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SOCIO-ECONOMIC STUDY OF FARM FORESTRY :

A SURVEY OF FOUR VILLAGES IN KERALA

Mammen Chundamannil
C.N. Krishnankutty
A.R. Rajan

KERALA FOREST RESEARCH INSTITUTE
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ABSTRACT

This study is an attempt to examine the variation in tree cropping in home gardens infour villages in Kerala A socio-economic and land use survey was carried out in 247 households from where cropping pattern and tree growth details were recorded A cropping intensity index appropriate for comparing mixed cropping agriculture was developed and separate intensities were worked out for seasonal and annual crops, perennial crops, tree crops and miscellaneous crops.

Using the size class of land holdings as a proxy for economic status, comparison between households in each village and comparison between villages were done. No difference was observed in the cropping intensity of tree crops between size classes of land holding in all villages. However, density of trees (in number) showed much variation.

With the increase in the intensity of perennial crops, intensity of tree crops declines. When the combined intensity of perennial and tree crops was considered, the highest intensity was found in the smallest size class of holdings in three out of four villages. Considering the intensity of all crops together, it was found that smaller holdings have relatively higher cropping intensities.

Among trees in home gardens, the category of multipurpouse trees accounted for 50 to 70 percent in different villages. The mean number of trees per hectare was found to be significantly different between villages and between size classes of holdings. In all villages, decrease in tree diversity was noticed with decrease in size of holding.

Socio-economic factors, such as size of land holding, level and source of income, number of sub-systems present in the homegarden and their period of development, etc. within the limits of agro-climatic and edaphic conditions. have contributed to the intensification of cultivation in home gardens. Multipurpose trees or trees with high valuse are preferred for newplanting.

INTRODUCTION

This study was initiated with the objective of analysing the pattern of tree growth in home gardens. In the wood economy of Kerala, non-forest sources are a major source of timber and fuelwood production. Within the non-forest sector, home gardens are major producers of wood (Krishnankutty. 1990).With increasing interest in agroforestry and availability of funding to develop the tree component in agroforeshy. it was considered worthwhile to study the distribution. composition and diversity of tree species within home gardens of Kerala.

Difference in socio-economic status, quality of land and size of holding would influence the nature of the home garden system. The level of income, dependence of households on agriculture, length of settlement and development of infrastructure would affect the intensity and diversity in the farming practices. Within the home garden system, different sub-components exist. The decision to grow or retain a particular tree or a group of trees will depend upon the opportunities available and its linkages with the other sub-systems.

The objectives of this study were to examine the variations in tree cropping in relation to socio-economic conditions of households in different agro-climatic regions in Kerala. This report presents data on the density, distribution and diversity of trees in four villages in four different agro-climatic regions in Kerala based on a socio-economic survey of households.

METHODOLOGY

The methodology adopted for the survey and calculation of cropping intensity Indices are presented here.

Selection of villages

The study is based on a household survey in four selected villages in Thrissur and Palakkad districts. Revenue villages in Thrissur District were stratified Into different natural regions - low land (below 7.62m). mid land (7.62 to 76.2 m) and high land (above 76.2m) regions. One village each from the above three regions was randomly selected. The villages chosen for the study are Nattika, Avinissery and Mulayam representing the three natural regions respectively. The fourth village, Alathur, was selected at random from

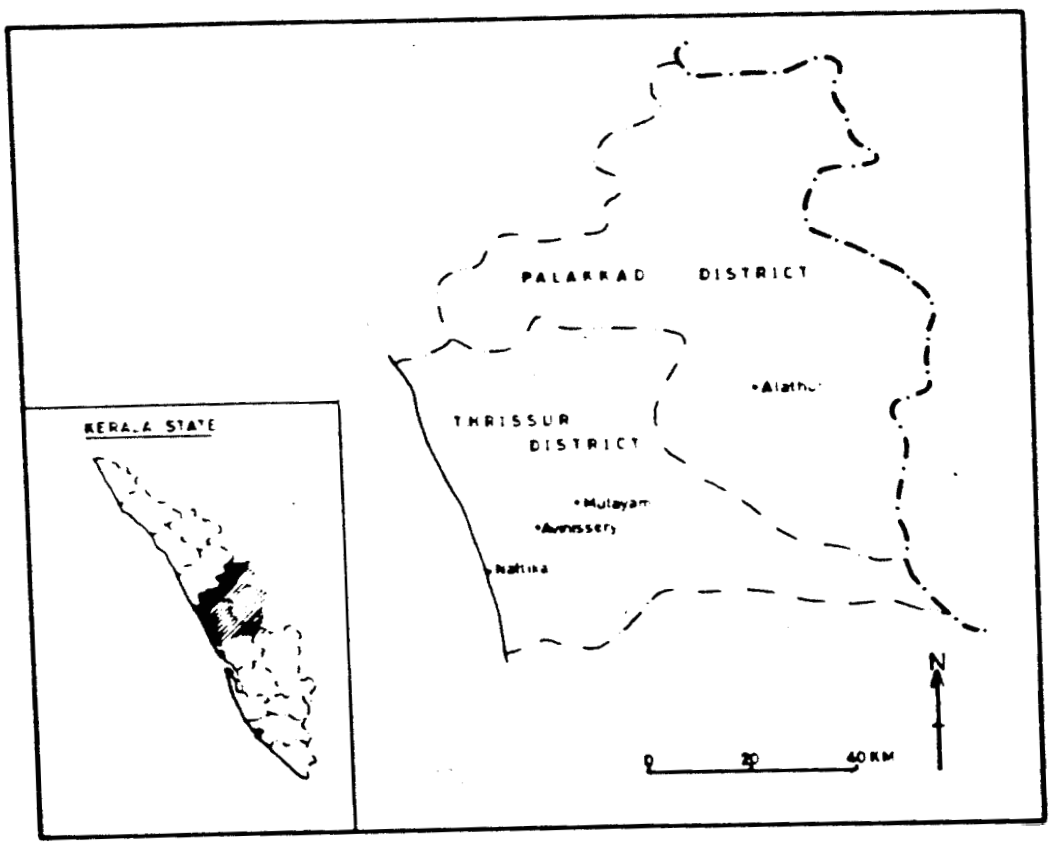

Fig. 1. Location of the selected villages

the predominantly rice growing villages in Palakkad District, which represents an entirely different agro-ecosystem in comparison with the other three villages in Thrissur District (Fig. 1). As the revenue villages consist of a very large number of households, one census village each was selected at random from the selected villages. After the selection of census villages. all the households in it were visited and basic information on land holding was collected.

Household selection

The households in the selected census village were stratified on the basis of size of land holding. Only garden lands were considered for stratifying the households as trees are found only in such lands. For the survey, rice fields or wet lands holding of the selected households were excluded. After stratification. households were selected at random taking half the number occurring in each stratum with a maximum of twenty households. A total of 247 households were selected from the four villages.

Data collection and definitions

Each of the households was again visited by the investigators along with local assistants. The survey method consisted of using a questionnaire for household details and a performa for recording land-use and tree growth details. Income from different sources. mode of acquisition of land and period of occupancy, etc. are some of the important household details collected. The number and area occupied by each seasonal, annual and perennial crops, duration of seasonal and annual crops, stem diameter and approximate crown diameter of each tree and area occupied by miscellaneous crops were recorded.

Seasonal and annual crops include all vegetables, pulses, tubers, betal vines ***(Piper betle),*** pineapple ***(Ananas comosus),*** banana ***(Musa paradisiaca).*** etc. The duration of these crops Is less than one year. Perennial crops are the major cash crops which include coconut ***(Cocos nucifera),*** arecanut ***(Areca catechu).*** pepper ***(Piper longum),*** coffee ***(Cofea*** arabica). cocoa ***(Theobroma*** *cacao),* nutmeg ***(Myristica fragrans),*** etc. Tree crops are defined as all trees other than those considered as perennial crops. Most tree crops are grown to obtain fruits for consumption, shade, timber, ornamental purposes, fodder and green manure. Some trees also provide income through sale of produce such as cashew ***(Anacardium occidentale),*** tamarind *(Tamarindus*

kudampuly ***(Garcinia gummigutta),*** etc. Trees have been further sub-classified as multipurpose trees, timber trees, fruit trees and ornamental trees. Many of the multipurpose trees are retained for their wood and fruit values. The main multipurpose use trees are jack ***(Artocarpus heterophyllus).*** mango ***(Mangifera indica),*** cashew ***(Anacardium occidentale),*** tamarind ***(Tamarindus indica),*** etc. Timber trees are teak ***(Tectona grandis),*** rosewood ***(Dalbergia latfiolia,*** anjily ***(Artocarpus hirsuta) ,*** matty ***(Ailanthus triphysa),*** etc. Fruit trees are custard apple ***(Annona squamosa).*** guava ***(Psidum guajava).*** narakom ***(Citrus*** sp.), muringa ***(Moringa oleifera),*** etc.. which have only marginal wood value compared to multipurpose trees. However, fruit trees excludes trees already listed as multipurpose such as jack, mango, cashew, etc. Arunamaram ***(Polyalthia longifolia),*** chempakom ***(Michelia champaka).*** etc. are grouped as ornamental trees. For each tree two parameters viz. stem diameter and crown radius were considered. For calculations of intensity of cropping, the estimated crown area for each tree was used. All trees were grouped into six stem diameter classes. The smallest class (below 5 cm dbh) was considered only for calculating the intensity index. The last group, 'miscellaneous crops' include bamboo, fodder grass and plants raised as live fence such as konna ***(Gliricidia sepium).*** kaitha ***(Pandanus tectorius),*** etc. Appendix 18 gives a list of local names of trees and plants in the home gardens and their botanical names.

Estimation of cropping intensity index

Cropping intensity index is usually defined as the ratio of gross cropped area in an year to net land area. This is given as a percentage. For comparing agricultural land use between two areas, the cropping intensity index is a good criterion. Traditionally, cropping intensity is calculated only for seasonal crops such as cereals. In this case cropping intensity will indicate the number of crops taken in an year. The convention usually followed is to consider only the frequency of cropping in an year and not the duration of the crops. For example, if the crop is sown twice successively on the same land, the cropping intensity would be double. For comparison with perennial crops or mixed cropping, the usual cropping intensity index is not sufficient since the duration of the crops is not taken into account. There is much diversity in the farming systems adopted in the garden lands ranging from single crop to highly mixed crop regimes. The duration of different crops may range from a few months to many years. The crops may also differ in the canopy cover with different crops occupying different levels. The cropping intensity for such systems must take into account all these factors.

In developing a cropping intensity index for mixed cropping land, major problems of aggregation emerge. The first problem is aggregation of seasonal crops with perennials. This can be overcome when each crop is weighed with its duration. For crops having duration less than one year, including time spent for land preparation. the intensity index is proportionately reduced. The second problem is with the aggregation of area occupied by each crop. For cereal crops the area occupied can be readily estimated. The optimum number of perennial crops per hectare is taken from the recommendations of the Kerala Agricultural University for each crop. This is only a general guideline. With increased inputs or water availability. a closer spacing can be adopted. In this study we consider the intensity to be 100 where the optimum number of plants of a crop is present.

In the home-gardens of Kerala, different trees are also present. The area occupied by trees other than palms change with the age of the tree and pruning practices (lopping).To estimate the area occupied by each tree, the crown area was used.

The method adopted for calculating the cropping intensity indices was to aggregate the area under all crops and divide with the area of the home-gardens excluding that under non agricultural uses such as house, courtyard, pond, etc. (Nair and Krishnankutty, 1985).Avariation from the above method is used here by using the total area of the homestead as the denominator instead of the area under agriculture alone since house, pond, well. stable, etc. are integral to the homestead system and contribute to crop production. The formulae adopted can be explained as follows:

Intensity index of seasonal and annual crops (ISC) $= \frac{100}{12A} \sum_{g} D_g S_g$

Intensity index of perennial crops (IPC) $= \frac{100}{A} \sum_{h} \frac{P_h}{O_h}$

Intensity index of tree crops (ITC) $= \frac{100\pi}{A} \sum_{i} \sum_{j} T^2_{ij}$

Intensity index of miscellaneous crops (IMC) $= \frac{100}{A} \sum_{k} M_k$

Intensity index of all crops (IAC) = ISC + + ITC + IMC

where S_g : area (in m^2) occupied by the g^{th} seasonal or annual crop,

Dg : duration (in months) of the crop,

Ph : observed number of plants/palms of the h^{th} perennial crop,

Oh : optimal number of plants/palms per m^2,

Tij : crown radius (in m) of the j^{th} tree of the i^{th} species,

Mk : area (in m^2) occupied by the miscellaneous crops such as bamboo, etc.,

A : area (in m^2) of homestead

Using the above formulae, intensity indices of seasonal and annual crops (ISC), perennial crops (IPC), tree crops (lTC), miscellaneous crops (IMC) and intensity index of all crops (IAC) were calculated for each home garden from the survey schedules. The intensity indices were used for comparison of farm forestry practices between different villages and home gardens within each village.

SOCIO-ECONOMIC FEATURES OF THE VILLAGES

This section contains a description of study area, patterns of landholding in the different villages, presence of different sub-systems and dependence on agriculture as a source of income.

Study area

Some features of the four villages selected for the study are given in Table 1. The population density varies considerably with age of the settlement and urbanisation. Mulayam village is closest to forest than the others. The period of occupation of lands varies from very old in Avinisseryand Nattika to fairly new in Mulayam. The settlement in Mulayam is probably less than fifty years old and in any case not more than a century.

