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Tea Based Smallholder Farming Systems in Rathnapura District Sri Lanka

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A B S T R A C T :

The popular method of tea cultivation is mono cropping, although, Tea Small Holders (TSH) tend to cultivate tea as a mixed cropping pattern, under different farming systems. Moreover, most of small holders cultivate tea as a supplementary source of income in order to maximize their income by diversified income sources and also by utilizing limited resources. There is no evidence or baseline information available regarding the current land use and socio-economic scenario of TSH farming systems. Thus, present study focused to identify and to evaluate existing tea-based farming systems in the Ratnapura District in Sri Lanka. In order to achieve above objective, a household survey was conducted by selecting 320 households in 44 Grama Niladhari divisions under five divisional secretariat areas in Ratnapura District, namely Ratnapura, Opanayaka, Kuruvita, Imbulpe and Kalawana. Farm typology was built up by using two sequential multivariate statistical techniques, principle component analysis (PCA) and cluster analysis (CA) techniques. Classification was done on the basis of cropping systems. The results of classification procedure provided five clusters with meaning full separation. Five clusters were identified as Tea+Coconut+Paddy, Tea+ Tea with mixed crops+ Coconut, Tea + Coconut, Tea + Rubber, Tea only. Moreover, revenue generated from different crop combinations or the farm types showed a significant deviation.

Key Words: Classification, Farming systems, Socio economic, Tea small holders, Typology

1. Introduction

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 9.5 pt. Here follows further instructions for authors. The tea industry in Sri Lanka is categorized into two primary production systems based on operational scale, specifically the smallholdings sector and the plantations sector. In Sri Lanka, the official definition of Tea Small Holders (TSH) provided in the Tea Control Act No. 51 of 1957 states, “Producers of green leaf for manufacture of tea, on lands not more than ten acres in extent. ” The area specified in this definition has automatically increased to 50 acres, as stipulated by the Land Reform Act of 1972, which determines the land ceiling for private ownership. (Humbel, 1983).

The tea smallholders sector plays a significant role in the Sri Lankan tea industry, contributing to 74 percent of the national production. Thus, the future of the tea industry is significantly reliant on the smallholder sector and its production systems (ILO, 2018). The smallholder sector has recorded 1. 5 million dependents and more than 400 factory owners have emerged as a major force in the production and trade of tea . Tea smallholders are spread across all tea-growing districts in the country. The smallest number of tea small holdings (7. 4% of the total) and the least acreage (7. 3% of the total) is in the upcountry, while in the mid-country, the proportion of holdings was 45. 5% and the area accounted for 47. 7% of the total. In the low-grown area, 47% of the holdings were located on 45% of the total tea land (Palihakkara *et al.* ,2020).

A noteworthy aspect of Sri Lankan rural history has been the gradual transfer of tea and rubber production from the plantation sector to the smallholder sector. Land reform policies across the developing world have significantly affected farm size distribution and have favoured smaller farms (Binswanger and Elgin 1998).

Tea smallholders grow tea as a supplementary income source along with other activities, including paddy cultivation, vegetable farming, carpentry, and various occupations. Moreover, there is a current trend towards diversifying from mono-cropping to multiple cultivation systems. Consequently, the patterns and processes resulting from agricultural farming systems and the sustainability of these practices are subjects of research. In understanding the existing realities of marginal tea smallholders, it is equally essential to assess the socio-economic and environmental effects of the current tea-based land use systems (FAO, 2009).

The traditional farming system of the humid tropics typically involves, in small plots of not more than a few hectares, a mix of trees in association with a variety of perennial and annual crops. Together, they provide food and income for the smallholder farmer (FAO, 2000).). According to Nair and Kumar (2006), home gardens are the earliest land-use practices globally that originated from biological and cultural changes caused by human-induced pressures on arable land, after shifting cultivation.

A farming system represents a compilation of resources that are organized and maintained based on the entirety of production and consumption choices made by a farm household, including the selection of crops, livestock, and both on-farm and non/off-farm activities (Fresco and Westphal, 1988). According to Siriweera (2005), there are three principal types of farming systems that have been adopted by the Sri Lankans from ancient times. Rajapaksha (1998) outlines the categories of farming systems in ancient Sri Lanka. Paddy cultivation is the most commonly practiced farming system within the country. The second farming system is upland cultivation, which is widely recognized as Chena cultivation. It has emerged from shifting cultivation due to the reduction of arable land. These Chena areas produced various forms of food for farm families. Home gardens have also been preserved since ancient times. Furthermore, a combination of useful fruits, vegetables, and medicinal plants has been grown around residences.

