	1.917	0.500
13	2.504	2.013	1.770	2.096	1.500
14	2.776	2.704	2.443	2.641	3.000
15	2.872	2.500	1.134	2.169	2.500
Mean Total	2.596	2.332	1.626	2.185	2.070
SD	0.347	0.284	0.614	0.274	0.914
SE	0.089	0.073	0.159	0.071	0.236
Min-Max	1.745-2.983	1.742-2.755	0.883-2.609	1.798-2.641	0.500-4.000
F value	19.622			Correlation coefficient=0.621*	
CD (0.01)	0.432**				

*Significant at 5 %   ** Significant at 1 %

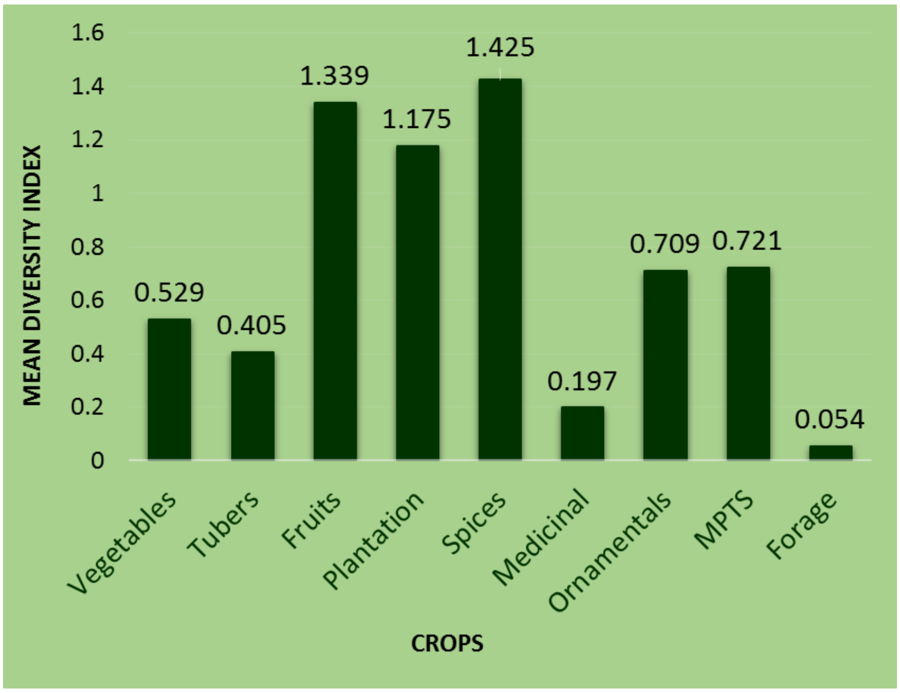


Fig 6. Crop wise diversity index in the banana based home gardens

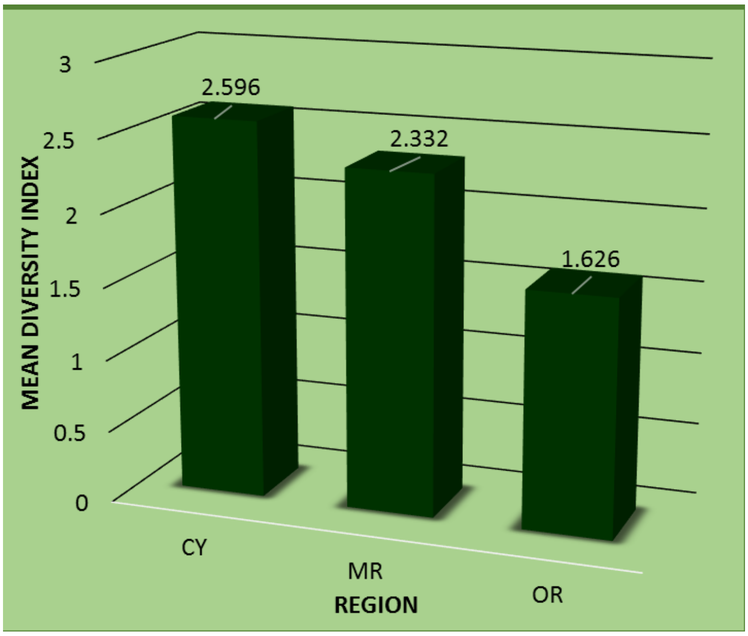


Fig 7. Region wise diversity index of banana dominant home gardens

The results presented in Table 6 revealed that the diversity index of courtyard region ranged from 1.745-2.983 and was recorded with the highest diversity index of 2.596 compared to mid-region and outer region. The mid-region of different home gardens exhibited a diversity index of range 1.742- 2.755. Unlike pepper and cardamom-based home gardens, mid-region of banana-based home gardens were found to be on par with courtyard region with a mean diversity index of 2.332. However, the lowest diversity index was noted in the outer region and the diversity indices varied from 0.883-2.609 with a mean diversity index of 1.626.

The total mean biodiversity index of the banana dominant high range home gardens varied from 1.798 - 2.641 with a mean value of 2.185. The area of home gardens ranged from 0.500-4.000 acre with an average size of 2.070 acres. The correlation analysis pointed out that the total mean diversity index exhibited a positive significant correlation with size of holding with a correlation coefficient of 0.621.

Similar results were also corroborated by Gautam *et al.* (2008), as they suggested that the size of home gardens exhibited a significant positive correlation with species richness with a correlation coefficient of 0.46 in hill agro ecosystems of Nepal. However, Kumar *et al.* (2011) reported that as the size of home garden increased, the species diversity was also increased but the number of individual species / unit area exhibited a dwindling trend in tested 839 home gardens of Kerala.

4.1.2.2. Crop wise diversity index in the different regions of black pepper dominant home gardens

The crop wise diversity indexes of black pepper dominant home gardens are depicted in Table 7 and Fig 8.

Table 7. Crop wise diversity index in the different regions of black pepper dominant home gardens (N=15)

Crops	Veg	Tub	Fru	Pla	Spi	Med	Orn	MPTS	For
Mean total	0.485	0.442	0.676	0.661	1.548	0.417	0.577	0.808	0.000
SD	0.330	0.330	0.322	0.324	0.563	0.303	0.370	0.298	0.000
SE	0.085	0.085	0.083	0.084	0.145	0.078	0.095	0.077	0.000
F value	21.932								
CD (0.01)	0.323**								

The results of the crop wise diversity index of pepper dominant home gardens presented in Table 7 revealed that the highest diversity index was exhibited by spice crops (1.548) which was significantly different from all other crops and was followed by multipurpose trees (0.808). The lowest biodiversity was recorded with forage crops (0.000) which was significantly different from other crops and was followed by medicinal plants (0.417), tubers (0.442), vegetables (0.485), plantation crops (0.661) and fruits (0.676), which were statistically on par.

In pepper-based home gardens, the highest diversity of spice crops may be due to the ecological peculiarities of the region which favours the cultivation of spices along with the assurance of high economic returns. Furthermore, the dominance of spices in the home garden reduced the soil temperature and soil evaporation rate, thus maintained the soil microclimate which favours the diversity of crops in the spice-based cropping systems (Shehana *et al.*, 1992).

The higher diversity index of MPTS in the pepper-based home garden was due to the necessity of shade for the cultivation of pepper and the farmer's habit of retaining all type of tree species for trailing pepper. This may be also due to high market value of the multipurpose tree species and these species does not require additional management practices.

Salam *et al.* (1991) reported that the tree species grown around the gardens enhance both the productivity and also resource use efficiency of home gardens.

Chandrasekara (2009) also reported the high diversity index of multipurpose trees in coffee-based homesteads of high range areas aids in shade, mulching and also as live fence.

4.1.2.2.1. Region wise and total diversity index of each black pepper dominant home gardens and relationship between its area and total diversity index

The results of region wise and total diversity index of each black pepper dominant home gardens relationship between its area and total diversity index is presented in Table 8 and Fig 9.

Table 8. Region wise and total diversity index of each pepper dominant home gardens and relationship between its area and total diversity index

(N= 15)

HGS	CY	MR	OR	Mean Total DI	Area (acre)
1	2.669	1.327	1.524	1.840	2.500
2	2.989	1.406	1.510	1.968	7.000
3	2.793	1.746	2.171	2.237	0.400
4	2.638	1.897	1.754	2.096	1.000
5	2.351	2.126	1.232	1.903	2.800
6	1.852	1.478	2.169	1.833	2.500
7	2.624	1.950	1.336	1.970	3.000
8	2.572	1.351	1.737	1.887	3.000
9	2.034	1.997	1.203	1.745	0.300
10	1.271	1.815	1.244	1.443	2.280
11	2.563	2.375	1.771	2.236	3.500
12	2.467	1.684	1.643	1.931	0.700
13	3.241	1.481	1.944	2.222	1.250
14	2.344	2.291	1.945	2.193	2.750
15	2.414	2.240	1.720	2.125	1.500
Mean Total	2.455	1.811	1.660	1.975	2.299
SD	0.472	0.353	0.319	0.219	1.661
SE	0.122	0.091	0.082	0.057	0.429
Min-Max	1.271-3.241	1.327-2.291	1.510-2.171	1.443-2.237	0.300-7.000
F value	17.853	Correlation coefficient= -0.0533 ^{NS}			
CD (0.01)	0.381**				

*Significant at 5 %   ** Significant at 1 %

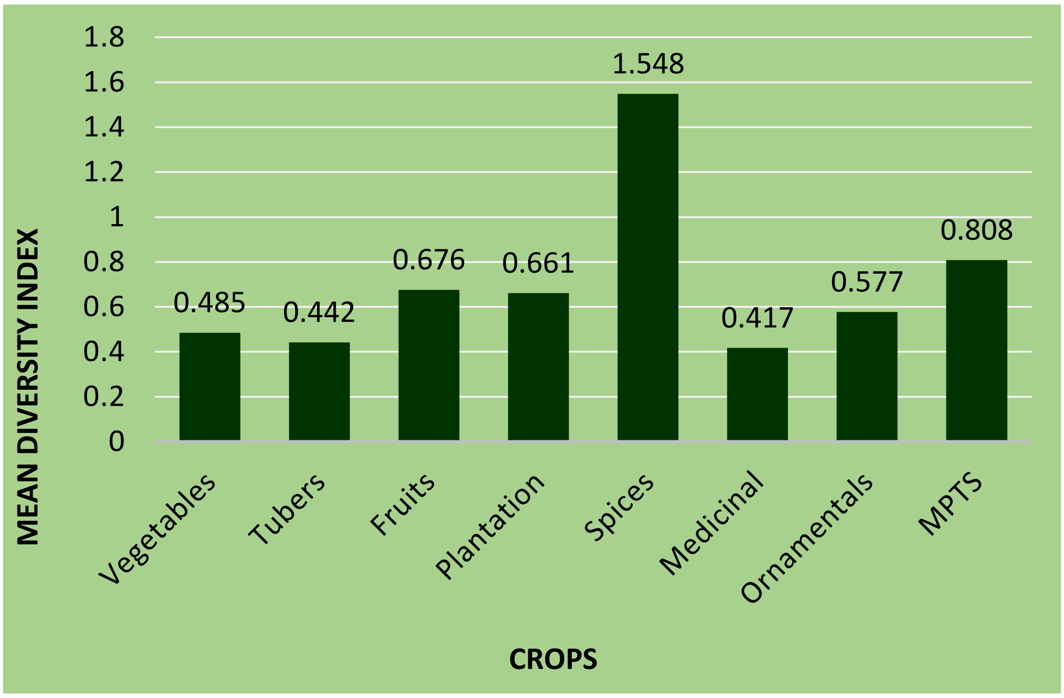


Fig 8.Crop wise diversity index in the different regions of black pepper dominant home gardens

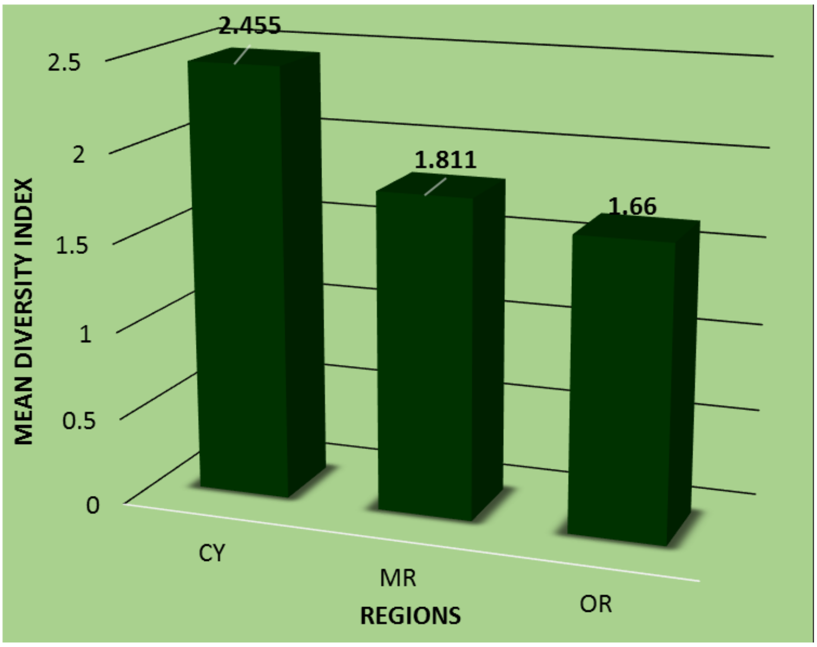


Fig 9. Region wise diversity index of black pepper dominant home gardens

Table 8 illustrates that the mean diversity index of the courtyard region ranged from 1.271-3.241 whereas the diversity index in mid-region varied from 1.327-2.291. The diversity index of outer region was noted with a range varying from 1.510- 2.171 in the pepper dominant home gardens. On comparing the region-wise diversity index, the highest crop diversity was recorded in courtyard region with a diversity index of 2.455. The outer region recorded lowest diversity index (H=1.660) which was found to be on par with the mid-region (H=1.811).

The courtyard region is the immediate surroundings of the home which enable the easy access to the resources by farmer family, so that a diverse crop cafeteria was maintained in this region in high range home gardens. This finding was contradictory to the findings of a study conducted in Kerala that suggested a higher biodiversity in the mid-region in home gardens of Kerala (Thomas, 2004).

The total mean biodiversity index of the pepper dominant high range home gardens varied from 1.443-2.237 with a mean value of 1.975. The size of landholdings varied from 0.300-7.000 acre with an average area of 2.299 acres.

The average home garden size varied from 0.10 – 0.50 ha around the world (Das and Das, 2005) that was lower than the size of home gardens in high range regions. The significantly higher size of the holdings in the high range regions provides sufficient space for growing crops to meet food security along with commercial cultivation of cash crops which assure additional income.

On comparing the correlation between total mean diversity index and size of holding, it revealed a non- significant negative correlation with a correlation coefficient of -0.0533, which indicated that the biodiversity index was not influenced by the size of holding in pepper home garden.

However, Kumar *et al.* (1994) recorded that species diversity exhibited a negative correlation with species richness in home gardens of Kerala. Similar results were also pointed out by Drescher *et al.* (2006) while studying the home gardens of Africa. Albuquerque *et al.* (2005) reported that the size of holding was not influenced by the size of holding in a study conducted at home gardens of Northern Brazil which was in accordance to this study results.

4.1.2.3. Crop wise diversity index in the different regions of cardamom dominant home gardens

The crop wise diversity indexes of cardamom dominant home gardens are depicted in Table 9 and Fig 10.

Table 9. Crop wise diversity index in the different regions of cardamom dominant home gardens (N=15)

Crops	Veg	Tub	Fru	Pla	Spi	Med	Orn	MPTS	For
Mean total	0.595	0.282	0.975	0.801	1.274	0.31	0.895	0.601	0.000
SD	0.384	0.307	0.325	0.337	0.358	0.226	0.550	0.351	0.000
SE	0.099	0.079	0.084	0.087	0.092	0.058	0.142	0.091	0.000
F value	19.864								
CD (0.01)	0.324**								

The crop wise diversity indexes of cardamom-based home gardens are given in Table 9 and the results revealed that the highest diversity was recorded in spices (1.274) compared to all other crops and the range of diversity index values for different crops varied from 0.000 (forage crops) to 1.274 (spices).

The second most dominant crop in terms of diversity index was fruits (0.975) which were statistically on par with ornamentals (0.895) and plantation crops (0.801).

Forage crops were recorded with the lowest diversity index (0.000) which significantly differed from other crops. It was followed by tuber crops (0.282) and medicinal plants (0.310) which were statistically on par.

4.1.2.3.1 Region wise and total diversity index of each cardamom dominant home gardens and relationship between its area and total diversity index

The results of region wise and total diversity index of each cardamom dominant home gardens relationship between its area and total diversity index is presented in Table 10 and Fig 11.

Table 10. Region wise and total diversity index of each cardamom dominant home gardens and relationship between its area and total diversity index (N=15)

HGS	CY	MR	OR	Mean Total DI	Area(acre)
1	2.961	1.418	1.380	1.919	1.000
2	1.911	2.057	1.991	1.986	1.500
3	2.893	1.755	1.770	2.139	4.000
4	2.678	1.638	1.122	1.813	0.700
5	2.035	1.820	1.788	1.881	1.500
6	2.039	1.928	2.212	2.060	4.000
7	2.400	2.070	1.351	1.940	2.500
8	2.039	1.821	1.053	1.638	3.000
9	2.217	1.804	1.547	1.856	2.500
10	2.734	2.767	2.178	2.560	5.000
11	2.492	1.328	1.249	1.690	2.000
12	2.702	1.863	1.841	2.135	3.500
13	1.855	1.393	1.938	1.728	0.850
14	1.768	0.489	1.812	1.357	0.500
15	1.960	1.701	2.218	1.960	0.700
Mean Total	2.312	1.724	1.697	1.911	2.217
SD	0.404	0.485	0.392	0.272	1.427
SE	0.104	0.125	0.101	0.070	0.368
Min-Max	1.768-2.961	0.489-2.767	1.053-2.218	1.357-2.560	0.500-5.000
F value	9.824			Correlation coefficient= 0.706*	
CD (0.01)	0.423**				

*Significant at 5 % ** Significant at 1 %

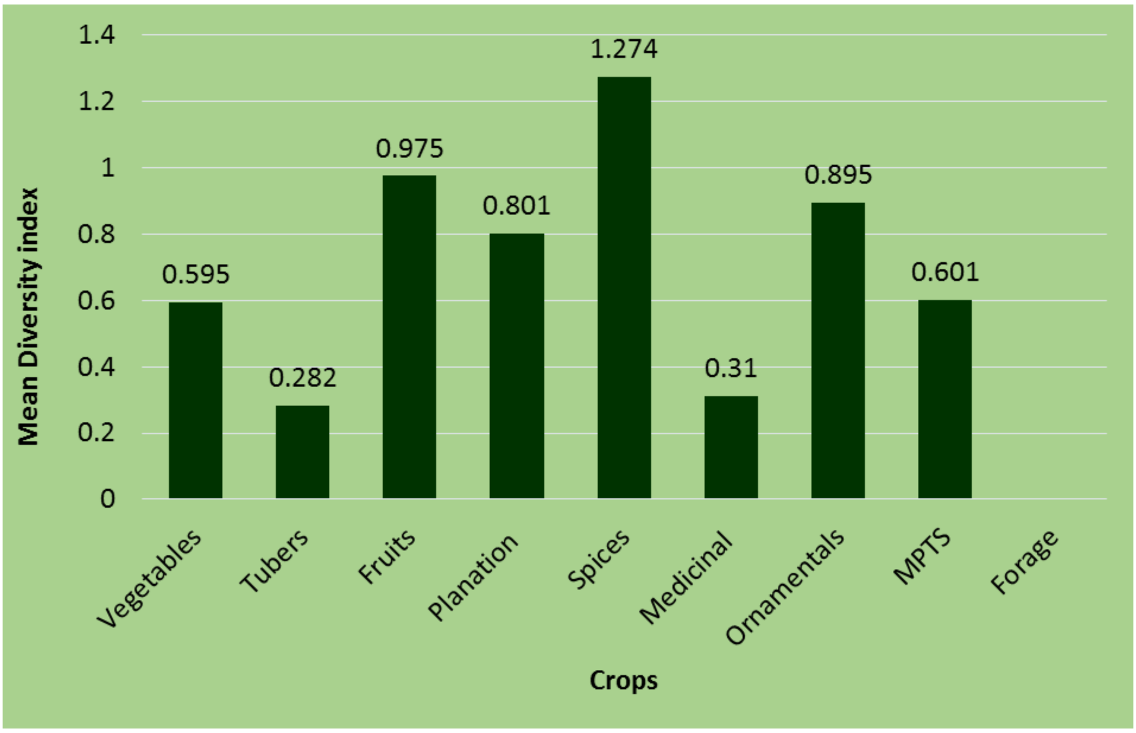


Fig 10. Crop wise diversity index in the different regions of cardamom dominant home gardens

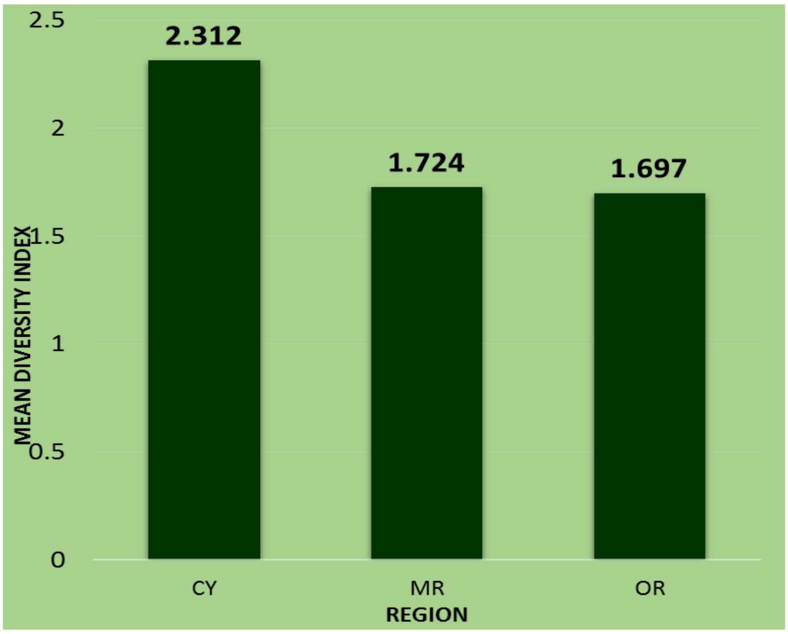


Fig 11. Region wise diversity index of cardamom dominant home garden

The diversity indices in cardamom based high range home gardens exhibited a similar trend as that of pepper-based home gardens of high range area. The results of Table 10 depicted that the diversity indexes of courtyard region varied from 1.768-2.961 with a mean value of 2.312 and recorded maximum diversity index compared to that of the mid-region and outer region. The outer region recorded the lowest biodiversity index (H=1.697) which was on par with the mid-region (H=1.724). The results of this study were contradictory to the findings of Thomas and Kurian (2013) who reported that the highest diversity was recorded in outer regions of home gardens followed by mid regions and courtyards. The higher biodiversity index of outer regions was owing to the factors such as planting of non-commodity trees and regeneration of neglected seed lots and the lowest diversity at courtyards was due to the plastering or interlocking of courtyard region.

The total mean diversity index of cardamom based home gardens ranged from 1.357-2.560 with a mean value of 1.911. The area of home gardens ranged from 0.500-5.000 acre with an average landholding of 2.217 acres.

The larger size of home gardens was an indicator of high productivity that enables self-sufficiency and also aids to gain additional income through the sale of products (Barbhuiya *et al.*, 2015).

The correlation analysis revealed that the total mean diversity index showed a positive significant correlation with the area of home garden with a correlation coefficient of 0.706.

Kumar and Nair (2004) reported that the size of home gardens played a vital role in determination of diversity profile of home gardens in Kerala. Similarly, Sunwar *et al.* (2006) reported that the species richness exhibited a positive correlation with size of home gardens based on a study conducted at Western Nepal which corroborated the present findings.

4.1.2.4. Crop wise diversity index in the different regions of vegetable dominant home gardens

The crop wise diversity indexes of vegetable dominant home gardens are depicted in Table 11 and Fig 12.

Table 11. Crop wise diversity index in the different regions of vegetables dominant home gardens (N=15)

Crops	Veg	Tub	Fru	Pla	Spi	Med	Orn	MPTS	For
Mean total	1.252	0.019	0.542	0.098	0.324	0.063	0.734	0.029	0.040
SD	0.626	0.057	0.802	0.147	0.356	0.128	0.557	0.087	0.112
SE	0.162	0.015	0.207	0.038	0.092	0.033	0.144	0.022	0.029
F value	15.994								
CD (0.01)	0.388**								

The results given in Table 11 indicated that the highest mean diversity index was recorded with vegetable crops (1.252) which statically differ from all other crop groups. It was followed by ornamental (0.734) which was statistically on par with fruits (0.542). The lowest mean biodiversity index was recorded in tuber crops (0.019) which were on par with multipurpose trees (0.029), forage crops (0.040), medicinal plants (0.063) and plantation crops (0.098).

The dominance of vegetable crops in the region was owing to the ecological and climatological peculiarities of the region which favors the cultivation of cool season crops. Similarly, the dominance of vegetables in home gardens of Nepal was reported by Gautam *et al*. (2008) which pointed out the importance of home gardens in ensuring food and nutritional security. Similar results were also given by Sahoo (2009). The higher diversity of ornamentals was also reported by Regassa (2016) in the home gardens of Ethiopia as it was dominated by ornamentals (47.29%) followed by food plants (29.75%) and medicinal plants (15.89%). Niyas *et al.* (2016) also pointed out that ornamentals dominated in the urban and periurban home gardens of Kerala.

4.1.4.1. Region wise and total diversity index of each vegetable dominant home gardens and relationship between its area and total diversity index

The total diversity index of each vegetable dominant home gardens in different regions *viz*., courtyard, mid-region and outer region of cabbage-based high range home gardens are depicted in Table 12 and Fig 13.

Table 12. Region wise and total diversity index of each vegetable dominant home gardens and relationship between its area and total diversity index

(N=15)

HGS	CY	MR	OR	Mean Total DI	Area(acre)
1	0.214	1.093	0.909	0.739	1.750
2	1.266	1.159	1.040	1.155	1.000
3	0.635	1.298	0.550	0.827	0.500
4	0.662	0.777	0.222	0.553	1.500
5	0.673	1.011	0.084	0.589	0.500
6	0.671	1.685	0.613	0.990	0.250
7	2.200	1.010	1.130	1.447	0.150
8	1.740	1.770	0.670	1.393	0.040
9	0.670	0.630	0.450	0.583	0.050
10	1.370	1.410	1.200	1.327	0.450
11	0.690	1.130	1.600	1.140	0.150
12	1.930	1.870	0.930	1.577	0.150
13	1.580	0.140	0.120	0.613	0.200
14	1.840	1.060	1.280	1.393	0.500
15	1.690	0.700	1.160	1.183	1.000
Mean Total	1.189	1.116	0.797	1.034	0.546
SD	0.617	0.459	0.455	0.358	0.532
SE	0.159	0.118	0.118	0.093	0.137
Min-Max	0.214-2.200	0.140-1.870	0.120-1.600	0.553-1.577	0.040-1.750
F value	2.446			Correlation coefficient= -0.347^{NS}	
CD (0.01)	NS				

*Significant at 5 %   ** Significant at 1 %

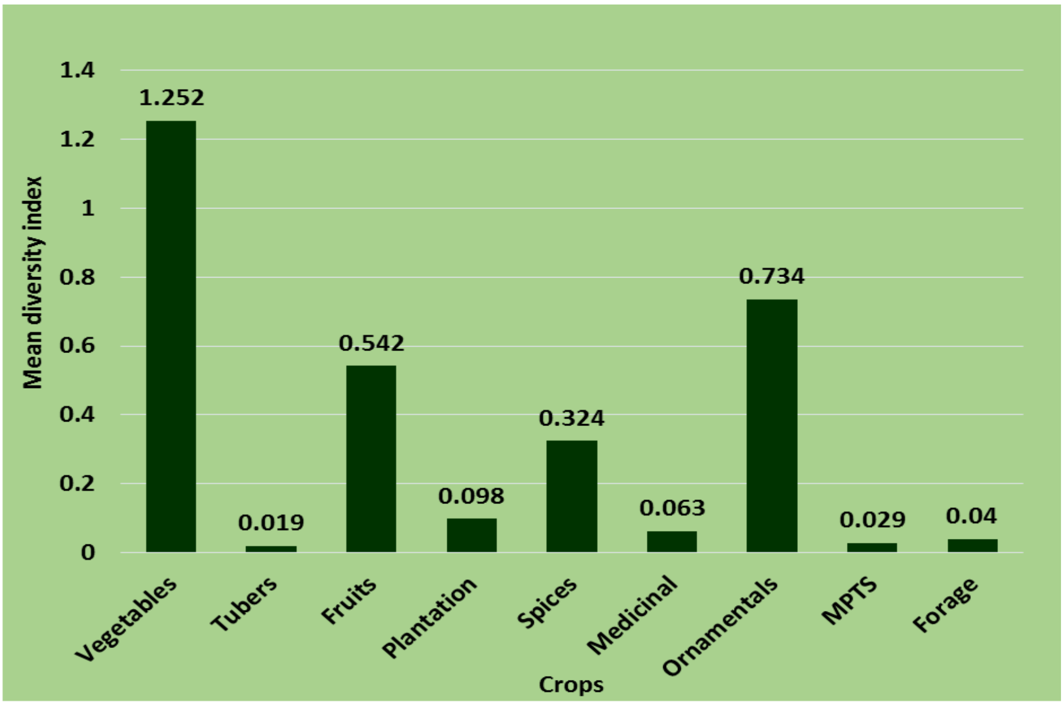


Fig 12. Crop wise diversity index in the different regions of vegetables dominant home gardens

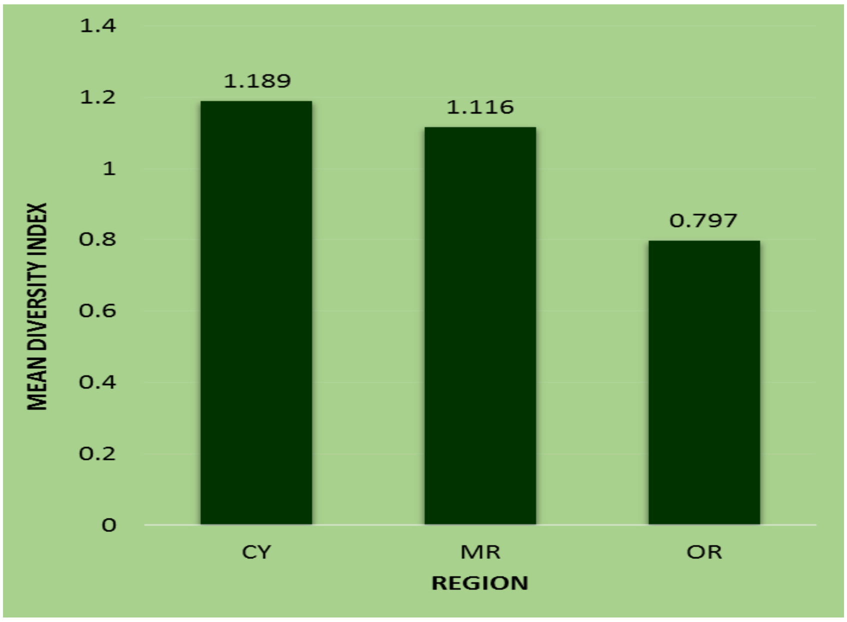


Fig 13. Region wise diversity index of vegetable dominant home gardens

The diversity indexes of the courtyard, mid-region and outer region ranged from 0.214-2.200, 0.140-1.870 and 0.120-1.600 respectively. The statistical analysis revealed that diversity index of different regions in the cabbage dominant home gardens was in parity with each other with a mean value of 1.189, 1.116 and 0.797 in the courtyard, mid-region and outer region respectively.

The total mean diversity of cabbage-based home gardens ranged from 0.553-1.577 with a total mean diversity index of 1.034. The area of home gardens varied from 0.040-1.750 acre with an average size of 0.546. On comparing the correlation between the total mean diversity index and area of home gardens, it exhibited a non-significant negative correlation with a correlation coefficient of -0.347 which indicated that the size of holding neither influence the biodiversity index in cabbage-based home gardens. Similarly, Mohan (2004) reported that the diversity index of different home gardens were almost similar despite of the varying size of the holding.

4.1.5. The mean biodiversity index of different crop based high range home gardens

The data on total mean diversity index of different crop based high range home gardens derived through ANOVA are depicted in Table 13 and Fig 14.

Table 13. The mean biodiversity index of different crop based high range home gardens

	Pepper	Cardamom	Banana	Cabbage
CY	2.455	2.312	2.596	1.189
MR	1.811	1.724	2.332	1.116
OR	1.660	1.697	1.626	0.797
Total mean biodiversity index	1.975	1.911	2.185	1.034
F value	47.680			
CD (0.01)	0.278**			

** Significant at 1% level

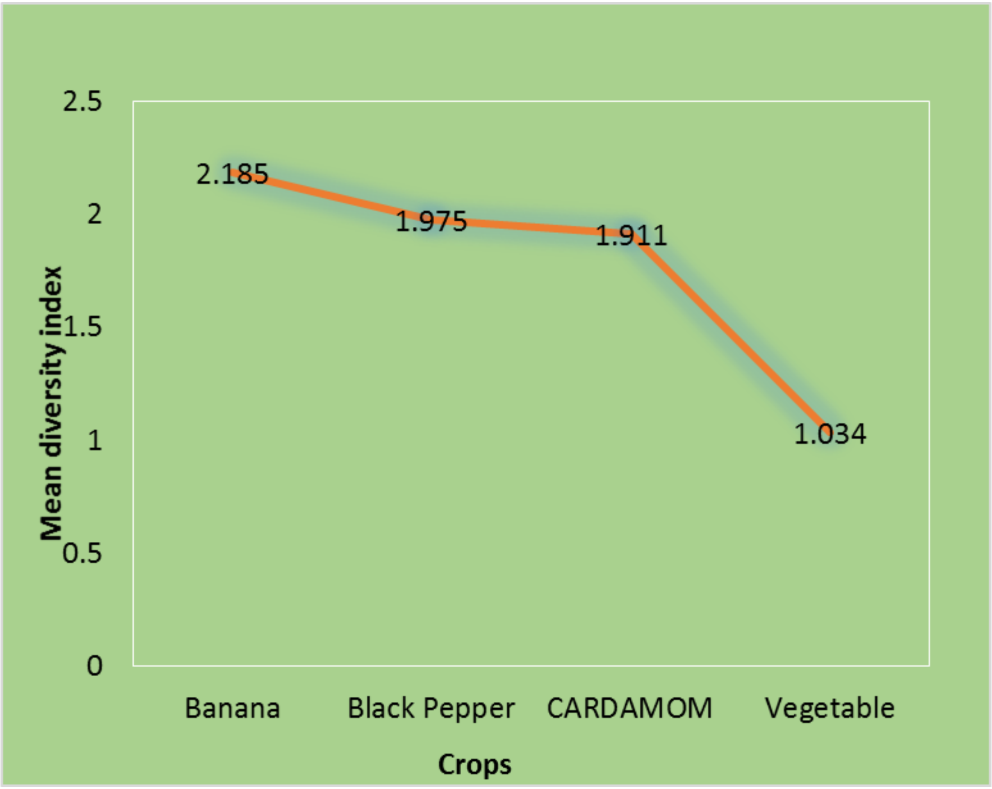


Fig 14.The mean biodiversity index of different crop based high range home gardens

A perusal of the data pointed out that the highest total mean diversity was exhibited in banana-based home gardens with a mean value of 2.185 which was significantly superior to other crop-based home gardens. The pepper-based home gardens and cardamom based home gardens exhibited a total mean diversity index of 1.975 and 1.911 respectively which were found to be on par. However, the lowest diversity index was recorded in cabbage-based crop gardens with a mean value of 1.034 which significantly differed from all other crop-based home gardens. The total mean diversity indices of different crop based home gardens ranged from 1.034-2.185. The results showed that biodiversity is on the decline side if compared to the works in home gardens of Thailand which recorded a similar Shannon-Weiner diversity index that ranged from 1.9 to 2.7 which was comparable to the diversity index of a dipterocarp forest in Thailand (Gajaseni and Gajaseni, 1999). However, Mohan (2004) pointed out that the home gardens of Kerala exhibited similarity to natural forests in terms of species richness with a diversity index of 1.15-1.42.