Table 1. General characteristics of villages selected

Characteristics	Village			
	Mulayam	Avinissery	Nattika	Alathur
Population density (1981 Census)	456	1984	1788	1078
Age of settlement	New	Very old	Very old	Old
Distance of forests	0-5 km	20 km	40 km	30 km
Main commercial crops	Pepper, vegetables	Coconut, arecanut	Coconut, arecanut	Rice
Normal rainfall* (mm)	3177	3177	3177	2398
Irrigated or not	No	Partly	Yes	Partly
Terrain	Rugged	Moderately undulating	Flat	Flat
Terraced or not	Partly	Yes	Not needed	Yes
Soil	Lateritic	Lateritic	Sandy loam	Lateritic

*District figures are used (State Land Use Board,

Except for Nattika, which has sandy loam soil, the other villages have lateritic soil. The terrain ranges from flat in Nattika and Alathur to hilly in Mulayam. The main commercial crops differ in the villages due to differences

in the natural endowments and due to historical factors. Perennial tree crops like coconut and arecanut dominate the lands in Nattika and Avinissery. Alathur has a rice based system. In Malayalam, the main commercial crops are pepper, vegetables and tubers. The rainfall given in the Table is only indicative and not based on village level data. Alathur has a lower rainfall than the others. In the matter of land development, while in Nattika irrigation is very common, lands in Avinissery and Alathur are partly irrigated: whereas those in Mulayam are very rarely irrigated (Table 3.1). Water availability and electricity connection are important factors that influence irrigation facilities. Due to newness of settlement and poverty in the households, lands in Mulayam which have a hilly terrain are not fully terraced. In the other villages, due to almost flat topography, terracing is not critically needed although most lands have field bunds.

Patterns of land holding

Table 2 gives the distribution of size of land holdings in the four villages. While 92% of the households in Alathur belong to the class less than 0.202 ha (50 cents). that in Mulayam only 11% of households had a holding less

Table 2. Percentage distribution of home gardens according to size of holding

Size of land holding in ha (and in cents)	Villages			
	Mulayam N* = 289	Avinissery N = 523	Nattika N = 1986	Alathur N = 392
<0.20 (<5)	0.0	4.2	4.8	15.8
(5-25)	6.9	46.7	38.4	61.5
0.101-0.203 (25-50)	3.8	22.4	21.6	14.6
0.203-0.405 (50-100)	11.8	18.9	18.5	6.1
0.405-0.809 100-200)	28.7	5.6	11.7	2.0
0.809-1.214 (200-300)	18.3	1.8	3.2	0.0
1.214-2.023 (300-500)	26.3	0.4	1.2	0.0
>2.023 (>500)	4.2	0.0	0.6	0.0
Total	100.0	100.0	100.0	100.0

Total number of households visited and listed for stratification.

than 0.202 ha. Alathur, is a rice growing area where garden lands are limited. Compared to Alathur,Avinissery and Nattika. Mulayam has relatively larger size of holdings. The distribution of area under non-agricultural uses in different villages is given in Appendix-1. The area occupied by buildings, cattle shed, courtyard, pond, etc. come under this category. This is also a reflection of the diversity in the land use and the presence or absence of rice component. Alathur has very high percentage of area under non- agricultural use. Partly this is due to the formation of yards for drying paddy *(kalams)*. Area under non-agricultural uses is also influenced by the socio-economic status of the household particularly their dependence on agricultural income and the age of the settlement.

Subsystems in home gardens

Within the home garden system, different subsystems can be identified. Apart from different crops as subsystems, a livestock subsystem is usual in Kerala. Among the crop subsystems, rice cultivation is carried out outside the homestead. As the rice subsystem is linked to food and fodder availability in the household, this is considered as integral to the home garden system. Within homestead farms. four subsystems can be identified. Of these, seasonal and annual crops occupy the lowest strata of the canopy. Perennial crops are grown either as a pure crop resembling a plantation or in mixtures of several perennial crops or along with other crop subsystems. The tree crop subsystem consists of planted trees of useful species and those that come up naturally. The tree component usually occupies the top canopy in the young phase of the home garden and the intermediary level below the top canopy dominated by coconut or arecanut in the mature phase. Miscellaneous crops generally occupy the boundary of the home garden.

Table 3 gives the percentage distribution of the number of households in each village where all subsystems are present. Among villages, Mulayam has the largest number of households where all subsystems are present. As the size of land holding declines. the number of subsystems declines. Alathur, which has a predominance of small holding, has the lowest percentage of households having all subsystems. It can be seen from Table 4 that the tree sub component is present in almost all homestead farms. So is the case with perennial crop subsystem also. Seasonal and annual crops are present in all home gardens in all villages except a few in Alathur.

Table 3. Percentage number of households where all subsystems are present in different villages

Size of land holding (in ha)	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
0.20-0.101	NA**	10	5	5
0.101-0.202	0	11	11	6
0.202-0.405	20	47	5	20
0.405-0.809	29	46	20	33
0.809-1.214	46	67	79	NA
Above 1.214	50	50	89	NA
Total	36	30	33	9

The subsystems are rice, livestock, seasonal and annual crops, perennial crops, tree crops and miscellaneous crops.

**Sample not available.

Table 4. Percentage number of households according to presence of various subsystems in different villages

Presence of subsystems	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
Rice	46	43	31	44
Livestock	79	67	59	40
Seasonaland annual crops	100	100	100	87
Perennial crops	100	98	100	98
Trees	100	98	100	98
Miscellaneous crops	71	66	86	44
All subsystems	36	30	22	9

With regard to livestock and miscellaneous crop components also, Alathur has the lowest percentage of households with all subsystems present. Even considering individual subsystem, Mulayam village has the highest percentage of households in all subsystems except miscellaneous crops. Larger size of land holding and high dependence on agriculture are important reasons for this performance. Dependence on agriculture. income level, etc. are shown below.

Dependence on agriculture

Household income and contribution of crops in different villages is given in Table 5.

Table 5. Household income in different villages

[Mean annual income per household in rupees)

Source of Income	Village			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
Crops	7,098 (1439)*	4,916 (963)	11,606 (2174)	2,036 (637)
All sources (total)	10,788 (1707)	22,163 (2718)	25,639 (3341)	11,339 (1404)
Contribution of crops to total income (%)	66	22	45	18

*Figures in parentheses are standard errors.

The mean income per household differs significantly both between villages and between land holding classes within each village (Appendix-2). Nattika is the most affluent village whereas Mulayam is the poorest. Considering the income from agriculture or all crops, although Nattika has highest income per household, as a percentage of the total income Mulayam has the highest income from crops. In Avinissery and Alathur the dependence on agriculture is relatively low. The share of agricultural income in the total income of households belonging to each land holding classes is given in Appendix-3. The share of agricultural income increases with size of land holding in Mulayam and Nattika. In Avinissery and Alathur the share of agricultural income rises with size of land holding up to a level, but in the highest land holding classes agriculture income is relatively low.

Households have been classified according to main source of income and their distribution is given in Table 6. The percentage of households depending on agriculture as the main source of income ranges from 61 in Mulayam to 16 Alathur.

In villages other than Mulayam the main source of income is earnings of resident members or employment. Income from remittance of non-resident members is the main source of income in 22 percent of households in Nattika. In none of the households surveyed in Mulayam. remittance was a main

source of income. This Table reveals the degree of dependence on agriculture of household in different villages.

Table 6. Percentage distribution of household according to main source of income in different villager

Source of income	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
Crops	60.7	19.0	31.6	15.6
Livestock, etc.	7.2	3.8	5.3	15.5
Earnings of residents	32.1	72.1	41.0	53.4
Others (remittance from non-residents,etc.)	0.0	5.1	22.1	15.5
Total	100.0	100.0	100.0	100.0

Total household income increases with size of land holding in all villages (Appendix-4). In Mulayam and Nattika income from crop increases with increase in size of land holding and in Avinissery a decline in income from crops is observed beyond land holding size 1.214 ha (300cents) (Appendix-5). The importance of non- agricultural source of income in Avinissery makes large land holding an indication of economic and social status rather than a source of income. In Alathur also the income from crops do not seem to increase in holdings beyond 0.405 ha (100 cents). In the absence of samples in the higher classes in that village the trend in income from crops cannot be commented on. The distribution of households according to income from all sources is given in Table 7. The villages can be classified as relatively poor

Table 7. Percentage distribution of households according to income from all sources in different villages

Annual income from all sources (Rs.)	Village			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<5,000	21.4	10.1	6.3	22.2
5,000-10,000	35.7	27.8	28.4	40.0
10.000-25,000	32.2	36.7	36.8	26.7
25,000-50,000	10.7	12.7	16.9	8.9
>50,000	0.0	12.7	11.6	2.2
Total	100.0	100.0	100.0	100.0

and rich. Avinissery and Nattika can be considered as rich since more than 60 percent of the households have an annual income above Rs.10,000. Households with income below Rs.5,000 is also low in Nattika and Avinissery. In Mulayam and Alathur, about 22 percent of the households have income below Rs.5,000.

The importance of agriculture as a source of income in different villages can be seen in Table 8. Mulayam and Alathur are two extremes in the lowest agriculture income class. Mulayam has only 14 percent of households while Alathur 67 percent. The distribution of households in the agricultural income class above Rs.25.000 shows that Nattika has highest percentage of 17 percent. Mulayam, which comes next has 7 percent. In Nattika, the dominance of coconut, which is a high income earning crop with 8 harvests per year, is the reason for high agricultural income. The main cash crop in Mulayam are vegetables and plantain which are both low value crops and provide only one harvest in an year. Pepper is another important cash-crop in Mulayam. However, the intensity of the crop is much lower than coconut in Nattika.

Table 8. Percentage distribution of households according to income from crops in different villages

Annual income from crops (Rs.)	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<1,000	14.3	45.6	22.1	66.7
1.000-5,000	35.7	26.6	36.9	20.0
5,000-10,000	32.1	10.1	12.6	2.2
10,000-25,000	10.7	13.9	11.6	11.1
>25,000	7.2	3.8	16.8	0.0
Total	100.0	100.0	100.0	100.0

Of the four villages surveyed, the pattern of land holding and agricultural land use differed. Various crop subsystems and livestock subsystems were found in the home gardens surveyed. Socioeconomic differences, particularly the dependence on agriculture. influenced the diversity of subsystems present in a home garden. While the oldness of the settlement and population density inversely affected the size of land holding, agroclimatic specificities influenced the cropping pattern.

CROPPING INTENSITY IN HOME GARDENS

Within each home garden, cropping intensities were worked out as described in section 2. The levels of cropping intensities of different groups of crops and inter-village comparison are presented here.

Analysis of variance was done for the intensities of seasonal and annual crops (ISC). perennial crops (IPC). seasonal and perennial crops combined, tree crops (ITC).miscellaneous crops (IMC) and all crops (IAC) (Appendix-6). The inter-village differences in intensity indices were significant between villages in all categories, except for miscellaneous crops.

Between size class of land holdings, the mean intensity indices were not significantly different in the case of miscellaneous crops as well as tree crops (Appendix-6).The intensity of different types of crops in different villages is given in Table 9.

Table 9. Intensity indices of different types of crops in different villages

(Mean intensity index per holding)

Crops	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
Seasonal and annual crops	29.47 (4.0)*	9.39 (0.9)	5.9 (0.7)	7.19 (1.8)
Perennial crops	18.11 (2.9)	43.38 (3.2)	78.69 (3.8)	26.44 (3.4)
Seasonal, annual and perennial crops (combined)	47.58 (4.8)	52.77 (3.6)	84.59 (3.9)	33.63 (4.3)
Tree crops	23.51 (2.7)	39.32 (2.6)	12.35 (1.5)	29.22 (3.2)
Perennial and tree crops (combined)	41.62 (4.2)	82.71 (4.1)	91.04 (4.0)	55.67 (4.7)
Miscellaneous crops	0.6 (0.2)	1.85 (0.5)	2.27 (0.3)	1.68 (0.4)
All crops	71.76 (4.6)	93.94 (4.4)	99.22 (4.1)	64.54 (5.5)

*Figures in parentheses are standard errors.

Seasonal and annual crops

The relative dependence of households on agriculture, particularly subsistence crops. among the villages can be seen in Table 10. Fifty percent of the number of households in Mulayam had intensity index of seasonal and annual crops above 25, while in all other villages it was less than 7 percent. In the intensity class above 50, none of the households in Avinissery and Nattika were present, while 18 percent of households in Mulayam had that distinction. Alathur had the largest number of households having very low intensity index for seasonal and annual crops.

Table 10. Percentage distribution of home gardens according to intensity index of seasonal and annual crops in different villages

Intensity index of seasonal and annual crops	Village			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<5	3.5	34.2	56.9	64.4
5-10	17.9	29.1	22.1	17.8
10-25	28.6	30.4	18.9	11.1
25-50	32.1	6.3	2.1	4.5
50-100	17.9	0.0	0.0	2.2
Total	100.0	100.0	100.0	100.0

Compared to all others, Mulayam has very high intensity of seasonal and annual crops. This Is partly due to the fact that households in Mulayam are more land-dependent than the rest, and seasonal annual crops are produced on a commercial scale for the market. In other villages these crops are usually for home consumption only. In Nattika due to sandy soil and high water table, the usual crops such as tapioca are not common. Further, the fairly complete canopy cover provided by coconut do not permit cultivation of light-demanding seasonal crops.

In Avinissery the dependence on agriculture is low and also family labour available for working on land is less due to employment opportunities in packing case and tile industries. With hired labour, production of seasonal and annual crops may not be remunerative.

Intensity indices of seasonal and annual crops in different land holding size classes in the selected villages are given in Appendix-7. Between classes

the intensity of seasonal and annual crops is increasing in Mulayam up to a holding size of 0.809 ha (200 cents). The suitability of land in Mulayam for seasonal and annual crops due to good soil and recent settlement is a factor which increases the intensity of such crops. Low opportunity cost of labour in the absence of other avenues of employment and the low income from other sources including that from perennial crops is another reason for the high intensity of seasonal and annual crops. This is an indication of subsistence cultivation and production for the market with household labour. There is a decline in Intensity in holdings above 0.809 ha (200 cents). Larger holdings require hired labour and hence lowering of intensity can be expected with the increase in size of holding. In Nattika, the decline in intensity in successive land holding classes is clearly brought out indicating higher subsistence cropping in lower size classes. However, in Avinissery and Alathur the highest intensity of seasonal and annual crops occur in the classes 0.405-0.809 ha (100-200 cents) and 0.202-0.405 ha (50-100 cents) respectively.