The classification of farming systems must be sufficiently detailed to achieve an accurate categorization of the diverse farming systems present in the study area. Simultaneously, the number of observations regarding farming systems should be substantial enough to apply quantitative methods. Cluster analysis is the method most frequently utilized as it guarantees that the classification is informed by a comprehensive set of variables that are pertinent to the issue at hand. Consequently, this study was undertaken to identify tea-based farming systems in the Low Country region (Rathnapura) in Sri Lanka and to assess the effectiveness of the current farming systems.

2.Methodology

The present study was conducted in Rathnapura district. Forty-four Grama Niladhari Divisions under five District Sectariat Divisions (DSD) namely Rathnapura, Kuruwita, Imbulpe, Kalawana, and Opanayake in Rathnapura district were selected for data collection. Stratified random sampling technique employed in tea smallholder census and "Sampath Pathikada" data to select the DSD divisions.

Since the data set consists of categorical data as well as continuous data, Categorical Principle Component Analysis (CATPCA) was employed. This procedure simultaneously quantifies categorical variables while reducing the dimensionality of the data. Furthermore, expert-based classification was followed as an alternative way, in order to compare and to choose the best fit of classification of farming systems. In this method, the key variables were chosen based on the expert's opinion. Thereafter, to handle categorical and continuous variables, Two Steps Cluster Analyses (TSCA) method was employed using SPSS statistical software. The TSCA procedure uses a likelihood distance measure which assumes that variables in the cluster model are independent. Further, each continuous variable is assumed to have a normal (Gaussian) distribution and each categorical variable is assumed to have a multinomial distribution.

Moreover, in order to evaluate the performance of these systems, socio-demographic factors were analysed using descriptive statistics, including percentages, minimum and maximum values, means, range and standard deviation. Subsequently, economic analysis was conducted by using total costs per unit area, Net returns per measure of production as main economic indicators.

Total Costs per unit of production or unit of land area (depend on the product)

Defined as: [Cash-costs + non-cash costs + land costs + capital costs (replacement and opportunity cost of capital) + farm overhead expenses] / Total land area in ha.
This indicator can also be expressed in terms of total area planted or operated, weight or volume of product, animal head for livestock activities or any other unit of relevance, especially local or customary units. Subsets of the cost indicators can be produced. A common sub-aggregate is displaying cash costs or purchased inputs only or adding cash costs and land rental costs. When reliable data are available, indicators are often displayed for individual cost items, such as feed costs per animal unit, seed cost per land area or labour cost per made tea of output quantity.

Net returns per measure of production (or net margin)
Defined as: [Value of output – total Costs] / MT of output.
The unit in which total returns are expressed can be chosen among the ones presented above, depending on the type of activity, regional or national standards. Subsets of this indicator can be displayed as returns over cash-costs (gross margin), returns over cash and non-cash costs, returns over cash and land costs.

3. Results and Discussion

3.1. Socio-demographic profile of the respondents

The sample consists of 74% male and 26% female respondents, respectively. The majority of the respondents (98%) were married. The mean age of the respondents was 54 years, with a minimum of 23 years and a maximum of 87 years (SD = 12.96). Of the total respondents, 13% were educated up to Primary School. The respondents who completed were 20%. About 41% of the respondents' highest educational qualification was GCE O/L. Secondary Education, about 23% completed GCE A/L. Only a few (nearly 2%) had tertiary education, such as a degree or certificate level qualification. As shown in Table 1, the average household size was 3.7, with a minimum of 1 and a maximum of 7 (SD = 1.38). Moreover, to female ratio of the families was 1:1, and for the working category, that ratio was 4:3. With regards to the mean level of experience in smallholder farming, the respondents

had 25 years' experience, with a minimum of 3 years and a maximum of 65 years (SD = 12.47). The average land size was 1.92 acres, with a minimum of 0.1 acres and a maximum of 13.5 acres (SD = 1.75).