4.2. TECHNOLOGY NEEDS ASSESSMENT

Technology needs of the farmers vary with farmer due to vide variety of reasons. Even though various institutions and agencies have developed and disseminated technologies, its acceptance and adoption by the home garden farmers varies due to various reasons. In this study, technology need assessment for top seven dominant crops only (considering both numerical and economic dominance) was considered and the results for the same in banana, black pepper, cardamom and vegetable based home garden has been worked out and presented from Table 14 to 17.

4.2.1. Technology needs assessment for the dominant crops in banana based home gardens.

The technology needs assessment for the dominant crops in banana based home garden is revealed in Table 14 and Fig 15.

Table 14: Technology needs assessment for the top seven dominant crops in banana based home gardens with reference to production, protection and value addition **(N=15)**

Crop	Production				Protection				Value addition			
	VMN	N	NMN	WM	VMN	N	NMN	WM	VMN	N	NMN	WM
Rubber	4	5	6	4.67	3	2	10	3.83	2	10	3	4.83
Banana	12	2	1	6.83	10	4	1	6.50	11	1	3	6.33
Tapioca	9	3	3	6.00	8	5	2	6.00	7	3	5	5.33
Cowpea	7	5	3	5.67	7	5	3	5.67	0	0	15	2.50
Cocoa	4	9	2	5.33	5	7	3	5.33	6	5	4	5.33
Black pepper	10	3	2	6.33	10	2	3	6.17	7	4	4	5.50
Small chilly	3	6	6	4.50	4	4	7	4.50	9	2	4	5.83
Total	49	33	23	39.33	47	29	29	38.00	42	25	38	35.67
Mean	7.00	4.71	3.29	5.62	6.71	4.14	4.14	5.43	6.00	3.57	5.43	5.10
SD	3.46	2.36	1.98	0.85	2.81	1.77	3.18	0.96	3.83	3.31	4.28	1.24
SE	1.31	0.89	0.75	0.32	1.06	0.67	1.20	0.36	1.45	1.25	1.62	0.47

VMN- Very Much Needed, N- Needed, NMN- Not Much Needed, WM- Weighted mean

The results clearly reveal that production (5.62) technology was the most needed compared to protection (5.43) and value addition (5.10) technology in banana based home gardens. However, in the production aspects maximum technology need was reported for banana (6.83) followed by black pepper (6.33) and tapioca (6.00). In case of protection aspects same trend was followed as that of production aspects. Whereas in value addition aspects maximum technology need was reported for banana (6.33) followed by small chilly (5.83) tapioca and black pepper (5.33).

It was interesting to note that in all the three aspects, technology need for banana was conspicuous. It was because all the banana based home garden farmers had cultivated different varieties of banana for their household consumption as well as for marketing. Also, the technology need for crop management was very intensive and the amount of value addition was very less compared to other crops. This might be the reason for which farmers demanded technologies on all three aspects of production protection and value addition.

While considering aspect wise attributes need, it differed crop wise. It is evident from the table that there was high technology demand for the crops like tapioca and black pepper on production as well as protection aspects. The high demand of technology need of tapioca may be due to the production potential of tapioca which can be grown as an intercrop or relay crop in banana plantations, which provide an additional income to the farmer. The technology demand for black pepper was solely because of the economic motive of the farmer.

4.2.2. Technology needs assessment for the dominant crops in black pepper based home gardens.

The technology needs assessment for the dominant crops in black pepper-based home garden is revealed in Table 15 and Fig 16.

Table 15: Technology need assessment for the top seven dominant crops in black pepper based home gardens with reference to production, protection and value addition (N=15)

Crops	Production				Protection				Value addition			
	VMN	N	NMN	WM	VMN	N	NMN	WM	VMN	N	NMN	WM
Black pepper	8	4	3	5.83	12	2	1	6.83	6	7	2	5.67
Rubber	3	5	7	4.33	4	10	1	5.50	7	3	5	5.33
Taro	2	2	10	3.33	0	0	15	2.50	0	0	15	2.50
Turmeric	8	2	5	5.50	9	4	2	6.17	5	8	2	5.50
Cocoa	2	7	6	4.33	9	2	4	5.83	4	4	7	4.50
Tapioca	6	4	5	5.17	8	5	2	6.00	9	3	3	6.00
Thipalli	4	9	2	5.33	2	9	4	4.67	2	6	7	4.17
Total	33	33	38	33.83	44	32	29	37.50	33	31	41	33.67
Mean	4.71	4.71	5.43	4.83	6.29	4.57	4.14	5.36	4.71	4.43	5.86	4.81
SD	2.63	2.56	2.64	0.87	4.35	3.74	4.95	1.42	3.04	2.76	4.56	1.21
SE	0.99	0.97	1.00	0.33	1.64	1.41	1.87	0.54	1.15	1.04	1.72	0.46

VMN- Very Much Needed, N- Needed, NMN- Not Much Needed, WM- Weighted mean

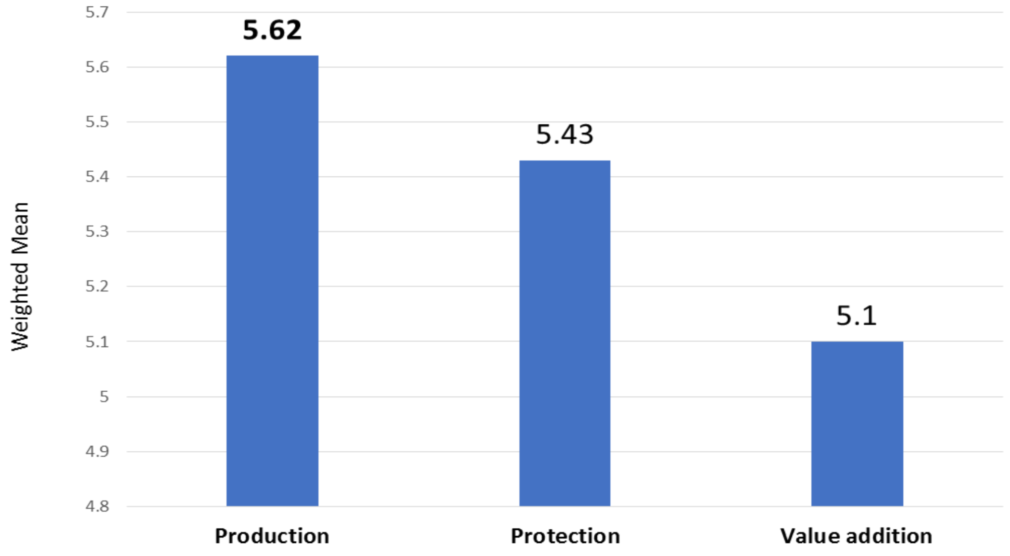


Fig 15. Technology needs assessment for the top seven dominant crops in banana based home gardens with reference to production, protection and value addition

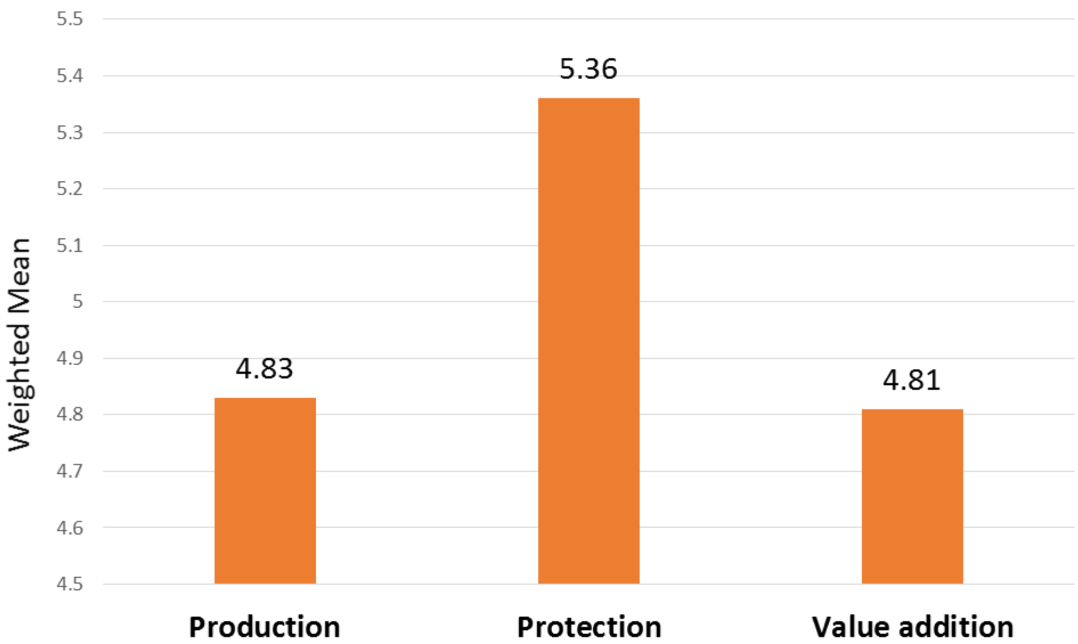


Fig 16. Technology needs assessment for the top seven dominant crops in black pepper based home gardens with reference to production, protection and value addition

A perusal of Table 15 clearly shows that in black pepper-based home garden, protection (5.36) technology was the most needed compared to production (4.83) and value addition (4.81) technologies. It is clear from table that, maximum technology need was reported for black pepper (5.83) followed by turmeric (5.50) and thippali (5.33), on production technologies.

In case of protection technologies, the maximum technology need was reported for the crop black pepper (6.83) which was followed by turmeric (6.17) and tapioca (6.00). In case of value addition of technologies maximum technology was observed for tapioca (6.00) followed by black pepper (5.67) and turmeric (5.50).

It is a noticeable fact that in all the three aspects technology need for black pepper was conspicuous. It was because black pepper black pepper was dominant in all the system and it was incorporated solely for economic motive, for which farmers demanded technologies on production protection and value addition.

While considering aspect wise attributes, technology need differed crop wise. It is evident from the table that there was high technology need requirement for crops like tapioca, thippali and turmeric on all the three aspects. The high technology demand for these crops might be due to lack of sufficient knowledge on the cultivation practices because of the introduction of these as intercrops to the existing cropping system.

4.2.3. Technology needs assessment for the dominant crops in cardamom based home gardens.

The technology need assessment for the dominant crops in cardamom-based home garden is depicted in Table 16 and Fig 17.

Table 16: Technology needs assessment for the top seven dominant crops in cardamom based home gardens with reference to production, protection and value addition

Crops	Production				Protection				Value addition			
	VMN	N	NMN	WM	VMN	N	NMN	WM	VMN	N	NMN	WM
Cardamom	4	5	6	4.67	11	3	1	6.67	5	7	3	5.33
Black pepper	6	3	6	5.00	8	4	3	5.83	6	5	4	5.33
Vanilla	8	5	2	6.00	4	6	5	4.83	9	4	2	6.17
Ginger	5	6	4	5.17	5	8	2	5.50	3	4	8	4.17
Smallchilly	7	6	2	5.83	4	9	2	5.33	4	5	6	4.67
Clove	3	5	7	4.33	5	7	3	5.33	4	4	8	4.67
Rubber	6	6	3	5.50	2	6	7	4.17	5	6	4	5.17
Total	39	36	30	36.50	39	43	23	37.67	36	35	35	35.50
Mean	5.57	5.14	4.29	5.21	5.57	6.14	3.29	5.38	5.14	5.00	5.00	5.07
SD	1.59	0.99	1.91	0.56	2.77	1.96	1.91	0.72	1.81	1.07	2.20	0.60
SE	0.60	0.37	0.72	0.21	1.05	0.74	0.72	0.27	0.68	0.40	0.83	0.23

VMN- Very Much Needed, N- Needed, NMN- Not Much Needed, WM- Weighted mean

It is evident from Table 16 that in cardamom-based home garden, protection (5.38) technology was the most needed compared to production (5.21) and value addition (5.07) technologies. It is clear from table that, maximum technology need was reported for vanilla (6.00) followed by small chilly (5.83) and rubber (5.50), on production technologies.

In case of protection technologies, the maximum technology need was reported for the crop cardamom (6.67) which was followed by black pepper (5.83) and ginger (5.50). In case of value addition of technologies maximum technology was observed for vanilla (6.17) followed by cardamom and black pepper (5.33).

It is conspicuous from the table that cardamom based home garden was basically a spice based home garden system and the crops present in the system often fetches very high market price. The incidence of pest and disease to this crop can drastically reduce the economic returns as well as the income from the farm; this might be the reason for the high demand of the protection technology need compared to production or value addition technologies by the farmers. Cardamom and pepper being a high value crop motivated the farmers to market the produce without any further value addition and this could be the reason that the need for value addition technologies among farmers fetched comparatively lower score than that of protection and production technology needs.

4.2.4. Technology needs assessment for the dominant crops in vegetable based home gardens including strawberry.

The technology need assessment for the dominant crops in vegetable based home garden is revealed in Table 17 and Fig 18.

Table 17: Technology needs assessment for the top seven dominant crops in vegetable based home gardens with reference to production, protection and value addition (N=15)

Crop	Production				Protection				Value addition			
	VMN	N	NMN	WM	VMN	N	NMN	WM	VMN	N	NMN	WM
Cabbage	12	2	1	6.83	10	2	3	6.17	0	0	15	2.50
Strawberry	9	4	2	6.17	7	3	5	5.33	9	5	1	6.33
Potato	9	3	3	6.00	5	2	8	4.50	0	0	15	2.50
Carrot	8	4	3	5.83	2	6	7	4.17	0	0	15	2.50
Beans	7	5	3	5.67	2	3	10	3.67	0	0	15	2.50
Butter beans	4	6	5	4.83	1	1	13	3.00	0	0	15	2.50
Coriander	3	9	3	5.00	3	1	11	3.67	0	0	15	2.50
Total	52	33	20	40.33	30	18	57	30.50	9	5	91	21.33
Mean	7.43	4.71	2.86	5.76	4.29	2.57	8.14	4.36	1.29	0.71	13.00	3.05
SD	3.10	2.29	1.21	0.69	3.25	1.72	3.48	1.09	3.40	1.89	5.29	1.45
SE	1.17	0.87	0.46	0.26	1.23	0.65	1.32	0.41	1.29	0.71	2.00	0.55

VMN- Very Much Needed, N- Needed, NMN- Not Much Needed, WM- Weighted mean

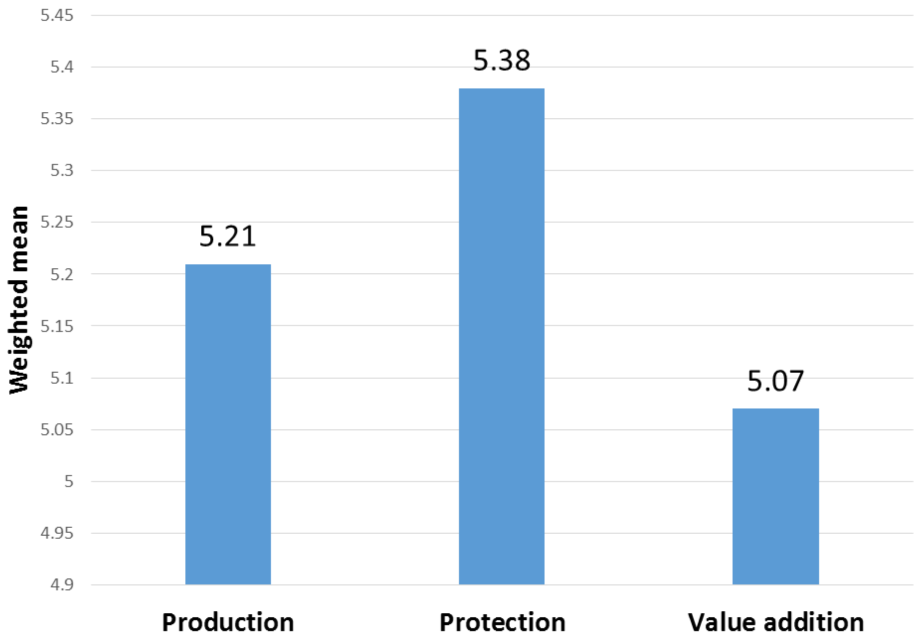


Fig 17. Technology needs assessment for the top seven dominant crops in cardamom based home gardens with reference to production, protection and value addition

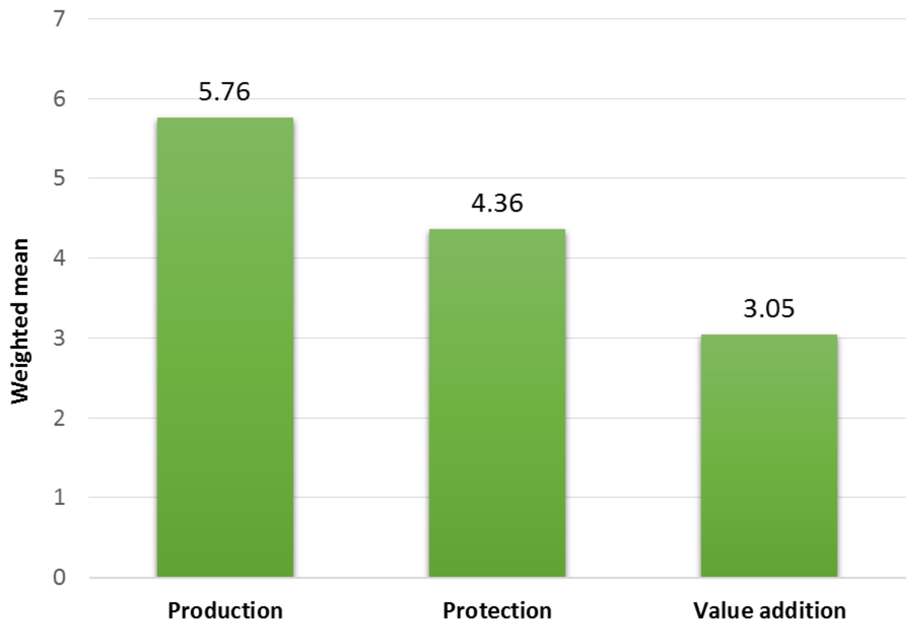


Fig 18. Technology needs assessment for the top seven dominant crops in vegetable based home gardens with reference to production, protection and value addition

The results clearly revealed that production (5.76) technology was the most needed compared to protection (4.36) and value addition (3.05) technology in vegetable based home gardens. However, in the production aspects maximum technology need was reported for cabbage (6.83) followed by strawberry (6.17) and potato (6.00). In case of protection aspects same trend was followed as that of production aspects. Whereas in value addition aspects maximum technology need was reported for strawberry (6.33) and all the other crops had least demand for post-harvest technologies.

The Table 17 highlighted that in production and protection aspects maximum technology need was reported for cabbage. It was because the most dominant crop in the vegetable based home garden was cabbage. High cost of production, excessive usage of fertilizers and severe pest and disease attack was noticed in their fields. This might be the reason for the demand of maximum production technology need by the farmers.

It was evident from the table that there was high technology demand for the crop like strawberry on production, protection as well as for the value addition. The high demand of technology need of strawberry might be due to the high local as well as interstate market demand of strawberry, which fetches a good price in the market. The value addition need for this crop may be due to the perishable nature of the crop and its high demand as an ingredient in many flavored products.

4.2.5. Practice wise technology needs for different crop based home gardens.

An attempt was made to understand the perception of farmers based on the technology needs of different crops under the four attributes for production, protection and value addition technologies that is presented in Table 18.

Table 18: Distribution of respondents based on technology needs for different crop based home gardens

	Technology not available-4	Technology available but not applicable 3	Technology available, applicable but not sustainable-2	Technology available, applicable and sustainable-1
Banana				
Production-b	6.00	4.91	2.00	2.09
Protection-b	6.40	2.20	5.00	1.40
Value addition-b	3.50	5.00	4.00	2.50
	chi=3.77	df=6	p=0.708	rxc=3x4
Black pepper				
Production-c	2.62	3.68	4.08	4.62
Protection-c	5.80	4.00	4.20	1.00
Value addition-c	5.00	4.00	4.00	2.00
	chi=3.99	df=6	p=0.513	rxc=3x4
Cardamom				
Production-p	3.38	2.50	3.63	5.50
Protection-p	3.25	5.00	5.75	1.00
Value addition-p	3.33	2.33	4.01	5.33
	chi=5.24	df=6	p=0.677	rxc=3x4
Vegetable				
Production-v	4.25	4.25	3.86	2.63
Protection-v	4.67	2.33	4.00	4.00
Value addition-v	6.00	2.00	5.00	2.00
	chi=7.09	df=6	p=0.313	rxc=3x4

From the Table 18, it is quite evident that the chi-square value shows no significant difference on technology needs for different crop under the four attributes for production, protection and value addition. However, farmers were of the opinion that maximum technology needs was on production for banana (6.00, 4.91), and vegetable (4.25, 4.25) whereas protection for black pepper (5.80, 4.00) cardamom (3.25, 5.00).

Black pepper and cardamom are two major high value spices but incidence of pest and diseases are the major menace for the cultivation of these crops. Therefore, farmers perceived the need for more sustainable protection technologies. Whereas, in case of vegetables and banana production aspects heavily affected the profitability hence farmers perceived the need for more sustainable and effective production technologies for remunerative and profitable agriculture. In general, technology needs of the farmers had radically changed from the conventional ones to those of technologies like scientific storage, processing and value addition of home garden produces.

This could be due to the higher social and biophysical standards of home garden respondents of Kerala and the various specialization it incorporates in the limited spatial land resource associated with the home gardens with an intend to maximize returns as reported by Ravikishore *et al.* (2017). Hence, technology needs will reflect the element of remunerativeness from the components of integrations in the home gardens as well as technology needs will be orented to the overall profitability that could be derived.

The most important aspect of the study was to identify the practice wise technology need for the most dominant crop namely banana, black pepper, cardamom, and cabbage. The results of the practice wise technology needs for of the following dominant crops are presented in Table 19 to 23.

4.2.5.1. Practice wise technology needs score for banana

The results of the practice wise technology need score for banana in banana dominant home garden system are presented in Table 19.

Table 19: Practice wise technology needs score for banana-based home gardens with special reference to banana

Practice/item	Weighted mean
Production	
Planting material preparation	4.50
Varieties	4.10
Spacing	4.30
Organic matter application	4.20
Nutrient application	5.50
Irrigation	3.90
Weeding	4.40
Intercropping	4.70
Desuckering	4.60
Pre-harvest bunch spray	5.10
Harvesting	4.00
Mean	**4.482**
Protection	
Rhizome weevil	4.70
Pseudostem Weevil	4.20
Sigatoka disease	4.30
Panama wilt	4.00
Viral diseases	4.60
Mean	**4.36**
Post harvest technology	
Banana chips	3.60
Compost	3.50
Banana flour	4.30
Handicrafts using fiber	4.40
Mean	**3.95**

It is noticeable from Table 19 that maximum technology need was reported for production aspect which is also in line with the results presented in Table 18. In production aspect, top three maximum technology need was reported for nutrient application (5.50) followed by pre-harvest bunch spray (5.10) and intercropping (4.70). The least technology need was reported for irrigation techniques.

Whereas in case of protection aspects main technology need reported by the farmers were for the attack of rhizome weevil (4.70) and viral diseases (4.60). In case of post-harvest technology needs, the preparation of handicrafts using banana fiber was the needed technology (4.40).

4.2.5.2. Practice wise technology needs score for black pepper

The results of the practice wise technology need score for black pepper in pepper dominant home garden system are presented in Table 20.

Table 20: Practice wise technology needs score for black pepper based home gardens with special reference to black pepper

Practice/item	Weighted mean
Production	
Varieties	3.80
Spacing	4.40
Planting material preparation	3.70
Planting standards	1.90
Organic matter application	4.00
Nutrient application	3.60
Irrigation	3.90
Shading	2.30
Intercropping	2.60
Weeding	3.90

Pruning and training	3.40
Underplanting	3.70
Harvesting	3.40
Mean	**3.43**
Protection	
Pollu beetle	4.40
Root mealybugs and scales	4.20
Top shoot borer	4.10
Foot rot	5.30
Fungal pollu	4.30
Mean	**4.46**
Post harvest technology	
Drying and Blanching	3.80
Value added products (white pepper, pepper oil, oleoresin etc)	4.60
Mean	**4.20**

From Table 20 it was clear that maximum technology needs were reported for protection (4.46) technologies which were in confirmatory with the findings of Table 18. In protection aspects top three maximum technology need was reported for foot rot (5.30) followed by pollu beetle (4.40) and fungal pollu (4.30), the least technology need was reported for top shoot borer (4.10). In case of production aspects (3.43) the most important technology need was reported for spacing (4.40) and organic matter application (4.00). However, technology need for post-harvest technologies were maximum for value added products like white pepper, pepper oil and oleoresins (4.60).

4.2.5.3. Practice wise technology needs score for cardamom

The results of the practice wise technology need score for cardamom in cardamom dominant home garden system are presented in Table 21.

Table 21: Practice wise technology needs score for cardamom based home gardens gardens with special reference to cardamom

Practice/item	Weighted mean
Production	
Varieties	3.20
Spacing	3.60
Organic matter application	3.50
Nutrient application	4.30
Shading	1.90
Irrigation	3.80
Weeding	3.60
Harvesting	3.10
Mean	**3.10**
Protection	
Cardamom thrips	4.40
Shoot or capsule borer	4.20
Katte/ Mosaic disease	4.10
Azhukal	3.50
Mean	**4.05**
Post harvest technology	
Drying	2.00
Bleaching	3.80
Oleoresin extraction	4.30
Mean	**3.37**

From Table 21 it was evident that maximum technology needs were reported for protection (4.05) technologies which were in confirmatory with the findings of Table 18. In protection aspects top three maximum technology need was reported for cardamom thrips (4.40) followed by shoot or capsule borer (4.20) and katte/ mosaic disease (4.10), the least technology need was reported for azhukal (3.50), disease of cardamom. However, in case of production aspects (3.10), the most important technology need was reported for nutrient application

(4.30) and irrigation (3.80). Whereas technology need for post-harvest technologies were maximum for oleoresins extractions (4.30).

4.2.5.4. Practice wise technology needs score for vegetables

The results of the practice wise technology need score for vegetable in cardamom dominant home garden system are presented in Table 22.

Table 22: Practice wise technology needs score for vegetable based home gardens with special reference to cabbage

Practice/item	Weighted mean
Production	
Varieties	4.00
Spacing	4.10
Organic matter application	4.80
Nutrient application	5.00
Irrigation	3.10
Earthing up	3.70
Weeding	4.00
Harvesting	3.40
Mean	**4.01**
Protection	
Leaf eating cater pillars	3.40
Black rot	3.90
Collar rot	4.00
Mean	**3.77**
Post harvest technology	
If any	0.00

It is very clear from the Table 22 that maximum technology needs were reported for production technologies (4.01) which were in line with the findings of Table 18. In production aspects top three maximum technology need was reported for nutrient application (5.00) followed by organic matter application (4.80) and spacing (4.10), the least technology need was reported for irrigation (3.10)

However, in case of protection aspects (3.77) the most important technology need was reported for collar rot (4.00) and blackrot (3.90). It was interesting to note that none of the farmers required the post-harvest technology needs.

Therefore, it can be assumed from Table 19 and 22 the technology needs as recognized by majority of the home garden farmers of banana and cabbage were of the opinion that production technologies, pertaining to nutrient application, organic matter application and spacing were the most required technology, which clearly showed the need for location specific and sustainable technologies for effective management of home gardens. From the Table 20 and 21 it is very clear that the technology needs were also comparatively high for protection aspects in case of black pepper and cardamom. Foot rot disease of black pepper and thrips in cardamom were reported as a serious problem in these crops. This might be due to the lack of knowledge on the management practices that are recommended by KAU.

4.3. EXTENT OF VERTICAL AND HORIZONTAL CROP DIVERSIFICATION IN DIFFERENT HOME GARDENS

4.3.1. Extent of vertical diversification in different home gardens

Vertical diversification is the functional dynamics and economic entities as a result of product diversification or value addition. Horizontal diversification is the measure of both the cropping pattern and the structure of home gardens. The results of extent of vertical and horizontal crop diversification in different home gardens are presented in Table 23 to 26.

Table 23. Extent of vertical diversification for the dominant crops of banana based high range home gardens

Economically dominant crops of Banana based home garden	Levels	Total levels
Rubber	Latex/Sheet	2
Banana	Leaves/Fruit/Rhizome	3
Tapioca	Tuber/Processed tuber	2
Cowpea	Raw	1
Cocoa	Raw/Dried	2
Black pepper	Raw/Dried	2
Small chilly	Raw/Dried	2

Table 24. Extent of vertical diversification for the dominant crops of black pepper based high range home gardens

Economically dominant crops of Banana based home garden	Levels	Total levels
Black pepper	Raw/Dried/vines	3
Rubber	Latex/Sheet	2
Taro	Tuber	1
Turmeric	Raw/Dried/Powder	3
Cocoa	Raw/Dried	2
Tapioca	Tuber	1
Thipalli	Seedlings/Spice	2

Table 25. Extent of vertical diversification for the dominant crops of cardamom based high range home gardens

Economically dominant crops of Banana based home garden	Levels	Total levels
Cardamom	Raw/Dried/Graded/Saplings	4
Black pepper	Raw/Dried	2
Vanilla	Seedlings/Raw/processed	3
Ginger	Raw/Dried	2
Small chilly	Raw/Dried	2
Clove	Bud	1
Rubber	Latex/Sheet	2

Table 26. Extent of vertical diversification for the dominant crops of vegetable based high range home garden

Economically dominant crops of Banana based home garden	Levels	Total levels
Cabbage	Seedlings/Raw	2
Strawberry	Seedlings/Fruit	2
Potato	Seedlings/Raw	2
Carrot	Seedlings/Raw	2
Beans	Raw	1
Butter beans	Raw	1
Coriander	Leaf	1

A perusal of Table 23 to 26 underlined simple but important findings. Considering the vertical diversification for the dominant crops in different crop based home gardens, majority of the dominant crop component had only and two level of diversification. Only few crops such as cardamom (4), banana (3), black pepper (3), vanilla (3) and turmeric (3) had four and three level of diversification. Hence it can be inferred that there should be a strong extension intervention in the area of value addition and product diversification to utilize the full potential of these home gardens. The findings of the study were in contrary to the findings from the study conducted by Krishnan (2013) and Sreelakshmi (2018).

4.3.2. Extent of horizontal diversification in high range home gardens

The results of the distribution of high range home gardens based on extent of horizontal diversification is mentioned in Table 27.

Table 27. Distribution of high range home gardens based on the extent of horizontal diversification

(N=60)

Horizontal diversification of numerically and economically dominant crops	Banana n=15		Black pepper n=15		Cardamom n-15		Vegetable n-15		Total	
	No	%	No	%	No	%	No	%	No	%
One tier diversification	0	0	0	0	0	0	0	0	0	0
Two tier diversifications	0	0	0	0	2	13.33	0	0	2	3.33
Three tier diversifications	2	13.33	3	20.00	8	53.34	2	13.33	15	25.00
Four tier diversifications	3	20.00	7	46.67	3	20.00	2	13.33	15	26.67
Five tier diversifications	6	40.00	2	13.33	2	13.33	3	20.00	13	23.33
Six tier or more diversification	4	26.67	3	20.00	0	0	8	53.33	15	25.00

From Table 27, it was evident that there were no home gardens with one tier of diversification. However, majority of the banana based home gardens had five-tier diversification, whereas in black pepper-based home garden, four-tier diversification was more. It was also interesting to note that in cardamom and vegetable based home garden more than fifty per cent (53.34%) of the home gardens had three-tier diversification and six or more tiers of diversification respectively. Hence it can be deduced unequivocally that 75 per cent of the home gardens had more than four tier of diversification. The result of high diversification might be due to the higher economic motivation of the farmer and the systematic planning of the home garden farmers to get an assured farm income throughout the year. The results of the study were on similar lines with the study conducted by Krishnan (2013).

4.4. FRONTLINE DEMONSTRATIONS IN HIGH RANGE HOME GARDEN SYSTEMS.

Based upon the technology needs of the dominant crops in different crop-based home gardens, frontline demonstrations were conducted in four home gardens on production aspects of banana and cabbage, and protection for black pepper and cardamom and represented in Table 28 to 31.

4.4.1. Frontline demonstration of production practices of banana

Table 28. Frontline demonstration of production practices of banana

Stages of intervention	Biophysical parameters	KAU practice	Farmers practice	CD
3 MAP	Plant height (m)	0.875	0.774	0.054**
	Girth of pseudostem (cm)	21.48	18.313	1.985**
	Number of leaves	9	8.933	NS
	Leaf area (m2)	0.227	0.193	0.029**
	Leaf area index	0.509	0.431	0.059*
Bunch emergence	Plant height (m)	2.893	2.701	0.100**
	Girth of pseudostem (cm)	58.997	52.857	2.542**
	Number of leaves	10.933	10.933	NS
	Leaf area (m2)	1.685	1.412	0.092**
	Leaf area index	4.595	3.634	0.493**
Yield parameters	Bunch weight (kg)	11.82	9.433	0.869**

The biophysical parameters of banana on the farmers field and KAU field were compared at 3 months after planting. The results revealed that the highest plant height was recorded on KAU practice (0.876 m) than that of farmers practices (0.774 m). Similarly, the plants intervened with KAU practice recorded with the highest girth of plants, leaf area and leaf area index with 21.480 cm, 0.227 m^2 and 0.509 respectively compared to plants on farmers practice. The number of leaves was found to be non-significant at 3 MAP.

The biophysical parameters were also calculated at the time of bunch emergence and the results showed a similar trend. Plants maintained under KAU practice was noted with highest plant height (2.893 m), girth of plant (58.997), leaf area (1.685 m^2) and leaf area index (4.595). The total number of leaves was recorded as non-significant. The yield data were compared and the results disclosed that the highest yield was recorded in plants under KAU practice with a bunch weight of 11.820 kg compared to that of Farmers practice (9.433 kg).

The yield data were compared and the results revealed that the highest yield was recorded in plants under KAU practice with a bunch weight of 11.820 kg compared to that of Farmers practice (9.433 kg). The study clearly highlights that scientific approach in farming and correct use of technology in accordance to KAU POP will help the farmer to derive more profit through improved production and also will enable the farmers to learn the skill of judicious use of fertilizers and pesticides.

The benefit cost ratio achieved by farmers adopting KAU POP was very satisfying for the farmers and the results of the four intervention plot among 15 farmers selected is presented in Table 29 and the detail economics done for calculating the BC ratio is presented as Appendix IX.