Correlation coefficients between intensity indices of cropping and size of land holding were calculated for seasonal and annual crops, perennial crops and tree crops (Table 11). The inverse relationship indicates that intensity is higher in smaller holdings. Correlation coefficient between seasonal and annual crops with size of land holding was significant in Mulayam village. The specific nature of the land and agricultural population in Mulayam are responsible for this relationship. The land has been brought under cultivation only recently and Mgh yields for all crops are possible. As the settlement is yet to reach the mature phase in land development and intensification of perennial crops, seasonal and annual crops have high importance.

Table 11. Correlation between size of land holding and intensity of cropping

Between variables	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
ISC & SLH	-0.46*	-0.01	-0.23	-0.06
IPC & SLH	0.25	0.09	-0.42*	-0.28
ITC & SLH	0.10	-0.36*	0.07	-0.06

*1-tailed significance at 1 percent level.

ISC : Intensity of seasonal and annual crops
IPC : Intensity of perennia1 crops
ITC : Intensity of tree crops
SLH : Size of land holding

The higher intensity observed in smaller holding is due to greater efforts to meet survival needs. Smaller holdings had higher intensity of perennial crops in the case of Nattika and tree crops in Avinissery.

Perennial crops

Analysis of variance has shown that the mean intensity indices of perennial crops is significantly different between villages and land holding classes (Appendix-6). Comparison of indices between size classes indicates that with the increase in the size of land holding, the indices are decreasing in Nattika and Alathur villages (Appendix-8).But the picture in Avinissery is entirely different. the indices show a slightly increasing trend with respect to size of holding which is due to the species combination with more number of perennial crops (See Appendix-17.2). But the slight increase in the intensity indices in Mulayam village is due to the intensive cultivation of pepper.

The low intensity of tree crops in Nattika should not give the impression that there are few trees in Nattika. The perennial crops components which include coconut and arecanut palms is well represented in Nattika. Table 12 gives percentage distribution of home gardens according to intensity of perennial crops. Nattika has half the number of home gardens in the higher intensity classes (above 75).None of the home gardens in Mulayam was found in the higher class. In the intensity class for perennial crops above 100, Nattika had 32 percent of home gardens while Avinissery which came next had only 4 percent of the home gardens with similar intensity. Even in the

Table 12. Percentage distribution of home gardens according to intensity index of perennial crops in different villages

Intensity index of perennial crops	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<25	67.9	26.2	9.5	53.3
25-50	28.6	36.7	10.5	28.9
50-75	3.5	24.0	30.5	13.3
75-100	0.0	8.9	17.9	4.5
100-125	0.0	2.5	21.0	0.0
125-150	0.0	1.3	7.4	0.0
Above 150	0.0	0.0	3.2	0.0
Total	100.0	100.0	100.0	100.0

matter of perennial crops, Alathur performed better than Mulayam. Considering the proportion of households depending on agriculture in Mulayam (Table 6) the relative low intensity of perennial crops in Mulayam is due to the newness of the settlement compared to other villages. Perennial crops require time to develop not only for the crops to mature but also for the households to accumulate enough capital to invest.

Comparing the intensity indices for perennial crops in different villages, the highest intensity (79) is in Nattika which is very high compared to 18 in Mulayam (Table 9). The high density of coconut in Nattika is responsible for the high intensity of perennial crops. The land in Nattika is ideally suited for coconut. The number of coconut palms per hectare is highest in Nattika which has 177 compared to only 29 in Mulayam (Table 13). Arecanut is more common in Avinissery which has 126 palms per hectare. Alathur has the lowest number of arecanut palms.

Table 13. Number of coconut and arecanut palms in different villages

(number per ha)

Crops	Village			
	Mulayam	Avinissery	Nattika	Alathur
Coconut	29.1 (22.2)**	129.4 (41.9)	177.4 (54.7)	100.5* (26.0)
Arecanut	32.6 (15.2)	126.5 (18.5)	94.7 (22.0)	2.9 (0.0)

***Includes 4 palmyra palms also.**

****Figures in parentheses denote the number of young palsms.**

The low intensity of perennial crops in Mulayam is due to several factors of which the newness of the settlement is an important reason. The low income and meagre accumulated wealth in Mulayam is another reason. Establishing of perennial crops involves long waiting periods and high cost of inputs. Further, the current income from seasonal crops has to be forgone before yield from perennial crops such as coconut is realised. Unlike in other areas, the preferred perennial crop in Mulayam is pepper. Annual crops such as ginger ***(Zingiber officinale),*** turmeric ***(Cureuma domestics).*** etc. are complimentary to pepper cultivation. In Alathur. on the other hand, scarcity of water is one of the reasons for the low intensity of perennial crops. Tamarind and neem ***(Azadirachta indica)*** are two trees that are very frequent in house

compounds in Alathur. Although these trees fetch income from their fruits, they have not been considered as perennial crops. Even though the land in Alathur is not ideal for perennial crops such as coconut, they are grown due to the need for the produce for home consumption.

Seasonal, annual and perennial crops combined

Considering all agricultural crops together, that is. seasonal, annual and perennial crops combined, the development of agriculture is highest in Nattika with 87 percent of households having intensity index over 50 (Table 14). About 33 percent of households were located in the intensity class

Table 14. Percentage distribution of home gardens according to intensity index of seasonal, annual and perennial crops (combined) in different villages

Intensity index of seasonal, annual and perennial crops	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<10	3.5	6.3	4.2	20.0
10-25	25.0	10.1	4.2	24.5
25-50	21.5	34.2	4.2	33.3
50-75	35.7	27.8	29.5	15.6
75-100	14.3	12.7	25.3	4.4
Above 100	0.0	8.9	32.6	2.2
Total	100.0	100.0	100.0	100.0

above 100. In the same class no household was present in Mulayam and only 2 percent of the households in Alathur. Although Mulayam concentrated on seasonal and annual crops and Avinissery on perennial crops, when their total agricultural performance is considered they have a similar household distribution. In the intensity class above 50 both villages have around 50 percent of the households. Taking into consideration the fact that Avinissery Village is an old settlement and Mulayam a new settlement, if we consider the natural endowment as similar we could expect agriculture in Mulayam to transform itself to the pattern of Avinissery in course of time. The settlers in Mulayam, although having Iarger holding, can switch over to perennial crops only gradually as they do not have enough capital. The interesting finding is that if we consider Mulayam to be in transition towards intensifying perennial crops, the intensity of agriculture in an aggregate sense may remain

the same even though a shift in composition can be expected. Among all villages, Alathur had highest number of households in the lower intensity class for all agricultural crops. The low intensity of seasonal and annual crops in Alathur is the primary reason for this.

Seasonal, annual and perennial crops represent the totality of agricultural crops. Comparison of the combined intensity index of these crops shows that Nattika has the highest intensity, while it is lowest in Alathur (Table 9). Relatively poor land and water scarcity could have influenced the low intensity in Alathur. In Mulayam also the Intensity is low. This is due to the deficit in perennial crops such as coconut. The inter-class difference in intensity of seasonal, annual and perennial crops is significant (See Appendices 6 and 9). Highest intensity of seasonal, annual and perennial crop combined was found in the smallest size class of land holding in only two villages (Nattika and Alathur). In the other two, the highest intensity was observed in the largest size class of land holding. Among the four villages, while the intensity was declining with size of holding in two villages, it was increasing with size of holding in the other two. The debate on farm size and productivity has to be re-examined to see whether locatlonal differences do change the location of the highest productivity farms. The crop-mix. history of land development, the main commercial crops grown, the land dependence and other factors influence the intensity of cropping. This is a complex phenomena: with the type of agriculture and the level of technology used, the optimum size of the farm for the highest intensity of seasonal, annual and perennial crops combined is different in different villages.

Tree crops

While Nattika had the highest intensity index for all crops, considering the component of tree crops alone Nattika's performance is dismal. In the intensity class above 50, Avinissery had the largest number of home gardens (28 percent). This is followed by Alathur with 18 percent and Mulayam 7 percent (Table 15). Comparatively Nattika had only 2 percent of home gardens in the higher classes (above 50). In the matter of tree crops the achievement of Avinissery is remarkable. The lowest intensity class (below 10) contained only 8 percent of home gardens while in the same class in Mulayam and Alathur 18 to 20 percent of home gardens are found. More than half the number of home gardens (54 percent) in Nattika had tree cropping intensity below 10.

Table 15. Percentage distribution of home gardens according to intensity index of trees in different villages

Intensity index of trees	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 93	Alathur n = 45
<10	17.9	7.6	53.7	20.0
10-25	42.9	21.5	29.4	31.1
25-50	32.1	43.0	14.7	31.1
50-75	7.1	21.5	1.1	15.6
75-100	0.0	5.1	1.1	2.2
100-125	0.0	1.3	0.0	0.0
Total	100.0	100.0	100.0	100.0

The intensity of tree crops alone (Table 9) shows that Avinissery has the highest tree cover, while Nattika has the lowest. This does not mean that it is possible to increase the number of trees in the farm lands of Nattika because it already has avery high density of perennial crops such as coconut. Surprisingly Alathur has a higher intensity of tree crops than Mulayam which adjoins a forest area. One important reason for the low intensity of trees in Mulayam is the methodology adopted for estimating the intensity of tree crops. The area occupied by the crown alone was considered irrespective of the number. Mulayam which has a very high density of pepper also has trees supporting the pepper crop. During the time of field survey the pepper supports were pruned for green manure and also to admit more light during the rainy season and so the crown area was extremely small. Alathur has a large number of tamarind and neem trees. In all the villages commercial trees dominate, while Avinissery has a mixture of multipurpose trees. The oldness of the settlement and very high non-agricultural income in Avinissery compared to other villages may be a reason for maintaining a mixture of multipurpose trees in preference to commercial tree crops.

Between size classes the intensity indices of tree crops is not significantly different in any village (Appendices 6 and 10). The lack of significant differences in tree cropping intensity between size classes of holding is striking. Several explanations can be given for this. Due to socio-cultural reasons or tradition, a mixed cropping practice is adopted by most households. In this, multipurpose trees producing items for home consumption has a prominent place. Even within a group such as fruit producing trees,

there is a tremendous diversity of trees which a larger holding can accommodate. Species diversity is discussed in Section 5.2. Larger holdings also have larger perimeter of boundary where trees are grown or retained. In large holdings, older trees with large crown are generally retained thereby increasing the intensity of tree crops proportionately. However, the density of trees in different size of land holding vary considerably (See Appendices 11.1 to 11.4). While in Nattika and Avinissery higher density of important trees are found in smaller holdings. no such clear pattern is seen in the case of Mulayam and Alathur villages. In different diameter classes of trees, the density also varies. The larger number of trees in the smaller diameter classes reflect the survival as a cumulative process of new planting, removal and mortality.

Perennial and tree crops combined

To get a better picture of the tree cover in all villages, Table 16 gives the percentage distribution of home gardens according to the combined intensity of tree crops and perennial crops. In the intensity class above 100 Nattika had 38 percent of home gardens while Avinissery had 29 percent, Alathur 11 percent and Mulayam zero. In the lowest intensity class, Mulayam had the highest number of home gardens followed by Alathur. Avinissery and Nattika had the least number of home gardens in the lowest intensity class.

When the combined intensity of perennial crops and tree crops is considered, Nattika ranks first followed by Avinissery, Alathur and Mulayam.

Table 16. Percentage distribution of home gardens according to intensity index of tree crops and perennial crops (combined)in different villages

Intensity index of perennial crops and trees combined	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<25	25.0	6.3	5.3	15.6
25-50	39.3	8.8	7.4	35.5
50-75	25.0	30.4	25.2	22.2
75-100	10.7	25.3	24.2	15.6
100-125	0.0	22.8	17.9	6.7
125-150	0.0	1.3	11.6	4.4
>150	0.0	5.1	8.4	0.0
Total	100.0	100.0	100.0	100.0

The small number of coconut trees in Mulayam is an important reason for the low intensity in that village (See Table 13). When the number of all trees and palms are considered, Avinissery has the highest density with 463 trees per hectare, whereas Mulayam has 348 which is the lowest (Table 17). In spite of the fact that the villages belong to different agro-climatic regions and have greatly varying tree composition, the density of all trees and palms together do not exhibit much variability. This may be due to an ingrained tree culture peculiar to Kerala.

Table 17. Density of trees and palms combined in different villages

(Number per ha)

Crops	Villages			
	Mulayam	Avinissery	Nattika	Alathur
Trees	286.7 (50.3)*	206.8 (104.3)	138.0 (57.0	275.5 (236.5)
Palms@	61.7 (37.4)	255.9 (60.4)	272.1 (76.7)	103.4** (26.0)
Total	348.4 (87.7)	462.7 (164.7)	410.1 (133.7)	378.9 (262.5)

The figures in parentheses denote young trees (below 5 cm dbh) and young palms (without stemwood)

****Includes 4 palmyra palms.**

@Coconut and arecanut.

The inter-class comparison shows that the highest intensity of trees and perennial crops together is found in the lowest land holding class in three out of four villages, Mulayam being the exception (Appendix-12). This is an important finding when considering the extension of tree crops in government programmes such as farm forestry.

Miscellaneous crops

In the category of miscellaneous crops, Alathur had highest number of home gardens with intensity index of miscellaneous crops above 10 (Table 18). Mulayam had the largest number of home gardens in the lowest intensity class for miscellaneous crops.