Table 1: Descriptive statistics of household characteristics

	Minimum	Maximum	Mean	SD
Farm Size (Acre)	0.1	13.5	1.92	1.75
Respondents' Age (yrs)	23	87	54	12.96
Education Level (grade)	1	8	2	1.07
Experience (yr)	3	65	25	12.47
Size of Household (No.)	1	7	4	1.38
Employed Male members (No.)	0	4	1	.66
Employed Female members(No.)	0	3	0.8	0.57
Unemployment (No.)	0	3	0.31	0.54
Engaged with Agricultural activities (No.)	0	6	2	0.89
Age of tea	1	150	20	15.38
% of Income from tea	20.81	100.00	88.66	11.45
% of Income (agriculture) NonTea	0.00	79.19	11.34	11.45
REV/ac	108,608	2,803,200	1,063,962	392,363
Investment/ac	24,274	609,229	224,488	93,484
GM/ac	313,611	12,498,399	1,337,527	1,749,966

3.2. Farming systems

Although all farms were similar in growing tea on their farms, the presence of other crops and also the varying sizes of the farms created differences among farmers. Therefore, attempts were made to identify different farm types. Owing to the results of CATPCA were not impacted fully for the cluster analysis as anticipated, an alternative method that is expert based classification was used to choose the variables. In this method, the key variables were chosen based on the expert's opinion. As per the survey data, it was decided to carry out classification according to the cropping pattern. Therefore available crop categories such as tea mono cultivation, tea with mixed crops, coconut cultivation, rubber cultivation , paddy and cinnamon as well cultivated area, availability off farm income sources and percentage of family labour were used for the classification. Therefore the approach is explained as cropping system classification which is defined as a natural farm system.

The results of the classification procedure provided five clusters with meaning full separation. Tea mono crop (T), tea with mixed crops (T+M), coconut cultivation (CC), paddy (P) and rubber (R) cultivation were the predictor variables. Five clusters were identified as shown in Figure 4. The crop distribution among the clusters is explaining below (Table 2).

Table 2 Crop distribution with clusters

	Group 1	Group 2	Group 3	Group 4	Group 5
Tea	√	√	√	√	√
Tea with mixed crops	●	√	●	●	●
Coconut	√	√	√	●	●
Paddy	√	●	●	●	●
Rubber	●	●	●	√	●
	T+CC+P	T+(T+M)+CC	T+CC	T+R	T