Table 29. Benefit cost ratio of banana farmers under recommended practices

Sl.no	Particulars	B.C ratio	Mean BC ratio of farmers practices N=11
11	Farmer 1	2.14	1.73 Maximum= 1.92 Minimum= 1.54
22	Farmer 2	2.04	
33	Farmer 3	2.07	
14	Farmer 4	2.02	

The B:C ratio of banana field that adopted the KAU practices were 2.14, 2.04, 2.07 and 2.02 respectively. The slight deviations in the B:C ratio may be due to the differences in the soil nutrients and failure in complete adoption of demonstrated technology by the participating farmers. However, the mean B:C ratio of farmers practices was 1.73 with a maximum of 1.92 and minimum of 1.54. An experiment conducted at Kerala revealed that adoption of KAU practices along with the application of micronutrient mixtures recorded a B:C ratio of 1.94 which was comparable to the present finding (Bindhu, 2019). The study by Stephy *et al.* (2018) proved that B:C ratio appreciated while adopting scientific practices and recorded a BC ratio of 2.25 in banana which also corroborated the present finding.

4.4.2. Frontline demonstration of management of practices of foot rot diseases of black pepper

The results of the FLD of management of practices of foot rot diseases of black pepper are presented in Table 30.

Table 30: Frontline demonstration of management of practices of foot rot diseases of black pepper

	Treatment	Disease severity index	Percent of disease reduction over control
Before application of treatments (May 2018)	Farmers field	8.20	-
	KAU Practices	8.05	-
	Control	8.18	-
3 month after application of first set of treatments	Farmers field	11.68	36.00
	KAU Practices	9.70	46.84
	Control	18.25	-
3 month after application of second set of treatments	Farmers field	12.08	28.22
	KAU Practices	7.8	53.65
	Control	16.83	-

The disease severity index of quick wilt was calculated from plots maintained under KAU practice and farmers practice using scoring method. The per cent of disease reduction over control was also calculated. The results showed that pepper vines maintained under KAU practice recorded with lower disease severity index of 9.70 compared to farmers practice (11.68) at 3 months after application of first set of treatments. The highest percentage reduction of disease over control was also recorded in KAU practice (36.00) as compared to farmers practice with a value of 46.84 at 3 months after application of first set of treatments.

Similar results were also recorded at 3 months after second set of treatments. The results showed that pepper vines maintained under KAU practice recorded with lower disease severity index of 7.8 compared to farmers practice (12.08) at 3 months after application of second set of treatments. The highest percent reduction of disease over control was also recorded in KAU practice

(53.65) as compared to farmers practice with a value of 28.22 at 3 months after application of second set of treatments.

Ali *et al*. (1996) reported that the application of Akomin and Bordeaux mixture recorded with a percentage of disease control *viz.,* 52-66 per cent and 40-78 per cent respectively which was similar to the present findings. Likewise, Sivakumar (2012) reported that the application and drenching of Akomin (3ml/L) as along with the application of *Trichoderma harzianum* @ 50 g per vine was effective in the management of foot rot in pepper gardens of Kerala and was followed by the spraying and drenching of Bordeaux mixture (1%) or Copper oxychloride (0.2%) which substantiated the present findings.

4.4.3. Frontline demonstration of management of cardamom thrips

The results of the FLD of management of management of cardamom thrips is presented in Table 31 (a) and (b).

Table 31 (a): Frontline demonstration of management of cardamom thrips

	Istspray				
	PTC	10DAS	20 DAS	30 DAS	Mean
Farmers practice	27.695	25.088 (29.636)	22.887 (28.327)	21.478 (27.419)	23.151
KAU practice	33.449	32.398 (34.567)	27.544 (31.549)	19.801 (26.328)	26.581
CD	NS	**4.757***	**2.435***	NS	-

Table 31 (b): Frontline demonstration of management of cardamom thrips

	IInd spray				
	PTC	10DAS	20 DAS	30 DAS	Mean
Farmers practice	21.478 (27.419)	20.501 (26.814)	16.734 (24.084)	15.234 (22.923)	17.489
KAU practice	19.801 (26.328)	24.225 (29.386)	19.777 (26.339)	17.223 (24.484)	20.408
CD	NS	**2.156***	**2.092****	**1.167***	-

The extent of damage in terms of percentage capsule damage caused by cardamom thrips were recorded at before spraying, 10 days after spraying (DAS), 20 DAS and 30 DAS. The percent capsule damage just before the spraying was recorded and the statistical analysis revealed that there was no significant difference between the KAU practice and farmers practice. The observations on 10 days after spraying recorded the lowest damage on farmers practice (25.088 %) compared to that of KAU practice (32.398 %). Similar trend was also noted on 20 DAS with lowest damage on farmers practice (22.887) compared to that of KAU practice (27.544 %). At 30 DAS, the treatments were found to be non- significant. On comparing the mean values after first spray, farmers practice recorded the lowest damage of 23.151 per cent as compared with the KAU practice (26.581%).

The observations after second round of spray also showed a similar trend. The pre-count data was found to be non-significant whereas observations on 10, 20 and 30 DAS exhibited a significant difference between the treatment plots. The lowest capsule damage was noted in farmer's field with (20.501%), (16.734%) and (15.234%) at 10 DAS, 20 DAS and 30 DAS respectively. On comparing the mean data, the lowest capsule damage was noted in farmers field (17.489) compared to that of KAU practice (20.408) at the end of second round of spraying.

The higher efficacy of farmers practice may be due to the usage of new generation insecticides and the frequent application of pesticides. The lower efficacy exhibited by KAU practice may owe the factors *viz.*, development of resistance to quinalphos and also due to higher application intervals. Ranjith and Krishnamoorthy (2016) reported that the new generation insecticide diafenthiuron 50 WP was recorded with higher efficacy than that of quinalphos 0.05 % in tested cardamom fields of Idukki. Similarly, the superiority of diafenthiuron over quinalphos in management of cardamom thrips were also recorded by Sarkar *et al.* (2016) at West Bengal and Stanley *et al.* (2019) in Gudalur.

4.4.4. Frontline demonstration of production practices of cabbage

The results on frontline demonstration of production practices of cabbage are presented in Table 32.

Table 32. Frontline demonstration of production practices of cabbage

Biophysical parameters	KAU practice	Farmers practice	CD
Plant height (m)	43.037	40.567	NS
Non wrapper leaves/ plant	17.867	20.067	1.898*
Leaf length (cm)	33.673	31.753	NS
Leaf width (cm)	27.767	25.827	1.760*
Leaf size (cm^2)	937.531	825.085	NS
Head characteristics			
Head depth (cm)	17.167	14.787	1.434**
Head diameter (cm)	17.773	14.780	1.344**
Yield Parameters			
Net head weight (g)	2184.200	1510.933	338.744**
Gross head weight (g)	3251.933	2581.733	500.184**
Harvest index	0.679	0.580	0.097**
Yield/plot (kg)	19.658	23.489	3.626**

The biophysical characters of cabbage at the time of harvesting were recorded from plots with KAU practice and plots with farmers practice. The results revealed that plant height, leaf length and leaf size was recorded as non-significant whereas number of non-wrapper leaves/ plant and leaf width exhibited significant difference with the two compared plots. The highest number of non-wrapper leaves/ plant was recorded in farmers practice (20.067) than that of KAU practice (17.867). The highest leaf width was noted in KAU practice (27.767 cm) than that of farmer practices (25.827 cm).

The head characters of the plants were also compared and it showed that head depth and head diameter exhibited significant difference between the plots. The highest head depth and head diameter was recorded in KAU practice with a value of 17.167 cm and 17.773 cm respectively.

The yield parameters *viz.*, net head weight, gross head weight, harvest index and yield/ plot also exhibited a significant difference between the plots. The highest net head weight was recorded in KAU practice with a value of 2184.200 g and a gross head weight of 3251.933 g.

The harvest index was also recorded the highest value in KAU practice (0.679) than that of farmers practice (0.580). The yield / plot was highest in farmers field (23.489) as compared to KAU practice (19.658) which can be substantiated by the additional plant number maintained by the farmer due to the adoption of lower spacing of 45*45cm.

Gopalakrishnan (2004) evaluated the yield potential of cabbage varieties in high range zones of Wayanad and recorded an average head weight of 1.12 kg for the variety September, which was a lower value than the present finding. It was attributed to the varietal difference and ecological factors.

A study conducted to evaluate the yield performance of cabbage in Southern Kerala also recorded with a lower yield ranged from 330.39-559.19 g gross head weight (Divya, 2013). This may be due to the climatic and edaphic differences of the locations.

The benefit cost ratio achieved by farmers adopting KAU POP was very satisfying for the farmers and the results of the four-intervention plot among 15 farmers selected is presented in Table 33 and the detail economics done for calculating the BC ratio is presented as Appendix X.

Table 33. Benefit cost ratio of cabbage growers under recommended practices

Sl.no	Particulars	B.C ratio	Mean BC ratio of farmers practices N=11
1.	Farmer 1	3.61	3.14 Maximum=3.32 Minimum=2.7
2.	Farmer 2	3.44	
3.	Farmer 3	3.51	
4.	Farmer 4	3.70	

The Benefit-Cost analysis on cabbage recorded a BC ratio of 3.61 which was comparable with the BC ratio of other participating farmers with values 3.44, 3.51 and 3.70 respectively. The slight differences may be due to the edaphic factors in the region. Gopalakrishnan (2004) reported a BC ratio in the range 1.6 - 1.8 for the cabbage grown in the southern plains of Kerala. Likewise, an experiment conducted to evaluate the cabbage cultivars in Southern Kerala revealed a lower BC ratio ranged from 1.22-1.86 (Bindhu, 2019). This may be due to the differences in climatic conditions, soil factors and also due to the varietal variations.

4.5. CROWD SOURCING AND PERCENTAGE ADOPTION OF CROP PRODUCTION AND PROTECTION PRACTICES IN DIFFERENT CROP BASED HOME GARDENS

The crowdsourcing of knowledge was done in four stages for different crops like banana, black pepper, cardamom and cabbage dominant home garden systems. A total of fifteen farmers for participating in the action research were contracted for study. These 15 farmers were selected by consulting the Agricultural Officer of that panchayat and the willingness of the practicing farmers. The crowdsourcing of knowledge was done in four stages namely focus group discussion, contracting the farmers, Farmer-expert participatory preparation of the checklist as a part of crowdsourcing and participatory action research and learning. The activity cum checklist adopted by the participating farmers under the concurrent evaluation of lead farmers is presented in Table 34 to 38.

4.5.1. Crowd sourcing and percentage adoption of production activities in banana

The results on the checklist monitored by the lead farmer through crowd sourcing and percentage adoption of production activities of banana by participating farmers is presented in Table 34.

Table 34. Checklist monitored by the lead farmer through crowd sourcing and percentage adoption of production activities of banana by participating farmers.

(N=15)

Sl. No	Date	Cultivation practices/activities	Farmers Fully adopted		Farmers Partially adopted		Farmers Not adopted	
			No.	%	No.	%	No.	%
1	15-9-2018	Paring and pralinage (rhizomes are smeared with cowdung solution and dried under sunlight for about 4 days followed by shade drying up to 15 days)	12	80	2	13.33	1	6.67
2	30-9-2018	Land preparation and taking pits of size 50*50*50	13	86.66	1	6.67	1	6.67
3	30-9-2018	Planting of suckers at a spacing of 2m*2m	15	100	0	0	0	0
4	30-9-2018	Application of organic manure @ 10 kg/plant	11	73.34	2	13.33	2	13.33
5	30-9-2018	Sowing of cowpea/daincha/sun	14	93.33	0	0	1	6.67

		hemp @ a seed rate of 50 kg ha^{-1}						
6	1-11-2018	Application of first split dose of fertilizers, N: P_2O_5: K_2O, 40:65:60 g/plant/year	13	86.66	0	0	2	13.33
7	8-11-2018	Incorporation of cowpea/ daincha /sun hemp in to the soil	14	93.33	0	0	1	6.67
8	2-11-2018	Application of second split dose of fertilizers N: P_2O_5: K_2O, 30:50:60 g/plant/year	12	80	1	6.67	2	13.33
9	8-12-2018	Desuckering	14	93.33	1	6.67	0	0
10	1-1-2019	Application of third split dose of fertilizers N: P_2O_5: K_2O, 30:00:60 g/plant/year	15	100	0	0	0	0
11	5-1-2019	Record of biometric observations *viz.*, plant height, girth of pseudostem, number of leaves, leaf area index etc…	12	80	3	20	0	0
12	1-2-2019	Application of fourth split dose of fertilizers N: P_2O_5: K_2O, 30:00:60 g/plant/year	11	73.34	2	13.33	2	13.33
13	Contingent monitoring and reporting during the emergent of	Monitoring of pest and disease incidence and timely application of management practices	12	80	3	20	0	0

	pest &disease							
14	1-3-2019	Application of fifth split dose of fertilizers N: P_2O_5: K_2O, 30:00:60 g/plant/year	13	86.66	1	6.67	1	6.67
15	1-4-2019	Application of final split dose of fertilizers just after the complete emergence of bunch. (N: P_2O_5: K_2O, 30:00:00 g/plant/year)	11	73.34	2	13.33	2	13.33
16	14-4-2019	Pre harvest bunch spray of 3 per cent K_2SO_4 at two weeks after bunch emergence	13	86.66	1	6.67	1	6.67
17	28-4-2019	Pre harvest bunch spray of 3 per cent K_2SO_4 at four weeks after bunch emergence	13	86.66	1	6.67	1	6.67
18	As on 3 July 2019	Observations on yield and yield attributes	15	100.0	0	0	0	0
		Mean adoption (%)		86.30		7.40		6.30

It was evident from the Table 34 that more than eighty per cent of the farmers fully adopted the technology prescribed in the checklist, and the partial adoption was due to the climate aberration that has occurred**,** but they have followed the practices either one week after or prior to the suggested dates. In this study partial adoption can be operationalized as the number of farmers who have not adopted the package of practice technologies on the recommended dates suggested by the investigation team**.** The noticeable fact was that during an outbreak of pest and disease, the farmers immediately reported to the lead farmer and the lead farmer mobilized a meeting in his field and rendered suggestions to participating farmers. These meetings were informed to the investigation team as well who acted as virtual advisors. Proper management practices were suggested and almost 80 per cent of the farmers followed the practices that were suggested by the team.

Even though the mean adoption percentage was 86.30 for full adoption of practices it was interesting to note that three out of 18 activities, *viz*., planting of suckers at a spacing of 2m x 2m, application of third split dose of fertilizers N: P_2O_5: K_2O, 30:00:60 g/plant/year and observations on yield and yield attributes were adopted by 100 per cent farmers. It indicates the mind set of farmers on the importance they attach to important phase of crop growth for deriving maximum yield and profit. This again can be reiterated from the fact that when all the farmers (100%) adopted the third split application of NPK fertilizers (during flower bud differentiation stage), the percentage adoption for the first, second, fourth, fifth and sixth final split was 86.66, 80.00, 73.34, 86.66 and 73.34 per cent respectively.

Through crowdsourcing knowledge, farmers understood the importance of applying pre harvest bunch spray of 3 per cent K_2SO_4 at second and fourth weeks after bunch emergence, wherein, 86.66 percent of farmers adopted the same. The high adoption of almost all practices or activities can be attributed resultant to the outcome of crowdsourcing knowledge through farmer participatory approaches transforming them from citizen farmer to farmer scientist with enhanced knowledge, responsibility and pride.

4.5.2. Crowd sourcing and percentage adoption of management practices of foot rot disease in black pepper

Table 35. Checklist monitored by the lead farmer through crowd sourcing and percentage adoption of management practices of foot rot disease of black pepper by participating farmers.

(N=15)

Sl No	Time of application	Management practices	Farmers Fully adopted		Farmers Partially adopted		Farmers Not adopted	
			No.	%	No.	%	No.	%
1	Before the onset of monsoon	Pruning of runner shoots	10	66.67	2	13.33	3	20.00
2	Before the onset of monsoon	Lopping off the branches of support trees	12	80.00	1	6.67	2	13.33
3	Before the onset of monsoon	Application of lime @ 1kg	12	80.00	2	13.33	1	6.67
4	Before the onset of monsoon	Application of neem @ 2kg per vine one week prior to neem application	8	53.33	3	20.00	4	20.00
5	After the onset of monsoon in the month of June	Drenching with copper oxychloride 2 g per litre @ 5-10 litres per wines	13	86.67	2	13.33	0	0

6	After the onset of monsoon in the month of June	Drenching of potassium phosophonate 3ml per litre @ 5-10 litres per wines	14	93.33	0	0	1	6.67
7	In the month of October	Drenching and spraying of .03 per cent of potassium phosphonate	7	46.66	2	13.33	6	40.00
		Mean adoption (%)		72.37		11.43		15.24

It was very clear from the Table 35 that more than seventy per cent (72.37%) of the farmers fully adopted the technology prescribed in the checklist, and the partial adoption and non-adoption was due to the high cost of the inputs and low market price for black pepper during the year 2018 as reported by the farmers. Even though the mean adoption percentage was 72.37 per cent, it was quiet observable that more than 80 per cent of the farmers had full adoption on four practices out of seven practices, among which drenching of potassium phosophonate 3ml per litre @ 5-10 litres per wines (93.33) was the most adopted practice. The low adoption during the last phase of the study was due to the heavily affected flood that affected many black pepper home gardens of Idduki district and they left the crop neglected.

4.5.3. Crowd sourcing and percentage adoption of management practices of thrips in cardamom

Table 36. Checklist monitored by the lead farmer through crowd sourcing and percentage adoption of management practices of cardamom thrips by participating farmers. (N=15)

Sl No	Time of application	Management practices	Farmers Fully adopted		Farmers Partially adopted		Farmers Not adopted	
			No.	%	No.	%	No.	%
1	Mid-week of December	Spraying of quinalphos @ .05 per cent	11	73.33	3	20.00	1	6.67
2	Last week of January	Spraying of quinalphos @ .05 per cent	10	66.66	4	26.67	1	6.67
		Mean adoption (%)		70.00		23.33		6.67

It is very clear from the Table 36 that 70 per cent of the farmers fully adopted the recommended practices of spraying quinalphos @ .05 per cent. The partial and non-adoption by the farmers was recorded to be 23.33 and 6.67 per cent respectively. It was also interesting to note that farmers used different type of new generation pesticides apart from the recommended pesticide. This behaviour of the farmer was because of the high price that fetched for the cardamom during the past few years, so the farmers were ready to use pesticides that were of very high price for the management practices to get high returns for the produce.

4.5.4. Crowd sourcing and percentage adoption of production practices in cabbage

Table 37. Checklist monitored by the lead farmer through crowd sourcing and percentage adoption of production practices of cabbage by participating farmers.

Sl No	Time of application	Practices	Farmers Fully adopted		Farmers Partially adopted		Farmers Not adopted	
			No.	%	No.	%	No.	%
1	10-06- 2019	Application of organic manure @ 25 t/ha	6	40.00	7	46.67	2	13.33
2	11-06-2019	Spacing 60 cm *60 cm	11	73.33	0	0	4	26.67
3	20-06-2019	Application of 75:100:62.5 kg/ha of the dose of N, P K @7 DAT.	13	86.67	2	13.33	0	0
4	10-07-2019	Spraying of Psuedomonas *fluorscens* 2 % solution	10	66.67	2	13.33	3	20.00
5	17-07-2019	Earthing up of plants	15	100	0	0	0	0
6	17-07-2019	Spraying of *Pseudomonas fluorscens* 2 % solution	11	73.33	3	20.00	1	6.67
7	24-07-2019	Application of 75:62.5 kg/ha of the dose of N and K one month after planting	7	46.67	3	20.00	5	33.33
8	03-08-2019	Spraying of *Pseudomonas fluorscens* 2 % solution	13	86.67	2	13.33	0	0
9	Incidence of Spodoptera sp. was noticed in the month of july	2 Spraying of quinalphos 0.25 % was given in 10 days interval	10	66.67	1	6.67	4	26.66
		Mean adoption (%)		71.11		14.82		14..07

It is evident from the Table 37 that 71.11 per cent of the farmers fully adopted the recommended practices prescribed in the checklist. The partial and non-adoption by the farmers was recorded to be 14.82 and 14.07 per cent respectively. It was also interesting to note that among the nine prescribed cultural operation 100 per cent of the farmers practiced earthing up operations, and also 86.67 per cent of the farmers fully adopted the techniques of split dose application of fertilizers in right quantity and spraying of *Pseudomonas* solution. Farmers were also in the opinion that use of *Pseudomonas* resulted in reduce incidence of pest and disease and they also mentioned that the chemical pesticide used during this crop period was very low compared to that of their existing usage.

4.6 DIMENSIONS OF TECHNOLOGY SUITED FOR HIGH RANGE HOME GARDENS

The dimensions delineated through literature search and screened through focus group discussions and interaction with subject matter specialists were administered to home garden farmers, (participating and non-participating), agricultural officers and scientist. They were requested to rate each dimension on a 9-point continuum ranging from zero to nine. The response from all the farmers, agricultural officers and scientist were collected and presented in Table 38.

Sl No	Dimensions	Participating Farmers n=60	Rank	Non participating Farmers n=60	Rank	Agricultural Officers and Scientist n=50	Rank
	ECONOMIC DIMENSION						
1.	Commercialization	8.07	3	7.30	4	7.42	2
2.	Regularity of returns	7.98	4	7.30	4	7.68	1
3.	Rapidity of returns	8.25	2	7.05	6	7.34	3
4.	Availability of credit	7.97	5	7.42	1	6.98	5
5.	Accessibility of credit	6.88	7	7.07	5	6.57	7
6.	Margin of safety	8.45	1	7.35	3	7.56	4
7.	Supply chain	6.90	6	7.38	2	6.68	6
	Mean	**7.79**		**7.27**		**7.18**	
	TECHNICAL DIMENSIONS						
8.	Compatibility	8.15	2	7.33	1	6.27	5
9.	Efficiency	7.70	5	7.05	4	6.73	2
10.	Trial-ability	8.27	1	7.12	3	5.73	7
11.	Profitability	7.82	4	6.58	8	6.13	6
12.	Predictability	6.42	7	6.85	6	6.50	4
13.	Flexibility	8.08	3	6.92	5	6.67	3
14.	Viability	6.92	6	6.70	7	6.80	1
15.	Adaptability	7.82	4	7.22	2	6.27	5
	Mean	**7.65**		**6.97**		**6.39**	
	ENVIRONMENTAL DIMENSIONS						
16.	Local Resource Utilization	7.80	3	6.72	1	7.27	1
17.	Resource recycling	7.98	1	6.63	2	7.00	3
18.	Sustainability	7.82	2	6.50	3	7.17	2
	Mean	**7.87**		**6.62**		**7.14**	
	SOCIO CULTURAL DIMENSIONS						
19.	Social acceptance	6.95	4	7.67	1	7.20	1
20.	Social approval	7.25	1	7.08	3	6.60	2
21.	Social Beliefs	7.13	2	6.92	5	6.03	5
22.	Cultural traits	6.60	5	7.05	4	6.43	3
23.	Social status	7.10	3	7.12	2	6.40	4
	Mean	**7.01**		**7.17**		**6.53**	
PSYCHOLOGICAL DIMENSIONS							
24.	Satisfaction in life	7.85	1	7.67	1	7.17	1
25.	Change proneness	7.77	3	7.45	2	6.50	3
26.	Self – esteem	7.78	2	7.22	3	6.60	2

Mean		**7.80**		**7.45**		**6.76**	
POLITICAL DIMENSIONS							
27.	Bureaucratic support	8.03	2	7.33	3	6.83	1
28.	Public Private Partnership	7.67	3	7.48	2	6.57	3
29.	Data ownership	6.72	4	7.52	1	5.90	4
30.	Open-source technology	8.28	1	7.27	4	6.80	2
Mean		**7.68**		**7.40**		**6.53**	
	HUMAN RESOURCE DIMENSION						
31.	Access to extension services	7.63	2	7.68	1	6.22	4
32.	Decision making	7.35	4	7.05	3	6.67	1
33.	Acquisition of information	7.38	3	7.07	2	6.03	6
34.	Family labour	7.27	5	6.90	4	6.27	3
35.	Availability of input supplies	7.63	2	6.78	5	6.15	5
36.	Input efficiency	8.08	1	6.68	6	6.40	2
Mean		**7.56**		**7.03**		**6.29**	

A detailed scrutinization of table revealed technical, environmental, socio-cultural, psychological, political and human resource dimensions related to the high range home gardens were rated according to the evaluation by 60 participating home garden farmers, 60 non- participating home garden farmers and 50 experts including agricultural officers and scientist. The detailed examination of the results shows a variation in priorities between the participating farmers, non- participating farmers and experts. A few dimensions which were of high relevance to the participating farmers were considered rather insignificant to the other category of respondents.

It was evident from table that environmental dimensions (7.87) were the most important dimension for participating farmers of high range home gardens with almost equal importance for psychological (7.80) and economic dimensions (7.79). From the point of view of non-participating farmers psychological (7.45), political (7.40) and economic dimensions (7.27) were considered as the most important dimension. According to agricultural officers and scientists, economic dimensions (7.18), environmental dimension (7.14) and psychological dimension (6.76) were considered as essential dimensions. However, it was intriguing to note that among the different dimensions the sociocultural dimension (7.01) and environmental dimension (6.62) was considered as least important by participating farmers and non-participating farmers respectively. Contrary to those dimensions perceived to be of importance by the farmers, agricultural officers and scientist considered human resource dimension as the least important dimension (6.29).

In economic dimensions, margin of safety (8.45) was found to be important to the participating farmers followed by rapidity of returns (8.25) and commercialization (8.07). In the case of non-participating farmers, availability of credit (7.42) followed by supply chain (7.38) and margin of safety (7.35) were recorded as important ones. For agricultural officers and scientists, the dimensions perceived to be important was regularity return (7.68) followed by commercialization (7.42) and rapidity of returns (7.34).

In case of technical dimensions, trialability (8.27), compatibility (8.15) and flexibility (8.08) were found to be most important dimensions by the participating farmers. Compatibility (7.33), adaptability (7.22) and trialability (7.12) were considered as most important by nonparticipating farmers. However, agricultural officers and scientists considered viability (6.80), efficiency (6.73) and flexibility (6.67) as the most important dimensions pertaining to home gardens.

In case of environmental dimension, resource recycling (7.98), sustainability (7.82) and local resource utilization (7.80) were recorded as the important dimensions by participating farmers whereas nonparticipating farmers felt local resource utilization (6.72), resource recycling (6.63) and sustainability (6.50) as the important dimensions. Local resource utilization (7.27), sustainability (7.17) and resource recycling (7.00) were found to be important for agricultural officers and scientists.

Under, sociocultural dimensions, social approval (7.25), social beliefs (7.13) and social status (7.10) were considered to be important by the participating farmers. The nonparticipating farmers considered social acceptance (7.67), social status (7.12) and social approval (7.08) as the significant ones whereas agricultural officers and scientists recognized social acceptance (7.20), social approval (6.60) and cultural traits (6.43) as the important dimensions.

In case of psychological dimension, all the three sections were unanimous in labelling satisfaction of life as major concern. The dimensions *viz.*, satisfaction of life, self-esteem and change proneness were recorded as important by participating farmers and agricultural officers and scientists with value 7.85, 7.78 and7.77 and 7.17, 6.60 and 6.50 respectively. However nonparticipating farmers considered satisfaction of life (7.67) as most important one followed by change proneness (7.45) and self-esteem (7.22).

In case of political dimension, open-source technology (8.28), bureaucratic support (8.03) and public private partnership (7.67) were considered as the most important ones by participating farmers. Data ownership (7.52), public private partnership (7.48) and bureaucratic support (7.33) were noted as major concern of nonparticipating farmers whereas agricultural officers and scientists considered bureaucratic support (6.83), open-source technology (6.80) and Public private partnership (6.57) as the important dimensions.

Under human resource dimensions, input efficiency (8.08), access to extension service (7.63) and availability of input supplies (7.63) were considered as important by participating farmers whereas access to extension services (7.68), acquisition of information (7.07) and decision making (7.05) were recorded as important by nonparticipating farmers. Agricultural officers and scientists considered decision making (6.67), input efficiency (6.40) and family labour (6.27) as the important ones.

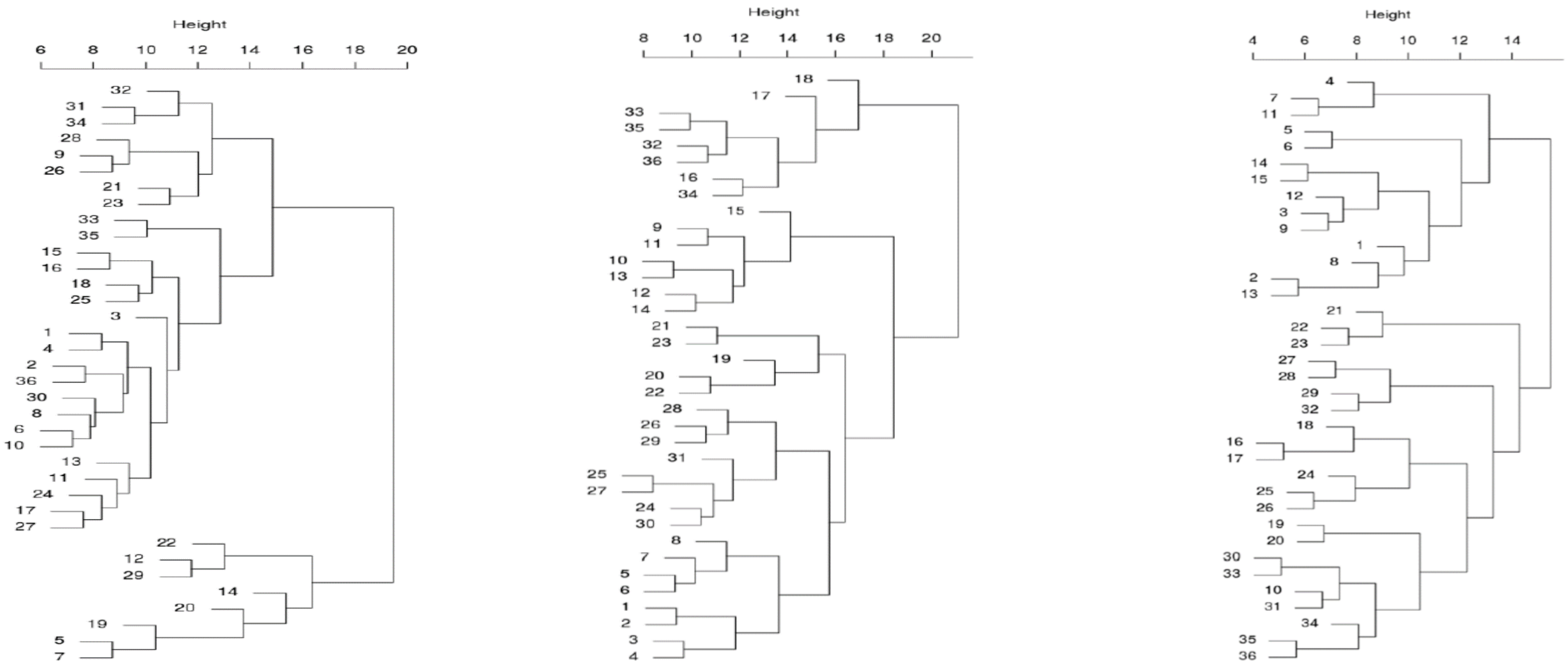
Table 39. Clustering of dimensions revealing the interaction effect of different dimensions perceived to be important by participating farmers, non-participating farmers and agricultural officers and scientists.

Category	Participating Farmers	Non- Participating Farmers	Agricultural officers and scientists
No of clusters	3	5	2
No of sub dimensions under each clusters and the number [in ( )] of the dimensions grouped together under different clusters	Cluster 1- 8 (6) Cluster 2- 20 (7) Cluster 3- 8 (4)	Cluster 1- 8 (4) Cluster 2- 7 (5) Cluster 3- 5 (4) Cluster 4- 8 (5) Cluster 5 -8 (7)	Cluster 1- 14 (7) Cluster 2- 22 (6)
Name of dimensions clustered together	Cluster 1- Economic, technical, environmental, psychological, human resource. Cluster 2- Economic, technical, environmental, sociocultural, psychological, human resource, political Cluster 3- Economic, technical, sociocultural, human resource.	Cluster 1- Economical, psychological, human resource, Sociocultural Cluster 2- Political, economical, environmental, technical, sociocultural. Cluster 3- Economical, technical, psychological, human resource. Cluster 4- economical, environmental, technical, human resource, sociocultural Cluster 5- Economical, environmental, technical, human resource, sociocultural, political, psychological.	Cluster 1- Economical, environmental, technical, human resource, sociocultural, political, psychological. Cluster 2- economical, environmental, technical, human resource, sociocultural, psychological

*Details of the sub dimensions are appended in Appendix XI

A cluster analysis was carried out to study the interaction of different technological dimensions that were suitable for high range home gardens. Detailed scrutinization of the table revealed that, in case participating farmers and agricultural officers / scientists, number of clusters formed were 3 and 2 respectively. Maximum number of sub dimensions (22) clustered together for extension professionals including scientists/agricultural officers that was followed by clustering of 20 sub dimensions in case of the practicing farmers. 20 sub dimensions under Cluster 2 of practicing farmers was represented by all the major seven dimensions unlike the case of extension professionals where the larger cluster (22) was represented by only 6 major dimensions. It was also interesting to note that 8 sub dimensions clustered together in case of cluster 5 that was represented by all the major seven dimensions of study for non-participating farmers. However, in rest of the case, only 4-5 dimensions were represented by the sub dimensions.

In all the case, it was evident that there exists a high level of interaction effect among different sub dimensions, as at least from one cluster each from each category of respondents, it was represented by sub dimensions belonging to all the 7 major dimensions of study. This invariably showed a higher level of interaction among the different dimensions. However, in the case of non- participating farmers, a total 5 clusters were identified which showed comparatively lesser interaction among the dimensions, except for the case of cluster 5. The higher interaction of dimensions in agricultural officers and scientists are mainly because they are well aware about the different dimensions that will make a home garden more profitable, sustainable and remunerative. Similarly, in case of participating farmers, the higher level of interaction was seen due to the interventions and extension support that were carried out during the study whereas in the case of non-participating farmers, the perception was based on their own practices adopted in home gardens under study (Fig 19).



a. Participating Farmers   b. Non Participating Farmers   c. AO's & Scientist

Fig 19. Cluster dendrogram of participating farmers, nonparticipating farmers and agricultural officers and scientists

4.7. DISTRIBUTION OF THE HOMEGRADEN FARMERS BASED ON THEIR PERSONAL, SOCIO-CULTURAL AND ECONOMIC FACTORS

4.7.1. Age

Age is the total number of years completed by the home garden respondent during the interview period. The results of assigning of respondent based on the age is showed in the Table 40 and Fig 20.

Table 40. Distribution of the respondents based on their age

(N=120)

Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
	No	%	No	%	No	%	No	%	No	%
<35	2	6.67	0	0	2	6.67	2	6.67	6	5.00
35-60	17	56.67	19	63.33	20	66.67	18	60.00	74	61.67
>60	11	36.67	11	36.67	8	26.67	10	33.33	40	33.33
Total	30	100	30	100	30	100	30	100	120	100

On analysis of the Table 40, it is evident that 61.67 per cent of the farmers belonged to middle age category, followed by old age (33.33 %) and young aged farmers (5.00%).

On viewing the homestead wise distribution of respondents based on age in each homesteads, all the four areas had more than 50 per cent of farmers under middle aged category with 56.67, 63.33, 66.67 and 60 per cent respectively in banana, black pepper, cardamom and vegetable based home gardens.