Table 18. Percentage distribution of home gardens according to intensity index of miscellaneous crops in different villager

Intensity index of miscellaneous crops	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<5	94.4	93.7	84.2	86.8
5-10	5.6	2.5	9.5	6.6
10-25	0.0	3.8	6.3	6.6
Total	100.0	100.0	100.0	100.0

The intensity of miscellaneous crops is not significantly different either between villages or between classes (Appendices 6 and 13). Miscellaneous crops include bamboo *(Bambusa bamboo).* Gliricidia and other species grown as live fence, *kaitha (Pandanus* sp.) fodder grass. etc. The differences in the composition of miscellaneous crops is due to local abundance or preference. Commercial crops like coconut require fencing to protect against others walking away with high value produce such as coconuts. In coastal areas even coconut leaf is high priced due to its demand as a thatching material. Nattika also has a large number of *kaitha* a fence crop, which provides material for weaving mats. In Avinissery *gliricidia* grown as fence and for green manure, is the most common species in the category. In Alathur bamboo occurs naturally and fetches income from poles and thorns. In Mulayam, on the other hand, due to the large size of holding and the small number of coconut palms, live fence using the species defined as miscellaneous crops is not frequent. Green manure is available from a variety of trees left over from the previous forest vegetation or from adjoining forests in Mulayam so that there is no necessity of growing such crops in the compounds.

All crops

Distribution of home gardens according to the intensity index of all crops is given in Table 19. Nattika has highest percentage of home gardens in the highest intensity class. There are no home gardens in Mulayam with intensity above 125 in the sample. Compared to Mulayam, Alathur has higher percentage of home gardens in the intensity class above 100. Home gardens with very low intensity is highest in Alathur with 42 percent of the home gardens having intensity index less than 50. The percentage home gardens

in the lowest intensity class (2) is 8 in both Nattika and Avinissery which is the lowest among the villages. It can be seen that Nattika and Avinissery have not only the largest number of home gardens in the higher intensity classes but also that the over all performance is much better than the other two villages in the matter of total intensity of cropping. Figures 2 to 5 illustrates some typical home garden vegetation in the study area.

Table 19. Percentage distribution of home gardens according to intensity index of all crops in different villages

Total index of all crops	Villages			
	Mulayam n = 2 8	Avinissery n = 79	Nattika n = 95	Alathur n = 45
<25	7.1	1.3	4.2	11.1
25-50	14.3	6.3	4.2	31.1
50-75	21.5	29.1	22.1	20.0
75-100	50.0	25.4	23.2	24.5
100-125	7.1	17.7	17.9	6.7
125-150	0.0	13.9	14.7	2.2
>150	0.0	6.3	13.7	4.4
Total	100.0	100.0	100.0	100.0

Nattika has the highest intensity when the intensity index of all crops is considered (Table 9). Alathur has the lowest cropping intensity. The highest intensity of all crops combined was found in the lowest size class (below 0.101 ha or 25 cents) in two out of the four villages (Nattika and Alathur). Even in the other two. the highest intensity was observed in the classes below 0.809 ha (200 cents) (Appendix-14). Higher intensity is primarily due to the increase in the perennial crop component. The increase in the perennial crops can be viewed as capital accumulation on land. The perennial crop component is influenced by time (period of settlement) and investments in land development. Therefore older settlements and affluent areas can be expected to have higher intensity of perennial crops. The quality of the soil. particularly the crop options it provides. is another factor. Survival needs and the capital accumulated also influence the crop-mix which in turn influences the cropping intensity. Only when survival needs are satisfied and sufficient capital is accumulated, perennial crops which require high investment and long waiting period can be intensified. Although the number of households depending on agriculture is highest in Mulayam (Table 7) and contribution

Fig.4. Typical home garden vegetation in a small holding in Nattika Village

Fig. 5. Typical home garden vegetation in a large holding in Nattika Village

Fig. 2. Typical home garden vegetation in a large holding in Mulayam Village

Fig. 3. Typical home garden vegetation in a large holdings in Avinissery Village

of agriculture to total income is also the highest in Mulayam (Table 6). total intensity is apparently low. This is due to the fact that in Mulayam. agriculture revolves around seasonal crops that contribute to subsistence needs but has relatively low intensity due to shorter duration. The lack of electricity connection in most households in Mulayam limits the capacity to irrigate farms. Further. tenure issues such as lack of permanent title deeds to property and consequent non-availability of credit, subsidy and extension services are factors lowering investment in perennial crops in Mulayam.

Intensity of trees and mode of acquisition of land

Comparison of intensity index of trees between home gardens acquired by inheritance and those purchased shows that the intensity of trees is lower in garden lands in the category of 'purchased' (Table **20).** It was hypothesised that before sale of garden land, valuable timber trees like teak, anjily, jack, etc. are cut and removed. The difference in mean intensity index of tree crops,

Table 20. Intensity index of trees and mode of acquisition of land in different villages

Village	Inherited			Purchased		
	Mean	Min.	Max.	Mean	Min.	Max.
Mulayam	25.5 (7.6)*	7.6	55.4	21.4 (4.3)	3.6	45.8
Avinissery	41.0 (3.1)	0	119.5	36.8 (5.1)	6.0	85.2
Nattika	14.6 (2.0)	0.1	79.4	4.1 (1.6)	0	25.4
Alathur	34.4 (5.1)	6.2	96.6	22.9	0	66.2

Mean: Minimum value;

Max.: Maximum value;

*Figures in parentheses are standard errors

however, did not show statistical significance. Aggregation of valuable and non-valuable trees may have contributed to the lack of statistical significance in the mean intensity indices. Further no cut-off date was considered for garden lands included in the 'purchased' category. Normally tree density is expected to increase over time, in purchased lands either as a form of investment or for shade, except in the case of very small plots for residential purposes.

DIVERSITY OF TREES AND DYNAMICS OF THE HOME GARDEN SYSTEM

Distribution of trees

Density of trees in home gardens in different villages is given in Table **21.** Among trees, the category defined as multipurpose has the largest number in all villages ranging from 50 percent to 70 percent of all trees. The next largest category is timber trees accounting for 20 to 36 percent of all trees in different villages. The relatively low position occupied by fruit trees is deceptive. The important fruit trees such as mango, jack, cashew, tamarind, etc. have been considered as multipurpose trees and hence not included under fruit trees. Fruit trees have been defined in this study to cover trees with only fruit value and very low wood values. The category of ornamental trees occupy the lowest position in all villages ranging from 0.1 to 2.8 percent of all trees. The classification as ornamental was quite arbitrary since all trees have different degrees of ornamental value. In this study only trees with very low wood value have been included as ornamental. It must be mentioned that no category of fuel trees could be jdentified in home gardens. Tree seedlings planted or retained out of natural regeneration have multipurpose qualities or commercial wood value or provide fruit or ornamental benefits. No trees are grown exclusively for fuel. The only tree that provide fuel material continuously is coconut which is also good fuel wood when felled. Even a few households, which have planted eucalypts distributed through school children, did so anticipating the use of eucalypts leaves for its medicinal properties.

Distribution of trees in home garden, in different villages is given in Appendices 15.1 to 15.4. Trees are grouped into five diameter classes (5-15, 15-30.30-45.45-60 and above 60 cm). The number of trees in each diameter class is shown on per hectare basis. The lowest diameter class contains the highest number of trees ranging from 95 (in Nattika) to 200 (in Mulayam) trees per ha in different villages. The distribution pattern of trees in the higher diameter classes (above 45 cm dbh) shows a different picture. Alathur has 18 trees while Mulayam has 11. Avinissery has 9 and Nattika has only 6 trees per ha. An observation that comes out of this data is that the interest in

Table 21. Density of trees (above 5 cm dbh) in home gardens in different villager

(number per ha)

Trees	Village							
	Mulayam		Avinissery		Nattika		Alathur	
	No.	%	No.	%	No.	%	No.	%
Multipurpose								
Jack	20.7	7.7	19.3	9.3	6.4	4.6	9.9	3.6
Mango	10.3	3.8	24.2	11.7	21.9	15.9	35.6	12.9
Cashew	25.2	9.4	25.3	12.2	16.7	12.1	5.2	1.9
Tamarind	1.9	0.7	6.0	2.9	1.3	0.9	52.7	19.1
Erythrina	99.0	36.8	7.0	3.4	0.4	0.3	1.5	0.5
Others	24.4	9.1	69.4	30.2	36.2	26.3	32.4	11.8
Sub total	181.5	67.5	144.3	69.8	82.9	60.0	137.3	49.8
Timber								
	0.4	0.1	0.1	0.1	8.2	5.9	0.0	0.0
Kanjiram[1]	0.8	0.2	4.6	2.2	0.5	0.4	0.0	0.0
Maruthy[2]	10.3	3.9	0.3	0.2	0.0	0.0	0.0	0.0
Mullilam[3]	0.9	0.4	0.9	0.4	0.0	0.0	0.8	0.3
Pala[4]	0.6	0.2	2.3	1.1	0.3	0.2	0.7	0.3
Teak	1.3	0.5	3.0	1.5	0.8	0.6	54.3	19.7
Others	39.6	14.8	29.1	14.0	28.9	20.9	42.9	15.5
Sub total	53.9	20.1	40.3	19.5	38.7	28.0	98.7	35.8
Fruit								
Custard apple	0.4	0.1	2.2	1.0	1.1	0.8	5.5	2.0
Drum stick	28.7	10.7	7.0	3.4	4.3	3.1	15.7	5.7
Lime	1.2	0.4	1.2	0.6	0.6	0.4	2.9	1.1
Guava	1.0	0.4	4.1	2.0	2.7	2.0	3.7	1.3
Others	1.8	0.7	4.4	2.1	4.5	3.3	4.1	1.5
Sub total	33.1	12.3	18.9	9.1	13.2	9.6	31.9	11.6
Ornamental								
Arunamaram	0.0	0.0	0.0	0.0	1.1	0.8	1.1	0.4
Chembakom	0.0	0.0	0.4	0.2	0.2	0.1	0.4	0.1
Others	0.2	0.1	2.9	1.4	1.9	1.4	6.3	2.3
Sub total	0.2	0.1	3.3	1.6	3.2	2.3	7.8	2.8
Total	286.7	100.0	206.8	100.0	138.0	100.0	275.5	100.0

1 *Strychnos nux-vomica* 2 *Terminalia paniculata*

3 *Zanthoxylum rhetsa,* 4 *Alstonia scholaris*

Table 22. Distribution of trees below 5 cm (dbh) in home gardens in different villages

(number per ha)

Trees	Village							
	Mulayam		Avinissery		Nattika		Alathur	
	No.	%	No.	%	No.	%	No.	%
Multipurpose								
Cashew	2.8	5.0	5.9	5.6	5.4	9.5	2.6	1.1
Jack	3.9	7.8	5.8	5.6	2.8	4.9	9.9	4.2
Mango	2.3	4.6	6.7	6.4	7.1	12.5	26.0	10.9
Neem	0.0	0.0	0.3	0.3	1.5	2.6	7.7	3.3
Tamarind	1.0	2.0	3.4	3.3	0.9	1.6	27.9	11.8
Others	14.2	28.2	31.5	30.2	4.3	7.5	9.5	4.0
sub total	24.2	48.1.	53.6	51.4	22.0	38.6	83.6	35.3
Timber								
Anjily	0.4	0.8	0.0	0.0	3.6	6.3	0.0	0.0
Kanikonna[1]	0.2	0.4	0.5	0.4	0.1	0.2	1.8	0.7
Kanjiram	0.2	0.4	2.5	2.4	0.1	0.2	0.4	0.2
Matty	1.5	3.0	1.7	1.6	0.1	0.2	0.0	0.0
	0.2	0.4	1.2	1.2	0.2	0.4	0.4	0.2
Rosewood	0.5	1.0	0.0	0.0	1.1	1.9	0.0	0.0
Teak	0.4	0.8	3.3	3.2	0.3	0.5	33.7	14.2
Mullilam	0.2	0.4	0.5	0.5	0.0	0.0	0.4	0.2
Thanni[2]	1.4	2.7	0.1	0.1	0.1	0.2	0.0	0.0
Others	10.8	21.5	19.5	18.7	15.4	26.9	57.6	24.4
sub total	15.8	31.4	29.3	28.1	21.0	36.8	94.3	39.9
Fruit								
Custard apple	0.3	0.6	2.2	2.1	1.4	2.4	4.0	1.7
Bread fruit	0.0	0.0	0.7	0.7	0.5	0.9	0.4	0.2
Drum stick	7.6	15.1	4.2	4.0	1.3	2.3	12.8	5.4
Lime	1.1	2.2	2.3	2.2	2.1	3.7	6.6	2.8
Guava	0.9	1.8	5.1	4.9	2.5	4.4	4.0	1.7
Others	0.3	0.6	2.8	2.7	2.0	3.5	2.2	0.9
sub total	10.2	20.3	17.3	16.6	9.8	17.2	30.0	12.7
Ornamental								
Aranamaram	0.0	0.0	1.3	1.2	0.9	1.6	4.4	1.9
Chembakom	0.0	0.0	0.5	0.5	0.5	0.9	0.7	0.3
Others	0.1	0.2	2.3	2.2	2.8	4.9	23.5	9.9
sub total	0.1	0.2	4.1	3.9	4.2	7.4	28.6	12.1
Total	60.3	100.0	104.3	100.0	57.0	100.0	236.5	100.0

***Percentage to total**

1. Cassia fistula 2. Terminalia

planting tree seedlings and that in maintaining as well as retaining them Over a period of time are not identical. Many trees in the lowest class may not reach the higher classes due to natural mortality or deliberate removal. In retaining trees definite preference for multipurpose trees is evident. One would expect timber trees to dominate the larger diameter classes since price of large diameter Umber is many times more than that of small diameter timber. However, the trend is to retain multipurpose trees in preference to other categories including timber trees. This is true for all villages except Mulayam where the largest class contains large number of timber trees. The presence of larger diameter timber trees in Mulayam is due to the forest vegetation in the area till recently and restrictions imposed by the Forest Department in felling and transporting timber trees. It is the newness of the settlement and the relict forest vegetation which are the reasons for this type of distribution in Mulayam. The preference for multipurpose trees by house-holds even in Mulayam can be observed since multipurpose trees account for 145 trees per ha while timber trees account for only 28 in the lowest diameter class. Regional variation in preference even within the group of multipurpose trees is seen. Trees generating cash income from produce occupy the highest place among trees. Cashew and mango in Avinissery, tamarind and mango in Alathur, mango and cashew in Nattika and erythrina and cashew in mulayam occupy the top positions. Erythrina is a support for peppervine which is the most important cash crop in Mulayam. Jack is common to all villages and occupies either third or fourth position everywhere.