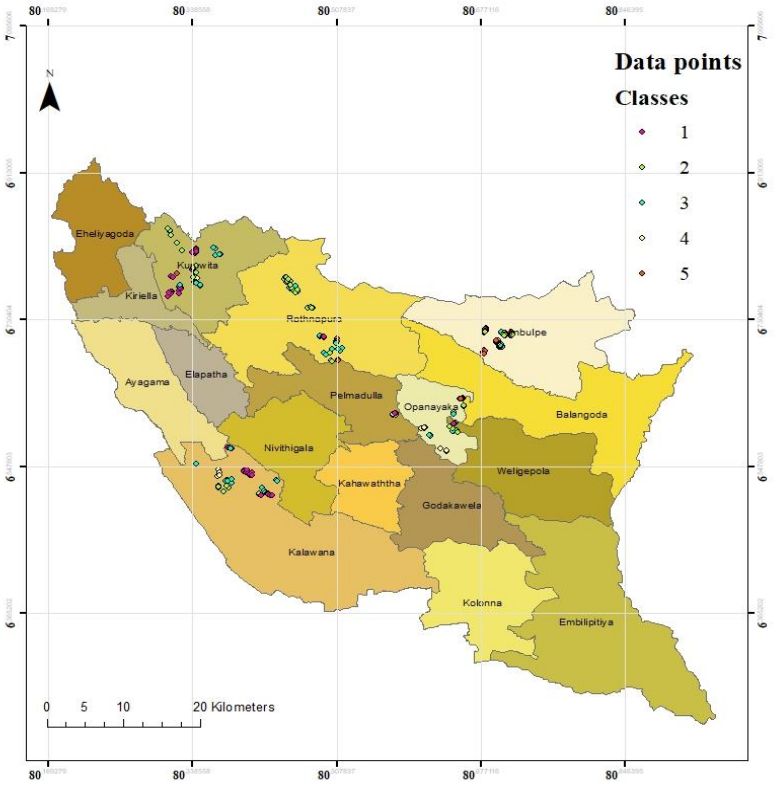

Figure 1: Distribution of the farm types

Group 1 consists of Tea+ Paddy + Coconut crop combination. 43% of farm households were included in this group. This group dissociates from the other clusters due to its higher number of tea, coconut, and paddy integrated cropping systems. Farmers in this group have an average land holding size (2.85 acres). This group could be identified as the medium resource endowed moderate financing farmers. It has a considerable level of self-sufficiency and produces rice and coconut for households and earns cash income from the tea cultivation. Few farmers were engaged in coconut cultivation in separate blocks, and few had surplus for sale. Coconut cultivation was the most popular secondary crop, along with tea cultivation. Paddy cultivation was undertaken by using minor irrigation systems except the Kuruwita region, which was mostly dependent on rainwater. It is possible to cultivate two crops per year in this area as water is abundant throughout the growing season. The growing conditions required for paddy cultivation are unique compared to other crops, and therefore, the possibility for expansion is limited. The production of paddy was entirely for household consumption. If there was any surplus after consumption, it was distributed or exchanged among family and friends.

Group 2 consists of 30% of farm households, which had having highest number of farm households. This group disassociates with other groups from the crop combination of coconut cultivation ,tea under mixed crops, and tea mono cultivation. Farmers in this group have an average farm size of 2.06 ranging from 0.05 to 10 acres. Frequent farm size is 1.5 acres. A large number of different crops were grown in mixed crop gardens. Mixed crops were cultivated on the block where the residence was situated. Fruit trees are an integral part of the species diversity of home gardens and tropical forests, which contribute to food security by diversification with other crops, use in agroforestry systems, and environmental conservation. Interactions between species are mediated by the environment through the “response and effect” principle (Goldberg and Werner, 1983). Likewise, in tree-tea agroforestry systems, shade tree species can affect tea bushes by modifying their environment. The modifications that may have a positive consequence (complementarily) for tea plants due to amelioration of the environment, or a negative consequence (competitive) due to the deleterious (adverse) effect on the environment depending upon eco zone where, the shade tree-tea systems are existed, adopted and operated (Goldberg and Werner, 1983).

Group 3 consists of tea and coconut only and this group represented the second most number of farm households (28%), average farm size was 1.44 acres, ranging from 0.05 acres to 7 acres. Most frequent farm size was 1 acre. This group could be distinguished from other groups, due to having higher proportion of coconut cultivation with tea and their higher investment in cultivation. However, farmers in this group have the moderate to high income per ha of land (Rs.70,000 to 1,000,000). It was considered that all farmers who had 15 coconut palms or more at the time of the survey were to be considered as coconut growers. According to the Coconut Cultivation Board, (CCB) under any condition, 15 palms consume a considerable space of land, whether it is grown in a mixture of crops or as a monocrop.

Group 4 consists of Tea and Rubber crop combination. It was revealed that the effectiveness of farming with rubber in smallholder lands is not at an acceptable level. Adopting proper agronomic practices is the most critical factor for ensuring the input efficiency of rubber intercropping due to various

social and physical limitations such as low price of produce and high production costs, particularly labour costs. High rainfall associated with a large number of wet days in this area leads to low profit margins by reducing the number of tapping days. Owing to these factors, it was observed that Tea and Rubber cropping system was practised by the smallest farmer group (12%). Although participation is much low in this cropping system, the second largest farm size was 2.72 acres, range of 0.25-8.00 acres. Percentage of the farmers who cultivated rubber on their holdings was 10.26%. The total area under rubber in 2017 was approximately 62.95 acres. Even though rubber occupies considerable land area, number of farmers engaged in rubber cultivation is lesser than other crop cultivations. It was observed that rubber cultivation was not greatly favoured by the farmers at the time of survey due to the low price of produce and high production costs, particularly labour costs. High rainfall associated with a large number of wet days in this area leads to lower profit margins by reducing the number of tapping days.