Respondents belonging to young age category were very less in all the four home gardens with 6.67 per cent in banana, cardamom and vegetable based home gardens, and no young age respondents in black pepper based home gardens.

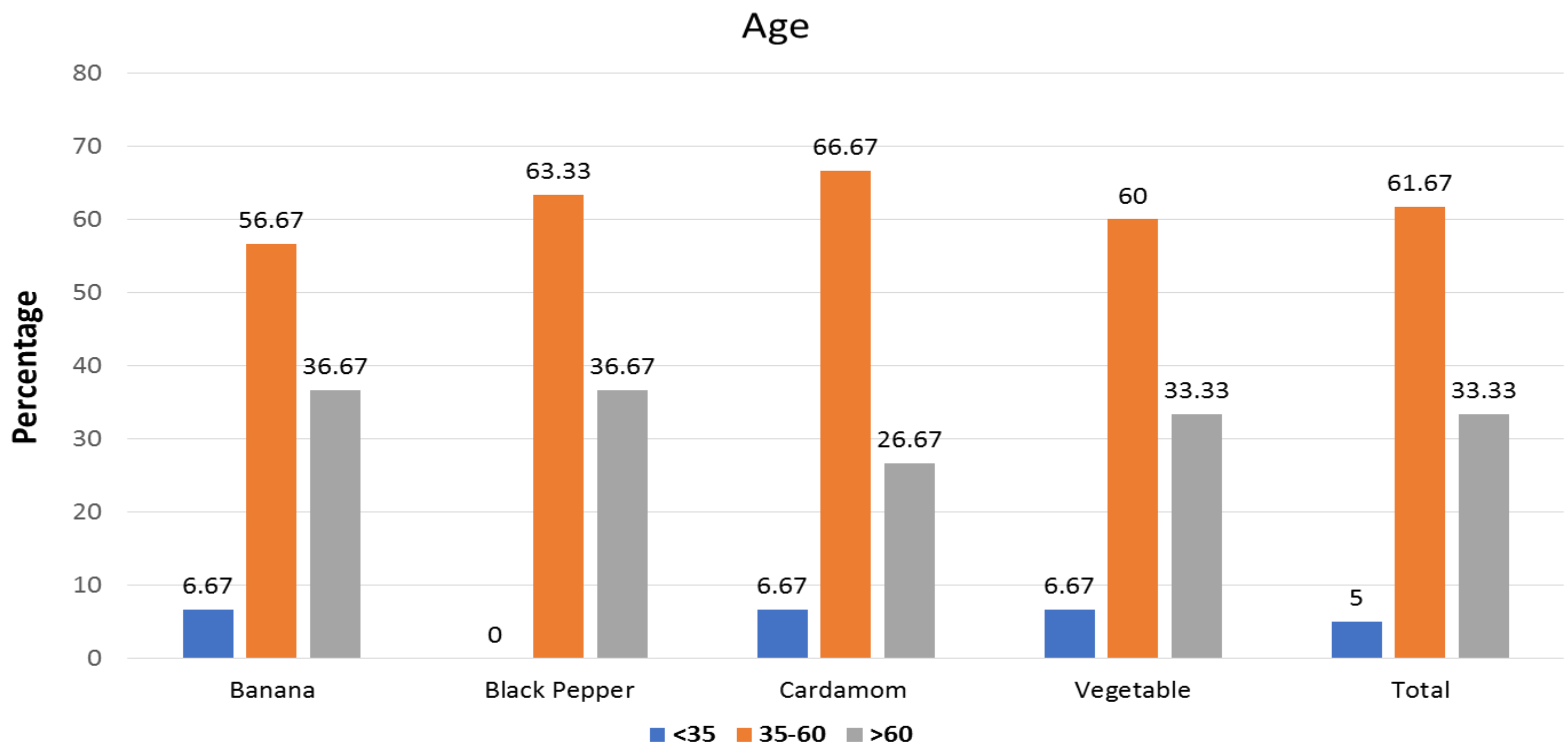


Fig 20. Distribution of the respondents based on their age.

Hence it could be inferred that majority of the farmers belonged to the category of middle aged followed by old age and only less than 10 per cent of respondents are young farmers. This distribution of farmers is a typical case of Kerala's farming situation where majority of farmers belong to middle age or old age category, this might be due to the non- lucrative nature of existing farming scenario to the youngsters

This situation demands for a suitable policy and supportive measures which ensures better profit and livelihood security for the home garden farmers in Kerala for motivating and attracting youth towards farming. The results are in agreement with the findings of Reeba (2015) and Basheer (2016).

4.7.2. Education

Education is the degree of acceptance of formal or non-formal information by the respondents. The home garden respondents were categorized based on their nature of education and is given in Table 41 and Fig 21.

Table 41. Distribution of respondents based on their education

N=120

Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
	No	%	No	%	No	%	No	%	No	%
Primary	6	20.00	7	23.33	8	26.67	12	40.00	33	27.50
Middle	6	20.00	4	13.33	8	26.67	5	16.67	23	19.17
High School	14	46.67	14	46.67	12	40.00	13	43.33	53	44.16
Collegiate	4	13.33	5	16.67	2	6.67	0	0	11	9.17
Total	30	100	30	100	30	100	30	100	120	100

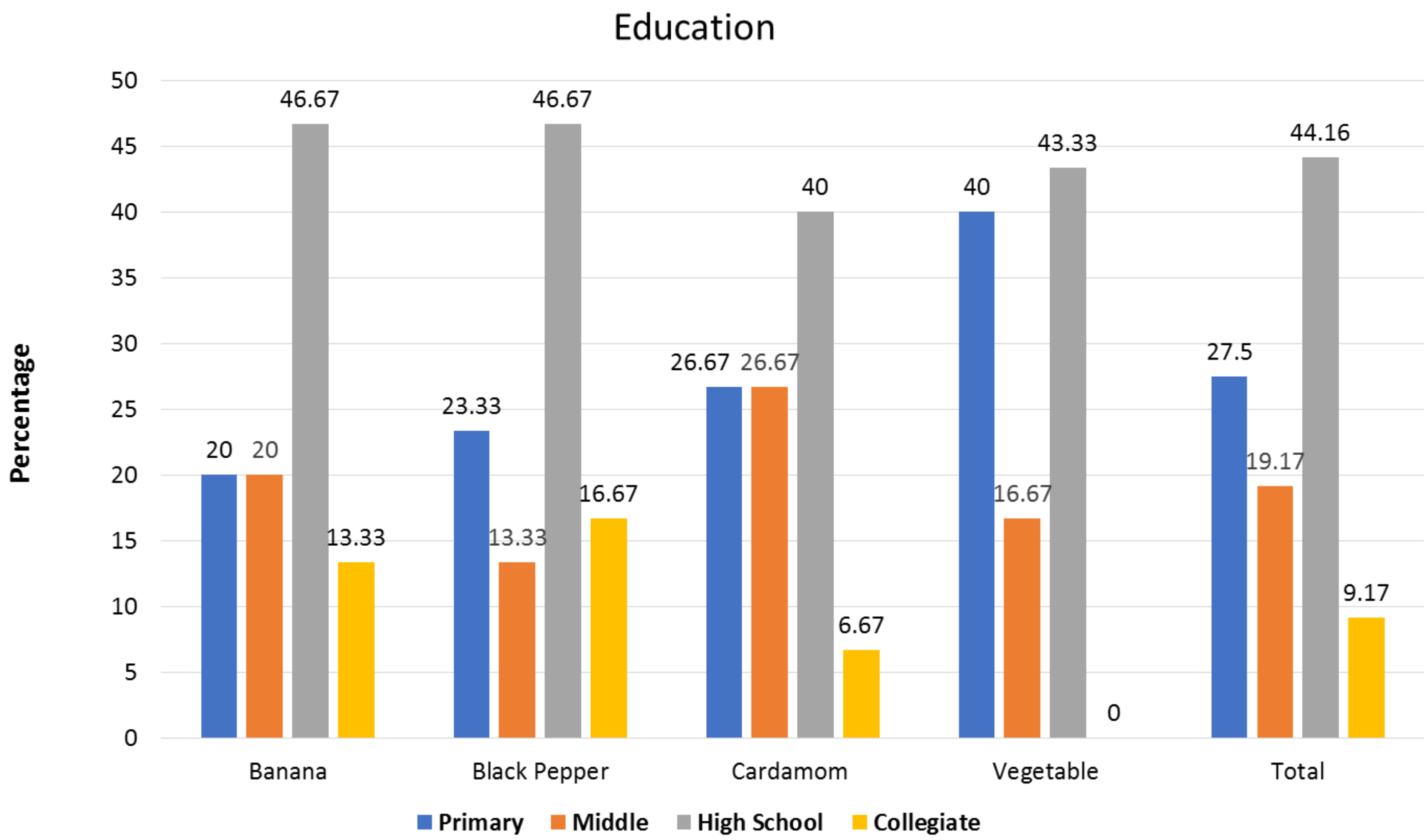


Fig 21. Distribution of respondents based on their education

A perusal of results presented in Table 41 revealed that all the home garden farmers surveyed were literate with educational qualification ranging from primary to collegiate level. It can be clearly seen that 44.16 per cent of the farmer went to high school followed by primary school, middle and collegiate level with 27.50, 19.17 and 9.17 per cent respectively.

A detailed analysis of different home garden wise distribution of respondents on education also shows a same trend were home garden farmers with high school level education was more. Banana based and Pepper based home gardens were the area with a greater number of respondents with high school education i.e., 46.67 per cent compared to the other two home gardens. Collegiate education was more in black pepper based home garden with 16.67 percent. No respondents in vegetable based home garden had collegiate education.

Thus, it can be determined that 53.33 per cent farmers had educational qualification from high school to collegiate level. The high level of education of the farmers might be an influence of the well-established educational system of the state. The findings that majority of the respondents possess higher level of education is in conformity with the studies of Krishnan (2013) and Sreelaksmi (2018).

4.7.3. Land area

Land area is the total available land to the respondent for home gardening purposes. The respondents were grouped to different category based upon their available land is presented in Table 42 and Fig 22.

Table 42. Distribution of respondents based on their land area

(N=120)

Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
	No	%	No	%	No	%	No	%	No	%
<50 cents	0	0	2	6.67	0	0	22	73.33	24	20.00
50-100 cents	7	23.33	7	23.33	5	16.67	4	13.33	23	19.17
100-150 cents	7	23.33	5	16.67	6	20.00	2	6.67	20	16.67
150-200 cents	2	6.67	3	10.00	8	26.67	2	6.67	15	12.50
>200 cents	14	46.67	13	43.33	11	36.67	0	0	38	31.67
Total	30	100	30	100	30	100	30	100	120	100

It is evident from Table 42 that 31.67 per cent of the farmers had farm size more than 200 cents, followed by 20 per cent of the farmers hold an area less than 50 cents, 19.17 per cent of the farmers hold an area of 50-100 cents, 16.67 per cent of the farmers hold an area 100-150 cents and 12.50 per cent of farms had a land area of 150-200 cents.

It was interesting to note that none of the vegetable-based home gardens respondents had an area above 200 cents and more than 73.33 per cent of the vegetable based home gardens farmers possessed an area less than 50 cents. However, on all the other three home gardens majority of the respondents of banana (46.67%), black pepper (43.33%), and cardamom (36.67%) based home garden system possessed an area more than 200 cents, and none of the respondents of the banana and cardamom based home garden farmers had an area less than 50 cents, and only 6.67 per cent of the black pepper famers had an area less than 50 cents.

Hence it can be summarized that majority of the home garden farmers except the vegetable-based home gardens are marginal farmers, whereas more than seventy per cent (73.33%) of the vegetable-based home garden were small farmers. The small and marginal land area might be due to the growing pressure of population and the

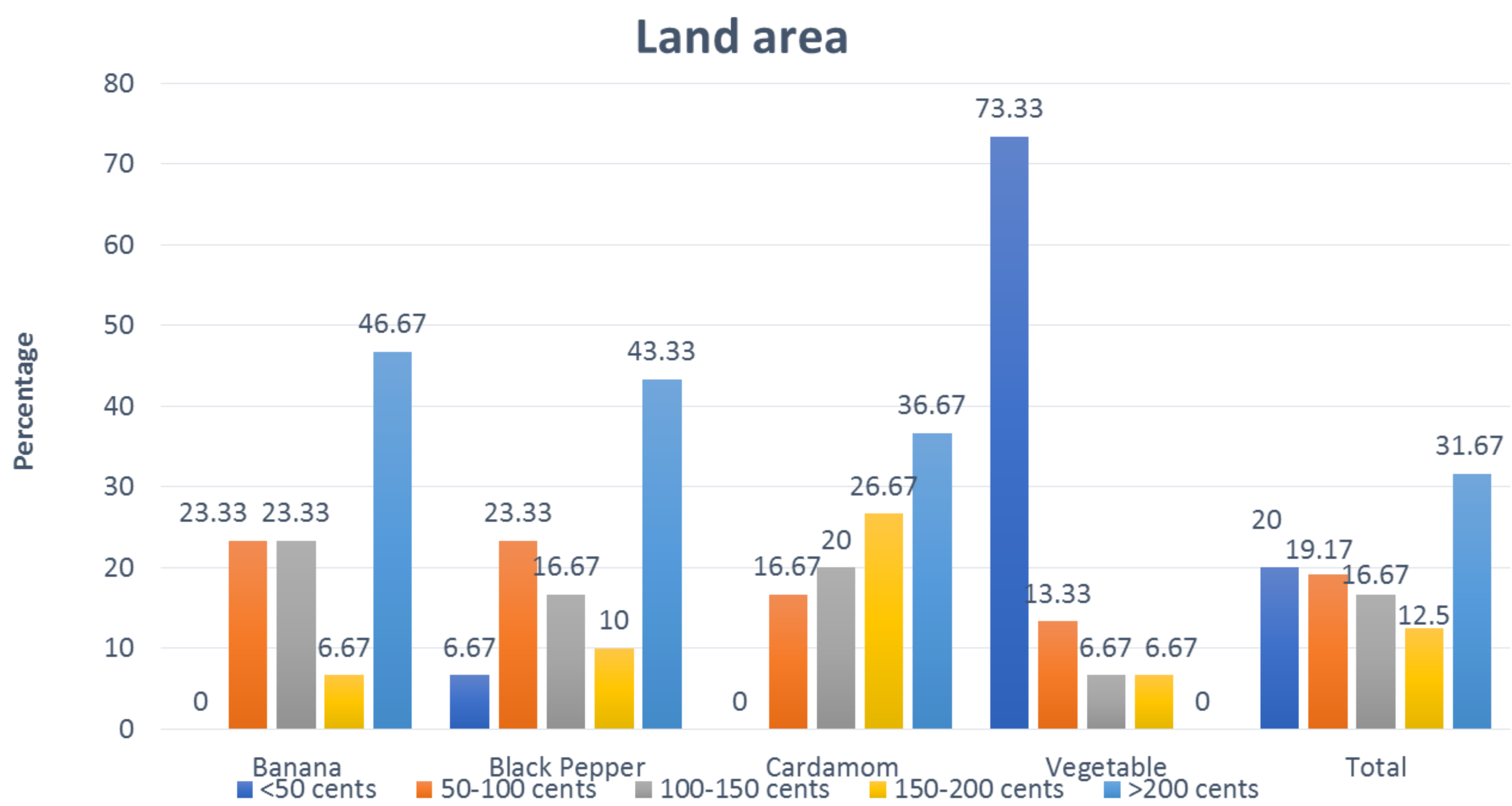


Fig 22. Distribution of respondents based on their land area

conversion of the agricultural land throughout the district for the construction of buildings, commercial establishments, which in turn reduces the total area under cultivation. The results are in confirmatory with the findings of the study done by Al-Shadiadeh *et al.* (2012) and Reeba (2015).

4.7.4. Annual income

Annual income can be described as the sum of on farm and off farm income obtained by the respondent annually. It was calculated in terms of lakhs of rupees per year as expressed by the home garden farmer respondents and shown on Table 43 and Fig 23.

Table 43. Distribution of respondents based on their annual income

(N=120)

Category (in Lakhs)	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=300		Total	
	No	%	No	%	No	%	No	%	No	%
<1	15	50.00	14	46.67	7	23.33	26	86.67	62	51.67
1 to 2	10	33.33	12	40.00	12	40.00	4	13.33	38	31.67
>2	5	16.67	4	13.33	11	36.67	0	0	20	16.66
Total	30	100	30	100	30	100	30	100	100	100

A cursory look at Table 43 revealed that 51.67 per cent of the home garden farmers obtained an income less than one lakh followed by 31.67 per cent with an income between 1 and 2 lakh while only 16.66 per cent farmers obtained an income more than lakh.

Home garden wise interpretation shows that in vegetable based home garden about 86.67 per cent of the farmers received an income less than one lakh, in banana, black pepper, and cardamom this amounted to only 50.00, 46.67 and 23.33 per cent respectively. Farmers incurring an income more than two lakhs were more in the case of cardamom based home garden with 36.67 per cent.

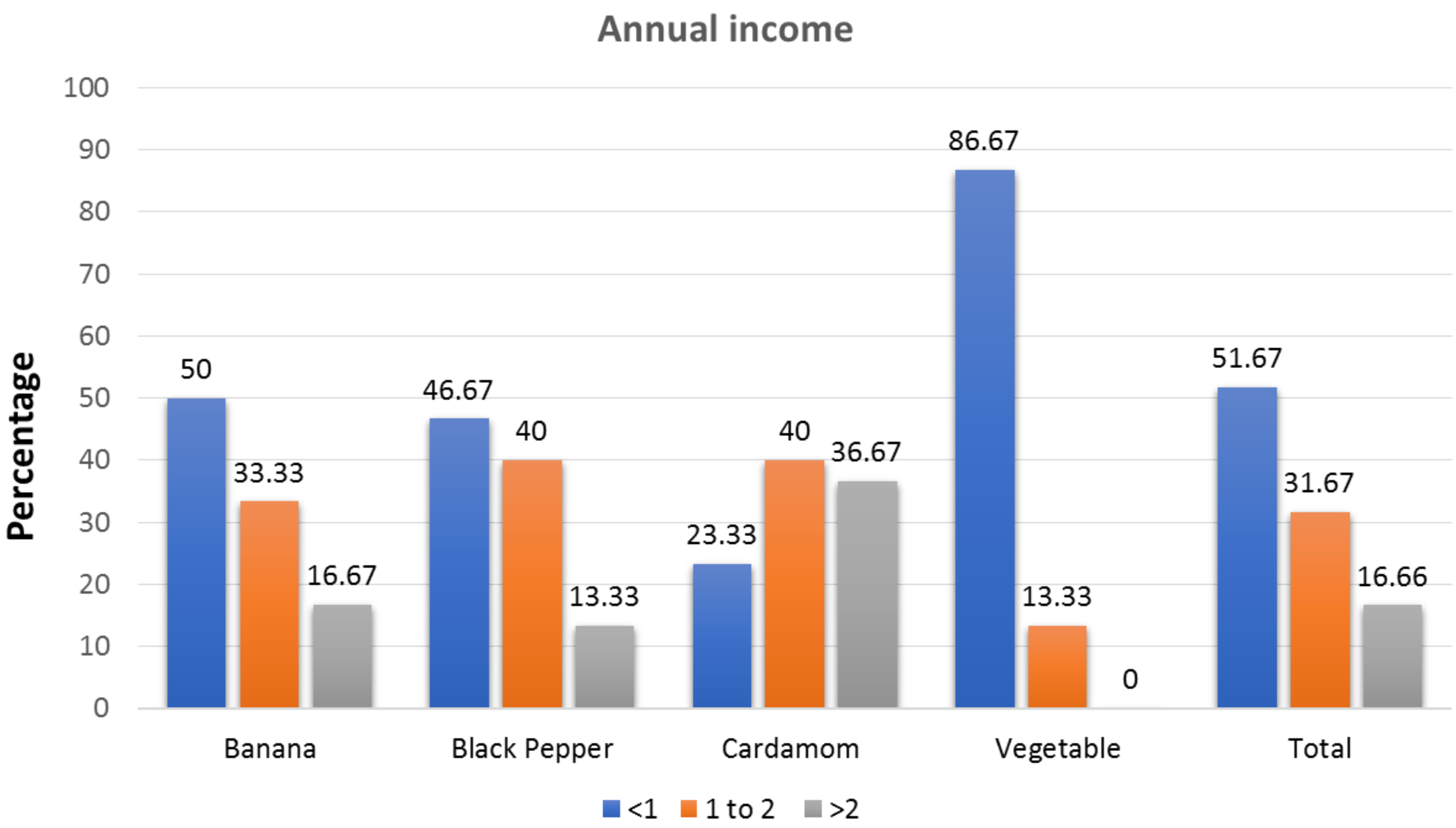


Fig 23. Distribution of respondents based on their annual income

Hence it can be inferred that majority of the home garden farmers of banana, black pepper and vegetable based home garden assumes an income less than rupees one lakh. This may due to low production and price drop or price variability of the agricultural commodities over the years. This finding was contradicted the findings of Krishnan (2013) and Sreelaksmi (2018) who reported that specialized components in homegardens brings in more profit.

4.7.5. Market orientation

Market orientation was the extent to which, respondents were oriented towards marketing for getting a considerable benefit from the sale of product. The respondents are grouped into low and high based on market orientation and presented in Table 44 and Fig 24.

Table 44. Distribution of respondents based on their market orientation (N=120)

Category	Banana N=30		Black Pepper N=30		Cardamom N=30		Vegetable N=30		Total	
	No	%	No	%	No	%	No	%	No	%
<3	3	10.00	3	10.00	3	10.00	0	0	9	7.50
>3	27	90.00	27	90.00	27	90.00	30	100.00	111	92.50
Total	30	100	30	100	30	100	30	100	120	100

It is evident from the Table 44 that the total market orientation of the home garden farmers sampled was high with 92.50 per cent falling in the category of greater than three score vide table.

It was also interesting to note that the market orientation was considerably high in all the four homesteads panchayats with banana (90.00%), black pepper (90.00%), cardamom (90.00%), and vegetable (100.00%) based home gardens getting a score above three. This was apparent because of the market oriented farming activity of home garden farmer and due to their highly selective nature

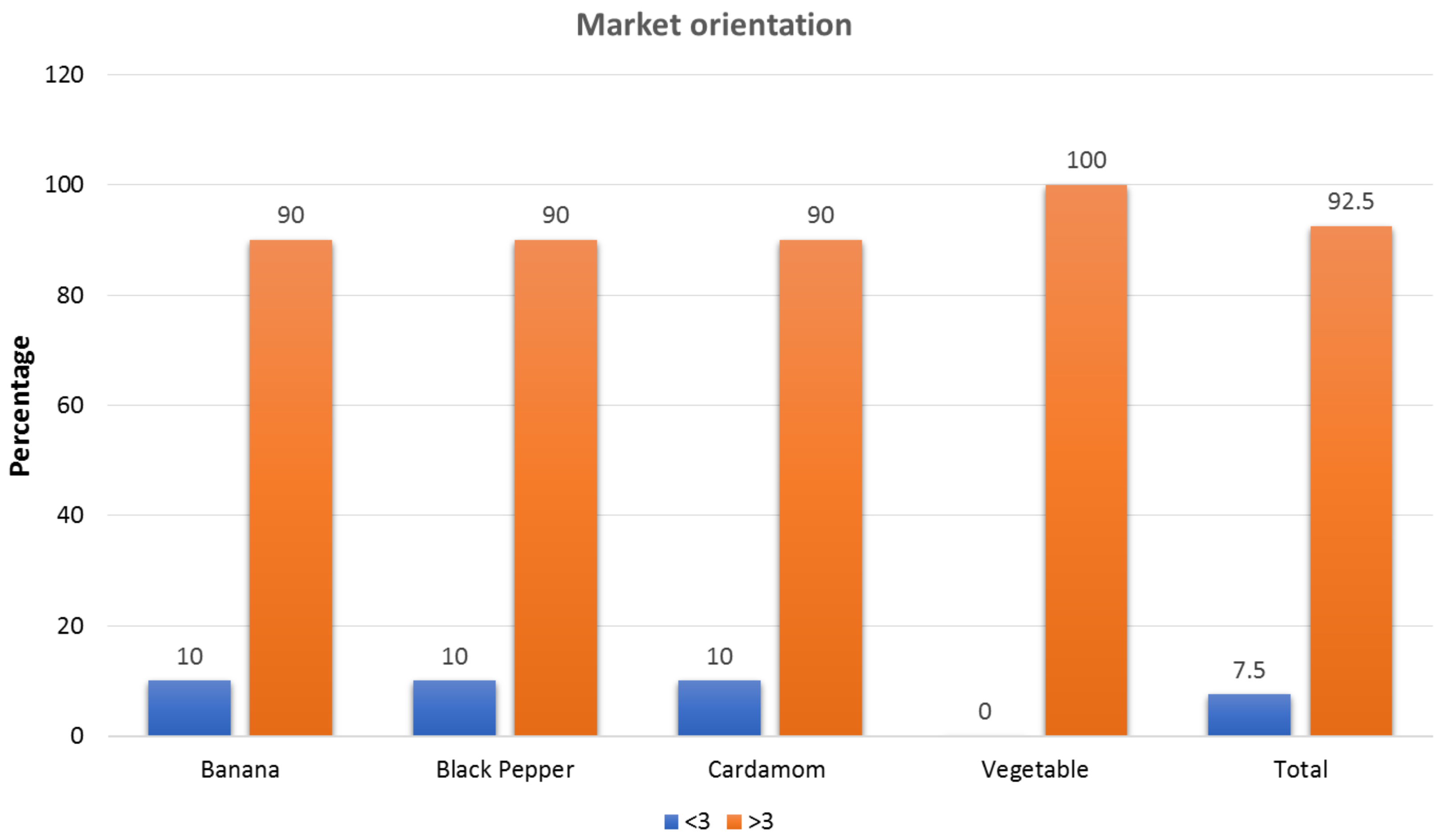


Fig 24. Distribution of respondents based on their market orientation

and profit motive behaviour. The results were in line with Sebastian (2013) and Basheer (2016).

4.7.6. Extension orientation

Extension orientation was the degree to which a farmer had contact with different extension personals and agencies also the respondent's participation in different extension activities or programs.

It was measured by taking the total of values obtained for extension event participation and extension personnel contact and categorized in to low, medium and high as presented in Table 45 and Fig 25.

Table 45. Distribution of respondents based on their extension orientation

(N=120)

Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
	No	%	No	%	No	%	No	%	No	%
Low	3	10.00	4	13.33	0	0	8	26.67	15	12.50
Medium	21	70.00	20	66.67	18	60.00	18	60.00	77	64.17
High	6	20.00	6	20.00	12	40.00	4	13.33	28	23.33
Total	30	100	30	100	30	100	30	100	120	100
Mean	7.57		8.17		6.60		9.27			
SD	1.52		1.64		1.96		1.98			

Summarizing the extension orientation of the respondents from Table 45 it is quite evident that the majority of the home garden farmers 64.17 percent have medium extension contact followed by 23.33 and 12.50 per cent of the farmers with high and low level of extension orientation respectively.

Distribution of home garden as evident from Table 44 reflected similar trends were exhibited in all the home garden areas except in vegetable based home garden

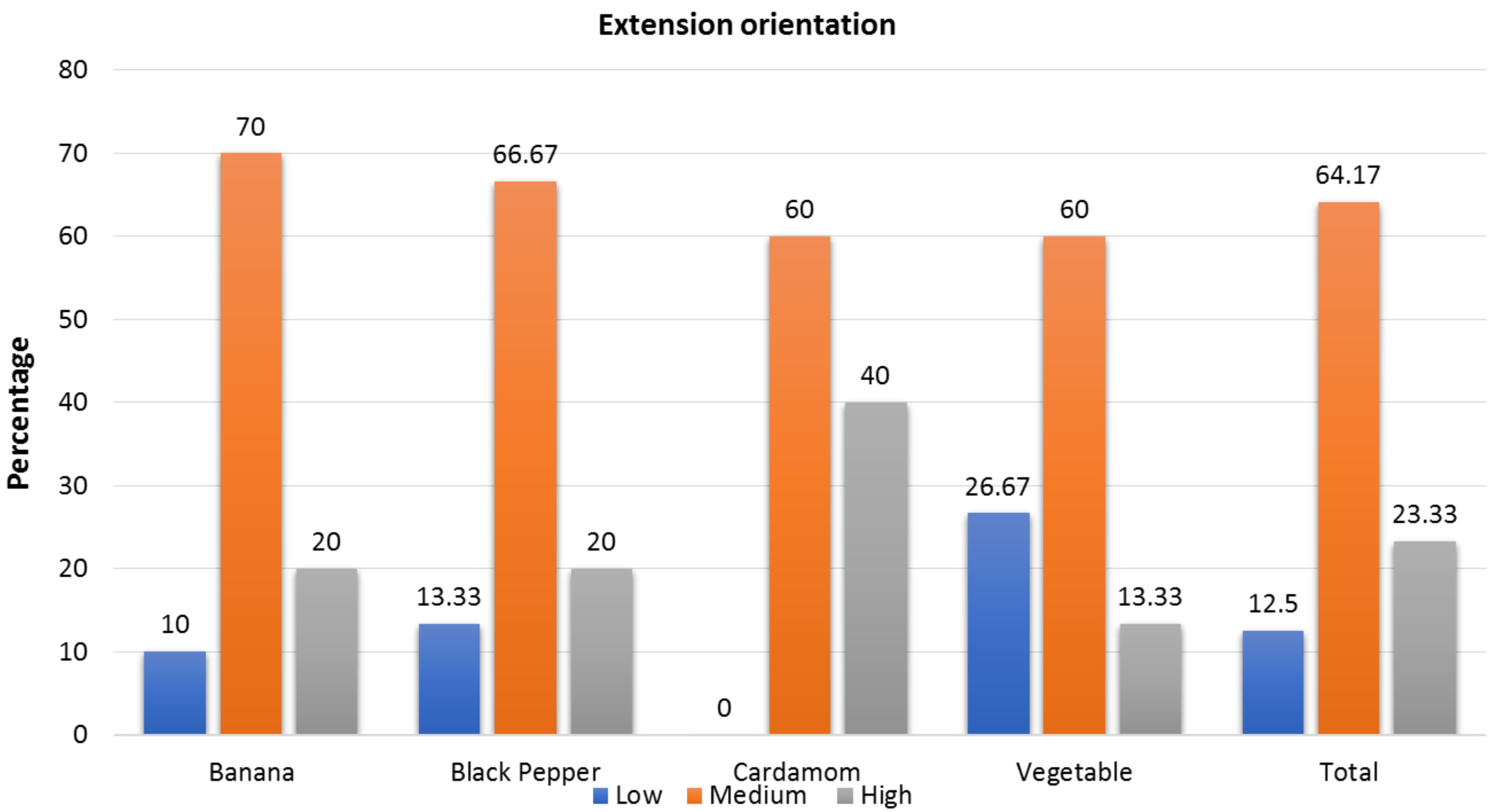


Fig 25. Distribution of respondents based on their extension orientation

were extension orientation ranged from medium to low. Hence it can be inferred that high per cent of medium extension contact might be due to the timely provision of inputs and subsidies by various government and other agencies.

4.7.7. Innovativeness

Innovativeness is the comparative earliness in adoption of an innovation by the respondents and classified in to high, medium and low classes based on the nature off innovativeness and presented below in Table 46 and Fig 26.

It can be summarized from Table 46 that 51.67 per cent of the respondents had medium innovativeness with a score of 2 followed by 26.67 percent with low innovativeness and 21.67 per cent with high innovativeness.

Table 46. Distribution of respondents based on their innovativeness (N=120)

Category	Score	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
		No	%	No	%	No	%	No	%	No	%
High	3	6	20.00	7	23.33	7	23.33	6	20.00	26	21.67
Medium	2	18	60.00	12	40.00	16	53.33	16	53.33	62	51.67
Low	1	6	20.00	11	36.67	7	23.33	8	26.67	32	26.67
Total		30	100	30	100	30	100	30	100	120	100

Home garden wise distribution also revealed that all the home gardens were having medium to high level of innovativeness. More number of low innovative farmers were seen in black pepper and cardamom based home gardens with 23.33 per cent followed by banana and vegetable based home gardens with 20.00 per cent. High innovative farmers were recorded more in black pepper based home gardens with 36.67 per cent followed by 26.67 per cent in vegetable based home

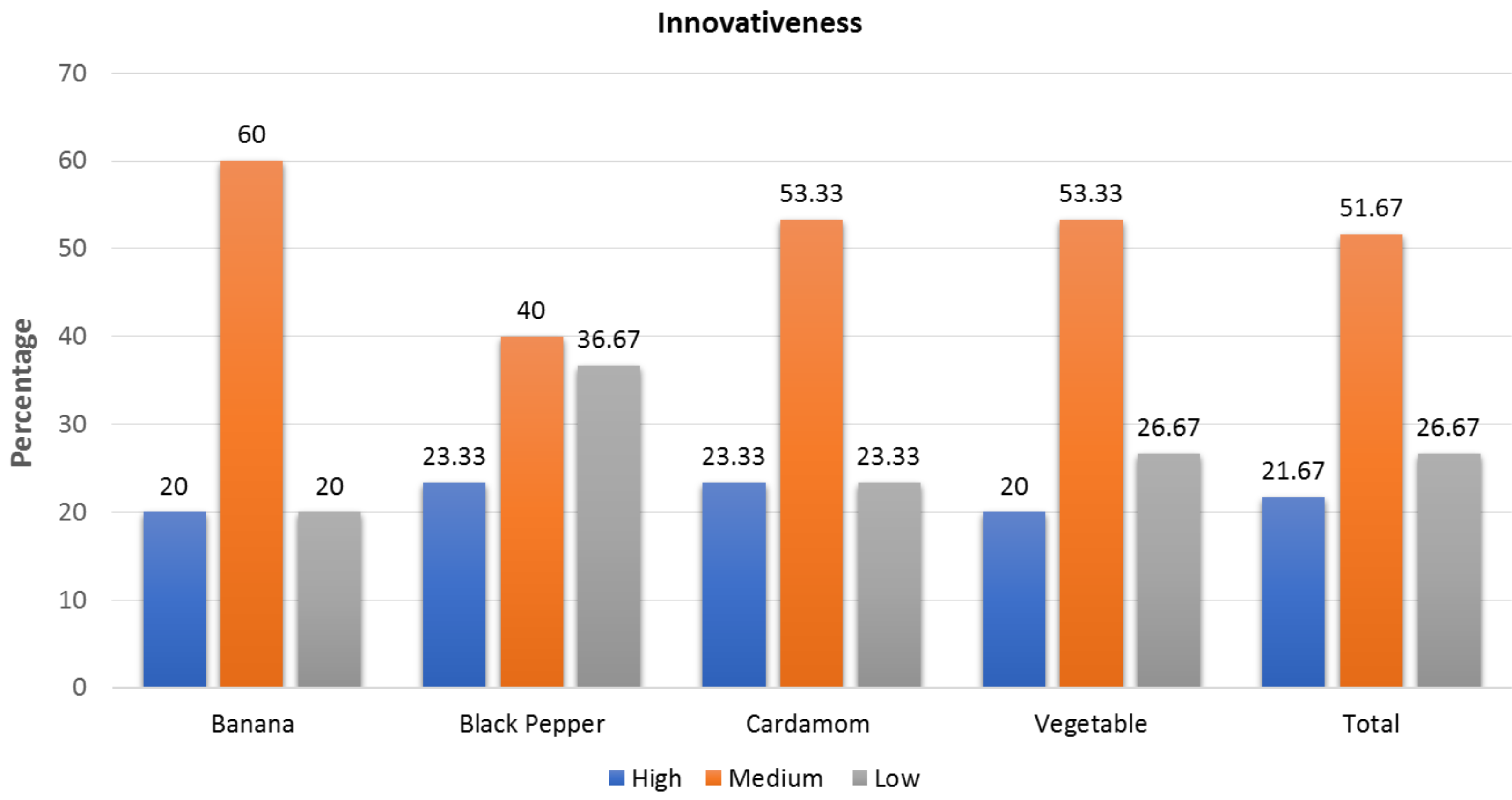


Fig 26. Distribution of respondents based on their innovativeness

garden, 23.33 per cent in cardamom based home gardens and 20.00 per cent in banana based home gardens.