Table 22 shows the distribution of tree saplings (below 5 cm dbh) in different villages. Contrary to the pattern in distribution in the higher diameter classes (Table 21), the proportion of multipurpose trees is seen reduced ranging from 15 to 51 percent of the total saplings in each village. The other tree categories have increased their proportion in the total number. Saplings of fruit trees have increased proportionately more than others. This indicates an increased preference for fruit trees. However, multipurpose trees continue to be the most preferred group for new planting also.

Diversity of trees

Diversity of crops in home gardens is analysed in this section. The mean number of species per holding differs significantly between villages as well as size of land holding for all groups of crops (See Appendix-16). Species diversity is highest in Mulayam for all groups of crops except fruit and ornamental

categories (Table 23). Nattika has the highest diversity for fruit and ornamental group of trees. Considering all trees together, Mulayam leads with 24 tree species per holding compared to only 9 tree species in Alathur. The total number of tree species found in each village is given in Table 24. The species diversity within the category of trees is maximum in Avinissery and minimum in Alathur.

Table 23. Species diversity in home gardens

(Mean number of species per holding)

Type of crop	Village			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
Seasonal and annual crops	9.0 (0.7)*	6.3 (0.3)	5.8 (0.3)	3.5 (0.4)
Perennial crops	3.7 (0.3)	2.7 (0.1)	2.4 (0.1)	1.4 (0.1)
Trees				
Multipurpose	7.0 (0.4)	6.1 (0.2)	5.3 (0.3)	3.7 (0.3)
Timber	12.5 (1.4)	5.3 (0.4)	4.5 (0.3)	2.0 (0.2)
Fruit	4.4 (0.4)	3.9 (0.2)	4.8 (0.3)	2.5 (0.3)
Ornamental	0.4 (0.1)	1.1 (0.1)	1.6 (0.2)	0.9 (0.1)
All trees	24.3 (1.9)	16.4 (0.7)	16.2 (0.8)	9.2 (0.7)

*Figures in parentheses are standard errors.

The minimum and maximum number of species in home gardens in different land holding classes is given in Appendices 17.1 to 17.7. Tree diversity within home garden is highest in Nattika with 52 species while Avinissery. which has the highest diversity on a village basis, had only a maximum of 30 species within any home garden. The number of species in all groups of crops increases with the size of holding in all villages. However, in Nattika in land holding classes above 1.214 ha (300 cents), there is a decline in the diversity of seasonal and perennial crops. In all villages, in the case of trees, the increase in diversity with the size of holding is evident in all classes.

Table 24. Tree species diversity in different villages

Item	Villages			
	Mulayam	Avinissery	Nattika	Alathur
Number of species	99	118	108	65

Contrary to expectation Mulayam village which had a forest vegetation till quite recently has a tree diversity lower than Avinissery and Nattika villages (Table 24). Tree diversity depends on cultural factors and the length of occupancy contributes to increasing the diversity of trees. Although in old settlements diversity is higher, a large proportion of species belong to useful categories or ornamental trees. With intensification of agriculture and modification of the natural vegetation. how many of the original tree species will either be retained or regenerated cannot be predicted. Of the four villages surveyed, sacred groves were noticed only in Nattika and Avinissery. The data presented does not include the species diversity in sacred groves.

Dynamics of the home garden system

The home garden system and the system dynamics has been described in Nair and Krishnankutty (1985). The traditional home garden system consists of several components which are linked together into an integrated whole. At the centre is the household with its land holding. The land use in the home garden is influenced by the crops already existing and the socio-economic situation of the household. The crops already existing may consist of different species of trees. Some tree crops such as coconut, arecanut, cocoa, etc., have been considered as perennial crops due to reasons given earlier. The other components are seasonal and annual crops, rice and other wet land crops, livestock and poultry.

The history of previous land development, the size of holding, family labour availability and the socio-economic level of the household determine the intensity of cropping, and the presence or absence of different components. Large holdings with low intensity of cropping may contain relatively large proportion of uncultivated or underutilised areas within. The tilised areas usually contain a variety of tree species.

The ideal state traditional home garden system can be disrupted by several factors. Reduction in size of holding by partitioning or sale of land and decline in income levels can destabilise the system. Reduction in size of holding tends to intensify cultivation initially by expansion to the underutilised areas. Intensificatlon usually involves replacement of miscellaneous tree growth with perennial crops. With intensification the diversity of trees will be reduced.

Nair and Krishnankutty (1985) indicated that with progressive reduction in size of holding, farmers totally dependent on agricultural income will be pauperised resulting in sale of land followed by migration to forests for encroachment. The buyers of land will adopt intensive commercial cultivation selecting quick yielding crops often as a monoculture. This is at variance with the traditional home garden system.

Although this could be the long term trend the pace of change is not very fast. Non-agricultural income and cultural factors have retarded a rapid movement towards intensive commercial farming in home gardens.

Sustainability

The question of sustainability of home garden system has been raised in Nair and Krishnankutty (1985). That the traditional home garden system is in transition is beyond doubt. The process of intensification of cultivation is very much in evidence. Reduction in the number of sub-systems consequent to the reduction in the size of holding and reduction in the degree of dependence on agriculture of the households will affect the home garden system as a whole. However, increase in non-agricultural income and the cultural heritage retards the progress towards highly intensive commercial farming. The maintenance of a mixed vegetation consisting of multipurpose trees, fruit trees, ornamental plants and trees along with food and cash crops is part of the cultural tradition of Kerala which has evolved over centuries. Replacement of low value vegetation with improved varieties of useful species does take place. This will reduce the number of indigenous trees which were retained in large holdings in the less intensive phase. Further intensive commercial monoculture cultivation using purchased fertilisers. pesticides and weedicides in homesteads is not in evidence particularly in the present context of escalating prices of such inputs. The Kerala farmers being highly literate and being fairly familiar with the literature on the toxic effects of high doses of chemical inputs would limit the use of such inputs to the cash crops

meant for the market only. Although impoverishment of of the genetic base of the home garden vegetation is rapidly occurring a major ecological crisis in the home gardens is not imminent.

Thus it can be said that in the long run the traditional home garden system is unlikely to be sustained due to the reduction in the size of holding and reduction in the dependence on agriculture of the households. Amodified form of the traditional system with fewer components and a higher proportion of perennial crops is becoming the norm. The wide range of perennial crops which can be grown in intimate mixtures in each region makes for high diversity in home gardens. Trees for home gardens therefore have to have either high value or multipurpose qualities to be acceptable.

CONCLUSIONS

This study is based on a survey of four villages representing different agro-climatic regions in Kerala. The differences in agro-climatic region, age of settlement and population density determine the different cropping patterns.

Within the home garden system, several subsystems function. A range of crop subsystems from rice to tree crops and a livestock subsystem was observed in all the villages. Socioeconomic differences between households have contributed to the presence or absence of particular subsystems in different home gardens. The highest percentage of households, where all subsystems were present, was found in Mulayam village which had the highest dependence on agriculture.

Cropping intensity indices for mixed cropping agriculture where trees are also present, were developed for comparison of agroforestry practices. The cropping intensity of all groups of crops, except miscellaneous crops, vary both between villages and sizes of land holding. No difference was observed in the cropping intensity of tree crops between size classes of holding in all villages. However, density of trees (in number) showed much variation. Although differences in the intensity of tree crops between garden lands acquired by inheritance and by purchase was expected, no significant difference was found. In the perennial crop group, Nattika village had the highest density. This was due to the high density of coconut palms.

In the villages studied, opposing trends were observed in the combined intensities of seasonal, annual and perennial crops. While the intensities of these crops increase with size of holding in Mulayam and Avinissery villages, it declines with size of holding in Nattika and Alathur villages. This was due to the relative differences in the intensity of perennial crops.

With increase in the intensity of perennial crops, intensity of trees declines. Nattika village has the highest intensity of perennial crops and the lowest intensity of tree crops. When the combined intensity of perennial and tree crops was considered, the highest intensity was found in the smallest size classes of holdings in all villages except Mulayam. Considering the

intensity of all crops together, it was found that smaller holdings have relatively higher cropping intensities.

Among trees in home gardens, the category of multi-purpose trees (MPT) accounted for 50 to 70 percent in different villages. The next largest category consisted of trees grown for timber. Among trees and palms, coconut had the highest density in all villages. The exception was erythrina in Mulayam village where it was grown in large numbers as standards for the pepper vines. The distribution of trees according to size classes shows a marked preference for multipurpose trees both for new planting as well as in the highest diameter classes in all villages.

The mean number of trees was found to be significantly different between villages and between size classes of holding. In all villages. increase in tree diversity was noticed with increase in size of holding.

Nattika Village with the highest mean annual household income had the highest intensity where all crops were considered. Highest intensity of trees was observed in Avinissery Village which had the largest percentage of households with main source of income from non-agricultural sources, specifically, earnings of resident members, remittances from non-resident members, etc.

Socio-economic factors such as size of landholding, level and source of household income, number of sub-systems present in the home garden and their period of development, etc. within the limits of agro-climatic and edaphic conditions have contributed to the intensificatlon of cultivation in home gardens. It was found that multi-purpose trees or trees with high value are preferred for new planting in home gardens.

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Appendix-1. Area under non-agricultural we within home gardens in different villages (in percentage)

Size of land holding (inha.)	villages			
	Mulayam n = 2 8	Avinissery n = 7 9	Nattika n = 9 5	Alathur n = 4 5
0.020-0.101	NA*	24	26	45
0.101-0.202	7	16	15	25
0.202-0.405	6	16	11	14
0.405-0.809	5 1	10	8	52
0.809-1.214	3 1	6	8	NA
1.214-2.023	2	7	8	NA
Above 2.023	NA	NA	7	NA
All Classes	3	11	10	31

'Sample not available

Appendix-2. Analysis of variance for household income from crops and all sources

Source of variation	Degrees of freedom	F-value	
		Income from crops	Income from all sources
Village	3	5.593**	11.016**
Land holding size class	6	85.864**	29.130**
Residual	237		

**Significant at 1 per cent level

Appendix-3. Agriculture income as percentage of total household income in different land holding classes

Size of holding (in ha.)	Villages			
	Mulayam n = 28	Avinissery n = 79	Nattika n = 95	Alathur n = 45
0.020-0.101	NA*	7	8	16
0.101-0.202	33	4	19	20
0.202-0.405	36	20	22	35
0.405-0.809	51	31	43	3
0.809-1.214	71	42	50	NA
1.214-2.023	82	17	51	NA
Above 2.023	NA	NA	80	NA
All Classes	66	22	45	18

N A Sample not available

Appendix-4. Household annual income from all sources in different villages

(in rupees)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	10598 (973)*	3850	19200	9488 (1960)	1800	46000	10346 (1545)	3200	27000
0.101-0.202	9000	9000	9000	18292 (6031)	1500	121450	11469 (1303)	6100	26400	10667 (2140)	1800	28000
0.202-0.405	6656 (1862)	2000	12000	18149 (3383)	800	53400	15250 (2062)	4500	35200	11900 (4139)	4000	27600
0.405-0.809	5760 (1439)	1700	12940	30204 (7446)	2200	85000	18585 1876)	7700	26000	20933 (14540)	5000	50000
0.809-1.214	13538 (2929)	3000	43000	43986 (8598)	17200	94040	49314 (8919)	13000	140000	NA	-	-
1.214-2.023	21750 (7250)	14500	29000	60000 (50000)	10000	110000	62185 (19491)	25000	176500	NA	-	-
Above 2.023	NA	-	-	NA	-	-	107250 (27280)	54000	180000	NA	-	-
All classes	10788 (1707)	1700	43000	22163 (2718)	800	121450	25639 (3341)	1800	180000	11339	1800	50000

Min: Minimum value; Max: Maximum value: NA: Sample not available

*The figures in parentheses are standard errors

Appendix-5. Household annual income from crops in different villages

(in rupees)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	693. (214)	0	3740	729 (173)	0	3600	1633 (931)	0	15000
0.101-0.202	3000	3000	3000	691 (202)	0	3870	2179 (410)	0	6420	2146 (1171)	0	15000
0.202-0.405	2756 (1018)	400	5000	3632 (1145)	0	17200	3430 (562)	600	10650	4200 1959)	0	l0000
0.405-0.809	3139 (1321)	311	10260	9324 (2867)	0	36800	6860 (1111)	2700	14000	667 (666)	0	2000
0.809-1.214	9548 (2387)	1570	31500	18340 (4508)	3700	46700	24536 (3388)	3000	45300	NA	-	-
1.214-2.023	17750 (9250)	8500	27000	10000 (0)	10000	10000	31729 (4859)	12500	50000	NA	-	-
Above 2.023	NA	-	-	NA	-	-	85750 (2220)	42000	132000	NA	-	-
All classes	7098 (1439)	0	31500	4916 (963)	0	46700	11606 (2174)	0	132000	2036	0	15000

Min: Minimum value: Max: Maximum value: NA: Sample not available

*The figures in parentheses are standard errors

Appendix-6 Analysis of variance for intensity indices of different types of crops

Source of vatiation	Degree of freedom	F-value for various indices					
		ISC	IPC	ISC & IPC combined	ITC	IMC	IAC
Village	3	36.072**	54.735**	36.130**	28.235**	1.240ns	14.372**
Land holding size class	6	2.822**	3.055**	3.655**	1.464ns	0.875ns	3.295**
Residual	237						