Group 5 consists of farmers who totally depend on Tea cultivation as the agricultural source of income. From the sample 17% were belonged to this group. Majority (40%) of this group were belonged to low experienced category. These results indicated this group has done replanting and new planting by changing previous land use. Therefore, tea as the mono crop is most prominent in group 5. These farmers could be identified as a moderate investor and moderate income group. This group has the smallest average farm size (1.21 acres). Farm size was ranging from 0.25 acres to 5 acres, frequent 1.21 acres. Study revealed that majority of tea small holders still tends to cultivate tea as a mono crop. Total extent under tea mono crop is 337.8 acres (55.06%). Tea cultivation has done as a mono crop cultivation system for commercial purpose. Farmers have intercropped tree species as shade providing trees. Some important permanent shade trees are Albizzia, Derris, Dalbergia, Acacia, Gravillea, and Leucaena and low shade proving spp as Gliricidia sepium as shade trees. Tea is a light and humid loving plant but shade tolerant tree species (Kulasegaram, 1980). The light utilization efficiency of a mono cropped tea plantation is very low due to its low light saturation point (Yu Shanqing, et al 2001). The growth of tea is negatively affected by strong light, high temperature and low humidity. Therefore, the tea is usually grown under shade of trees. Most of the farmers cultivate pepper with these shade trees. Since tea cultivation is the main cash crop here these types of lands were considered as tea mono cropped lands. Due to government policies and subsidy schemes motivates farmers to cultivate tea. Therefore, the higher proportion of tea small holders has tea gardens separately without any intercropping or mixed cropping. It could be observed that the early home garden system has been replaced with tea mono cultivation by replanting old seedling fields with vegetatively propagated new cultivars. As well as replacing home gardens with new planting activities with the aid of the subsidy schemes.

The present study shows that each crop has its own place in the farming system at any given time, but keeps on changing according to external conditions and the farmer's preferences. Selected cash crops such as tea, and minor export crops, have a considerable growth in the position within the system, while others such as cinnamon and fruit cultivation are becoming less important crops. Growing crops such as paddy and coconut, which determine the sustenance of the household, attract greater attention of farmers and hence become an important component in the system. The introduction and withdrawal, or increase and decrease of the area under specific crop are affected by characteristics such as perennial nature of the crop.

Table 3 Farm size variation among the groups

	Group 1 (T+CC+P) (ac)	Group 2 (T+TM+CC) (ac)	Group 3 (T+CC) (ac)	Group 4 (T+R) (ac)	Group 5 (T) (ac)
Average Extent	2.85	2.06	1.44	2.72	1.21
Mode of the farm size	2.00	1.50	1.00	1.00	0.75
Maximum farm size	13.50	10.00	7.00	8.00	5.00
Minimum farm size	0.25	0.16	0.05	0.25	0.25
SD	2.57	1.79	1.17	1.88	0.84

The presence of two major crops along with tea was associated with larger mean farm sizes, except with rubber (Table 4.7). While the farm type with more crops (Group 1) had the largest average size. However, the greatest area under one crop was always claimed by tea (Group 5). The average block size of the farms did not vary much among the farm types. The land tenor type was "owned" for the majority.

3.3. Labour use efficiency

Labor is a critical resource in agriculture, and improving labour use efficiency can help to reduce costs and improve productivity. This can be done through practices such as the use of labour-saving technologies and the adoption of appropriate labour management practices. The working hours in the tea smallholder sector depend on the nature of the task. It was observed that the tea pluckers complete their work before 2.30 pm enabling to provide tea leaves to the collector's. Other tasks such as pruning and planting, which are mainly assigned to male workers, are performed until 4.30 pm.

Farmers who have engaged with multiple cropping systems have to manage time very devotedly, especially women. It was highlighted that women have a great pressure with the workload mainly in tea and rubber mixed farming systems. As they have to go for the rubber tapping in the morning up to 10 am and then straight way to the tea field, in addition to day household chaos. In this study, the average contribution of family to farm labour was estimated at 1.94 members. The present study revealed a significant difference among the group with respect to family labour utilization (Table 4).

Table 4 Results of ANOVA percentage of family labour utilization

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28,610.412	4	7152.603	8.915	.000
Within Groups	251,930.889	314	802.328		
Total	280,541.301	318			

3.3.1 Labour-use and Productivity in Different Farming Systems

Utilization of family labour and maximization of labour productivity are also the important determinants of composition of a farming system. Figure 2 presents the labour productivity for different farming systems. It is observed that the productivity for unit of labour (for total labour as well as for family labour) was high for the farming system with tea mono crop alone i.e. group 5. It may be due to being a mono crop, ease of management and uniform field practices. Furthermore, as mentioned earlier this group highly depends on hired labour. Close monitoring and supervision may have led to higher labour output.