This might be due to competent behaviour of the farmers to effectively use their knowledge and skills according to the situations. The results are in confirmatory with the studies of Basheer (2016).

4.7.8. Irrigation potential

Irrigation potential was the availability of water for a homestead to be irrigated during a complete year. Home garden respondents were grouped based upon the availability of water for irrigating the field as shown in Table 47 and Fig 27.

Table 47. Distribution of respondents based on their irrigation potential

N=120

Category	Score	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
		No	%	No	%	No	%	No	%	No	%
NWS/LWS	3	9	30.00	13	43.33	6	20.00	6	20.00	34	28.33
EWS	2	12	40.00	17	56.67	12	40.00	14	46.67	55	45.83
PWS	1	9	30.00	0	0	12	40.00	10	33.33	31	25.83
Total		30	100	30	100	30	100	30	100	120	100

[PWS- Physical Water Scarcity EWS- Economic Water Scarcity NWS/LWS- No / Little Water Scarcity]

On perusal of Table 47, it can be inferred that 45.83 per cent of home garden farmers ascertain that there exists a state of economic water scarcity followed by 28.33 per cent of home garden farmers stating that there is little or no

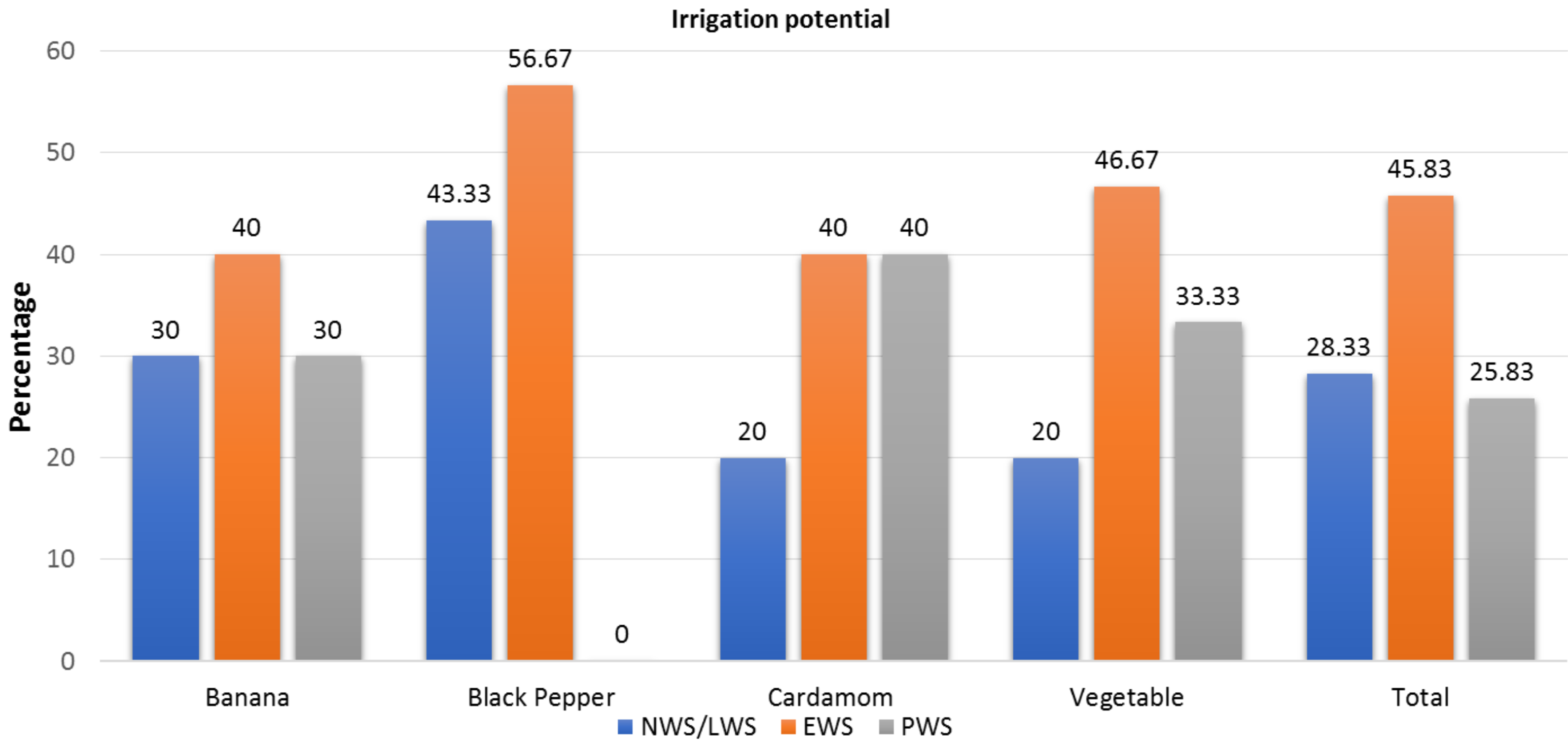


Fig 27. Distribution of respondents based on their irrigation potential

water scarcity and finally 25.83 per cent farmers stated that they face a condition of physical water scarcity.

The home garden wise distribution shows that 43.33 per cent of black pepper based home garden farmers discoursed that they do not meet with water scarce situations followed by banana based home garden farmers 30 percent and cardamom and vegetable based home garden farmers with 20 per cent. In contrast none of the famers in black pepper based home garden face physical water scarcity.

However, the findings of the other three home garden areas highlights the importance of water conservation, as majority of the farmers (71.66 %) either encounter with economic or physical water scarcity. This finding suggests the importance of educating the farmers on effective irrigation techniques and to adopt more water harvesting measures.

4.7.9. Economic motivation

Economic motivation was the assessment of a home garden respondent to gain profit and considerable value on economic ends and was the major factor determining the adoption of technology.

Farmers were sorted in to different group based on their economic motivation and presented in Table 48 and Fig 28.

Table 48. Distribution of respondents based on their economic motivation

N=120

Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
	No	%	No	%	No	%	No	%	No	%
Low	3	10.00	6	20.00	6	20.00	0	0	15	12.50
Medium	24	80.00	19	63.33	20	66.67	25	83.33	88	73.33
High	3	10.00	5	16.67	4	13.33	5	16.67	17	14.17
Total	30	100	30	100	30	100	30	100	120	100.00
Mean	3.97		4.13		4.37		3.67			
SD	1.19		1.41		1.03		0.84			

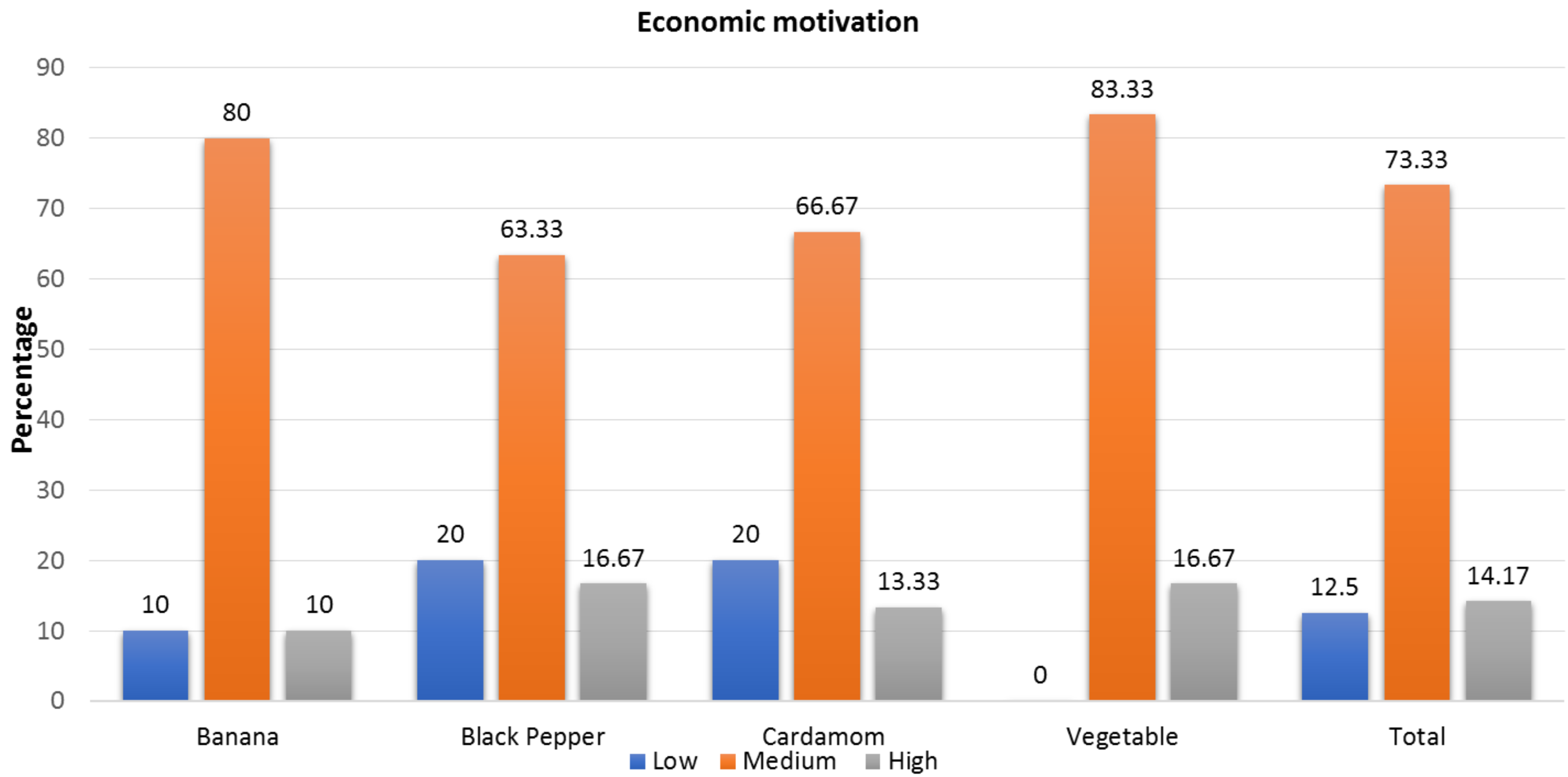


Fig 28. Distribution of respondents based on their economic motivation

A cursory look at Table 48 revealed that majority (73.33%) of the home garden farmers had medium economic motivation, followed by high (14.17%) and low (12.50%) levels of economic motivation.

The home garden wise distribution of respondents also reflected the total results where respondents with medium economic motivation were higher in vegetable based (83.33%) home gardens followed by banana (80.00%), cardamom (66.67%) and black pepper (63.33%).

Hence it can be summarized that 87.50 per cent of the home garden farmers have medium to high economic motivation. This might be due to the reason that majority of them are profit oriented. This supports the findings of Basheer (2016).

4.7.10. Rational orientation

Rational orientation was measured from the respondent's nature towards the belief of science and religion and scored in to three categories as presented in Table 49 and Fig 29.

Table 49. Distribution of respondents based on their rational orientation

N=120

Category	Score	Banana n=30		Black Pepper n=30		Cardamom n=30		Vegetable n=30		Total	
		No	%	No	%	No	%	No	%	No	%
Belief	1	1	3.33	0	0	0	0	1	3.33	2	1.67
Belief+ Science	2	17	56.67	19	63.33	9	30.00	20	66.67	65	54.16
Science	3	12	40.00	11	36.67	21	70.00	9	30.00	53	44.17

From the data furnished in Table 49, it can be inferred that majority of the respondents (54.16 %) of the home garden farmers had belief on belief and science together. Only 44.17 per cent of the farmers rely on scientific aspects

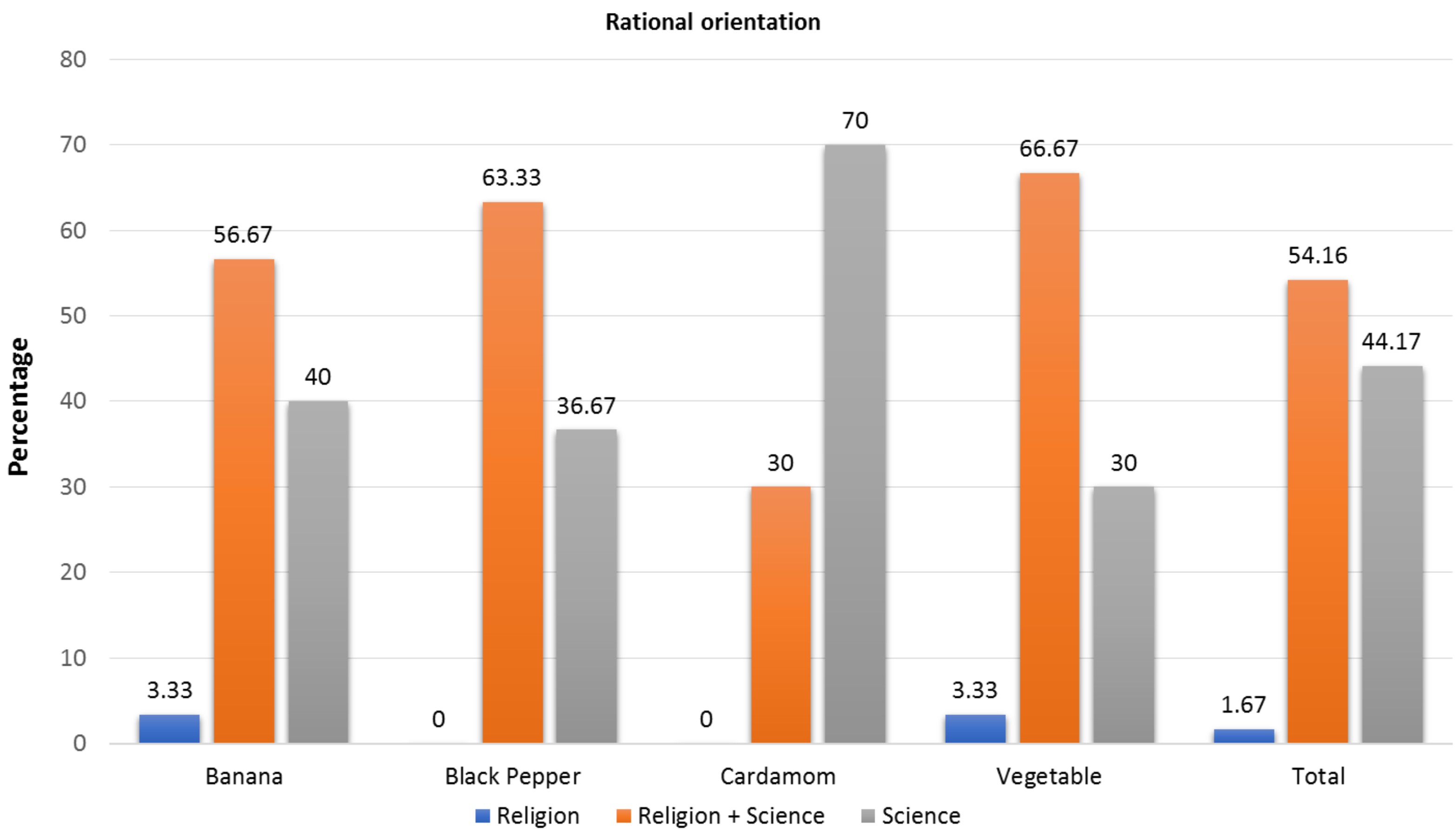


Fig 29. Distribution of respondents based on their rational orientation

alone whereas only two of the total respondents considered the belief aspects like astrology and stars.

An interpretation of the data home garden wise also showed that 70 per cent of the farmers of cardamom based home garden solely depend on scientific recommendations and only 30 per cent farmers considered belief along with scientific practices. The reverse of this trend was seen in other home gardens.

Hence it can be understood that more than 50 per cent (54.16 %) of the home garden farmers surveyed had medium level of rational orientation and only 44.17 per cent had high level of rational orientation. However, 98.33 per cent of

the respondents had medium to high level of rational orientation which indicates that the farmer considers the scientific approach to make their farming more profitable. The results are on par with the findings of Krishnan (2013).

4.7.11 Extent of adoption of recommended practices

The extent of adoption of recommended practices was worked out on percentage basis of respondents and presented in Table 50 and Fig 30.

Table 50. Distribution of respondents based on the extent of adoption of recommended practices

N=120

Sl.No	Category	Banana n=30		Black Pepper n=30		Cardamom n=30		Cabbage n=30	
		No.	%	No.	%	No.	%	No.	%
1	High (Mean + SD)	12	40.00	6	20.00	6	20.00	5	16.66
2	Medium (Mean ± SD)	10	33.33	21	70.00	23	76.67	18	60.00
3	Low (Mean - SD)	8	26.67	3	10.00	1	3.33	7	23.33
Mean:20.61 SD:3.57									

It is evident from Table 50 that 60-77 per cent of farmers adopting recommended practices in cardamom, black pepper and cabbage belongs to

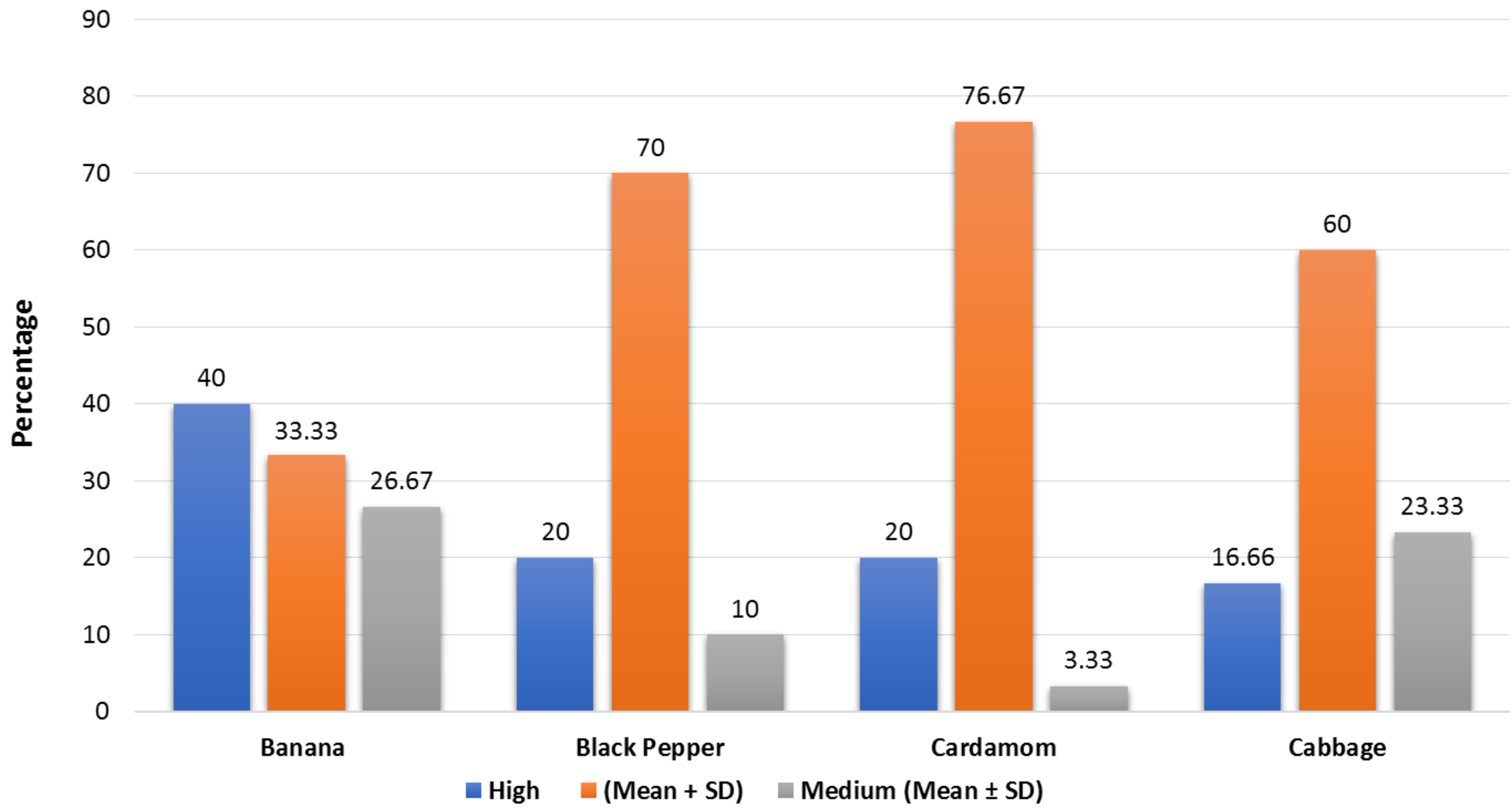


Fig 30. Distribution of respondents based on the extent of adoption of recommended practices

medium category. However, a detailed perusual of table indicated that 90-97 per cent of farmers adopting practices under blackpepper and cardamom belongs to medium to high category indicating that the extend of adoption of practices in blackpepper and cardamom is higher than that of extend of adoption of cabbage where 83 per cent of farmers fall in the medium-low category.

The results on extend of adoption of banana is conspicuously different from three other crops as mentioned in Table 50. It is evident that 40 per cent of farmer fell under high medoium category of adoption.Considering the medium category, if the combined figures are considered in case of banana, from Table 50 it can be concluded that 73 per cent of farmers belong to medium to high level of adoption. The adoption of different recoomended practices was medium to low for cabbage and medium to high for black pepper and cardamom. In case of banana, more farmers belongs to the category of high level of adoption. But, in general, the table points out that, more efforts to be needed to improve the extend of adoption of scientific practices for all the four crops.

The general reasons that can be attributed to farmers not adopting the scientific practices as recommended by competent systems are that farmers may not face the problem targeted by the innovation, farmer practice could be equal to or better than the suggested innovation, the belief of farmers that innovation simply does not work, the out reach extension fails, the innovation costs too much, and multiple 'social' factors.

Hence efforts should be focused on developing location specific technologies and disseminating the same to the farming community considering the techno socio economic realms of the home garden farming community in order to provide a better livelihood security for the farmers. The findings of the studies were in line with the study conducted by Basheer (2016).

4.7.12. Correlation between the extent of adoption of recommended practices and the selected characteristics of the respondents

The correlation between the extent of adoption of recommended practices and the selected characteristics of the respondents is depicted in Table 51 and an empirical model is given in Fig 31.

Table 51. Correlation between the extent of adoption of recommended practices and the selected characteristics of the respondents.

Sl No	Independent Variables	Correlation coefficient			
		Banana n=30	Black pepper n=30	Cardamom n=30	Cabbage n=30
1	Age	0.025^{NS}	0.118^{NS}	-0.165^{NS}	-0.038^{NS}
2	Education	0.272^{NS}	-0.130^{NS}	0.098^{NS}	-0.124^{NS}
3	Land area	0.290^{NS}	0.125^{NS}	-0.232^{NS}	0.521^{**}
4	Annual income	0.159^{NS}	-0.059^{NS}	-0.191^{NS}	0.381^{*}
5	Market Orientation	0.431^{*}	0.541^{**}	0.817^{**}	0.659^{**}
6	Extension orientation	0.369^{*}	0.464^{**}	0.834^{**}	0.579^{**}
7	Innovativeness	0.598^{**}	0.277^{NS}	0.727^{**}	0.337^{NS}
8	Irrigation Potential	0.665^{**}	0.607^{**}	0.617^{**}	-0.171^{NS}
9	Rational Orientation	0.130^{NS}	0.131^{NS}	0.338^{NS}	-0.101^{NS}
10	Economic motivation	0.707^{**}	0.825^{**}	0.533^{**}	0.704^{**}

It is clear from Table 51 that in case of banana based home gardens age, land area, education, annual income and rational orientation possess no significant relation with the extent of adoption of recommended practices. Whereas variables like market orientation and extension orientations were significant at 5 per cent level and variables like innovativeness, irrigation potential and economic motivation were found to be significant at one per cent level.

The table also reveals that in case of black pepper based home garden variables like age, land area, education, annual income, rational orientation and rational orientation were found to be non-significant. However, the independent variables like market orientation, extension contact, irrigation potential and economic motivation were found to be significant at one per cent level.

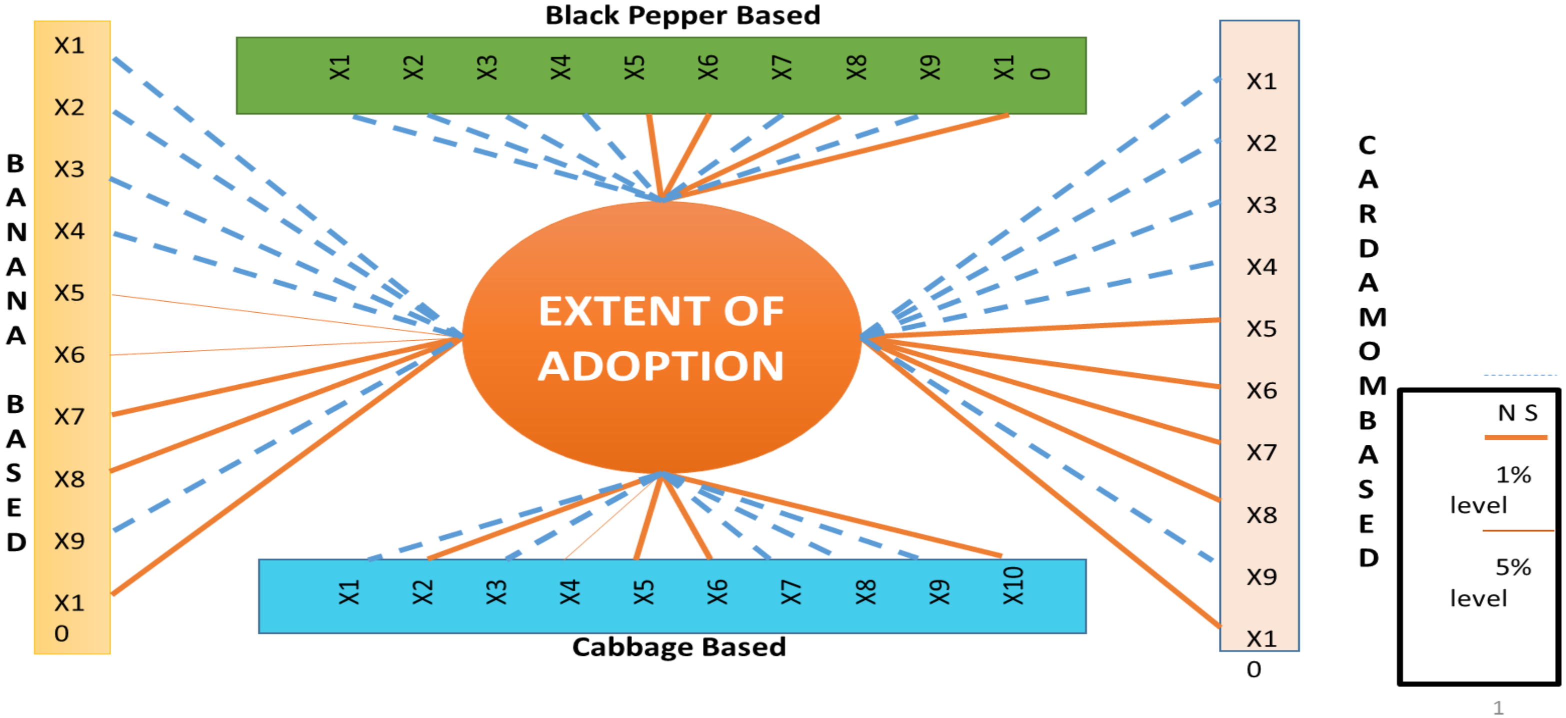


Fig 31. Empirical model on the relationship of independent variable with the dependent variable extent adoption

It is evident from the Table 51 that independent variables like age, land area, education, annual income and rational orientation of cardamom based home gardens possess no significant relation with the extend of adoption whereas variables like market orientation, extension contact, innovativeness, irrigation potential and economic motivation were found to be significant at one per cent level.

A perusal of Table 51, it was found that in case of cabbage farmers variables like land area, market orientation, extension orientation and economic motivation were found to be significant at 1 per cent level and annual income was found to significant at 5 per cent level. Whereas age, education, rational orientation, irrigation potential and innovativeness had no significant relationship.

4.7.12. Market orientation and extent of adoption of recommended practices

Market orientation was found to be positively and significantly influencing adoption of scientific practices. These results tend to depict that farmer who have high market orientation or knowledge on the trend of market have a tendency to adopt scientific practices and plan the crop calendar accordingly to obtain better profit for their produce. This finding is in line with the findings of Basheer (2016). The extension agents focus more on technology transfer largely ignoring the delivery of information on the prices and quality of new agricultural technologies. If there are systems to help farmers with market knowledge and intelligence the extent of adoption will be more and faster. The market owners further identified that many input providers provide information only on those technologies that benefit them, rather than farmers that can adversely affect the farming in the long run. Hence, it's very important to orient farmers on all aspects of market and its intracacies throughout the production cycle upto marketing of the produce.

4.7.13. Extension orientation and extent of adoption recommended practices

Extension orientation is found to be significantly and positively correlated with the extent of adoption of scientific practices. As the extension orientation of the respondent's increases, they could make themselves to expose to different information regarding the novel practices which helped them to reinforce their knowledge and learning skills in implementation of the scientific practices. The findings of the study were on par with the study conducted by Jacob *et al*. (2016). Steps should be initiated to facilitate frequent extension–farmer contact that can help farmers to become aware of new practices, and it will help to enhance their willingness to understand and adopt them.

4.7.14. Innovativeness and extent of adoption recommended practices

Innovativeness is found to be significantly and positively correlated with the extent of adoption of scientific practices. Adoption of improved or scientific practices will be more if the innovativeness of farmers is high. This might be due to their risk-taking ability and higher economic motivation. This result is in line with the findings of Sai *et al.* (2013). Innovativeness is dependant on innovation characteristics. Those innovations with clear degree of predictability will diffuse faster and deeper among the members of social system. This is because predictions of the speed and extent of adoption of new agricultural practices and technologies are required to inform decisions and plans in agricultural policy, research and extension focusing home gardemns.

4.7.15. Irrigation potential and extent of adoption recommended practices

The results of this study show that irrigation potential was another significant factor which influences the adoption of recommended practices. This finding might be from the assertion that improved irrigation facilities and availability of enough water for irrigating the crops will enable the farmers to adopt improved scientific practices. The finding of the study is on par with the study conducted by Krishnan (2013). Inadequate finance or subsidy schemes should be rendered as a support to high range home garden farmers which will help them towards installing micro irrigation facilities to improve the water use efficiency. The study points out to the significance of promoting such efficient irrigation system helping the home garden and the state to commute an effective irrigation and water use system. The farmers also should be trained focusing on skill development with reference to its installation and use.

4.7.16. Economic motivation and extent of adoption of recommended practices

Economic motivation of the farmers was found to have positive and significant correlation with their extent of adoption. It was obvious that economic motivation could be significant because, if a farmer develops higher level of economic motivation, he strives hard to achieve it and also manages the farm in such a way to ensure maximum profit. In addition, aspiration, economic motivation and increase in annual income will motivate the farmers to adopt innovations in agriculture to maximize the profit especially if they find the homegarden farmin is remunerative through horizontal and vertical integrations. The findings are in line with the results obtained by Singha *et al.* (2012) and Basheer (2016).

4.8. GENDER ROLES IN DIFFERENT CROP BASED HOME GARDENS.

The results based on gender roles with special reference to different activities of engagement by the gender in the different crop based high range home gardens is presented from Table 52 to Table 55.

Table 52. Gender roles in banana based home garden with special reference to banana cultivation N=30

Particulars	Men	%	Women	%	Both	%
Land preparation	16	53.33	2	6.67	12	40.00
Planting material preparation	10	33.33	5	16.67	15	50.00
Planting	20	66.67	2	6.67	8	26.67
Irrigation	7	23.33	3	10.00	20	66.67
Fertilizer application	13	43.33	3	10.00	14	46.67
Inter cropping	4	13.33	8	26.67	18	60.00
Weeding	5	16.67	20	66.67	5	16.67
Crop protection activities	20	66.67	2	6.67	8	26.67
De- trashing	10	33.33	5	16.67	15	50.00
Harvesting operations	20	66.67	2	6.67	8	26.67
Value addition of products	2	6.67	25	83.33	3	10.00

A cursory look into the Table 52, revealed that majority of men alone take part in heavy physical activities such as land preparation (53.33%), planting (66.67%), crop protection activities (66.67%) and harvesting operations (66.67%). Whereas majority of the women take part in operations such as weeding (66.67%) and value addition of the products (83.33%). But in most of the operations such a planting material preparation (50.00%), irrigation (66.67%), fertilizer application (46.67%), inter cropping (60.00%) and detrashing (50.00%) both the men and women are actively engaged.

Table 53. Gender roles in black pepper based home garden with special reference to black pepper cultivation

(N=30)

Particulars	Men	%	Women	%	Both	%
Land preparation	16	53.33	2	6.67	12	40.00
Planting material preparation	10	33.33	5	16.67	15	50.00
Planting	20	66.67	2	6.67	8	26.67
Irrigation	7	23.33	3	10.00	20	66.67
Fertilizer application	13	43.33	3	10.00	14	46.67
Inter cropping	4	13.33	8	26.67	18	60.00
Weeding	5	16.67	20	66.67	5	16.67
Crop protection activities	20	66.67	2	6.67	8	26.67
De- trashing	10	33.33	5	16.67	15	50.00
Harvesting operations	20	66.67	2	6.67	8	26.67
Value addition of products	2	6.67	25	83.33	3	10.00

From the Table 53, it can be seen that the farming operations such as land preparation (53.33%), planting (66.67%) and crop protection activities and harvesting operations 66.67 per cent are mainly carried by men farmers, also it can be seen that 83.33 per cent of value addition of products and 66.67 per cent of the weeding operations are carried out by women farmers.

Whereas the activities such as irrigation (66.67%), planting material prepartions and detrashing (50.00%), fertilizer application (46.67%), activities are undertaken together by men and women farmers.

Table 54. Gender roles in cardamom based home garden with special reference to cardamom cultivation

(N=30)

Particulars	Men	%	Women	%	Both	%
Land preparation	16	53.33	6	20.00	8	26.67
Planting	15	50.00	2	6.67	13	43.33
Fertilizer application	10	33.33	6	20.00	14	46.67
Shading	12	40.00	5	16.67	13	43.33
Irrigation	10	33.33	5	16.67	15	50.00
Weeding	5	16.67	18	60.00	7	23.33
Plant protection activities	10	33.33	3	10.00	17	56.67
Harvesting	5	16.67	8	26.67	17	56.67
Post-harvest management	24	80.00	2	6.67	4	13.33

On a cursory look to the Table 54, it was clear that 53.33 per cent and 50 percent of the activities such as land preparations and planting operations respectively are taken up by men. It is also interesting to note that 80 per cent of the post-harvest management practices are done by men.