**Significant at 1 per cent level

nsNon-signiticantat 5 percent level

Appendix-7. Intensity indices of seasonal and annual crops in different villages

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	7.32 (1.3)*	0.48	21.12	9.33 (2.5)	0.00	45.36	7.58 (3.5)	0.00	75.23
0.101-0.202	25.15	25.15	25.15	9.24 (1.8)	0.05	26.78	5.90 (1.1)	0.04	17.36	7.56 (2.3)	0.00	32.75
0.202-0.405	43.87 (10.3)	18.53	75.06	10.57 (2.3)	0.53	28.43	5.30 (0.9)	0.33	15.36	7.72 (3.2)	0.52	17.96
0.405-0.809	44.07 (8.8)	18.88	75.24	13.26 (3.2)	0.00	36.36	4.85 (1.4)	0.80	12.68	1.57 (1.6)	0.00	4.69
0.809-1.214	18.80 (3.9)	4.41	43.60	7.33 (1.7)	0.49	16.78	4.56 (1.0)	0.03	13.48	NA	-	-
1.214-2.023	13.92 (4.8)	9.10	18.73	7.65 (1.4)	6.23	9.06	4.08 (2.0)	0.02	15.57	NA	-	-
Above 2.023	NA	-	-	NA	-	-	1.25 (0.5)	0.00	2.35	NA	-	-
All classes	29.47 (4.0)	4.41	75.24	9.39 (0.9)	0.0	36.36	5.9 (0.7)	0.0	45.36	7.19 (1.8)	0.0	75.23

Min: Minimum value: Max: Maximum value: NA: Sample not available

*The figures in parentheses are standard errors

Appendix-8). Intensity indices of perennial crops in different villages

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	35.91 (6.6).	0.00	103.01	98.03 (8.9)	2.59	155.54	29.16 (5.9)	0.00	82.69
0.101-0.202	8.17	8.17	8.17	49.02 (7.2)	2.40	132.21	92.83 (6.2)	56.73	158.33	24.17 (4.8)	3.25	61.00
0.202-0.405	11.39 (3.9)	0.05	24.68	38.13 (6.7)	1.44	115.58	73.02 (7.8)	10.86	165.93	25.23 (6.3)	11.13	46.22
0,405-0.809	11.81 (3.4)	0.30	26.18	48.71 (8.9)	0.00	92.04	83.11 (8.4)	49.30	127.56	21.56 (13.3)	6.75	48.19
0.809-1.214	24.03 (5.5)	0.36	60.66	48.05 (6.31	29.17	78.50	60.82 (9.9)	0.57	123.38	NA	-	-
1.214-2.023	23.45 (10.0)	13.44	33.45	52.03 (11.3)	40.77	63.34	51.60 (14.4)	0.00	119.15	NA	-	-
Above 2.023	**NA**	-	-	**NA**	-	-	**37.09 (14.2)**	**5.21**	**73.45**	**NA**	-	-
All classes	**18.11 (2.9)**	0.05	60.66	**43.38 (3.2)**	0.0	132.21	**78.69 (3.8)**	0.0	165.93	26.44 (3.4)	0.0	82.69

Min: Minimum value; Max: Maximum value; NA: Sample not available

*The figures in parentheses are standard errors

Appendix-9. Intensity indices of seasonal, annual and perennial crops (combined) in different villages

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery (n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	43.23 (6.4)	1.79	107.42	107.36 (8.2)	4.95	157.09	36.74 (7.7)	1.15	154.82
0.101-0.202	33.32	33.32	33.32	58.26 (8.2)	2.45	149.70	98.77 (6.6)	68.99	168.701	31.73 (5.8)	3.25	83.00
0.202-0.405	55.26 (10.7)	29.66	87.23	48.70 (8.1)	4.35	142.31	78.32 (7.5)	17.14	168.22	32.95 (9.3)	15.83	64.18
0.405-0.809	55.88 (7.7)	21.78	78.05	61.97 (10.9)	4.64	126.01	87.96 (9.3)	55.43	139.17	23.13 (12.7)	6.77	48.19
0.809-1.214	42.82 (8.3)	4.77	93.42	79.98 (5.3)	57.10	105.59	65.41 (10.5)	0.60	136.86	NA	-	-
1.214-2.023	72.20 (3.9)	68.29	76.11	84.49 (14.1)	70.41	98.57	55.67 (14.9)	4.36	122.60	NA	-	-
Above 2.023	NA	-	-	NA	-	-	38.34 (14.3)	5.21	74.24	NA	-	-
All classes	47.58 (4.8)	4.77	93.42	52.77 (3.6)	1.79	149.70	84.59 (3.9)	0.60	168.70	33.63 (4.3)	1.15	154.82

Min: Minimum value: Max: Maximum value: NA: Sample not available

*The figures in parentheses are standard errors

Appendix-10. Intensity indices of tree crops in different villages

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	51.48 (5.7)*	0.00	96.65	14.34 (3.5)	0.16	51.00	30.01 (5.2)	0.00	96.64
0.101-0.202	40.92	40.92	40.92	37.56 (3.9)	0.00	61.90	5.8 (4.1)	0.22	79.44	26.95 (5.3)	5.25	74.75
0.202-0.405	23.62 (8.9)	3.60	50.68	36.30 (5.6)	7.96	88.35	7.58 (2.3)	0.08	28.89	29.56 (9.3)	13.78	57.70
0.405-0.809	15.24 (4.1)	1.92	36.51	39.01 (8.8)	3.36	119.56	14.29 (3.8)	0.47	39.91	35.25 (11.4)	21.40	57.78
0.809-1.214	24.85 (3.7)	7.61	47.76	23.94 (2.3)	13.54	33.76	17.01 (3.3)	4.19	43.81	NA	-	-
1.214-2.023	34.69 (11.1)	23.62	45.75	22.48 (5.8)	16.69	28.26	21.60 (3.2)	9.66	37.58	NA	-	-
Above 2.023	NA	-	-	NA	-	-	19.67 (7.5)	0.04	33.80	NA	-	-
All classes	23.51 (2.7)	1.92	50.68	39.32 (2.0)	0.0	119.56	12.35 (1.5)	0.04	79.44	29.22 (3.2)	0.00	96.64

Min: Minimum value: Max: Maximum value; NA: Sample not available

*The figures in parentheses are standard errors

Appendix-11.1, Density of important trees in different land holding size classes in Mulayam Village

(Number per ha.)

Species		Size of land holding (ha.)				
		0.101 to 0.203	0,203 to 0.405	0.405 to 0.809	0.809 to 1.214	1.214 to 2.023
Jack	N1	25.32	22.39	10.71	24.02	25.77
	N2	18.99	4.63	7.34	15.04	12.34
	N3	12.66	0.77	4.67	7.52	4.81
Mango	N1	6.33	18.53	8.52	15.77	10.08
	N2	6.33	6.95	2.75	5.82	4.57
	N3	0.00	0.00	1.10	2.18	1.08
Cashew	N1	6.33	17.75	11.27	49.95	28.81
	N2	6.33	2.31	2.75	7.04	11.03
	N3	0.00	0.77	1.10	1.70	3.97
Tamarind	N1	0.00	6.95	1.37	3.88	1.17
	N2	0.00	0.77	0.02	1.21	0.39
	N3	0.00	0.00	0.00	0.24	0.08
Erythrina	N1	101.26	93.43	93.19	104.59	116.14
	N2	37.97	9.26	7.15	22.33	9.47
	N3	0.00	0.77	0.00	12.62	0.08
Teak	N1	0.00	9.26	2.47	0.48	0.62
	N2	0.00	6.17	0.00	0.24	0.23
	N3	0.00	1.54	0.00	0.24	0.00
Matty	N1	0.00	1.54	0.55	0.00	2.87
	N2	0.00	0.00	0.00	0.00	0.00
	N3	0.00	0.00	0.00	0.00	0.00
Maruthy	N1	12.66	12.35	7.42	7.77	13.28
	N2	6.33	6.94	3.85	2.92	8.85
	N3	0.00	6.17	1.65	1.46	5.98
Irul	N1	0.00	1.54	2.47	5.09	5.05
	N2	0.00	1.54	2.20	4.12	3.50
	N3	0.00	1.54	2.20	3.39	3.11
Karesu	N1	0.00	0.77	1.91	1.46	5.59
	N2	0.00	0.00	0.54	0.00	1.09
	N3	0.00	0.00	0.27	0.00	0.39

N1 : Numberoftreesabwe 5cm dbh

N2 : Number of trees above 15 cm dbh

N3 : Number of trees above 30 cm dbh

Appendix-11.2. Density of important trees in different land holding size classes in Avinissery Village

(Number per ha.)

Species		Size of land holding (ha.)					
		0.020 to 0.101	0.101 to 0.203	0.203 to 0.405	0.405 to 0.809	0.809 to 1.214	1.214 to 2.023
Jack	N1	54.01	14.11	8.26	2.66	1.46	14.79
	N2	46.15	9.79	6.04	2.28	1.23	12.09
	N3	24.54	4.78	2.68	1.45	0.98	10.17
Mango	N1	53.04	22.08	8.34	3.63	2.29	12.09
	N2	25.54	12.98	3.98	1.97	1.27	9.24
	N3	8.82	6.38	1.84	0.97	0.59	4.62
Cashew	N1	31.44	15.93	9.43	3.66	3.60	10.17
	N2	7.86	5.23	3.22	1.11	1.81	6.47
	N3	1.96	0.91	0.54	0.21	0.20	0.92
Tamarind	N1	13.76	6.38	9.29	0.47	0.72	0.92
	N2	6.88	3.42	1.37	0.19	0.33	0.92
	N3	1.96	1.37	0.61	0.12	0.15	0.00
Vatta	N1	55.01	20.48	17.44	7.39	4.97	37.91
	N2	6.88	4.32	4.06	1.46	0.95	13.8'7
	N3	0.00	0.68	0.08	0.04	0.00	1.81
Ceiba	N1	57.95	8.19	4.89	1.83	1.25	1.80
	N2	14.73	2.96	1.53	0.55	0.32	0.92
	N3	1.96	0.68	0.15	0.00	0.02	0.00
Teak	N1	0.98	3.41	0.84	0.52	0.39	0.00
	N2	0.00	0.68	0.38	0.42	0.07	0.00
	N3	0.00	0.23	0.00	0.07	0.02	0.00
Kanjiram	N1	3.92	1.14	0.85	0.88	1.02	0.00
	N2	1.96	0.23	0.31	0.43	0.18	0.00
	N3	0.98	0.00	0.08	0.08	0.02	0.00
Karesu	N1	14.74	6.37	2.07	1.63	1.02	12.02
	N2	4.92	1.82	0.46	0.39	0.20	8.32
	N3	0.00	0.00	0.15	0.04	0.00	0.00
Erythrina	N1	23.56	4.10	2.22	1.52	0.36	6.47
	N2	3.92	1.14	0.61	0.28	0.11	2.77
	N3	0.00	0.00	0.15	0.07	0.02	0.00

N1 : Number of trees above

N2 : Number of trees above 15 cm dbh

N3 : Number of trees abwe 30 cm dbh

Appendix-11.3. Density of important trees in different land holding size claseses in Nattika Village

(Number per ha.)

Species		Size of land holding (ha.)						
		0.020 to 0.101	0.101 to 0.203	0.203 to 0.405	0.405 to 0.809	0.809 to 1.214	1.214 to 2.023	>2.023
Jack	N1	19.19	12.87	7.31	4.26	5.54	7.72	3.75
	N2	6.00	7.29	4.72	3.14	3.15	5.49	3.33
	N3	1.20	3.00	1.89	1.12	1.52	4.62	3.12
Mango	N1	71.95	30.90	30.17	20.91	19.01	15.89	12.28
	N2	16.79	14.60	16.03	15.06	8.80	8.09	9.16
	N3	2.40	4.30	4.72	7.19	4.89	2.89	5.62
Cashew	N1	58.76	24.88	32.75	13.93	9.66	11.86	2.30
	N2	23.99	7.72	10.84	8.76	7.05	8.68	0.84
	N3	6.00	5.15	2.36	2.91	4.12	5.21	0.84
Kudampuly	N1	22.79	10.30	6.36	5.17	7.17	6.64	5.21
	N2	8.40	5.15	2.59	2.25	3.15	4.62	4.38
	N3	4.80	2.58	1.65	0.90	1.41	2.60	2.71
Njaval	N1	1.20	3.01	3.30	2.91	1.84	1.45	0.63
	N2	1.20	1.29	2.36	2.01	1.30	1.45	0.63
	N3	1.20	0.86	1.18	1.34	0.76	1.16	0.21
Aryaveppu	N1	6.00	3.43	5.18	2.63	2.82	3.18	0.63
	N2	2.40	0.43	1.41	0.44	0.65	0.87	0.21
	N3	0.00	0.00	0.47	0.22	0.00	0.00	0.00
Rosewood	N1	6.00	2.58	1.42	4.49	0.66	3.48	0.00
	N2	4.80	0.86	0.48	1.50	0.33	2.61	0.00
	N3	3.60	0.43	0.24	0.22	0.11	1.45	0.00
Anjily	N1	20.39	21.88	10.14	5.62	4.88	8.96	5.41
	N2	3.60	9.87	4.01	3.37	2.17	8.38	4.79
	N3	2.40	3.45	1.65	2.25	0.98	4.62	1.88
Punna	N1	4.80	3.01	4.72	5.16	2.17	0.29	0.63
	N2	0.00	0.86	0.95	2.24	0.54	0.00	0.63
	N3	0.00	0.00	0.24	1.12	0.00	0.00	0.42
Karesu	N1	17.99	9.01	6.37	4.71	8.47	10.12	10.83
	N2	3.60	1.72	0.71	0.89	1.09	3.47	3.33
	N3	1.20	0.00	0.24	0.22	0.00	1.16	0.83

N1 : Number of trees above 5 cm dbh

N2 : Number of trees above 15 cm dbh

N3 : Number of trees above 30 cm dbh

Appendix-11.4. Density of important trees in different land holding size class in Alathur Village

(Number per ha.)