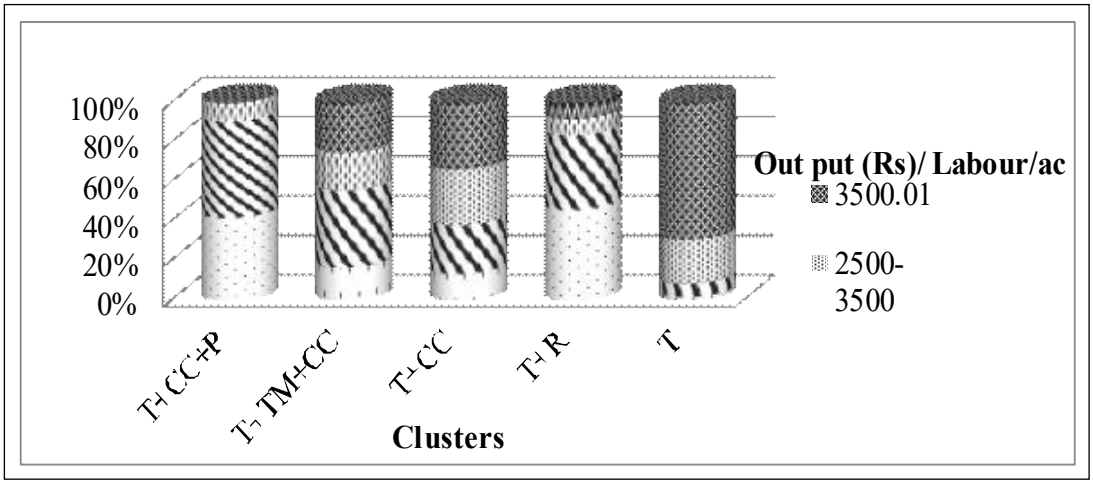

Figure 2 Labour productivity

3.4. Investment and Revenue

Inputs (Figure 3) and outputs (Figure 4) of a system and their utilization were collected through a well-structured pre-tested schedule such that it captured the material flows in to and out of the components of the given farming system. Generally, annual gross margin and net household income were used as tools for analysing farming systems. Though these measures summarize the overall performance of the system, they do not reveal the linkages between the components. The gross margin was calculated as the difference between the value of all outputs generated from the system and the value of all variable costs.

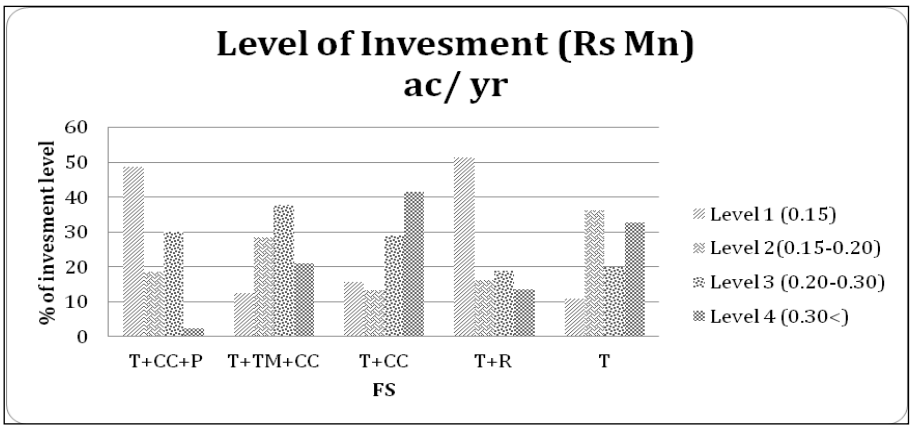

Figure 3 Level of investment

At the farm level, data on cost of production contributes to improve the economic assessment of farm operation. They allow the producer to question his own operation and to benchmark it against the best practices of farms in the same region with similar characteristics. This, in turn, can lead to better informed decisions at the farm-level and improved market efficiency and performance (FAO, 2000). In Group 1, majority belonged to the lowest investment category. This may be due to escalating cost of production of rice along with the increasing cost of living affected the investment power of the farmer on inputs in rice cultivation (FAO,2000). This along with the inherent poverty, small land holding size and unattractive land tenure system further aggravated the capacity to invest on inputs. This further illustrates in Figure 7 as this group of farmers falls into lowest income generating group.

Furthermore, farmers in group also showed low investment levels and this group consists of rubber small holders. Low yield is one of the main issues in plaguing rubber smallholders, who are often forced to replace rubber with other commodities to improve their livelihoods. Another major problem in rubber cultivation is the heavy fluctuation of rubber prices. Rubber prices vary seasonally as well as cyclically (Edirisinghe *et al*., 2010). This variation leads to fluctuating income levels as shown in Figure 7 which are especially detrimental to smallholder rubber farmers. The repercussions of such fluctuating income levels were observed in the recent past where with low prices large number of smallholder rubber farmers abandoned their cultivations (Edirisinghe *et al*., 2010). Moreover, revenue generated from different crop combinations or the farm types showed a significant deference. Tea mono crop type (Group 5) gives higher revenue. It may be due to adoption of good agricultural practices and proper management practices could be easy in a uniform type of cultivation.