Whereas majority of the women take part in operations such as weeding (60.00). Most of the activities such as fertilizer application (46.67%), shading (43.33%), irrigation (50.00%), plant protection activities (56.67%) and harvesting operation (56.67%) are taken by both men and women.

Table 55. Gender roles in vegetable based home garden with special reference to cabbage cultivation

Particulars	Men	%	Women	%	Both	%
Land preparation	22	73.33	2	6.67	6	20.00
Planting	8	26.67	10	33.33	12	40.00
Fertilizer application	10	33.33	7	23.33	13	43.34
Irrigation	5	16.67	17	56.67	8	26.67
Earthing up	13	43.33	9	30.00	8	26.67
Plant protection activities	13	43.33	5	16.67	12	40.00
Weeding	4	13.33	21	70.00	5	16.67
Harvesting	11	36.67	6	20.00	13	43.33

On a cursory look to the Table 55, it was evident that 73.33 per cent and 43.33 per cent of the activities such as land preparations and earthing up are taken up by men. Whereas majority of the women were involved in weeding (70.00 %). Operations such as fertilizer application (43.34 %) and harvesting (43.33%) were carried out by both men and women.

Hence from Table 52 to 55, it can be inferred that labour intensive works such as land preparation, planting activities are done majorly by men farmers, while weeding and irrigation activities are mainly taken down by women farmers alone. It was also observed that most of activities are done by both the women and men farmers. The findings of the study are in line with the study conducted by Krishnapriya (2011).

The finding showed that in high range home gardens, both male and female were equally responsible in overall home garden management activities but with variations in task that involved heavy sort of physical activities. The relative low level female participation could be as a result of attitudinal change, difficult land terrain, unfavorable government policy and skewed approach of agricultural extension services which concentrated on only the farmer instead of the entire farm family. To achieve sustainable food production in order to ensure food security, home gardens are the dominant venue and the extension services need a new gender neutral orientation and better funding to enable it carry out its function. The government should incentivize women headed homegarden production system and encourage women to own their own farms by giving priority to them in service rendering.

4.9. CONSTRAINTS EXPERIENCED BY THE HOME GARDEN FARMERS

Home gardens are unique farming systems that is managed by a farming family with or without the involvement of hired labourers. Usually farm family gets involved in many farming operations and in the process they accustom with many constraints. The results of the major constraints experienced by high range home garden farmers is presented in Table 56.

Table 56. Constraints experienced by the high range home garden farmers

Sl. No	Constraints	Score	Rank
1	Extortionate cost of inputs	352	2
2	Scarcity of labours	205	11
3	High labour cost and scarcity of skilled labours on scientific crop production	300	6
4	Lack of site-specific technologies	335	5
5	Inadequate knowledge on scientific crop production	347	3
6	Poor knowledge on diagnosis of pest and disease	193	12
7	Unpredictable natural calamities as a result of climate change or variations related to crop loss	365	1
8	Lack of proper marketing channels	266	9
9	Poor transportation facilities	227	10
10	Lack of extension services	337	4
11	Price fluctuation	296	7
12	Lack of sufficient profit generation	291	8

A brief examination of Table 56 revealed that, among the top four constraints, unpredictable natural calamities as a result of climate change or variations related to crop loss (365) ranked first followed by extortionate cost of inputs (352), inadequate knowledge on scientific crop production (347) and lack of extension services (337). Other major constraints include lack of site-specific technologies, high labour cost, price fluctuation, lack of sufficient profit generation, lack of proper marketing channels, poor transportation facilities, scarcity of labours and poor knowledge on diagnosis of pests and diseases in the decreasing order of importance.

Unpredictable natural calamities as a result of climate change topped the constraint ranking as perceived by the farmers. This was evident owing to the last three years of unlimely rain during flood and drought situation during dry season in Kerala. Under changing climatic situations where kerala is often witnessing heavy down pour and untimely rainfall resulting in complete crop failures, shortage of yields, reduction in quality and increasing pest and disease problems, they render the vegetable production unprofitable. On the contrary when there is little or no rainfall, high temperatures, reduced irrigation-water availability, and ocassional issues of salinity will be the major limiting factors in sustaining and increasing vegetable productivity. Sound adaptation strategies should be developed to mitigate the adverse impact of climatic change on productivity and quality of vegetable crops. For example, issues of excessive soil moisture due to heavy rain that becomes a major problem can be overcome by growing crops on raised beds. Like wise during drought thee crop management practices like mulching with crop residues and plastic mulches will help in conserving soil moisture. Other strategies to address the issues of aforesaid mention challenges due to climate change and variations can be developing genotypes tolerant to high temperature, combating moisture stress, salinity and climate proofing through conventional, non-conventional, breeding techniques, genomics and biotechnology.

Extortionate cost of inputs like seed, fertilizers etc. is the major constraint faced by farmers as majority of the farmers cannot afford to purchase the desired quantity timely needed to enhance vegetable productivity. This coupled with other factors such as scarcity of labour has a direct influence on the high labour cost in the high range home gardens. Krishnan (2013) also reported that the higher price of inputs and high labor cost were important constraints in specialized home gardens of Kerala. The existing work culture of Kerala was derived as a part of the prevailing socio-political scenario of the state that led to shortage of labours in agriculture.

The inadequate knowledge on scientific crop production that was ranked third important constraint could be due to the fact that vegetable farming is an intensvive activity that demands advisory support to farmers for various field operations especially like field preparation, sowing, nursery raising, weed management, water management, fertilizer management, pest and disease management and including various other intercultural operations. Lack of extension services was rated the fourt important constraints and this could be attributed due to less number of field staffs in high range areas. Extension support system, thus should be reoriented to situations that are suitable for high range home garden, which eventually helps them to make home garden more sustainable and remunerative. To minimise the economical loss due to these constraints, and help farmers remain motivated in vegetable cultivation key stakeholders should take suitable steps to address these contraints. More number of extension activities, training programmes, awareness programmes, and use of ICT tools along with mass media is the need of the hour to help farmers overcome the difficulties they face during vegetable cultivation.

4.10. SUGGESTIONS FOR REFINEMENT AS PERCEIVED BY HOME GARDEN FARMERS

Farmers themselves have opinions or suggestions for overcoming the constraints faced by them during the farm production activities. Multiple responses were generated from the farmer respondents and frequency and percentage was worked out. The suggestions as perceived by the high range home garden farmers in the decreasing order of importance are presented in Table 57.

Table 57. Suggestions for refinement as perceived by the high range home garden farmers

N=120

Sl. No	Suggestion	Frequency	%
1.	Development of package of practices in tune with the home garden system	113	94.16
2.	Follow up and assistance by extension agencies on the adoption of recommended scientific practices	111	92.50
3.	Participatory technology development between the extension unit and the farmers.	108	90.83
4.	Inclusion of traditional farmer practices and developing a unified mix of scientific and farmer practices.	105	87.50
5.	Inclusion of market clusters to increase profit and to reduce the risk	102	85.25
6.	Development of home garden suited farm implements which is gender neutral	100	83.33

A cursory look at Table 57 indicated that majority of the respondents (94.16) perceived 'Development of package of practices in tune with the home garden system' as the major strategy for refinement followed by 'Follow up and assistance by extension agencies on the adoption of recommended scientific practices' (92.50%); 'Participatory technology development between the extension unit and the farmers' (90.83%); 'Inclusion of traditional farmer practices and developing an unified mix of scientific and farmer practices' (87.50 %);

'Inclusion of market clusters to increase profit and to reduce the risk' (83.33 %). Strategies suggested by 78.33 per cent of the farmers were 'development of home garden suitedfarm implements which is gender neutral'.

Home gardens are an integral part of local food systems and the agricultural landscape of Kerala is unique and ever evolving. High range home gardens are yet more distinctive and have endured the test of time. Since crops are not in isolation, the management pratices cannot be uniform and it requires a specific treatment for maintaining the remunerativeness of different crop components in home gardens. Hence the foremost suggestion that ranked top the table *viz* 'development of package of practices in tune with the high range home garden system' holds good and valid.

The role of extension agents and the nature of extension services should address the key issues of the transfer of agricultural technologies to farmers and to persuade farmers to adopt those agricultural techniques. The results showed that agricultural extension workers are playing a major role in the transfer of agricultural technologies to farmers. However, the results according to Table 57 reveal the perception of farmers with reference to addressing question on key barriers confronted by agricultural extension agents in the delivery of extension on aspects of climate change included lack of transportation facilities for extension agents, lack of appropriate extension materials, high agricultural extension agent to farmer ratios, and inadequate funds to implement adaptation practices and making available timely inputs, support sevices and advisories. Periodic workshops and hands on training should be organised for agricultural extension agents on the use of ICT to deliver extension services, whilst encouraging the use of expert systems, mobile apps and weather advisories on agricultural recommendations for the benefit of farmers in extension delivery. These efforts should be supported by regular assessments of extension agents' capacity building needs.

It is possible to make extension services more responsive to local conditions, more accountable, more effective and more sustainable by putting responsibility in the hands of farmers to determine agricultural extension programs, they are in need. This could be the reason farmers felt the need for participatory technology development as it can integrate the effective farmer practices with the scientific practices recommended for adoption. To garner these benefits, the role of the public sector like agricultural and allied department has to be relooked to permit several approaches which account for user diversity, and to develop linkages with farmer organizations, NGOs and the private sector for service delivery.

Agriculture is a vital human effort that intrinsically depends on nature and at the same time poses a threat to it. Thus, sustainability has emerged as a necessity in future agricultural policy and practice with the paradox of profit and environmenytal goals. Hence, sustainable agriculture will need first and foremost to deliberate two inseparable, intertwined societal priorities viz., preserving the environment and providing safe and healthy food for all. In the process developing stakeholder linkages with entities involved in the food system and nature conservation becomes imminent. Here comes the significance of integrating traditional farmer's practices with modern science and technology in the field of agriculture. This could be the reason why farmers perceived that it was important to include traditional farmer practices and develop a unified mix of scientific and farmer practices in high range home gardens.

Farmers also felt the importance of inclusion of market clusters to increase profit and to reduce the risk. Primary reason could be that kerala homegardens are more marginal in nature with special reference to the area and production surplus is low that is not sufficient enough for marketing, Also high level of fragmented home garden units make it less remunerative at individual level. Hence, if home garden clusters are formed it will create a number of benefits for small producers and agribusiness firms, from agglomeration economies to joint-action benefits, such as improving access to local and global markets, promoting local governance, and scaling up and disseminating innovations. Consequently, such home garden clusters will be equipped to raise the competitive advantage of farmers and agribusiness firms as they increase their current productivity and their innovative capacity.

The study found that home gardens play a significant role in the livelihood of farm family and the portfolios of women especially due to their responsibility for family food provision and subsistence livelihoods deriving income through sale of surplus. Although Kerala home gardens are marginal or small with reference to spatial dimension, it is ever evolving and dynamic with emphasis on both gender involvement. Gender division of labour is not rigid in this realm and home garden production systems well fall within women's traditional space, unlike agricultural activities that takes place at commercial level only. Men tend to take on tasks in home gardens considered as additional "heavy" work involving more physical tasks associated with home garden establishment, while women take on the relatively "lighter" tasks related to planting, weeding, fertilizer application, inter cultural operation, harvesting at lower tier level and daily garden tending tasks. However, it is common to see women and men in client households perform tasks that are traditionally perceived as the responsibility of the opposite sex. Women believe that they do not receive as much appreciation inspite of taking additional responsibilities either in the absence of their husbands. Involving in the physical task associated with heavy work is a limiting factor and it becomes imperative to introduce innovations on home garden suited gender neutral implements and machinaries so that women could have a better role to perform in home gardens.

4.11 HYPOTHESIS OF THE STUDY

1. **There exist no particular type of crop dominance (economical and numerical) in the high range home garden**

   The crop dominance of four different high range home gardens was studied and the study revealed that each high range home gardens of different agro ecological units exhibited specific crop dominance with respect to economical and numerical dominance. There exist particular type of crop dominance in the high range home gardens. Hence the hypothesis is rejected.

2. **There exist no significant difference in the biodiversity of high range home gardens with reference to different region in the home gardens.**

The result from Table 13 showed that the highest total mean diversity was exhibited in banana-based home gardens with a mean value of 2.185 which was significantly superior to other crop-based home gardens. The pepper-based home gardens and cardamom based home gardens exhibited a total mean diversity index of 1.975 and 1.911 respectively. The lowest diversity index was recorded in cabbage-based crop gardens with a mean value of 1.034. Hence it is proved that there existed a significant difference in the biodiversity of high range home gardens with reference to different regions. Hence the hypothesis is rejected.

3. **There exist very low vertical and horizontal crop diversification in high range home gardens**

The results of vertical crop diversification in high range home gardens revealed that there existed two to four levels of vertical diversification and in case of horizontal diversification, about 75 per cent of the home gardens had more than four tier of diversification. Hence the hypothesis is rejected.

4. **There exist no significant concurrence between the technology need of the high range home garden farmers on production, protection and value addition aspects**.

Farmers were of the opinion that maximum technology needs was on production for banana (6.00, 4.91), and vegetable (4.25, 4.25) whereas protection for black pepper (5.80, 4.00) cardamom (3.25, 5.00). Black pepper and cardamom are two major high value spices but incidence of pest and diseases are the major menace for the cultivation of these crops. Therefore, farmers perceived the need for more sustainable protection technologies. Whereas, in case of vegetables and banana production aspects heavily affected the profitability hence farmers perceived the need for more sustainable and effective production technologies for remunerative and profitable agriculture. Also the study invariably proved that the technology needs of different dominant crops differed for production, protection and value addition technologies as evident from the results depicted in Table 17.

5. **There exist no preference towards a particular dimension of technology as perceived by home garden farmers, agricultural officers and scientists and the dimensions doesnot possess any association of nearness.**

The results of Table 38 revealed that all the seven dimensions namely economical, technical, environmental, socio-cultural, psychological, political and human resource dimensions showed variation in priorities between the home garden farmers, agricultural officers and scientists. A few dimensions which were of high relevance to the participating farmers were considered rather insignificant to the other category of respondents. Also, the results of the cluster analysis as shown in Table 39 and Fig 18 proves beyond doubt that the dimensions does possess an association of nearness and various subdimensions under the different dimensions has clustered together proving the interaction effect. Hence, the null hypothesis is rejected.

6. **Crowd sourcing has no significant contribution on the adoption of technology by high range home garden farmers.**

Crowd sourcing as a technique for disseminating information on technology components to the farmers of four different high range home gardens showed high level of adoption of almost all practices or activities which can be attributed to the outcome of crowdsourcing knowledge through farmer participatory approaches. Hence the null hypothesis is rejected.

7. **There exist no improvement in the BC ratio when comparing the farmer practices with that of demo plots while conducting the Front Line Demonstration of production practices in banana and cabbage dominant home gardens.**

   On comparing the BC ratio of farmer practice and demo plots, higher BC ratio was noted in demo plots compared to farmers practice. Hence the the null hypothesis is rejected.

8. **There exist no significant contribution of the characteristics of respondents (independent variable) in the extent of adoption of technology in high range home gardens.**

   It was clearly evident from fig 32, depicting the empirical model on the relationship of independent variable with the dependant variable *viz*., extent adoption four out of ten variables namely market orientation, extension contact and economic motivation were positively significant at either 1% or 5% level of significance for all the four dominant crops based home garden farming system. Hence, the null hypothesis stands rejected.

9. **There exist no difference in the gender role with reference to the extent of involvement of men and women in carrying out the different practices in the high range home gardens**

   The results from Table 52 to 55 revealed that labour intensive works such as land preparation, planting activities are done majorly by men farmers, while weeding and irrigation activities are mainly taken down by women farmers alone. Eventhough most of activities are done by both the women and men farmers, there are unique activities wherein either of the gender has more role. Hence the null hypothesis stands rejected.

SUMMARY

5. SUMMARY

The home gardens in Kerala are an integral part of the rich tradition which impart a dominant role in livelihood security of the people and also act as predominant food production system of the state with the unique structural arrangement and diversified cropping patterns. The traditional home gardens are in the menace of homogenization which creates downstream effects on the ecosystem balance. Unanticipated developments may induce a paradigm shift in the structural configuration and diversity profile of home gardens in Kerala especially in high range areas.

In this scenario, a study was conducted to identify the crop dominance cum its technology gaps through environmental scanning of the high-range home garden systems and thereafter conduct action research for assessing the technology adoption through participatory technology intervention. The study also delineated the dimensions of technologies suited for high range home gardens in order to design the technological forecast for sustainable high range home garden systems.

- The structural configuration in terms of dominance biodiversity profile of crops in high range home gardens of Idukki district was studied under two aspects *viz.*, numerical and economical dominant crops in HHGs and the diversity profile of HHGs in Kerala.

- The study revealed that in banana based HGs, out of the 25 identified crops, the most dominant one was rubber followed by banana and tapioca whereas in black pepper dominant HGs a total of 22 crops were identified of which the maximum dominance was noted with black pepper followed by rubber and taro.

- A study on cardamom dominant HGs revealed a total of 23 crops in which cardamom exhibited maximum dominance followed by black pepper whereas the in vegetable based HGs, a total of 37 crops were recorded, of which the maximum dominance was noted with cabbage.

- On comparing the diversity profile of banana based HHGs, the maximum diversity index was noted with spices followed by fruit crops and plantation crops. The lowest biodiversity index was recorded in forage crops.
- In black pepper based HHGs, the maximum diversity index was noted with spices followed by MPTS and fruit crops wherein the lowest diversity index was recorded in medicinal plants.
- In cardamom based HHGs, the maximum diversity index was noted with spices followed by fruit crops and ornamentals whereas the lowest diversity index was recorded in tubers
- The crop wise diversity index of vegetable based HHGs were studied and the results showed that the maximum diversity index was noted with vegetables followed by ornamentals and fruit crops. The lowest diversity index was recorded in tubers
- The mean diversity index of different crop based HHGs were compared and the results showed that the maximum diversity index was noted in banana based HHGs followed by pepper, cardamom and vegetable. The maximum diversity index was noted in the courtyard of banana based HHGs and the lowest DI was noted in the outer region of vegetable based home garden.
- The study identified that in banana and vegetable based HHGs, the maximum technology need was recorded with production practices whereas in cardamom and black pepper, the highest technology need was noted with protection practices.
- The distribution of respondents based on the technology needs under different attributes revealed that the highest weighted mean score for the different crop based home gardens was under the attribute *viz.*, technology not available and technology available but not applicable.

- The study on vertical diversification of crops in different crop based HHGs revealed that in banana based HGs maximum diversification was seen for banana with three levels of diversification whereas in black pepper based HGs maximum diversification was seen for black pepper and turmeric with three levels of diversification
- In cardamom based HGs the maximum diversification was seen for cardamom with four levels followed by vanilla with three levels whereas in vegetable based HGs maximum diversification was seen for cabbage, strawberry, potato and carrot with two levels of diversification
- The extent of horizontal diversification was also recorded from the HHGs and it was found that 40 % of the banana based HG'S had 5 tier diversification whereas in black pepper, 46.67 % of the home gardens had 4 tier diversification. In case of cardamom, 3 tier diversification was seen and it also note that in case of vegetable based home gardens, more than 50% of the HGs were having more than 6 tier of diversification.
- The frontline demonstration banana clearly highlights that scientific approach in farming and correct use of technology in accordance to KAU POP will help the farmer to derive more profit through improved production.
- The FLD studies on black pepper revealed that the highest percent reduction of foot rot disease over control was recorded in KAU practice as compared to farmer's practice which also highlighted the importance of adoption of scientific technologies.
- The FLD studies on cardamom revealed that the farmers practice were more effective than KAU practices in management of cardamom thrips as due to the application of new generation pesticides and higher frequency of application.

- The FLD on cabbage demonstrated that KAU POP practices was recorded with the higher yield parameters compared to farmers practices. However the yield / plot was highest in farmers field that can be substantiated by the additional plant number maintained by the farmer due to the adoption of lower spacing of 45*45cm.
- A total 7 dimensions were identified which is suitable for the high range home gardens. The economic dimensions, environmental dimensions, and psychological dimensions were the most important ones perceived by the participating farmers. Economic dimensions, psychological dimension and political dimensions were the important dimensions for the non-participating farmers. Extension personals perceived economic dimension, environmental dimension, and psychological dimension as the most important ones.
- Cluster analysis was done for the different dimensions for different categories of respondent. The cluster analysis invariably shows interaction effects of different dimensions.
- The distribution of respondents based on the extent of adoption of recommended practices, 40 % of banana farmers had high adoption of recommended practices whereas 70 % farmers of black pepper had medium level of adoption. 77.67 % of cardamom farmers had medium level of adoption and 60 % of the cabbage farmers recorded with medium level of adoption.
- This study on the gender roles in different crop-based high range home gardens revealed that in case of banana, black pepper, cardamom and vegetable-based home gardens men involved more in land preparation, planting, crop protection and harvesting operations and women were involved in weeding and value addition however in case of vegetable based home gardens women engaged in irrigation also.

- The major constraints faced by the home garden farmers were unpredictable natural calamities related crop loss, High cost of inputs, inadequate knowledge on scientific crop production.

- The major suggestions as perceived by farmers and extension personnel's for refinement of home garden farmers were, development of package of practices in tune with the home garden system, follow up and assistance by extension agencies on the adoption of recommended scientific practices, promotion of FIGs and FPO'S for post-harvest handling and marketing and inclusion of market clusters to increase profit and to reduce the risk.

The present study establishes different level of dominance and diversity profile and delineated the technology needs, technology adoption and different dimensions suited for high range home gardens. The gender roles, constraints and suggestions for promoting sustainable high range home gardens were also delineated from the high range home gardens of Kerala.

Future line of work

The present study was conducted confining to the four different dominant crop based high range home gardens in Idukki district. The same study can be extended to Wayanad which have similar climatic situations and the studies need to be focused on agro ecological units that is mutually exclusive from that of Idukki district. Similar studies can be taken up in home gardens in unique agro eco systems such as coastal home gardens, Kole home gardens, home gardens in problem areas like Kuttanad and land lying below mean sea level. Action research should be initiated in similar line with emphasize on agro ecological units, which will have unique type of cropping system. Studies on technology needs for different components in home gardens such as integrated farming systems needs to be taken up. Focus also can be given to studies related to specialized home gardens. Also, studies on systematic integration of horizontal and vertical diversification in home gardens should be initiated.

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PARTICIPATORY TECHNOLOGY INTERVENTION AND ITS ASSESSMENT THROUGH ENVIRONMENTAL SCANNING OF HIGH RANGE HOME GARDENS IN IDUKKI DISTRICT: AN ACTION RESEARCH

by

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Abstract of the thesis

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ABSTRACT

The study on “Participatory technology intervention and its assessment through environmental scanning of high range home gardens in Idukki district: Action research” was conducted during 2017 to 2020 with the objectives to identify the crop dominance cum its technology gaps through environmental scanning of the high-range home garden systems and thereafter conduct action research for assessing the technology adoption through participatory technology intervention.

Kerala is often consecrated as the 'Mecca of home gardens', owing to its rich species diversity, sustainability, ethnic values and as a means of livelihood. It contributes to the food, nutritional, economic needs and biodiversity security of the state fulfilling the different pillars of socio-economic and environmental stability in almost 70 lakhs home gardens in the state.

In this study, Idukki district was selected with the intention to identify the variability in the structure and cropping pattern of the home garden systems of the high range areas. The numerical and economical dominance of crops were worked out in different crop based high range home gardens on a seven-point continuum and the results revealed that banana, black pepper, cardamom and cabbage were the most dominant crops in the high range home gardens. However, there were 25 crops in banana-based, 22 crops in black pepper-based, 23 crops in cardamom based and 37 crops in vegetable-based home gardens.

An exploration on the diversity profile of high range home gardens under four agro ecological unit of Idukki revealed that significant variability existed in the crop diversity in high range home gardens. The diversity for the four major crop based home gardens viz., ‘banana, black pepper, cardamom and vegetables’ based home garden was calculated using Shannon-Weiner index of diversity and the highest total mean diversity index (2.185) was recorded in banana-based home gardens whereas the lowest diversity index was noted in vegetable-based home gardens (1.034).

On enumerating the crop wise diversity index for different crop based high range home garden system, maximum biodiversity was observed for spices (1.425, 1.548 and 1.274) respectively in banana based, black pepper based and cardamom based high range home gardens. However, in vegetables-based home gardens maximum biodiversity (1.252) was observed for vegetables. The lowest biodiversity index was recorded in forage crops (0.054) for banana based high range home gardens, medicinal plants (0.417) in pepper-based home gardens, tubers (0.282, 0.019) respectively in cardamom and vegetables based high range home gardens.

On comparing the region wise diversity index, it was observed that the courtyard had maximum biodiversity (2.596, 2.455, 2.312 and 1.189) respectively in all the four dominant crop based high range home gardens. However, the diversity index for banana and vegetable based high range home gardens did not vary much for courtyard and mid-region biodiversity.

The technology need assessment for top seven dominant crops was done and the results revealed that production technology was the most needed compared to protection and value addition technology in banana and vegetables based high range home gardens. However, in black pepper and cardamom based high range home gardens, protection technology was the most needed compared to production and value addition.

On assessing the perception of farmers for the technology needs of different crops under the four attributes viz., technology not available; technology available but not applicable; technology available, applicable but not sustainable; and technology available, applicable but sustainable, it was noted that highest weighted mean score was observed for the attributes viz., technology not available and technology available but not applicable for both production and protection technologies. The practice wise technology needs studies also reconfirmed the above findings with maximum technology need reported for nutrient management (5.50, and 5.00) in the case of banana and vegetables-based home gardens respectively, whereas for black pepper-based home gardens, maximum technology need was reported for foot rot disease (5.30). In the case of cardamom-based home gardens, maximum technology need was reported for cardamom thrips (4.40).

Maximum of three levels of vertical diversification was observed in banana itself in banana-based home gardens, whereas in black pepper based home gardens maximum diversification was noted for black pepper and turmeric with three levels of vertical diversification. In cardamom-based home gardens, maximum vertical diversification was recorded in cardamom with four levels of diversification whereas in vegetable based home garden maximum diversification was noted in cabbage, strawberry, potato and carrot with two levels of vertical diversification.

The study on the extent of horizontal diversification revealed that about 40 per cent of the banana-based home gardens exhibited 5-tier horizontal diversifications. About 46.67 per cent of black pepper dominant home gardens showed 4-tier of horizontal diversification whereas cardamom based home gardens exhibited 3-tier diversification. In case of vegetable based home gardens, more than 50 per cent of the home gardens exhibited more than 6-tier of diversification. About 75 per cent of the home gardens were comprised under the category of 4, 5 or 6 tier horizontal diversification.

Based upon the technology needs of the dominant crops in different cropbased home gardens, frontline demonstrations were conducted in four home gardens on production aspects of banana and cabbage, and protection aspects for black pepper and cardamom. The study clearly highlights that adoption of scientific approach in banana cultivation and correct use of technology in accordance to KAU POP will help the farmer to derive more profit (BC ratio2.06) through improved production and also will enable the farmers to learn the skill of judicious use of fertilizers and pesticides. The adoption of scientific plant protection operations in black pepper also aids the farmers to counteract the impact of foot rot disease. However, in cardamom, farmers practice was more effective and it may be due to the usage of new generation insecticides and the frequent application of pesticides. The lower efficacy exhibited by KAU practice may owe the factors viz., development of resistance to quinalphos and also due to longer application intervals. The adoption of KAU POP practices increased the yield in cabbage compared to farmer practices, but the yield / plot was highest in farmers field as compared to KAU practice that can be substantiated by the additional plant number maintained by the farmer due to the adoption of lower spacing.

The crowdsourcing of knowledge was done in four stages for different crops like banana, black pepper, cardamom and cabbage dominant home garden systems. The results on the checklist monitored by the lead farmer through crowd sourcing and percentage adoption of production activities of banana revealed that 86.30 per cent of the farmers fully adopted the technology. The high adoption of almost all practices or activities can be attributed to the outcome of crowdsourcing knowledge through farmer participatory approaches. The crowd sourcing studies on management practices of foot rot disease of black pepper revealed that more than 70 per cent of the farmers fully adopted the technology. The drenching of potassium phosophonate 3ml per litre @ 5-10 litres per vine was the most adopted practice (93.33 %) in black pepper based high range home gardens of Idukki district. In case of management practices of thrips in cardamom, the results showed that 70 per cent of the farmers fully adopted the recommended practices. However, it was interesting to note that farmers used different type of new generation pesticides, despite of its higher cost for the management of thrips to get high returns for the produce. In vegetable-based home gardens, the study revealed that 71.11 per cent of the farmers fully adopted the recommended practices. It was also noted that among the nine prescribed cultural operations 100 per cent of the farmers practiced earthing up operations, and 86.67 per cent of the farmers fully adopted the techniques of split dose application of fertilizers in right quantity and spraying of Pseudomonas.

A total of seven technological dimensions were identified as suitable for the high range home gardens. The economical (7.79), environmental (7.87) and psychological (7.80), dimensions were the most important ones perceived by the participating farmers whereas economical (7.27), psychological (7.45), and political (7.40) dimensions were the important dimensions as perceived by the non-participating farmers. In case of extension personnel's, economical (7.18), environmental (7.14), and psychological (6.76) dimension were perceived as the most important ones. The results of the cluster analysis revealed that the different clustering of sub dimensions of different major dimensions invariably shows the interaction effect.

The study on distribution of respondents based on the extent of adoption of recommended practices revealed that about 40 per cent of banana farmers showed higher adoption rate of recommended practices whereas 70 per cent farmers of black pepper showed medium level of adoption. About 77.67 per cent and 60 per cent of cardamom farmers and cabbage growing farmers exhibited medium level of adoption.

The relationship between ten independent variables with the dependent variable extent of adoption was worked out for the four major crop based high range home garden systems. It was found that in case of banana growing farmers five out of ten independent variable were positively and significantly correlating with the extent of adoption, wherein innovativeness (0.598), irrigation potential (0.665) and economic motivation (0.707) were significant at 1 per cent level of significance and market orientation (0.431) and extension contact (0.369) was significant at 5 per cent level of significance. In case of black pepper growing farmers four out of the ten independent variables were positively and significantly correlating with the dependent variable, wherein market orientation (0.541), extension contact (0.464), irrigation potential (0.607) and economic motivation (0.825) were significant at 1 per cent level of significance. Among the cardamom growing farmers it was found that five independent variables were found to be positively and significantly correlated with the extent of adoption, where market orientation (0.817), extension contact (0.834), innovativeness (0.727), irrigation potential (0.617 and economic motivation (0.533) were significant at 1 per cent level of significance. In case of the vegetable growing farmers, it was found that five out of the ten independent variables were positively and significantly correlated with the extent of adoption, wherein land area (0.521), market orientation (0.659), extension contact (0.579) and economic motivation (0.704) were significant at 1 per cent level of significance and annual income (0.381) was significant at 5 per cent level of significance.

This study on the gender roles in different crop-based high range home gardens revealed that in case of banana, black pepper, cardamom and vegetablebased home gardens men involved more in land preparation, planting, crop protection and harvesting operations and women were involved in weeding and value addition however in case of vegetable based home gardens women engaged in irrigation also.

The constraints delineated were, unpredictable natural calamities related crop loss (365) followed by extortionate cost of inputs (352), inadequate knowledge on scientific crop production (347) and lack of extension services (337) in the decreasing order of importance.

The major suggestions as perceived by extension personnel's for refinement of home garden farmers were, development of package of practices in tune with the home garden system (94.16%) and follow up and assistance by extension agencies on the adoption of recommended scientific practices (92.50%), promotion of FIGs and FPO'S for post-harvest handling and marketing (96.00%) and inclusion of market clusters to increase profit and to reduce the risk (92.50%).

To conclude, the study establishes different level of dominance and diversity profile and delineated the technology needs, technology adoption and different dimensions suited for high range home gardens. The extent of horizontal and vertical diversification, the extent of adoption of technologies through crowd sourcing and the relationship of independent variables with extent of adoption was determined. The gender roles, constraints and suggestions for promoting sustainable high range home gardens were delineated.

സംഗ്രഹം

ഇടുക്കി ജില്ലയിലെ ഹൈറേഞ്ച്മേഖലയിലെ വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങളുടെ സൂക്ഷ്മ നീരീക്ഷണത്തെ ആസ്പദമാക്കി പങ്കാളിത്ത സാങ്കേതിക ഇടപെടലും അവയുടെ വിലയിരുത്തലും എന്ന വിഷയത്തിൽ 2017-2021 കാലത്തിൽ നടന്ന പഠനത്തിൻറ്റെ പ്രധാന ലക്ഷ്യങ്ങൾ ഓരോ പാരിസ്ഥിക മേഖലയിലെയും പ്രബല വിളയെ കണ്ടെത്തി അവയുടെ ലഭ്യമായ സാങ്കേതിക വിദ്യയിലുള്ള ന്യൂനത മനസിലാക്കുകയും അതനുസരിച്ചുള്ള പങ്കാളിത്ത സാങ്കേതിക ഇടപെടലുകൾ നടത്തുകയുമായിരുന്നു.

വീട്ടുവളപ്പിലെ കൃഷിക്ക് വളരെയധികം പ്രാധാന്യമുള്ള സംസ്ഥാനമാണ് കേരളം. കേരളത്തിൽ കാലാവസ്ഥപരമായും ഭൂപ്രകൃതിപരമായും വളരെ അധികം വ്യത്യസ്തത പുലർത്തുന്ന ജില്ലയായതിനാലാണ് പ്രസ്തുത പഠനത്തിനായി ഇടുക്കി ജില്ലയിലെ ഹൈറേഞ്ച് ഭാഗത്തുള്ള വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങൾ തെരെഞ്ഞെടുത്തത്.

ഹൈറേഞ്ച് മേഖലയിലെ വിളകളുടെ സാമ്പത്തിക പ്രാധാന്യവും സംഖ്യാപരമായ പ്രാധാന്യവും ആസ്പദമാക്കിയുള്ള പഠനത്തിൽ നിന്ന് വാഴ, കുരുമുളക്, ഏലം, കാബ്ബേജ് എന്നിവ പ്രധാന വിളകളായി തിരിച്ചറിഞ്ഞു.

ഹൈറേഞ്ച് മേഖലയിലെ വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങളിലെ വിള വൈവിധ്യം ഷാനോൺ - വീനർ വിള വൈവിധ്യ സൂചികയിലുടെ കണ്ടെത്തി താരതമ്യ പെടുത്തിയതിൽ നിന്ന് ഏറ്റവും ഉയർന്ന ശരാശരി വാഴ പ്രധാന വിളയായ കൃഷിയിടങ്ങളിൽ (2.185) നിന്നും ഏറ്റവും കുറഞ്ഞത് പച്ചക്കറിയധിഷ്ഠിത കൃഷിയിടങ്ങളിൽ (1.034) നിന്നും രേഖപ്പെടുത്തി.