Species		Size of land holding (ha.)			
		0.020 to 0.101	0.101 to 0.203	0.203 to 0.405	0.405 to 0.809
Jack	N1	18.80	8.63	5.87	8.37
	N2	3.76	6.28	2.94	0.00
	N3	0.00	4.91	2.94	0.00
Mango	N1	18.80	37.64	30.79	33.46
	N2	13.16	11.76	8.80	12.54
	N3	3.76	4.70	4.40	8.36
Cashew	N1	15.04	4.71	0.00	0.00
	N2	7.52	0.00	0.00	0.00
	N3	0.00	0.00	0.00	0.00
Tamarind	N1	56.40	53.33	38.13	83.67
	N2	30.08	25.88	23.47	58.57
	N3	16.92	14.90	22.00	41.83
Aryaveppu	N1	24.44	24.31	16.13	25.10
	N2	7.52	3.13	8.80	16.73
	N3	1.88	0.78	1.47	4.18
Nelly	N1	5.64	3.13	1.47	4.18
	N2	0.00	0.78	1.47	0.00
	N3	0.00	0.00	0.00	0.00
Aaval			7.05	5.88	4.18
	N2	1.88	3.13	4.41	0.00
	N3	1.88	0.78	2.94	0.00
Teak	N1	84.59	36.08	70.38	37.65
	N2	3.76	14.12	2.93	12.55
	N3	1.88	0.00	0.00	8.37
Manjapavata	N1	13.16	6.27	16.13	0.00
	N2	0.00	0.78	2.93	0.00
	N3	0.00	0.00	0.00	0.00
Malavaka	N1	7.52	7.84	2.93	8.36
	N2	7.52	0.78	0.00	4.18
	N3	3.76	0.78	0.00	4.18

N1 : Numberoftreesabove 5cmdbh

N2 : Number of trees above 15 cm dbh

N3 : Number of trees above 30 cm dbh

Appendix-12. Intensity indices of perennial crops and tree crops (combined) in different villager

(In rupees)

Size of land holding (in ha.)	Villages											
	Mulayam n = 2 8			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.10 1	NA			87.40 (9.5).	0.00	168.78	112.37 (9.3)	12.97	184.00	59.17 (7.4)	0.00	130.62
0.101-0.202	49.09	49.09	49.09	86.58 (8.4)	24.22	187.27	98.62 (6.7)	61.82	158.6 1	51.12 (8.0)	12.00	
0.202-0.405	35.02 (11.2)	3.65	60.41	74.43 (8.1)	23.38	159.24	80.60 (7.8)	23.45	166.10	54.79 (8.8)	24.91	73.59
0.405-0.809	27.05 (6.6)	4.82	55.71	87.71 11.7	46.28	200.77	97.41 (8.9)	50.73	147.84	56.80 (24.7)	28.15	105.97
0.809- 1.214	48.88 (6.2)	14.93	84.75	71.99 (4.5)	56.62	92.04	77.84 (10.9)	4.76	159.93	NA		
1.214-2.023	58.13 (1.1)	57.07	59.19	74.50 (17.1)	57.40	91.60	73.20 (16.6)	19.42	156.73	NA		
Above 2.023	NA			NA			56.76 (20.7)	5.25	102.21	NA		
All classes	41.62 (4.2)	3.65	84.75	82.71 (4.1)	0.00	200.77	91.04 (4.0)	4.76	184.00	55.67 (4.7)	0.00	130.62

Min: Minimum value; Max: Maximum value; NA Sample not available

*The figures in parentheses are standard errors

Appendix-13. Intensity indices of miscellaneous crops in different villages

(In rupees)

Size of land holding (in ha.)	Villages											
	Mulayam n = 2 8			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			1.47 (0.9).	0.00	16.26	3.27 (0.9)	0.00	15.81	1.73 (0.7)	0.00	12.36
0.101-0.202	0.00	0.00	0.00	1.57 (0.4)	0.00	7.87	3.58 (1.0)	0.00	12.36	1.69 (0.8)	0.00	10.50
0.202-0.405	1.00 (0.7)	0.00	3.61	3.56 (2.1)	0.08	32.82	1.52 (0.5)	0.00	8.24	2.07 (1.7)	0.00	8.95
0.405-0.809	0.15 (0.1)	0.00	0.40	1.64 (0.5)	0.00	4.47	2.30 (0.8)	0.00	8.29	0.74 (0.6)	0.00	2.06
0.809-1.214	0.96 (0.4)	0.00	5.57	0.65 (0.3)	0.00	2.49	0.88 (0.2)	0.06	3.11	NA		
1.214-2.023	0.16 (0.1)	0.00	0.31	2.35 (1.6)	0.74	3.95	1.78 (0.9)	0.00	6.77	NA		-
Above 2.023	NA			NA			0.12 (0.1)	0.00	0.26	NA		
All classes	0.67 (0.2)	0.00	5.57	1.85 (0.5)	0.00	32.82	2.27 (0.3)	0.00	15.81	1.68 (0.4)	0.00	12.36

Min: Minimum value: Max: Maximum value: N A Sample not available

*The figures in parentheses are standard

Appendix-14. Intensity indices of all crops in different villages

(In rupees)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.02.0-0.101	NA			96.18 (9.7)	1.79	173.20	124.97 (8.8)	18.30	197.56	68.49 (8.7)	4.09	163.25
0.101-0.202	74.25	74.25	74.25	97.39 (9.3)	33.49	204.79	108.15 (7.2)	73.12	179.34	60.36 (9.7)	12.00	160.00
0.202-0.405	79.88 (10.3)	52.13	107.49	88.55 (8.4)	59.11	191.78	87.43 (7.5)	25.62	169.14	*64.58* (9.36)	30.62	81.07
0.405-0.809	71.27 (8.7)	23.70	91.13	102.62 (14.1)	54.63	241.13	104.56 (9.7)	57.05	159.47	59.12 (24.7)	28.33	108.04
0.809-1.214	68.63 (8.3)	19.76	124.38	79.98 (5.4)	57.10	105.59	83.31 (1 1.6)	4.86	169.91	NA		
1.214-2.023	72.20 (3.9)	68.29	76.11	84.49 (14.1)	70.41	98.57	79.06 (16.9)	23.78	160.58	NA		
Above 2.023	NA			NA			58.13 (20.9)	5.24	103.16	NA		
All classes	71.76 (4.6)	19.76	124.38	93.94 (4.4)	1.79	241.13	99.22 (4.1)	4.86	197.56	64.54 (5.5)	4.09	163.25

Min: **Minimum value:** Max: **Maximum value: NA Sample not available**

***Figures in parentheses are standard**

Appendix 16.1. Distribution of trees in home gardens in Mulayam Village

(number per ha.)

Trees	Diameter at breast helght (cm)						
	5-15	15-30	30-45	45-60	>60	Total	%
Multiple use							
Cashew	17.6	5.0	2.3	0.3	0.0	25.2	9.4
Erythrina	88.4	8.4	2.2	0.0	0.0	99.0	36.8
Jack	9.9	6.2	3.2	1.1	0.3	20.7	7.7
Kudampuli	0.3	0.0	0.0	0.0	0.0	0.3	0.1
Mango	6.1	3.1	0.9	0.2	0.0	10.3	3.8
Tamarind	1.3	0.5	0.1	0.0	0.0	1.9	0.7
Others	19.4	3.4	1.0	0.2	0.1	24.1	9.0
Sub total	143.0	26.6	9.7	1.8	0.4	181.5	67.5
Timber							
Anjily	0.2	0.1	0.1	0.0	*0.0*	0.4	0.1
Chadachy	2.0	0.3	0.4	0.1	*0.0*	2.8	1.0
Kanikonna	0.4	0.0	0.0	0.0	0.0	0.4	0.1
Kanjiram	0.6	0.2	0.0	0.0	0.0	0.8	0.2
Manjakadamba	0.6	0.4	0.0	0.1	0.0	1.1	0.4
Maruthy	4.0	2.2	1.9	1.0	1.2	10.3	3.9
Matty	1.7	0.0	0.0	0.0	0.0	1.7	0.7
Mullilam	0.7	0.2	0.0	0.0	0.0	0.9	0.4
Pala	0.3	0.2	0.1	0.0	0.0	0.6	0.2
Punna	0.2	0.0	0.1	0.0	0.0	0.3	0.1
Rosewood	0.2	0.2	0.1	0.1	0.1	0.7	0.3
Teak	0.8	0.4	0.1	0.0	0.0	1.3	0.5
Thannl	0.5	0.2	0.2	0.2	0.1	1.2	0.5
Others	15.7	5.2	4.6	4.3	1.6	31.4	11.7
Sub total	27.9	9.6	7.6	5.8	3.0	53.9	20.1
Fruit							
Custard apple	0.4	0.0	0.0	0.0	*0.0*	0.4	0.1
Hog plum	1.2	0.2	0.0	0.1	*0.0*	1.5	0.6
Drumstick	25.4	3.2	0.1	0.0	*0.0*	28.7	10.7
Lime	1.2	0.0	0.0	0.0	*0.0*	1.2	0.4
Guava	0.8	0.2	0.0	0.0	*0.0*	1.0	0.4
Others	0.3	0.0	0.0	0.0	*0.0*	0.3	0.1
Sub total	29.3	3.6	0.1	0.1	*0.0*	33.1	12.3
Ornamental							
Others	0.2	*0.0*	*0.0*	*0.0*	*0.0*	0.2	0.1
Sub total	0.2	*0.0*	*0.0*	*0.0*	*0.0*	0.2	0.1
Total (%)	200.4 (74.61	39.8 (14.8)	17.4 (6.5)	7.? (2.9)	3.4 (1.2)	286.7	((100.0)

Appendix 15.2. Distribution of trees in home gardens in Avinissery Village

(number per ha.)

Trees	Diameter at breast height (cm)						
	5-15	15-30	30-45	45-60	>60	Total	
Multiple use							
Cashew	15.7	8.2	1.1	0.3	0.0	25.3	12.2
Erythrina	5.3	1.4	0.3	0.0	0.0	7.0	3.4
Jack	4.0	6.4	4.5	3.2	1.2	19.3	9.3
Mango	11.2	7.0	3.0	2.5	0.5	24.2	11.7
Neem	0.5	0.1	0.0	0.1	0.0	0.7	0.4
Tamarind	2.9	1.8	0.7	0.4	0.2	6.0	2.9
Others	47.5	13.0	1.1	0.2	0.0	61.8	29.9
Sub total	87.1	37.9	10.7	6.7	1.9	144.3	69.8
Timber							
Anjily	0.0	0.1	0.0	0.0	*0.0*	0.1	0.1
Kanikonna	0.1	0.1	0.0	0.0	*0.0*	0.2	0.1
Kanjiram	3.2	1.1	0.2	0.1	*0.0*	4.6	2.2
Manjapavata	0.5	0.2	0.0	0.0	*0.0*	0.7	0.3
Marotty	1.4	0.4	0.1	0.0	*0.0*	1.9	0.9
Maruthy	0.1	0.1	0.1	0.0	*0.0*	0.3	0.2
Mullilam	0.6	0.2	0.1	0.0	*0.0*	0.9	0.4
Pala	1.9	0.3	0.0	0.1	*0.0*	2.3	1.1
Teak	1.8	1.0	0.2	0.0	*0.0*	3.0	1.5
Thannl	0.0	0.3	0.1	0.0	*0.0*	0.4	0.2
Others	19.8	5.1	0.8	0.2	*0.0*	25.9	12.5
Sub total	29.4	8.9	1.6	0.4	*0.0*	40.3	19.5
Fruit							
Custard apple	2.0	0.2	0.0	0.0	*0.0*	2.2	1.0
Irubampuli	1.4	0.3	0.1	0.1	*0.0*	1.9	0.9
Bread fruit	0.3	0.5	0.4	0.1	*0.0*	1.3	0.6
Drumstick	5.3	1.5	0.2	0.0	*0.0*	7.0	3.4
Lime	0.8	0.3	0.1	0.0	*0.0*	1.2	0.6
Guava	3.8	0.3	0.0	0.0	*0.0*	4.1	2.0
Others	1.2	0.0	0.0	0.0	*0.0*	1.2	0.6
Sub total	14.8	3.1	0.8	0.2	*0.0*	18.9	9.1
Ornamental							
Arali	0.4	*0.0*	*0.0*	*0.0*	*0.0*	0.4	0.2
Chembakam	0.4	*0.0*	*0.0*	*0.0*	*0.0*	0.4	0.2
Others	2.1	0.4	*0.0*	*0.0*	*0.0*	2.5	1.2
Sub total	2.9	0.4	*0.0*	*0.0*	*0.0*	3.3	1.6
Total	134.2	50.3	13.1	7.3	1.9	206.8	
(%)	(64.9)	(24.31	(6.4)	(3.5)	(0.9)		(100.0)

Appendix 15.3. Distribution of trees in home gardens in Nattika Village

(number per ha.)