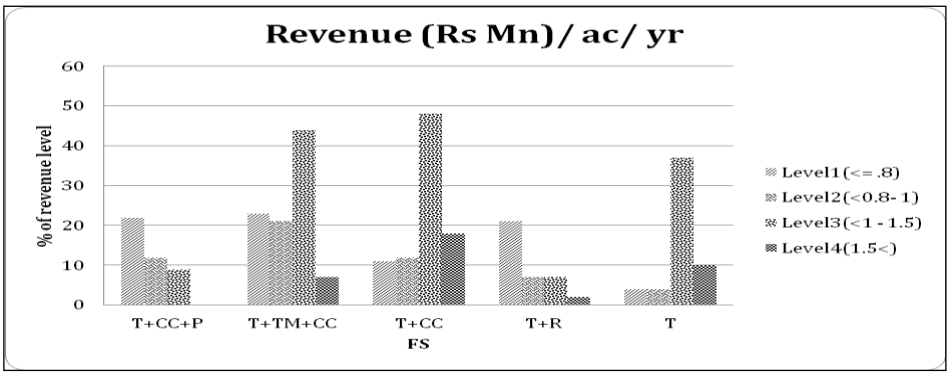

Figure 3 Distribution of income levels

3.5 Farm Size and Gross Margin

The results revealed that revenue generated per unit area is not related to the farming area. It was observed number of higher and average income categories loaded to 0.6-2.3 the second farm size category These results may imply the sustainable management strategies have been impacted income generation. Performance of small farms as well as larger farms performance was below the average. Table 6 shows the gross margin per unit area.

Table 6 Gross margin per unit area

	AREA (classes)			
GM/per month/ac (classes)	<= .5	.6 - 2.3	2.4 - 4.0	4.1+
<= 40000	3	18	14	10
40001 - 70000	4	68	39	11
70001 - 100000	10	73	22	5
100001<	8	27	7	0

The main cash income generator in the crop enterprises principally is the tea crop. It was revealed that the considerable proportion of smallholders those who employed in off-farm activities, engaged in temporary labour work on other farms. Some were employed as drivers in commercial vehicles and in building constructions. All these were directly connected to the performance of the tea industry in the area. However, there was a clear tendency towards growing more cash crops. Therefore, the fluctuation of the cash crops market directly affected the living standards and the sustainability of the farm households.

As a shown in table 7 component of the gross household income, off- farm income made a little contribution. The households of the largest farm type had no income from outside. Even though group 1 farmers mostly relied on off farm income as mentioned earlier, the income generating from farming activities for this group is very low. The major contribution to the cash income was the sale of farm produce which amounted to over 95% of the total cash income, except in the T+CC+P type in which it was generated from tea and off farm income. Farm income was derived from the tea crop along with other products mainly coconut and rice which were entirely used for household consumption. For other groups other than group 5, income from tea amounted to 3/4 of the gross household income. The rest of the farm cash income was generated by selling all other crops. Although the tea crop played the main role in generating farm cash income, other crops also play a significant role in revenue generating. Furthermore, observations exemplify that the farmers who had relatively large farms tend to generate cash income through a number of crops unlike those in the smaller types.

Table 7 Income from secondary sources other than tea

	T+CC+P	T+TM+CC	T+CC	T+R	T
Off farm income NO	30	55	57	68	64
Off farm income YES	70	45	43	32	36

4. Conclusion

Tea cultivation is the main enterprise in terms of cash earnings but for the larger farmers, a considerable proportion of farm cash income was derived from other crops. It is reasonable to think that the tea smallholders are cash crop farmers has limited resources, who need other diverse enterprises. The land is the primary factor which decides the number of crop enterprises and the sustenance of the households. Small farm types had intensified their farms by moving towards the mono cash crop and high input farming activities of farmers in group 5 and group 3. Therefore, farmers having smaller farm size had higher incomes per unit area. The farmers who have larger farm sizes earned income per unit area was mainly comes only from tea not from the other crops. Therefore, land utilization is inefficient in this farmer category.

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