വാഴ, കുരുമുളക്, ഏലം എന്നീ വിളകളുടെ വിള വൈവിധ്യം നിരീക്ഷിച്ചതിൽ നിന്നും സുഗന്ധ വിളകളിലാണ് ഏറ്റവുമധികം വൈവിധ്യം രേഖപ്പെടുത്തിയത്. എന്നാൽ പച്ചക്കറിയധിഷ്ഠിത കൃഷിയിടങ്ങളിൽ പച്ചക്കറി വിളകളിലാണ് (1.252) കൂടുതൽ വൈവിധ്യം കണ്ടെത്തിയത്. വാഴയടിസ്ഥിത കൃഷിയിടങ്ങളിൽ തീറ്റപുല്ലിനങ്ങളും (0.054) കുരുമുളകാടിസ്ഥനമാക്കിയുള്ള കൃഷിയിടങ്ങളിൽ ഔഷധ സസ്യങ്ങളും (0.417) ഏലം, പച്ചക്കറിയടിസ്ഥിത കൃഷിയിടങ്ങളിൽ കിഴങ്ങു വർഗ്ഗ വിളകളും (0.282, 0.019) ഏറ്റവും കുറവ് വൈവിധ്യം രേഖപ്പെടുത്തി. വീടിനോടു അനുബന്ധിച്ച സ്ഥലങ്ങളെ പല മേഖലകളായി തിരിച്ചു വിള വൈവിധ്യം പരിശോധിച്ചതിൽ നിന്നും വീടിനോടു ചേർന്ന് കിടക്കുന്ന ഭാഗങ്ങളിൽ ഏറ്റവുമധികം വൈവിധ്യം രേഖപ്പെടുത്തി.

ലഭ്യമായ സാങ്കേതിക വിദ്യയുടെ ന്യൂനതകൾ മനസിലാക്കാനുള്ള പഠനത്തിൽ നിന്ന് വാഴ, പച്ചക്കറി എന്നീ വിളകളിൽ ഉല്പാദനവുമായി ബന്ധപ്പെട്ട സാങ്കേതിക വിദ്യയുടെ ആവശ്യകത കൂടുതലാണെന്നു മനസ്സിലാക്കാൻ കഴിഞ്ഞു. എന്നാൽ കുരുമുളക്, ഏലം എന്നീ വിളകളിൽ വിള സംരക്ഷണവുമായി ബന്ധപ്പെട്ട സാങ്കേതിക വിദ്യയാണ് കൂടുതൽ ആവശ്യമായി കണ്ടെത്തിയത്.

സാങ്കേതിക വിദ്യയുടെ ആവശ്യകത മനസിലാക്കുന്നതിനായി കർഷകരുടെ അഭിപ്രായ രൂപീകരണം നടത്തുകയും അതിൽ നിന്ന് വാഴ (5.50), പച്ചക്കറി (5.00) എന്നീ വിളകളിൽ വിളപരിപാലന രീതികളും കുരുമുളകിന് ദ്രുതവാട്ടവും (5.30) ഏലത്തിനു ഇലപ്പേനുകളുടെ നിയന്ത്രണവുമായും (4.40) ബന്ധപ്പെട്ട സാങ്കേതിക വിദ്യയാണ് ആവശ്യം എന്ന് മനസിലാക്കി.

ലംബരീതിയിലുള്ള വിളവൈവിധ്യം പരിശോധിച്ചതിൽ നിന്ന് വാഴയടിസ്ഥാന കൃഷിയിടങ്ങളിൽ ഏറ്റവുമധികം വൈവിധ്യം വാഴയ്ക്കും കുരുമുളകടിസ്ഥിത കൃഷി ഇടങ്ങളിൽ കുരുമുളക്, മഞ്ഞൾ എന്നീ വിളകൾക്കും രേഖപ്പെടുത്തി. ഏലം പ്രധാന വിളയായ വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങളിൽ നാലു തലത്തിലുള്ള വൈവിധ്യവും പച്ചക്കറിയധിഷ്ഠിത കൃഷിയിടങ്ങളിൽ രണ്ടു തലത്തിലുള്ള ലംബവൈവിധ്യവും കണ്ടെത്തി.

തിരശ്ചീന രീതിയുള്ള വിളവൈവിധ്യം പഠിച്ചതിൽ നിന്ന് 40% വാഴയടിസ്ഥിത കൃഷിയിടങ്ങൾ അഞ്ചു തലത്തിലും 46.67% കുരുമുളക് അടിസ്ഥിത കൃഷിയിടങ്ങൾ നാലു തലത്തിലും 50% ഏലം അധിഷ്ഠിത കൃഷിയിടങ്ങൾ മൂന്ന് തലത്തിലും 75% പച്ചക്കറിയടിസ്ഥിത കൃഷിയിടങ്ങൾ ആറു തലത്തിലുമുള്ള വൈവിധ്യം കണ്ടെത്തി.

ഓരോ വിളകളുടെയും സാങ്കേതിക വിദ്യയിലുള്ള ആവശ്യകത മനസിലാക്കി കർഷക പങ്കാളിത്തത്തോടെ മുൻനിര പ്രദർശന തോട്ടങ്ങൾ വാഴ, പച്ചക്കറി എന്നിവയ്ക്കു വളപ്രയോഗ രീതിയിലും കുരുമുളകിന് ദ്രുതവാട്ട നിയന്ത്രണം, ഏലത്തിനു ഇല പേൻ നിയന്ത്രണം എന്നിവയിൽ നടത്തി. കാർഷിക സർവ്വകലാശാലയുടെ ശുപാർശക്കനുസരിച്ചു വാഴയിൽ വളപ്രയോഗം നടത്തുക വഴി ഉയർന്ന വിളവും ലാഭവും കർഷകന് ലഭിക്കുകയുണ്ടായി. ഇതിൽ നിന്നും ശാസ്ത്രീയ വളപ്രയോഗ രീതികളും നൂതന വിള പരിപാലന മാർഗ്ഗങ്ങളും മനസിലാക്കാനും പ്രാവർത്തികമാക്കാനും കർഷകർക്ക് കഴിഞ്ഞു

കാർഷിക സർവകലാശാലയുടെ ദ്രുതവാട്ടത്തിനെതിരായ വിള സംരക്ഷണ മാർഗ്ഗങ്ങൾ സ്വീകരിക്കുക വഴി കുരുമുളക് കൃഷിയിലെ ദ്രുതവാട്ടം നിയന്ത്രിക്കാൻ ഒരു പരിധി വരെ കഴിയുകയും ഇത്നിന്റെ പ്രാധാന്യം കർഷകർ മനസിലാക്കുകയും ചെയ്തു.

ഏലത്തിലെ ഇല പേൻ നിയന്തിക്കുന്നതിൽ കർഷകർ നടപ്പാക്കുന്ന സംരക്ഷണ മാർഗ്ഗങ്ങൾ കാർഷിക സർവകലാശാലയുടെ നിർദേശങ്ങളെക്കാൾ മികച്ച ഫലം തന്നു. എന്നാൽ അനിയന്ത്രിതമായി കൂടുതൽ ഇടവേളകളിൽ കീടനാശിനികൾ ഉപയോഗിക്കുന്നത് ദൂരവ്യാപകമായ പ്രത്യാഘാതങ്ങൾക് കാരണമാകും. കാർഷിക സർവകലാശാലയുടെ ശുപാർശ അനുസരിച്ചുള്ള കീടനാശിനി തുടർച്ചയായി ഉപയോഗിച്ചതിനാൽ അവക്കെതിരെ കീടങ്ങൾ പ്രതിരോധ ശേഷി ആർജിച്ചതോ അതെല്ലങ്കിൽ നൂതന കീടനാശിനികളുടെ അമിതമായ അളവിലുള്ള ഉപയോഗമോ മൂലമാകാം ഈ വ്യത്യസം കണ്ടത്.

കാർഷിക സർവകലാശാല നിർദേശമനുസരിച്ചുള്ള വിള സംരക്ഷണ മാർഗ്ഗങ്ങൾ സ്വീകരിക്കുക വഴി കാബേജ് കൃഷിയിൽ കൂടുതൽ വിളവ് ലഭിക്കുന്നതായി കർഷകർ മനസിലാക്കി. എന്നാൽ വിളകളുടെ ഇടയകലം കുറച്ചതിനാൽ കൂടുതൽ എണ്ണം ചെടികൾ നടാൻ കർഷകരുടെ തോട്ടങ്ങളിൽ സാധിച്ചതിനാൽ വിളവ്/ തോട്ടം കൂടുതലായിരുന്നു.

ക്രൗഡ് സോഴ്സിങ് സാങ്കേതിക വിദ്യയുപയോഗിച്ചു നാലു വിളകളുടെയും വിവിധ ഘട്ടങ്ങളിൽ നടത്തിയ പഠനങ്ങളിൽ നിന്ന് 86.30 ശതമാനം കർഷകർ വാഴക്കൃഷിയിലെ സാങ്കേതിക വിദ്യകൾ പൂർണമായും പ്രവർത്തികമാക്കിയെന്നും 70 ശതമാനം കർഷകർ കുരുമുളകിലെ ദ്രുതവാട്ട നിയന്ത്രണ സാങ്കേതിക വിദ്യകൾ സ്വീകരിച്ചുവെന്നും മനസിലാക്കി. ഏലത്തിലെ ഇലപ്പേൻ നിയന്ത്രണ മാർഗ്ഗങ്ങൾ 70 ശതമാനം കർഷകർ പൂർണമായും പ്രാവർത്തികമാക്കി. ഉയർന്ന വില ലഭിക്കുന്ന വിളയായതിനാൽ കർഷകര് ഉയർന്ന വിലക്കുള്ള നൂതന കീടനാശിനികൾ ഉപയോഗിക്കുന്നതായി രേഖപ്പെടുത്തി. കാബേജിലെ . വിളപരിപാലന മാർഗ്ഗങ്ങൾ ഏകദേശം 71 ശതമാനത്തോളം കർഷകർ പ്രാവർത്തികമാക്കി.

ഹൈറേഞ്ചിലെ വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങൾക്കായി ഏകദേശം ഏഴ് സാങ്കേതിക സൂചകങ്ങൾ വഴി വിവര ക്രോഡീകരണം നടത്തിയതിൽ നിന്ന് പഠനത്തിൽ പങ്കെടുത്ത കർഷകർ സാമ്പത്തിക ഘടകങ്ങൾക് കൂടുതൽ പ്രാധാന്യം നൽകിയപ്പോൾ പഠനത്തിൽ പങ്കെടുക്കാത്ത കർഷകര് സാമ്പത്തിക, പാരിസ്ഥിക, രാഷ്ട്രീയപരമായ ഘടകങ്ങൾക്ക് പ്രാധാന്യം നൽകി.

സാങ്കേതിക വിദ്യകൾ സ്വീകരിച്ചതിന്റെ പരിധി പഠനവിധേയമാക്കിയതിൽ നിന്ന് 40% വാഴ കർഷകർ ഉയർന്ന തലത്തിലുള്ള സ്വീകരണവും 70 % കുരുമുളക് കർഷകർ, 77.67% ഏലം കർഷകരും, 60% കാബേജ് കർഷകരും മധ്യമ തലത്തിലുള്ള സ്വീകരണവും രേഖപെടുത്തി. സാങ്കേതിക വിദ്യകൾ സ്വീകരിക്കുന്നത് സംബന്ധിച്ചുള്ള പഠനത്തിൽ നിന്ന് വാഴ കർഷകർ പുതിയ കൃഷി രീതികളോടും ജലസേചന സൗകര്യങ്ങളോടും സാമ്പത്തിക

ലാഭങ്ങളോടും വ്യക്തമായ സ്വീകാര്യത കാണിക്കുന്നുവെന്നും കുരുമുളക് കർഷകർ മാർക്കറ്റ് ഓറിയന്റഷന്, വിജ്ഞ്ജാന വ്യാപന ഇടപെടലുകളോടും ജലസേചന മാർഗ്ഗങ്ങളും സാമ്പത്തിക ലാഭങ്ങളോടും കൂടുതൽ സ്വീകാര്യത കാണിക്കുമ്പോൾ ഏലം കർഷകർ ഇവ കൂടാതെ നൂതന കൃഷി രീതികളോടും ആഭിമുഖ്യം കാണിക്കുന്നു. എന്നാൽ കാബ്ബജ് കർഷകർ ഭൂവിസ്തൃതിയോടും സാമ്പത്തിക ലാഭത്തോടും വിജ്ഞാന വ്യാപനത്തോടും കൂടുതൽ ആഭിമുഖ്യം കാണിക്കുന്നു.

വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങളിലെ വിവിധ ജോലികളിൽ സ്ത്രീ- പുരുഷ പ്രാധിനിത്യം പഠിച്ചതിൽ നിന്ന് പുരുഷന്മാർ നിലമൊരുക്കൽ, നടീൽ, വിള സംരക്ഷണം, വിളവെടുപ്പ് എന്നെ ജോലികളിലും സ്ത്രീകൾ കളപറിക്കൽ, മൂല്യവർധനം, എന്നിവയിലും കൂടുതൽ ശ്രദ്ധ കേന്ദ്രീകരിക്കുന്നതായി കണ്ടെത്തി.

ഹൈറേഞ്ച് മേഖലയിലെ വീട്ടുവളപ്പിലെ കൃഷിയിടങ്ങൾ നേരിടുന്ന പ്രധാന പ്രശ്നങ്ങൾ പ്രവചനാതീതമായ പ്രകൃതി ദുരന്തങ്ങൾ മൂലമുള്ള കൃഷി നാശം (365), കൃഷിക്ക് ആവശ്യമുള്ള സാധനങ്ങളുടെ ഉയർന്ന വില (352), ശാസ്ത്രീയ വില പരിപാലന മാർഗ്ഗങ്ങളിൽ അജ്ഞത (347), വിജ്ഞാന വ്യാപന ഇടപെടലുടെ അപര്യപ്തത (337), എന്നിവയാണ് പ്രസ്തുത പഠനം രേഖപ്പെടുത്തിയത്.

ഹൈറേഞ്ച് മേഖലക്ക് അനുയോജ്യമായ തരത്തിലുള കൃഷി പരിപാലന രീതികൾ വികസിപ്പിക്കുക (94.16%), ശാസ്ത്രീയമായ കൃഷിരീതികൾ വിജ്ഞാന വ്യാപന മേഖലയുടെ പിന്തുണയോടെ നടപ്പിലാക്കുക (92.50%), മൂല്യ വർധിത ഉത്പന്നങ്ങളുടെ വികസനത്തിനും വില്പനക്കുമായി FIG'S, FPO'S എന്നിവയെ ശക്തിപ്പെടുത്തുക (96.00%), വിപണന കൂട്ടയ്മകൾ സംഘടിപ്പിക്കുക (92.50%) എന്നിവയാണ് പഠനം മുന്നോട്ടു വയ്ക്കുന്ന പരിഹാര നിർദേശങ്ങൾ.

APEENDICES

APPENDIX I

KERALA AGRICULTURAL UNIVERSITY

College of Agriculture, Vellayani, Thiruvananthapuram, 695522

Department of Agricultural Extension

Dr. Allan Thomas Date:15-10 2019

Associate Professor

Chairman, Advisory Committee

Greetings

Sir/Madam

Sri. Nithish Babu M (Ad. No. 201721-008) one of my Ph. D Scholar, Department of Agricultural Extension, College of Agriculture, Vellayani is undertaking a research study entitled " Participatory Technology intervention and its assessment through environmental scanning of highrange home gardens : An action research" as part of his PhD research work.

After extensive review of the available literature and discussion with extension Scientists and other experts, variables supposed to have close association with the study have been identified.

Considering your vast experience and professional expertise you have been selected as a judge to rate the relevancy of the variables. I request you to kindly spare some of your valuable time for examining the questionnaire critically. Kindly return the list duly filled at the earliest.

Thanking you

Yours sincerely

(Allan Thomas)

Please rate the independent variables to be included in the study based on the relevancy from the most relevant to the least relevant by ticking against each variable under the respective rating scale

Sl No	Independent variables	Relevancy rating (R-Relevant)				
		Most R	More R	R	Less R	Least R
1.	**Age:** total number of years completed by the homegarden respondent during the interview period					
2.	**Education:** degree of acceptance of formal or non-formal learning process by the respondents					
3.	**Family Size:** number of members living in a household / family dependent on the head of the family					
4.	**Occupation:** the main vocation and any other subsidiary vocation that the respondent possessing at the time of interview					
5.	**Land Area:** the total area undertaken for farming activities in a homegarden					
6	**Annual income:** the total earnings obtained by the homegarden farmers from the off farm and on farm activities					
7.	**Homegarden farming experience**: total years of experience in farming					
8.	**Availability of inputs:** the extent of availability of inputs that are suitable for homegardens					
9.	**Labour Utilization :** utilization of family labour and hired labour for homegarden activities					

10.	**Mass media participation:** degree of exposure to different mass media sources by the homegarden farmers to gather information on farming activities					
11.	**Risk orientation:** degree of risk involved in the incorporation of different components in the homegarden					
12.	**Market orientation:** the extent to which the homegarden respondents are oriented towards scientific farm management practices					
13.	**Extension orientation:** the extent of contact a homegarden respondent had with various extension personals and agencies and his participation in different programmes conducted by the agencies					
14.	**Extension contribution:** the extent of contribution of technology for the homegardens as perceived by the farmer					
15.	**Credit utilization:** extent of credit and availability of credit and the repayment is operationalized in terms of credit utilization					
16.	**Innovativeness:** relative earlinessin the adoption of modern technology by the homegarden farmers					
17.	**Knowledge:** on scientific practices in homegarden farming					
18.	**Irrigation potential:** the extent of availability of irrigation water for the home garden to be irrigated during a complete year					
19.	**Economic motivation:** drive of homegarden respondents towards the benefit and economic matters					
20.	**Rational orientation:** the degree of rationality and scientific belief of home garden farmers towards scientific orientation					
21.	**Livestock possession :** the number of livestock that the respondent possessed at the time of interview					

22.	**Credit availability:** the extent of availability of loans from banks and other agencies					
23.	**Family labour utilization:** the extent of availability of family members for homegarden activities					
24.	**Others if any**					

APPENDIX II

The variables with their mean relevancy score

SL No	Independent Variables	Mean relevancy score
1.	Age	**4.35**
2.	Education	**3.65**
3.	Family size	1.95
4.	Occupation	2.85
5.	Land area	**4.05**
6.	Annual income	**4.50**
7.	Home garden farming experience	3.05
8.	Availability of inputs	3.15
9.	Labour utilization	2.15
10.	Mass media participation	2.95
11.	Risk orientation	1.75
12.	Market orientation	**4.15**
13.	Extension orientation	**3.70**
14.	Extension contribution	2.65
15.	Credit utilization	1.85
16.	Innovativeness	**4.40**
17.	Knowledge	2.95
18.	Irrigation potential	**4.75**
19.	Economic motivation	**4.75**
20.	Rational orientation	**3.95**
21.	Livestock possession	1.85
22.	Credit availability	2.85
23.	Family labour utilization	2.25

APPENDIX III

Technology Assessment in the Homegarden Systems

Interview Schedule

Code: Mobile no Date:

1. Family structure and characteristics:

Sl. No	Name	R/n with head	Sex	Age	Caste	Education
1.	Head:					

2. Total area of homegarden (in ha):

a) Type: Irrigated/ Rainfed/ Gardenland

b) Topography: Level/ Undulating/Gentle slop/Steep

3. ANNUAL INCOME

a) Agriculture alone

4. MARKET ORIENTATION

Whether the respondent agree with the following statements?

Sl.No	Statements	A	DA
1	Market is not useful to a farmer		
2	A farmer get good price by elimination of middle man from market channel		
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		

5. EXTENSION ORIENTATION

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)			

6. 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

9. 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…………………………….

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 practiced?

How efficient it is? (Very efficient/ Moderately efficient/ less efficient)

10. INNOVATIVENESS

a) Have you ever cultivated high yielding varieties of any crop? Yes/No

b) Do you regularly collect information regarding new agricultural technologies or practices from krishibhavan/ universities/ other information sources? Yes/No

c) Do you practice the received information as soon as you receive it? Yes/ No

d) Do you practice any improved recommendation after getting necessary information without any delay? Yes/No

11. ECONOMIC MOTIVATION

a) Are u agreeing or disagreeing with the following statements

	Statements	Agree	Disagree
1	A farmer should do farming for more production and profit		
2	A farmer become successful when he/she gets more profit		
3	An innovative idea which brings more profit should be adopted		
4	Cash crops should be preferred by the farmer who aims at profit making than preferring food crops		
5	A farmer should earn for living but should never connect finance with life's important matter		
6	Without a financial support from the head of the farm family, his children will find it difficult to move ahead		

12. GENDER ROLES

*****Additional operations depending upon the crop

Particulars	Men	Women	Both
Land preparation			
Planting material preparation			
Planting			
Irrigation			
Fertilizer application			
Inter cropping			
Weeding			
Crop protection activities			
Harvesting operations			
Value addition of products			
*			

13. CONSTRAINTS EXPERIENCED BY THE HOMEGARDEN FARMERS

Sl. No	Constraints	Score	Rank
1	Extortionate cost of inputs		
2	Scarcity of labours		
3	High labour cost		
4	Price fluctuation		
5	Inadequate knowledge Scarcity of labours on scientific crop production		
6	Poor knowledge on diagnosis of pest and disease		
	*Add if any		

14. SUGGESTIONS FOR REFINEMENT AS PERCIEVED BY HOMEGARDEN FARMERS

Sl. No	**Suggestion**
1.	Development of package of practices in tune with the home garden system
2.	Follow up and assistance by extension agencies on the adoption of recommended scientific practices
3.	Participatory technology development between the extension unit and the farmers.
4.	Inclusion of traditional farmer practices and developing a unified mix of scientific and farmer practices.
	*Add if any

15. DIVERSITRY PROFILE OF HIGHRANGE HOMEGARDENS

No	Crops	CY/ BY	MR	OR

*CY-courtyard, BY-Backyard, MR-Mid Region , OR- Outer region

APPENDIX IV

KERALA AGRICULTURAL UNIVERSITY

College of Agriculture, Vellayani, Thiruvananthapuram, 695522

Department of Agricultural Extension

Dr. Allan Thomas Date:15-10 2019

Assistant Professor and Chairman

Greetings

Sir/Madam

Sri. Nithish Babu M (Ad. No. 201721-008) one of my Ph. D. Scholar, Department of Agricultural Extension , College of Agriculture , Vellayani is undertaking a research study entitled “ Participatory Technology intervention and its assessment through environmental scanning of highrange home gardens : An action research” as part of his PhD research work.

For the above said study, we need to develop an index “Dimension of technology that is suitable for highrange homegardens”, in this connection, he has constructed relevant dimensions which needs to be judged for further improvement.

Considering your vast experience and professional expertise you have been selected as a judge to rate the relevancy of the dimensions. I request you to kindly spare some of your valuable time for examining the dimensions critically. Kindly return the list duly filled at the earliest.

Thanking you

Yours sincerely

(Allan Thomas)

Dimensions of Technology Suited for High Range Home Gardens

These are some of the dimensions identified through literature search and discussion with subject matter specialists pertaining to technology for high range homegardens so as to identify those dimensions that are perceived by farmers to be important for remunerative and sustainable high range homegardens. The items for judgment are placed in a 9-point continuum ranging from 'No relevance' to 'Maximum relevance'. Please indicate your responses to express your judgment on the level of relevance of each dimensions, from the farmers' point of view. You are welcome to suggest new dimensions and rate its relevancy too, if any. Please don't leave any dimensions unrated. If any dimension is seemed to be irrelevant, please give the lowest score.

Dimensions	9	8	7	6	5	4	3	2	1
Economic dimension									
1. **Initial cost**- expenditure incurred by the home garden farmer for the availing the technology at the beginning.									
2. **Income generation potential-** ability of a technology to generate additional income in the home gardens under the existing conditions									
3. **Commercialization-** adoption of the technology has the potential to deepen the market share of agricultural output									
4. **Regularity of returns**- capability of a technology to generate returns on a regular basis in the home gardens									
5. **Rapidity of returns**- temporal ability of technology to ensure immediate or quick returns to the home garden farmer									
6. **Market integration**- adoption of technology have positive impact on farmers integration into output market									
7. **Land-saving technologies**- farmers with small land may adopt such technology to increase production overcoming the constraints of land availability									

8. **Availability of credit-** adequate and timely availability of credit for making available the technology and its use									
9. **Accessibility of credit-** adequate and timely access to credit for making available the technology for use									
10. **Break even-** the moment an investment on technology will start generating a positive returns									
11. **Margin of safety-** profit from post breakeven point of an investment till a point where there is continuing profit from home gardens as a result of using that technology									
12. **Supply chain-** a network between a high range home garden and its technology to produce and distribute a specific product to the final buyer									
Technical Dimensions									
13. **Compatibility-** degree to which technology is perceived as consistent with the need of the high range home garden farmer									
14. **Efficiency-** degree of obtaining maximum output by the use of technology from the high range home garden									
15. **Trial-ability-** degree to which the technology may be experimented in the high range homegardens on a limited basis.									
16. **Complexity-** degree to which the an innovation is perceived as relatively difficult to understand and use in the high range home garden									
17. **Predictability-** degree of certainty of receiving expected benefits from adoption of a technology in the high range home garden									
18. **Flexibility-** ability of the technology to be easily modified to respond to altered circumstances									
19. **Viability-** Farmers adopt the technology for the benefit they provide viability refers to the ‘technology in use’ capacity to live and grow									

20. **Adaptability- t**he ability of a technology to be modified for a new use or purpose for the benefit of high range home garden									
21. **Productivity-** the ability of the technologies to improve the output or nature of productivity in high range homegardens									
22. **Observability-** degree to which the successful results of a technology used in the home garden can be visually observed by the home garden farmer.									
23. **Profitability-** amount of money that will be realized as profit for the home garden as a result of adoption of a technology									
Environmental dimensions									
24. **Energy saving potential-** capacity of the technology that uses minimal energy or resources in the production function of high range home gardens									
25. **Local Resource Utilization-** capacity of the technology used in the home garden to make best use of the available resources									
26. **Resource recycling-** the enabling capacity of the technology to make use of available resources in a home garden that can be recycled among the existing home garden components									
27. **Sustainability -** technology fits in most appropriately with ones home garden conditions or its environment without causing any problem to surroundings.									
28. **Mitigation ability-** action taken by the home garden farmer to reduce or eliminate long term risk and hazard to the home garden system									
29. **Biodiversity-** adoption of the technology that will result in increase the biodiversity of home garden									
30. **Resilience-** Technology has the ability of the technology to help cope up with and rise to the inevitable challenges and problems that may rise.									
31. **Soil and water conservation-** adoption of the technology in home gardens will help in the conservation of soil and water									

Socio cultural dimensions									
32. **Social acceptance-** technology in use should be considered useful, practical and feasible by the majority of the members of a social system.									
33. **Social approval-** achieve the approval of others and gains in prestige or esteem by adopting a particular technology									
34. **Social Beliefs-** adoption of the Technology has to take place considering the societal belief and values									
35. **Social network effects-** social network should have the ability to spread information and thus enable or further the adoption of the technology									
36. **Cultural traits-** Home garden farmer would consider the cultural feelings of the place and people in which a particular technology is been adopted									
37. **Social status-** adoption of a technology in the home garden will enable increase the status of an individual in society									
38. **Community participation-** technology use will facilitate social involvement or participation of the farmers that results in faster adoption and improved profit									
Psychological dimensions									
39. **Attitude-** positive or negative feeling or effect of the homegarden farmer towards a technology									
40. **Perception-** clear understanding on selection, organization and interpretation of a technology to be used by a home garden farmer									
41. **Satisfaction in life-** farmer is happy and satisfied with the output generated as a result of use of a technology.									
42. **Proud feeling-** farmers feel proud as they are the first to adopt the technology that leads to a perception of increased social status									
43. **Adoption-** decision of the home garden farmer to make full use of an innovation									

44. **Change proneness-** disposition of the home garden farmer to accept the change									
45. **Achievement motivation-** farmers having intense desire for success through use of technology in home gardens									
46. **Self-esteem-** farmers having confidence through self-fulfillment in one's own worth or abilities									
Political dimensions									
47. **Availability of Subsidy-** adoption of the technology is based on the subsidy available									
48. **Bureaucratic support-** easy procedures of government services will facilitate the farmer to adopt the technology.									
49. **Agricultural policies-** favourable policy from government institution will result in improved adoption									
50. **Public Private Partnership**- Participation of the home garden farmers with public or private institution for facilitating, financial and market support through use of home garden technology									
51. **Data ownership-** extend of rights or documents pledged by the home garden farmers for facilitating production process for technology adoption									
52. **Open source technology-** the technology available are open and free for home garden farmers									
53. **Data security-** How far the data pertaining to maintaining the home garden system is secure and safe									
54. **Unionism-** involvement of trade union while facilitating the process of adoption of technology. (eg: loading and unloading, etc.)									
Human resource dimension									
55. **Employment generation potential-** extend of employment generated as a result of intervention in human gardens									
56. **Easy to follow up-** the farmer can easily use the technology without the help an extension agent									

57. **Access to extension services- e**xtend of adequate and timely availability of information services from the extension agent.									
58. **Decision making- a**bility of home garden farmer to make right choices of technology from a basket full of technologies									
59. **Acquisition of information-** relevant information or continuous flow of information about the technology is available for home garden farmer									
60. **Record keeping**- perception by the farmer on the importance of maintaining the records on each and every aspects of the technology and home garden activity.									
61. **Family labour-** extent of family labour involvement or participation in practicing a technology in the home garden.									
62. **Availability of input supplies-** extent of adequate and timely availability of required inputs or technology									
63. **Input efficiency-** technology has the ability to produce maximum output from the minimum quantity of inputs or technology.									

APPENDIX V

List of crops in banana based highrange homegardens

SL.NO	COMMON NAME	SCIENTIFIC NAME	FAMILY
1.	Curry leaf	*Murraya koenigii*	Rutaceae
2.	Vellari	*Cucumis sativus*	Cucurbitaceae
3.	Tomato	*Lycopersicon esculentum*	Solanaceae
4.	Chikrumanis	*Sauropus androgynus*	Phyllanthaceae
5.	Mathan	*Cucurbita pepo*	Cucurbitaceae
6.	Paval	*Momordica charantia*	Cucurbitaceae
7.	Koval	*Coccinia grandis*	Cucurbitaceae
8.	Kumbalam	*Benincasa hispida*	Cucurbitacea
9.	Bhindi	*Abelmoschus esculentus*	Malvaceae
10.	Cowpea	*Vigna ungiculata*	Fabaceae
11.	Chilly	*Capsicum annum*	Solanaceae
12.	Brinjal	*Solanum melongena*	Solanaceae
13.	Beans	*Phaseolus vulgaris*	Fabaceae
14.	Coleus	*Plectranthus rotundifolius*	Lamiaceae
15.	Bread fruit	*Artocarpus altilis*	Moraceae
16.	Chena	*Amorphophallus paeoniifolius*	Araceae
17.	Chemb	*Dioscorea esculenta*	Dioscoreaceae
18.	Kachil	*Dioscorea alata*	Dioscoreaceae
19.	Tapioca	*Manihot esculenta*	Euphorbiaceae
20.	Coova	*Maranta arundinacea*	Marantaceae
21.	Jackfruit	*Artocarpus heterophyllus*	Moraceae
22.	Mango	*Mangifera indica*	Anacardiaceae
23.	Lemon	*Citrus limon*	Rutaceae
24.	Guava	*Psidium guajava L.*	Myrtaceae
25.	Custard apple	*Annona reticulate*	Annonaceae
26.	Chamba	*Syzygium samarangense*	Myrtaceae
27.	Njaval	*Syzygium cumini*	Myrtaceae
28.	Passion fruit	*Passiflora edulis*	Passifloraceae
29.	Banana (palayankodan, nenthran,chaavapoovan, robusta,poovan, njalipoovan)	*Musa* sp.	Musaceae
30.	Karinarakam	*Zanthoxylum fagara*	Rutaceae
31.	Rmbutan	*Nephelium lappaceum*	Sapindaceae
32.	Pappaya	*Carica papaya*	Caricaceae

33.	Mulbery	*Morus nigra*	Moraceae
34.	Pomegranate	*Punica granatum*	Lythraceae
35.	Orange	*Citrus sinensis*	Rutaceae
36.	Bilimbi	*Averrhoa bilimbi*	Oxalidaceae
37.	Pineapple	*Ananas comosus*	Bromeliaceae
38.	Mullatha	*Annona muricata*	Annonaceae
39.	Dhurian fruit	*Durio zibethinus*	Malvaceae
40.	Sapota	*Manikara zapota*	Sapotaceae
41.	Eggfruit	*Pouteria campechiana*	Sapotaceae
42.	Avocado	*Persea Americana*	Lauraceae
43.	Phulasan	*Nephelium mutabile*	Sapindaceae
44.	Jaboticaba	*Plinia cauliflora*	Myrtaceae
45.	Lubica	*Flacourtia jangomas*	Salicaceae
46.	West Indian cherri	*Malpighia emarginata*	Malpighiaceae
47.	Wild jack	*Artocarpus hirsutus*	Moraceae
48.	Grapes	*Vitis Vinifera*	Vitaceae
49.	Panineer chmba	*Syzygium jambos*	Myrtaceae
50.	Ambazham	*Spondias mombin*	Anacardiaceae
51.	Nelli	*Phyllanthus emblica*	Phyllanthaceae
52.	Snake fruit	*Salacca zalacca*	Arecaceae
53.	Elephant apple	*Dillenia indica*	Dilleniaceae
54.	Mangosteen	*Garcinia mangostana*	Clusiaceae
55.	Pummelo	*Citrus maxima*	Rutaceae
56.	Coconut	*Cocos nucifera L.*	Arecaceae
57.	Cocoa	*Theobroma cacao*	Malvaceae
58.	Coffee	*Coffea Arabica*	Rubiaceae
59.	Arecanut	*Areca catechu*	Arecaceae
60.	Cashew	*Anacardium occidentale*	Anacardiaceae
61.	Pana	*Caryota urens*	Arecaceae
62.	Kodapana	*Borassus flabellifer*	Arecaceae
63.	Rubber	*Hevea brasiliensis*	Euphorbiaceae
64.	Betelvine	*Piper betle*	Piperaceae
65.	Cinnamom	*Myristica fragrans*	Myristicaceae
66.	Cardamom	*Elettaria cardamom*	zingiberaceae
67.	Bay leaf	*Cinnamomum tamala*	Lauraceae
68.	Kanthari	*Capsicum frutescences*	solanaceae
69.	Pepper	*Piper nigrum L.*	piperaceae
70.	Kudampuli	*Garcinia gummi-gutta*	Clusiaceae
71.	Turmeric	*Curcuma longa*	Zingiberaceae
72.	Cinnamon	*Cinnamomum verum*	Lauraceae
73.	Clove	*Syzygium aromaticum*	Myrtaceae
74.	kokum	*Garcinia indica*	Clusiaceae
75.	Vanilla seedlings	*Vanilla planifolia*	orchidaceae
76.	Tamarind	*Tamarindus indica*	Fabaceae
77.	Sarvasugandhi	*Pimenta dioica*	Myrtaceae
78.	Seebabul	*Leucaena leucocephala*	Fabaceae
79.	Eucalyptus	*Eucalyptus globulus*	Myrtaceae
80.	Elavu tree	*Bombax ceiba*	Malvaceae