Trees	Diameter at breast height (cm)						
	5-15	15-30	30-45	45-60	>60	Total	%
Multiple use							
Cashew	9.1	4.2	2.7	0.5	0.2	16.7	12.1
Erythrina	0.4	0.0	0.0	0.0	0.0	0.4	0.3
Jack	2.4	1.8	1.6	0.5	0.1	6.4	4.6
Kudampuli	3.4	1.7	1.4	0.5	0.0	7.0	5.1
Mango	10.4	6.5	3.0	1.8	0.2	21.9	15.9
Neem	2.3	0.6	0.1	0.0	0.0	3.0	2.2
Tamarind	0.9	0.3	0.1	0.0	0.0	1.3	0.9
Others	24.1	0.9	0.6	0.4	0.2	26.2	19.0
Sub total	53.0	16.0	9.5	3.7	0.7	82.9	60.1
Timber							
Anjiliy	3.7	2.4	1.3	0.6	0.2	8.2	5.9,
Kanikonna	0.3	0.0	0.0	0.0	0.0	0.3	0.2
Kanjiram	0.3	0.1	0.1	0.0	0.0	0.5	0.4
Marotty	0.4	0.2	0.0	0.0	0.0	0.6	0.4
Pala	0.1	0.2	0.0	0.0	0.0	0.3	0.2
Punna	1.8	0.5	0.2	0.1	0.0	2.6	1.9
Rosewood	1.0	0.5	0.3	0.1	0.0	1.9	1.4
Teak	0.4	0.3	0.1	0.0	0.0	0.8	0.6
Others	20.1	2.7	0.4	0.3	0.0	23.5	17.0
Sub total	28.1	6.9	2.4	1.1	0.2	38.7	28.0
Fruit							
Custard apple	1.1	0.0	0.0	0.0	0.0	1.1	0.8
Badam	0.4	0.1	0.0	0.0	0.0	0.5	0.4
Irubampull	1.3	0.1	0.0	0.0	0.0	1.4	1.0
Bread fruit	0.4	0.2	0.1	0.0	0.0	0.7	0.5
Drumstick	3.0	1.1	0.2	0.0	0.0	4.3	3.1
Lime	0.5	0.1	0.0	0.0	0.0	0.6	0.4
Guava	2.4	0.2	0.1	0.0	0.0	2.7	2.0
Others	1.5	0.3	0.1	0.0	0.0	1.9	1.4
Sub total	10.6	2.1	0.5	0.0	0.0	13.2	9.6
Ornamental							
Aranamaram	1.0	0.1	0.0	0.0	0.0	1.1	0.8
Chembakam	0.2	0.0	0.0	0.0	0.0	0.2	0.1
Others	1.7	0.2	0.0	0.0	0.0	1.9	1.4
Sub total	2.9	0.3	0.0	0.0	0.0	3.2	2.3
Total	**94.6**	**26.3**	**12.4**	**4.8**	**0.9**	**138.0**	
(%)	**(68.6)**	**(18.3)**	**(9.0)**	**(3.5)**	**(0.6)**		**(100.0)**

Appendix 16.4. Distribution of trees in home gardens in Alathur Village

(number per ha.)

Trees	Diameter at breast helght (cm)						
	5-15	15-30	30-45	45-60	>60	Total	%
Multiple use							
Cashew	3.7	1.5	0.0	0.0	0.0	5.2	1.9
Erythrina	1.5	0.0	0.0	0.0	0.0	1.5	0.5
Jack	5.5	1.5	1.8	1.1	0.0	9.9	3.6
Kudampull	0.0	0.0	0.4	0.0	0.0	0.4	0.2
Mango	24.2	6.6	2.6	1.1	1.1	35.6	12.9
Neem	15.8	5.1	1.5	0.0	0.0	22.4	8.1
Tamarind	23.8	9.5	6.6	9.9	2.9	52.7	19.1
Others	7.4	2.2	0.0	0.0	0.0	9.6	3.5
Sub total	81.9	26.4	12.9	12.1	4.0	137.3	49.8
Timber							
Kanikonna	1.5	0.0	0.0	0.0	0.0	1.5	0.6
Karingotta	2.6	1.5	0.7	1.1	0.0	5.9	2.1
Manjapavata	8.4	1.1	0.0	0.0	0.0	9.5	3.4
Mullilam	0.4	0.4	0.0	0.0	0.0	0.8	0.3
Pala	0.7	0.0	0.0	0.0	0.0	0.7	0.3
Teak	45.1	8.1	1.1	0.0	0.0	54.3	19.7
Others	20.5	3.7	1.8	0.0	0.0	26.0	9.4
Sub total	79.5	14.8	3.6	1.1	0.0	98.7	35.8
Fruit							
Custard apple	5.5	0.0	0.0	0.0	0.0	5.5	2.0
Hog plum	1.5	0.0	0.0	0.0	0.0	1.5	0.5
Irubampuli	0.7	0.0	0.0	0.0	0.0	0.7	0.3
Drum stick	12.8	1.1	1.1	0.7	0.0	15.7	5.7
Lime	2.9	0.0	0.0	0.0	0.0	2.9	1.1
Guava	3.7	0.0	0.0	0.0	0.0	3.7	1.3
Others	1.5	0.4	0.0	0.0	0.0	1.9	0.7
Sub total	28.6	1.5	1.1	0.7	0.0	31.9	11.6
Ornamental							
Aranamaram	0.7	0.0	0.4	0.0	0.0	1.1	0.4
Chembakam	0.4	0.0	0.0	0.0	0.0	0.4	0.1
Others	5.5	0.4	0.4	0.0	0.0	6.3	2.3
Sub total	6.6	0.4	0.8	0.0	0.0	7.8	2.8
Total	196.3	43.1	18.4	13.9	4.0	276.5	
(%)	(71.3)	(15.6)	(6.7)	(5.0)	(1.4)		( )

Appendix-16. Analysis of variance for species diversity among different groups of crops

Source of variation	Degrees of freedom	F-value for different types of crops						
		Seasonal and annual crop	Perennial crop	Trees for multiple uses	Trees for woo-use	Trees for fruits	Trees for ornamental use	Trees combined
Village	3	12.313**	16.320**	8.513**	16.454**	6.515**	10.391**	8.995**
Land holding size class	6	3.105**	7.999**	7.250**	14.181**	9.182**	2.601*	19.268**
Residual	237							

*Significant at 5percent level

**Significantat 1 percent level

Appendix-17.1. Diversity of seasonal and annual crops in different villages

(Number of species per holding)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			5.0 (0.4)	2	9	5.1 (0.6)	0	9	2.6 (0.4)	0	8
0.10 1-0.202	6.0	6	6	6.4 (0.6)	1	11	5.8 (0.5)	2	9	4.2 (0.7)	0	9
0.202-0.405	6.8 (1.5)**	2	10	6.7 (0.8)	3	14	5.3 (0.6)	2	11	5.6 (1.4)	2	10
0.405-0.809	8.7 (1.1)	4	13	6.8 (1.1)	1	15	5.9 (0.8)	2	9	2.6 (2.1)	0	7
0.809- 1.214	10.1 (1.2)	2	17	7.8 (0.7)	5	12	7.8 (1.0)	1	14	NA		-
1.214-2.023	10.5 (0.5)	10	11	7.0 (2.0)	5	9	6.3 (1.6)	1	11	NA		-
Above 2.023	NA			NA			4.0 (1.5)	0	7	NA		-
All classes	9.0 (0.7)	2	17	6.3 (0.3)	1	15	5.8 (0.3)	0	14	3.5 (0.4)	0	10

*Mean number of species per holding
Min: Minimum value; Max: Maximum value: NA: Sample not available
**The figures in parantheses are standard

Appendix-17.2. Diversity of perennial crops in different Villages

(Number of species per

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.10 1	NA			1.9 (0.1)	1	3	2.1 (0.1)	1	3	1.3	0	3
0.101-0.202	1.0	1	1	2.4 (0.2)	1	4	2.1 (0.1)	1	3	1.4 (0.2)	0	4
0.202-0.405	2.6 (0.5)**	1	4	3.2 (0.3)	2	5	2.3 (0.1)	1	3	1.6 (0.4)	1	3
0.405-0.809	3.4 (0.4)	2	5	3.2 (0.3)	1	5	2.4 (0.2)	2	4	1.3 (0.3)	1	2
0.809-1.214	4.2 (0.3)	3	6	4.2 (0.4)	3	6	3.4 (0.5)	1	8	NA		
1.214-2.023	5.5 (0.5)	5	6	2.0 (1.0)	1	3	2.4 (0.4)	1	3	NA		
Above 2.023	NA			NA			2.4 (0.5)	1	3	NA		
All classes	3.7 (0.3)	1	6	2.7 (0.1)	1	6	2.4 (0.1)	1	8	1.4 (0.1)	0	4

*Mean number of species per holding
Min :Minimum value; Max: Maximum value; NA Sample not available
**Figures in parantheses are standard errors

Appendix-17.3. Diversity of trees for multiple-uses in different villages)

(Number of species per holding)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			5.0 (0.3)	0	7	4.1 (0.3)	1	6	3.0 (0.4)	1	8
0.101-0.202	7.0	7	7	5.7 (0.3)	3	8	4.8 (0.4)	1	9	4.3 (0.6)	1	8
0.202-0.405	5.2 (1.1)**	2	8	6.7 (0.5)	2	11	5.1 (0.3)	1	7	4.0 (1.0)	1	7
0.405-0.809	6.0 (1.0)	3	10	6.4 (0.6)	2	9	6.0 (0.7)	2	9	5.0 (0.0)	5	5
0.809-1.214	8.0 (0.3)	6	10	7.7 (0.4)	6	9	7.7 (1.2)	3	19	NA		
1.214-2.023	8.5 (1.5)	7	10	7.0 (1.0)	6	8	5.3 (0.8)	1	7	NA		
Above 2.023	NA			NA			6.5 (1.1)	3	8	NA		
All classes	7.0 (0.4)	2	10	6.1 (0.2)	0	11	5.3 (0.3)	1	19	3.7 (0.3)	1	8

*Mean number of species per holding
Min : Minimum value: Max: Maximum value: NA: Sample not available
**Flgures parantheses are standard errors

Appendix-17.4. Diversity of timber trees in different villages

(Number of species per holding)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			2.7 (0.5)	0	8	2.4 (0.4)	0	7	1.4 (0.4)	0	6
0.101-0.202	5.0	5	5	3.8 (0.5)	1	8	3.9 (0.5)	1	8	2.6 (0.4)	0	5
0.202-0.405	5.2 (1.3)**	2	9	5.2 *(0.7)*	2	10	4.0 (0.4)	1	8	2.6 (1.2)	0	6
0.405-0.809	10.8 (2.2)	2	18	7.7 (0.9)	3	12	5.9 (1.0)	0	10	2.7 (0.3)	2	3
0.809-1.214	14.8 (1.7)	8	26	10.3 (1.0)	5	16	7.5 *(0.8)*	2	14	NA		
1.214-2.023	25.0 (1.0)	24	26	8.5 (2.5)	6	11	4.0 (1.1)	0	9	NA		
Above 2.023	NA			NA			6.5 (3.0)	0	14	NA		
All classes	12.5 (1.4)	2	26	5.3 (0.4)	0	16	4.5 (0.3)	0	14	2.0	0	6

*Mean number of species per holding
Min: Minimum value; Max: Maximum value; NA Sample not available
**Figures in parantheses are standard errors

Appendix-17.5 Diversity of fruit trees in different villages

(Number of species per holding)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA	-	-	2.7 (0.3)	1	5	3.2 (0.5)	0	8	1.8 (0.3)	0	4
0.101-0.202	1.0	1	1	3.9 (0.5)	0	8	4.3 (0.6)	2	15	2.9 (0.4)	0	5
0.202-0.405	3.0 (0.9)**	0	5	4.1 (0.5)	1	7	4.1 (0.5)	1	9	4.0 (0.8)	1	6
0.405-0.809	4.8 (0.6)	2	7	4.8 (0.4)	2	8	5.8 (0.7)	2	11	3.3 (1.2)	1	5
0.809-1.214	5.0 (0.5)	2	8	5.4 (0.7)	1	9	6.6 (0.9)	3	16	NA	-	-
1.214-2.023	4.5 (2.5)	2	7	4.0 (2.0)	2	6	6.6 (0.7)	3	9	NA	-	-
Above 2.023	NA	-	-	NA	-	-	6.0 (1.0)	3	8	NA	-	-
All classes	4.4 (0.4)	0	8	3.9 (0.2)	0	9	4.8 (0.3)	0	16	2.5 (0.3)	0	6

*Mean number of species per holding
Min: Minimum value: Max: Maximum value: N A Sample not available
**Figures in parantheses are standard errors

Appendix-17.6. Diversity of ornamental trees in different villages

(Number of species per holding)

Size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			0.8 (0.2)	0	3	1.1 (0.3)	0	3	0.6 (0.2)	0	2
0.101-0.202	0.0	0	0	0.8 (0.2)	0	2	1.6 (0.2)	0	3	1.2 (0.4)	0	5
0.202-0.405	0.2 (0.2)-	1	1	1.1 (0.2)	0	2	1.0 (0.2)	0	3	1.0 (0.0)	1	1
0.405-0.809	0.4 (0.2)	0	1	1.1 (0.2)	0	3	1.7 (0.5)	0	5	1.3 (1.3)	0	4
0.809-1.214	0.5 (0.3)	0	3	2.6 (0.5)	0	5	2.4 (0.8)	0	10	NA		
1.214-2.023	0.0 (0.0)	0	0	1.5 (0.5)	1	2	2.7 (0.6)	1	6	NA		
Above 2.023	NA			NA			2.3 (1.3)	0	6	NA		
All classes	0.4 (0.1)	0	3	1.1 (0.1)	0	5	1.6 (0.2)	0	10	0.9 (0.1)	0	5

*Mean number of species per holding
Min: Minimum value: Max: Maximum value: NA Sample not available
**Figures in parantheses are standard errors

Appendix-17.7. Diversity of multipurpose trees, timber, fruit and ornamental trees combined in different villages

(Number of species per holding)

size of land holding (in ha.)	Villages											
	Mulayam n = 28			Avinissery n = 79			Nattika n = 95			Alathur n = 45		
	Mean*	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
0.020-0.101	NA			11.1 (0.9)	4	20	10.9 (1.1)	1	24	***7.0 (0.7)***	3	14
0.101-0.202	13.0	13	13	14.1 (0.9)	7	14	14.7 (1.2)	8	25	10.9 (1.2)	2	21
0.202-0.405	13.6 (3.1)**	5	21	17.0 (1.4)	7	30	14.2 (1.1)	4	22	11.6 (2.3)	6	18
0.405-0.809	22.1 (3.4)	10	31	20.0 (1.3)	10	30	19.4 (2.5)	5	32	12.3 (2.4)	9	17
0.809- 1.214	28.4 (2.2)	17	**44**	26.0 (1.1)	21	30	24.3 (3.3)	11	52	NA		
1.214-2.023	38.0 *5.0)*	33	43	21.0 (1.0)	20	22	18.6 (2.2)	7	25	NA		
Above 2.023	NA			NA			21.3 5.7)	6	30	NA		
All classes	24.3 (1.9)	5	**44**	16.4 ***(0.7)***	4	30	16.2 ***(0.8)***	1	52	9.2 ***(0.7)***	2	21

***Mean number of species per holding**
Min: Minimum value; Max: Maximum value: NA Sample not available
****Figures in parantheses are standard errors**