81.	Iyal vaga	*Albizia lebbeck*	Fabaceae
82.	Palakapayani	*Oroxylum indicum*	Bignoniaceae
83.	Cheemakonna	*Glircidia sepium*	Fabaceae
84.	chembakam	*Michelia champaca*	Magnoliaceae
85.	Pongalium tree	*Ailanthus excels*	Simarobaceae
86.	Murikk	*Erythrina variegata*	Fabaceae
87.	Pala	*Alstonia scholaris*	Apocynaceae
88.	Venthekku	*Lagerstroemia microcarpa*	Lythraceae
89.	Silveroak	*Grevillea robusta*	Proteaceae
90.	Kollamavu	*Persea macrantha*	Lauraceae
91.	Thampakam	*Hopea parviflora*	Dipterocarpaceae
92.	Illanji	*Mimusops elengi*	Sapotaceae
93.	Panji maram	*Ceiba pentandra*	Malvaceae
94.	Illy	*Bambusa bambos*	Poaceae
95.	Mahogany	*Swietenia macrophylla*	Meliaceae
96.	Anjili	*Artocarpus hirsutus*	Moraceae
97.	Maruth	*Terminalia arjuna*	Combretaceae
98.	Eeta	*Dalbergia nigra*	Fabaceae
99.	Mangium	*Acacia mangium*	Fabaceae
100.	Vatta tree	*Macaranga peltata*	Euphorbiaceae
101.	Terminalia	*Terminalia catappa*	Combretaceae
102.	Palakapayini	*Pajanelia longifolia*	Bignoniaceae
103.	Wild nutmeg	*Knema attenuate*	Myristicaceae
104.	Teak	*Tectona grandis*	Lamiaceae
105.	Auricaria cooki	*Araucaria araucana*	Araucariaceae
106.	Arali	*Nerium oleander*	Apocynaceae
107.	Redpalm ornamental	*Cyrtostachys renda*	Arecaceae
108.	Ornamental arecanut	*Areca catechu*	Arecaceae
109.	Euphorbia	*Euphorbia antiquorum*	Euphorbiaceae
110.	Nishagandhi	*Epiphyllum Oxypetalum*	Cactaceae
111.	Kozhivalan	*Acalypha hispida*	Euphorbiaceae
112.	Phyllanthus	*Phyllanthus myrtifolius*	Phyllanthaceae
113.	Mother in law tongue	*Dracaena trifasciata*	Asparagaceae
114.	Milk flower	*Epilobium lactiflorum*	Ongraceae
115.	chrysanthimum	*Chrysanthemum indicum*	Asteraceae
116.	Allamanda	*Allamanda cathartica*	Apocynaceae
117.	Anthurium	*Anthurium andraeanum*	araceae
118.	Bougainvillea	*Bougainvillea glabra*	Nyctaginaceae
119.	Heliconia	*Heliconia psittacorum*	heliconiaceae
120.	Dhalia	*Dahlia pinnata*	asteraceae
121.	Gomphrena	*Gomphrena globosa*	Amaranthaceae
122.	Marigold	*Tagetes erecta*	asteraceae
123.	Nandyarvattam	*Tabernaemontana divaricata*	Apocynaceae
124.	Chethi	*Ixora coccinea*	Rubiaceae
125.	Rose	*Rosa rubiginosa*	*Rosaceae*
126.	Kanikonna	*Cassia fistula*	Fabaceae
127.	Chembarathi	*Hibiscus rosa-sinensis*	Malvaceae
128.	Jasmine	*Jasminum sambac*	Oleaceae

129.	Lilly	*Lilium candidum*	Liliaceae
130.	Melostoma	*Melastoma malabathricum*	Melastomataceae
131.	Pichi	*Jasminum angustifolium*	Oleaceae
132.	C0-3 grass	*Pennisetum purpureum*	Poaceae
133.	Pudhina	*Mentha spicata*	Lamiaceae
134.	Thulsi	*Ocimum tenuiflorum*	*Lamiaceae*
135.	Panikoorka	*Plectranthus amboinicus*	Lamiaceae
136.	Aloevera	*Aloe vera*	Asphodelaceae
137.	Erukk	*Calotropis gigantea*	Apocynaceae
138.	Mylanji	*Lawsonia inermis*	Lythraceae
139.	Ramacham	*Chrysopogon zizanioides*	Poaceae
140.	Neem	*Azadirachta indica*	Meliaceae
141.	Shathavari	*Asparagus racemosus*	Asparagaceae
142.	Lakshmitharu	*Simarouba glauca*	Simaroubaceae
143.	Ramba	*Pandanus amaryllifolius*	Pandanaceae
144.	Stevia	*Stevia rebaudina*	Asteraceae
145.	Noni	*Morinda citrifolia*	Rubiaceae
146.	Nithya vazhuthana	*Ipomoea muricata*	Convolvulaceae
	Crops known by local names: Perakam, Varichil, Manivaruth, Kattukizhi, Karuvetty, Karinjozha, Karinjozha, Kakka karichil, Sugandharajan		

APPENDIX VI

List of plants in black pepper based high range homegardens

SL.NO	COMMON NAME	SCIENTIFIC NAME	FAMILY
1.	Coconut	*Cocos nucifera L.*	Arecaceae
2.	Cocoa	*Theobroma cacao*	Malvaceae
3.	Coffee	*Coffea arabica*	Rubiaceae
4.	Arecanut	*Areca catechu*	Arecaceae
5.	Cashew	*Anacardium occidentale*	Anacardiaceae
6.	Pana	*Caryota urens*	Arecaceae
7.	Kodapana	*Borassus flabellifer*	Arecaceae
8.	Rubber	*Hevea brasiliensis*	Euphorbiaceae
9.	Betelvine	*Piper betle*	Piperaceae
10.	Nutmeg	*Myristica fragrans*	Myristicaceae
11.	Cardamom	*Elettaria cardamom*	zingiberaceae
12.	Bay leaf	*Cinnamomum tamala*	Lauraceae
13.	Kanthari	*Capsicum frutescences*	solanaceae
14.	Bush pepper	*Piper nigrum L.*	piperaceae
15.	Kudampuli	*Garcinia gummi-gutta*	Clusiaceae
16.	Turmeric	*Curcuma longa*	Zingiberaceae
17.	Cinnamon	*Cinnamomum verum*	Lauraceae
18.	Clove	*Syzygium aromaticum*	Myrtaceae
19.	kokum	*Garcinia indica*	Clusiaceae
20.	Vanilla seedlings	*Vanilla planifolia*	orchidaceae
21.	Tamarind	*Tamarindus indica*	Fabaceae
22.	Sarvasugandhi	*Pimenta dioica*	Myrtaceae
23.	Ginger	*Zingiber officinale*	Zingiberaceae
24.	Kiriyath	*Andrographis paniculata*	Acanthaceae
25.	Pudhina	*Mentha spicata*	Lamiaceae
26.	Vayambu	*Acorus calamus*	Acoraceae
27.	Thulsi	*Ocimum tenuiflorum*	*Lamiaceae*
28.	Neelakoduveli	*Plumbago auriculata*	Plumbaginaceae
29.	Vellakoduveli	*Plumbago zeylanica*	Plumbaginaceae
30.	Kasturi manjal	*Curcuma aromatica*	Zingiberaceae
31.	Panikoorka	*Plectranthus amboinicus*	Lamiaceae
32.	Aloevera	*Aloe vera*	Asphodelaceae
33.	Kacholam	*Kaempferia galangal*	Zingiberaceae
34.	Kasthurivenda	*A*belmoschus moschatus	Malvaceae
35.	Karinochi	*Vitex negundo*	Lamiaceae
36.	Erukk	*Calotropis gigantea*	Apocynaceae
37.	Mylanji	*Lawsonia inermis*	Lythraceae
38.	Ramacham	*Chrysopogon zizanioides*	Poaceae
39.	Neem	*Azadirachta indica*	Meliaceae
40.	Sangupushpam	*Clitoria ternatea*	Fabaceae
41.	Neelamari	*Indigofera tinctoria*	Fabaceae

1.	Thippali	*Piper longum*	Piperaceae
2.	Nila kanjiram	*Strychnos nux-vomica*	Loganiaceae
3.	Shathavari	*Asparagus racemosus*	Asparagaceae
4.	Stevia	*Stevia rebaudina*	Asteraceae
5.	Kasthoori venda	*Abelmoschus moschatus*	Malvaceae
6.	Ela mulachi	*Bryophyllum pinnatum*	Crassulaceae
7.	Phyllanthus	*Phyllanthus myrtifolius*	Phyllanthaceae
8.	Dhalia	*Dahlia pinnata*	asteraceae
9.	Gomphrena	*Gomphrena globosa*	Amaranthaceae
10.	Marigold	*Tagetes erecta*	asteraceae
11.	Lotus	*Nelumbo nucifera*	Nelumbonaceae
12.	Eenth orn	*Cycas circinalis*	cycadaceae
13.	Money plant	*Epipremnum aureum*	Araceae
14.	Naalumany chedi	*Mirabilis jalapa*	Nyctaginaceae
15.	Mandharam	*Bauhinia variegata*	Fabaceae
16.	Nandyarvattam	*Tabernaemontana divaricata*	Apocynaceae
17.	Chethi	*Ixora coccinea*	Rubiaceae
18.	Poothiyunarthi	*Sterculia foetida*	Malvaceae
19.	Gandharajan	*Gardenia jasminoides*	Rubiaceae
20.	Rose	*Rosa rubiginosa*	*Rosaceae*
21.	Kanikonna	*Cassia fistula*	Fabaceae
22.	Chembarathi	*Hibiscus rosa-sinensis*	Malvaceae
23.	Thuja	*Thuja occidentalis L.*	Cupressaceae
24.	Jasmine	*Jasminum sambac*	Oleaceae
25.	Pichi	*Jasminum angustifolium*	Oleaceae
26.	Chempakam	*Michelia champaca*	Magnoliaceae
27.	Chena	*Amorphophallus paeoniifolius*	Araceae
28.	Chemb	*Dioscorea esculenta*	Dioscoreaceae
29.	Kachil	*Dioscorea alata*	Dioscoreaceae
30.	Tapioca	*Manihot esculenta*	Euphorbiaceae
31.	Coova	*Maranta arundinacea*	Marantaceae
32.	Vellari	*Cucumis sativus*	Cucurbitaceae
33.	Padavalam	*Trichosanthes cucumerina*	Cucurbitaceae
34.	Tomato	*Lycopersicon esculentum*	Solanaceae
35.	Chikrumanis	*Sauropus androgynus*	Phyllanthaceae
36.	Yardlong been	*Vigna unguiculata*	Cucubitaceae
37.	Mathan	*Cucurbita pepo*	Cucurbitaceae
38.	Paval	*Momordica charantia*	Cucurbitaceae
39.	Koval	*Coccinia grandis*	Cucurbitaceae
40.	Kumbalam	*Benincasa hispida*	Cucurbitacea
41.	Mango ginger	*Curcuma amada*	Zingiberaceae
42.	Chilly	*Capsicum annum*	Solanaceae
43.	Curry leaf	*Murraya koenigii*	Rutaceae
44.	Cheera	*Amaranthus viridis*	Amaranthaceae

1.	Breadfriut	*Artocarpus altilis*	Moraceae
2.	Bhindi	*Abelmoschus esculentus*	Malvaceae
3.	Brinjal	*Solanum melongena*	Solanaceae
4.	Cowpea	*Vigna ungiculata*	Fabaceae
5.	Muringa	*Moringa oleifera*	Moringaceae
6.	Cheemakonna	*Glircidia sepium*	Fabaceae
7.	Chembakam	*Michelia champaca*	Magnoliaceae
8.	Murikk	*Erythrina variegata*	Fabaceae
9.	Pala	*Alstonia scholaris*	Apocynaceae
10.	Venthekku	*Lagerstroemia microcarpa*	Lythraceae
11.	Silveroak	*Grevillea robusta*	Proteaceae
12.	Kollamavu	*Persea macrantha*	Lauraceae
13.	Koovalam	*Aegle marmelos*	Rutaceae
14.	Bamboo	*Bambusa vulgaris*	Poaceae
15.	Kuttipanal	*Glycosmis arborea*	Rutaceae
16.	Panji maram	*Ceiba pentandra*	Malvaceae
17.	Marotti	*Hydnocarpus wightianus*	Achariaceae
18.	Illy	*Bambusa bambos*	Poaceae
19.	Mahogany	*Swietenia macrophylla*	Meliaceae
20.	Anjili	*Artocarpus hirsutus*	Moraceae
21.	Marotti	*Hydnocarpus kurzii*	Achariaceae
22.	Maruth	*Terminalia arjuna*	Combretaceae
23.	Venga	*Pterocarpus marsupium*	Fabaceae
24.	Eeta	*Dalbergia nigra*	Fabaceae
25.	Peepal	*Ficus religiosa*	Moraceae
26.	Poovarashu	*Thespesia populnea*	Malvaceae
27.	Mangium	*Acacia mangium*	Fabaceae
28.	Vatta tree	*Macaranga peltata*	Euphorbiaceae
29.	Terminalia	*Terminalia catappa*	Combretaceae
30.	Vellanjara	*Sysygium hemisphericum*	Myrtaceae
31.	Wild nutmeg	*Knema attenuata*	Myristicaceae
32.	Teak	*Tectona grandis*	Lamiaceae
33.	Chorakalli	*Bischofia javanica*	Phyllanthaceae
34.	Poomaram	*Spathodea campanulatea*	Bignoniaceae
35.	Jackfruit	*Artocarpus heterophyllus*	Moraceae
36.	Mango	*Mangifera indica*	Anacardiaceae
37.	Lemon	*Citrus limon*	Rutaceae
38.	Guava	*Psidium guajava L.*	Myrtaceae
39.	Custard apple	*Annona reticulata*	Annonaceae
40.	Champa	*Syzygium samarangense*	Myrtaceae
41.	Njaval	*Syzygium cumini*	Myrtaceae
42.	Passion fruit	*Passiflora edulis*	Passifloraceae
43.	Banana (palayankodan, nenthran,chaavapoovan, robusta,poovan, njalipoovan)	*Musa sp*	Musaceae

1.	Karinarakam	*Zanthoxylum fagara*	Rutaceae
2.	Rmbutan	*Nephelium lappaceum*	Sapindaceae
3.	Pappaya	*Carica papaya*	Caricaceae
4.	Mulbery	*Morus nigra*	Moraceae
5.	Aakasha vellari	*Passiflora quadrangularis*	passifloraceae
6.	Pomegranate	*Punica granatum*	Lythraceae
7.	Orange	*Citrus sinensis*	Rutaceae
8.	Bilimbi	*Averrhoa bilimbi*	Oxalidaceae
9.	Pineapple	*Ananas comosus*	Bromeliaceae
10.	Laqoat	*Eriobotrya japonica*	Rosaceae
11.	Pummelo	*Citrus maxima*	Rutaceae
12.	Fig	*Ficus carica*	Moraceae
13.	Nelli	*Phyllanthus emblica*	Phyllanthaceae
14.	C0-3 grass	*Pennisetum purpureum*	Poaceae
	Crops known by local names: Sugandharajan, Kariyilampatta, Muruthan		

APPENDIX VII

List of plants in cardamom based homegardens

SL.NO	COMMON NAME	SCIENTIFIC NAME	FAMILY
1.	Curry leaf	*Murraya koenigii*	Rutaceae
2.	Tomato	*Lycopersicon esculentum*	Solanaceae
3.	Cowpea	*Vigna ungiculata*	Fabaceae
4.	Chilly	*Capsicum annum*	Solanaceae
5.	Amaranthus	*Amaranthus viridis*	Amaranthaceae
6.	Muringa	*Oringa oleifera*	Moringaceae
7.	Paval	*Momordica charantia*	Cucurbitaceae
8.	Sword bean	*Canavalia gladiata*	Fabaceae
9.	Chundakka	*Solanum torvum*	Solanaceae
10.	Brinjal	*Solanum melongena*	SolanaceaeC
11.	Cherry tomato	*Solanum lycopersicum var. cerasiforme*	Solanaceae
12.	Bhindi	*Abelmoschus esculentus*	Malvaceae
13.	Beans	*Phaseolus vulgaris*	Fabaceae
14.	Cabbage	*Brassica oleracea*	Brassicaceae
15.	Jack bean	*Canavalia ensiformis*	Fabaceae
16.	Ash guard	*Benincasa hispida*	Cucurbitacea
17.	Koval	*Coccinia grandis*	Cucurbitaceae
18.	Snake guard	*Trichosanthes cucumerina*	Cucurbitaceae
19.	Redgram	*Cajanus cajan*	Fabaceae
20.	Chikrumanis	*Sauropus androgynus*	Phyllanthaceae
21.	Bilimbi	*Averrhoa bilimbi*	Oxalidaceae
22.	Bread fruit	*Artocarpus altilis*	Moraceae
23.	Coleus	*Plectranthus rotundifolius*	Lamiaceae
24.	Chena	*Amorphophallus paeoniifolius*	Araceae
25.	Chemb	*Dioscorea esculenta*	Dioscoreaceae
26.	Kachil	*Dioscorea alata*	Dioscoreaceae
27.	Tapioca	*Manihot esculenta*	Euphorbiaceae
28.	Jackfruit	*Artocarpus heterophyllus*	Moraceae
29.	Mango	*Mangifera indica*	Anacardiaceae
30.	Lemon	*Citrus limon*	Rutaceae
31.	Guava	*Psidium guajava L.*	Myrtaceae
32.	Njaval	*Syzygium cumini*	Myrtaceae

33	Mullatha	*Annona muricata*	Annonaceae
34	Lubica	*Flacourtia jangomas*	Salicaceae
35	Kalluvazhuthana	*Solanum artopurpureum*	Solanaceae
36	Passion fruit	*Passiflora edulis*	Passifloraceae
37	Custard apple	*Annona reticulata*	Annonaceae
38	Pineapple	*Ananas comosus*	Bromeliaceae
39	Panineer chmba	*Syzygium jambos*	Myrtaceae
40	Akasha vellari	*Passiflora quadrangularis*	Passifloraceae
41	Chamba	*Syzygium samarangense*	Myrtaceae
42	Banana (palayankodan, nenthran, poovan, njalipoovan)	*Musa* sp.	Musaceae
43	Rmbutan	*Nephelium lappaceum*	Sapindaceae
44	Mangosteen	*Garcinia mangostana*	Clusiaceae
45	Avocado	*Persea americana*	Lauraceae
46	Apple chamba	*S*yzygium malaccense	Myrtaceae
47	Tree tomato	*S*olanum betaceum	Solanaceae
48	Black berry	*R*ubus fruticosus	Rosaceae
49	Litchi	*Litchi chinensis*	Sapindaceae
50	Peach	*Prunus persica*	Rosaceae
51	Apple	*Malus domestica*	Rosaceae
52	Arinellika	*Phyllanthus acidus*	Phyllanthaceae
53	Karinarakam	*Zanthoxylum fagara*	Rutaceae
54	Baraba	*Garcinia intermedia*	Clusiaceae
55	Phulsan	*Nephelium mutabile*	Sapindaceae
56	Pappaya	*Carica papaya*	Caricaceae
57	Mulbery	*Morus nigra*	Moraceae
58	Pomegranate	*Punica granatum*	Lythraceae
59	Pummelo	*Citrus maxima*	Rutaceae
60	Eggfruit	*Pouteria campechiana*	Sapotaceae
61	Orange	*Citrus sinensis*	Rutaceae
62	Sapota	*Manikara zapota*	Sapotaceae
63	Avocado	*Persea americana*	Lauraceae
64	Wild jack	*Artocarpus hirsutus*	Moraceae
65	Nelli	*Phyllanthus emblica*	Phyllanthaceae
66	Pana	*Caryota urens*	Arecaceae
67	Coconut	*Cocos nucifera L.*	Arecaceae
68	Cocoa	*Theobroma cacao*	Malvaceae
69	Coffee	*Coffea arabica*	Rubiaceae

70	Arecanut	*Areca catechu*	Arecaceae
71	Cashew	*Anacardium occidentale*	Anacardiaceae
72	Karimpana	*Borassus flabellifer*	Arecaceae
73	Rubber	*Hevea brasiliensis*	Euphorbiaceae
74	Nutmeg	*Myristica fragrans*	Myristicaceae
75	Ginger torch	*Etlingera elatior*	Zingiberaceae
76	Tamarind	*Tamarindus indica*	Fabaceae
77	Cardamom	*Elettaria cardamom*	zingiberaceae
78	Bay leaf	*Cinnamomum tamala*	Lauraceae
79	Kanthari	*Capsicum frutescences*	solanaceae
80	Pepper	*Piper nigrum L.*	piperaceae
81	Clove	*Syzygium aromaticum*	Myrtaceae
82	kokum	*Garcinia indica*	Clusiaceae
83	Cinnamon	*Cinnamomum verum*	Lauraceae
84	Kudampuli	*Garcinia gummi-gutta*	Clusiaceae
85	Vanilla seedlings	*Vanilla planifolia*	orchidaceae
86	Sarvasugandhi	*Pimenta dioica*	Myrtaceae
87	Cheemakonna	*Glircidia sepium*	Fabaceae
88	Murikk	*Erythrina variegata*	Fabaceae
89	Ummam	*Datura stramonium*	Solanaceae
90	Vembu	*Azadiracta indica*	Meliaceae
91	Silveroak	*Grevillea robusta*	Proteaceae
92	Thampakam	*Hopea parviflora*	Dipterocarpaceae
93	Illanji	*Mimusops elengi*	Sapotaceae
94	Panji maram	*Ceiba pentandra*	Malvaceae
95	Eucalyptus	*Eucalyptus globulus*	Myrtaceae
96	Maruth	*Terminalia arjuna*	Combretaceae
97	Iyal vaga	*Albizia lebbeck*	Fabaceae
98	Mahogany	*Swietenia macrophylla*	Meliaceae
99	Anjili	*Artocarpus hirsutus*	Moraceae
100	Eety	*Dalbergia sisso*	Fabaceae
101	Mangium	*Acacia mangium*	Fabaceae
102	Vatta tree	*Macaranga peltata*	Euphorbiaceae
103	Manimaruth	*Lagerstroemia sprciosa*	Lythraceae
104	Venga	*Petrocarpus marsupium*	Fabaceae
105	Wild nutmeg	*Knema attenuata*	Myristicaceae
106	Teak	*Tectona grandis*	Lamiaceae
107	Bamboo	*Bambusa vulgaris*	Poaceae
108	Auricaria cooki	*Araucaria araucana*	Araucariaceae
109	Phyllanthus	*Phyllanthus myrtifolius*	Phyllanthaceae
110	Euphorbia	*Euphorbia antiquorum*	Euphorbiaceae

111	Quiqualis	Combretum indicum	Combretaceae
112	Mandharam	*Bauhinia acuminata*	Fabaceae
113	Chrysanthimum	*Chrysanthemum indicum*	Asteraceae
114	Allamanda	*Allamanda cathartica*	Apocynaceae
115	Mosanda	*Mussaenda erythrophylla*	Rubiaceae
116	Anthurium	*Anthurium andraeanum*	Araceae
117	Bougainvillea	*Bougainvillea glabra*	Nyctaginaceae
118	Chethi	*Ixora coccinea*	Rubiaceae
119	Brypphyllum	*Bryophyllum pinnatum*	Crassulaceae
120	Gerbera	*Gerbera jamesonii*	Asteraceae
121	Rose	*Rosa rubiginosa*	*Rosaceae*
122	Celotia	*Celosia sp.*	Amaranthaceae
123	Hydarangia	*Hydrangea macrophylla*	Hydrangeaceae
124	Balsm	*Impatiens balsamina*	*Balsaminaceae*
125	Bougainvillea	*Bougainvillea glabra*	Nyctaginaceae
126	Thuja	*Thuja occidentalis L.*	Cupressaceae
127	Arali	*Nerium oleander*	Apocynaceae
128	May flower	*Scadoxus multiflorus*	Amaryllidaceae
129	Ornamental arecanut	*Areca catechu*	Arecaceae
130	Money plant	*Epipremnum aureum*	Araceae
131	Naalumany chedi	*Mirabilis jalapa*	Nyctaginaceae
132	Croton	*Croton californicus*	*Euphorbiaceae*
133	Canna	*Canna indica*	*Cannaceae*
134	Chembarathi	*Hibiscus rosa-sinensis*	Malvaceae
135	Jasmine	*Jasminum sambac*	Oleaceae
136	Lilly	*Lilium candidum*	Liliaceae
137	Heliconia	*Heliconia psittacorum*	heliconiaceae
138	Nandyarvattam	*Tabernaemontana divaricata*	Apocynaceae
139	Kanikonna	*Cassia fistula*	Fabaceae
140	Cactus	*Opuntia littoralis*	Cactaceae
141	Melostoma	*Melastoma malabathricum*	Melastomataceae
142	Thulsi	*Ocimum tenuiflorum*	*Lamiaceae*
143	Arutha	*Ruta graveolens*	*Rutaceae*
144	Brahmi	*Bacopa monnieri*	*Plantaginaceae*
145	Panikoorka	*Plectranthus amboinicus*	Lamiaceae
146	Aloevera	*Aloe vera*	Asphodelaceae
147	Insulin plant	*Chamaecostus cuspidatus*	Costaceae
148	Vayamb	*Acorus calamus*	Acoraceae
149	Bixa	*Bixa orellana*	Bixaceae
150	Erukk	*Calotropis gigantea*	Apocynaceae

151	Lakshmitharu	*Simarouba glauca*	Simaroubaceae
152	Mylanji	*Lawsonia inermis*	Lythraceae
153	Adalodakam	*Justicia adathoda*	Acanthaceae
154	Shathavari	*Asparagus racemosus*	Asparagaceae
155	Sangupushpam	*Clitoria ternatea*	Fabaceae
156	Neelamari	*Indigofera tinctoria*	Fabaceae
157	Adapathiyan	*Holostemma adakothiyan*	Apocynaceae
158	Kodamanjal	*Curcuma caesia*	Zingiberaceae
159	Sugarcane	*Saccharum officinarum*	Poaceae
	Crops known by local names : Bogum fruit, Perakam, Chandana vayambu, Vellilav		

APPENDIX VIII

List of plants in cabbage based highrange homegardens

SL.NO	COMMON NAME	SCIENTIFIC NAME	FAMILY
1.	Curry leaf	*Murraya koenigii*	Rutaceae
2.	Tomato	*Lycopersicon esculentum*	Solanaceae
3.	Chilly	*Capsicum annum*	Solanaceae
4.	Amaranthus	*Amaranthus viridis*	Amaranthaceae
5.	Cluster bean	*Cyamopsis tetragonoloba*	Fabaceae
6.	Radish	*Raphanus sativus*	Brassicaceae
7.	Cauliflower	*Brassica oleracea var. botrytis*	Brassicaceae
8.	Choraka	*Angelica glauca*	Apiaceae
9.	Onion	*Allium cepa*	Amaryllidaceae
10.	Brinjal	*Solanum melongena*	SolanaceaeC
11.	Bhindi	*Abelmoschus esculentus*	Malvaceae
12.	Chow chow	*Sechium edule*	Cucurbitaceae
13.	Beans	*Phaseolus vulgaris*	Fabaceae
14.	Cabbage	*Brassica oleracea*	Brassicaceae
15.	Green peas	*Pisum sativum*	Fabaceae
16.	Garlic	*Allium sativum*	Amaryllidaceae
17.	Butter beans	*Phaseolus lunatus*	Fabaceae
18.	Broccoli	*Brassica oleraceae var. italica*	Brassicaceae
19.	Mung bean	*Vigna radiata*	Fabaceae
20.	Snake guard	*Trichosanthes cucumerina*	Cucurbitaceae
21.	Beetroot	*Beta vulgaris*	Amaranthaceae
22.	Carrot	*Daucus carota*	Apiaceae
23.	Potato	*Solanum tuberosum*	Solanaceae
24.	Kachil	*Dioscorea alata*	Dioscoreaceae
25.	Tapioca	*Manihot esculenta*	Euphorbiaceae
26.	Mango	*Mangifera indica*	Anacardiaceae
27.	Loqout	*Eriobotrya japonica*	Rosaceae
28.	Lemon	*Citrus limon*	Rutaceae
29.	Guava	*Psidium guajava L.*	Myrtaceae
30.	Strawberry	*Fragaria vesca*	Rosaceae
31.	Blueberry	*Vaccinum corymbosum*	Ericaceae

32.	Plum	*Prunus domestica*	Rosaceae
33.	Fig	*Ficus carica*	Moraceae
34.	Njaval	*Syzygium cumini*	Myrtaceae
35.	Sabarjell i	*Pyrus pyrifolia*	Rosaceae
36.	Passion fruit	*Passiflora edulis*	Passifloraceae
37.	Custard apple	*Annona reticulata*	Annonaceae
38.	Banana	*Musa* sp	Musaceae
39.	Avocado	*Persea americana*	Lauraceae
40.	Tree tomato	*S*olanum betaceum	Solanaceae
41.	Black berry	*R*ubus fruticosus	Rosaceae
42.	Peach	*Prunus persica*	Rosaceae
43.	Apple	*Malus domestica*	Rosaceae
44.	Pomegranate	*Punica granatum*	Lythraceae
45.	Orange	*Citrus sinensis*	Rutaceae
46.	Avocado	*Persea americana*	Lauraceae
47.	Coffee	*Coffea arabica*	Rubiaceae
48.	Coriander	*Coriandrum sativum*	Apiaceae
49.	Pudhina	*M[enth[a arvensis*	Lamiaceae
50.	Fennel	*Foeniculum vulgare*	Apiaceae
51.	Cardamom	*Elettaria cardamom*	zingiberaceae
52.	Vanchi tree	*M*imusops elengi	Sapotaceae
53.	Murikk	*Erythrina variegata*	Fabaceae
54.	Pinetee	*P*inus roxburghii	Pinaceae
55.	Euphorbia	*Euphorbia antiquorum*	Euphorbiaceae
56.	Idli poov	*Ixora coccinea*	Rubiaceae
57.	Chrysanthem	*Chrysanthemum indicum*	Asteraceae
58.	Anthurium	*Anthurium andraeanum*	Araceae
59.	Pichi	*Jasminum* angustifolium	Oleaceae
60.	Bottle brush	*C*allistemon citrinus	Myrtaceae
61.	Rose	*Rosa rubiginosa*	*Rosaceae*
62.	Balsm	*Impatiens balsamina*	*Balsaminaceae*
63.	Arali	*Nerium oleander*	Apocynaceae
64.	Money plant	*Epipremnum aureum*	Araceae
65.	Sun flower	*H*elianthus annuus	Asteraceae
66.	Chembarathi	*Hibiscus rosa-sinensis*	Malvaceae
67.	Dalia	*D*ahlia pinnata	Asteraceae
68.	Jasmine	*Jasminum sambac*	Oleaceae
69.	Lilly	*Lilium candidum*	Liliaceae
70.	Gomphena	*Gomphrena globosa*	Amaranthaceae
71.	Aloevera	*Aloe vera*	Asphodelaceae
72.	Sugarcane	*Saccharum officinarum*	Poaceae
73.	Maize	*Zea mays*	Poaceae
74.	Grandis	*Eucalyptus grandis*	Myrtaceae

APPENDIX IX

Cost of cultivation of Banana (1 ha) KAU practice

Sl. No	Particulars	Quantity	Rate/ unit	cost
1	Planting material	2500	15	37500
2	Labor charge	250	700	175000
3	Farm yard manure	25000kg	5	125000
4	Fertilizers	3877.5 kg		44110
5	Plant protection			1500
6	Total cost			383110
	Benefit	29025	28	819466.7
	BC ratio	2.14		

APPENDIX X

Cost of cultivation of Cabbage (1ha) KAU practice

Sl. No	Particulars	Quantity	Rate/ unit	cost
1	Planting material	375 g	55	20625
2	Labor charge	250 nos	600	150000
3	Farm yard manure	25000kg	5	125000
4	Fertilizers			11031
5	Plant protection	125 kg	50	6250
6	Total cost	312906		
	Benefit	49150 kg	23	1130450
	BC ratio	3.61		

APPENDIX XI

Factor values of different technology dimensions

Dimensions	Factor Value ≥6	Factor Value ≥7	Factor Value ≥8
ECONOMIC DIMENSIONS	1. Initial cost (0.606) 2. Commercialization (0.701) 3. Regularity of returns (0.828) 4. Rapidity of returns (0.759) 5. Availability of credit (0.794) 6. Market integration(0.626) 7. Availability of credit (0.794) 8. Accessibility of credit (0.867) 9. Break even (0.699) 10. Margin of safety (0.838) 11. Supply chain (0.728)	1. Income generation Potential (0.796) 2. Commercialization (0.701) 3. Regularity of returns (0.828) 4. Rapidity of returns (0.759) 5. Availability of credit (0.794) 6. Accessibility of credit (0.867) 7. Margin of safety (0.838) 8. Supply chain (0.728)	1. Regularity of returns (0.828) 2. Accessibility of credit(0.867) 3. Margin of safety (0.838)
TECHNICAL DIMENSIONS	9. Compatibility (0.792) 10. Efficiency (0.745) 11. Trial-ability (0.886) 12. Predictability (0.827) 13. Flexibility (0.752) 14. Viability (0.748) 15. Adaptability (0.775) 16. Productivity (0.681) 17. Observability (0.651) 18. Profitability (0.669)	9. Compatibility (0.792) 10. Efficiency (0.745) 11. Trial-ability (0.886) 12. Predictability (0.827) 13. Flexibility (0.752) 14. Viability (0.748) 15. Adaptability (0.775)	4. Trial-ability(0.886 5. Predictability (0.827)

ENVIRONMENTAL DIMENSIONS	19. Energy saving potential (0.638) 17. Local Resource Utilization (0.850) 18. Resource recycling (0.992) 19. Sustainability (0.773) 20. Biodiversity(0.603) 21. Soil and water conservation(0.660)	16. Local Resource Utilization (0.850) 17. Resource recycling (0.992) 18. Sustainability (0.773)	6. Local Resource Utilization (0.850) 7. Resource recycling (0.992)
SOCIO-CULTURAL DIMENSIONS	22. Social acceptance (0.805) 23. Social approval (0.871) 24. Social Beliefs (0.777) 25. Cultural traits (0.809) 26. Social status (0.728) 27. Community participation(0.669)	19. Social acceptance (0.805) 20. Social approval (0.871) 21. Social Beliefs (0.777) 22.Cultural traits (0.809) 23.Social status (0.728)	8. Social acceptance (0.805) 9. Social approval (0.871) 10. Cultural traits (0.809)
PSYCHOLOGICAL DIMENSIONS	28. Satisfaction in life(0.730) 29. Proud feeling (0.69) 30. Adoption (0.674) 31. Change proneness (0.872) 32. Self - esteem (0.789)	24. Satisfaction in life(0.730) 25. Change proneness (0.872) 26. Self - esteem (0.789)	11. Change proneness (0.872)
POLITICAL DIMENSIONS	33. Bureaucratic support (0.899) 34. Agricultural policies (0.622) 35. Public Private Partnership(0.895) 36. Data ownership (0.808) 37. Open source technology(0.862)	27. Bureaucratic support (0.899) 28. Public Private Partnership(0.895) 29. Data ownership (0.808) 30. Open source technology(0.862)	12. Bureaucratic support (0.899) 13.Public Private Partnership(0.895) 14.Data ownership (0.808) 15.Open source technology(0.862)
HUMAN RESOURCE DIMENSIONS	38. Easy to follow up (0.641) 39. Access to extension services(0.807)	31.Access to extension services (0.807) 32.Decision making (0.768) 33.Acquisition of information (0.984)	16.Access to extension services (0.807)

	40. Decision making (0.768) 41.Acquisition of information (0.984) 42. Family labour (0.740) 43. Availability of input supplies (0.804) 44. Input efficiency (0.807)	34.Family labour (0.740) 35.Availability of input supplies (0.804) 36.Input efficiency (0.807)	17.Acquisition of information (0.984) 18.Availability of input supplies (0.804) 19.Input efficiency (0.807)

APPENDIX XII-

List of plates

Plate 1. Frontline demonstration of production practices of banana

Plate 2 .Frontline demonstration on management of foot rot disease in black pepper

Plate 3 .Frontline demonstration on management of cardamom thrips

Plate 4. Frontline demonstration of production practices of cabbage

Plate 5. Crowd sourcing and percentage adoption of crop production and protection practices in different crop based home gardens