Perceptions of Climate Change and Adaptation of Climate Smart Technology by the Tea Smallholders: A Case Study of Ratnapura District in Sri Lanka

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Authors' contributions

Article Information

Original Research Article

ABSTRACT

Climate change impacts such as rainfall variability, rise in ambient temperature, extreme dry spells and excessive wet periods cause low productivity and quality of tea. Ratnapura District in Sri Lanka, having the largest number of tea smallholders, is highly vulnerable to natural disasters and other negative impacts of climate change. This study was conducted to assess the status of climate change using long term meteorological data, to determine the perception of tea smallholders on short term changes in the climate and to assess the level of adaptation of climate-smart technologies by tea smallholders. Four Divisional Secretariat Divisions were selected for the study. Using multistage sampling, a hundred farmers were selected for the social survey. Meteorological data for 42 years was collected from the Department of Agriculture Sri Lanka. Both descriptive and inferential statistics were used in the analysis. Results showed that there was a significant ($p < .05$) increasing trend in daily maximum temperature. A slightly increasing trend in

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consecutive wet days was also observed. The perception of the majority of smallholders about changes in daytime temperature, number of wet days and rainfall distribution was in line with actual changes. Further, the overall level of adaptation to climate-smart technologies was at a moderate level. Shade management practices were at a higher level while moisture conservation practices were at a lower level. It was pivotal to make people aware of the severity of the impacts of climate change on their livelihoods and introduce climate-smart technologies to manage the consequences of extreme weather events.

1. INTRODUCTION

1.1 Global Climate Change

Global climate change is an ever-increasing threat to mankind. Anthropogenic activities that support climate change (CC) generate significant risks to ecosystems and human societies [1]. As a small island and also as a developing country, Sri Lanka is having a minimum contribution to global Greenhouse gas (GHG) emissions, yet the vulnerability to the consequences of the CC is high in Sri Lanka. As CC is a multidimensional phenomenon in Sri Lanka, there are many more areas other than the environment that are vulnerable to direct and indirect effects of CC *i.e.* society, tourism and agriculture [2].

1.2 Climate Change in Sri Lanka

Analysis of long-term air temperature data provided strong evidence that significant and systematic warming of the atmosphere has occurred in all climatic zones of Sri Lanka. The rate of warming in the majority of locations has exceeded the global average rate of warming. In the majority of locations, reductions in rainfall have accompanied the warming of the lower atmosphere. Since rainfall at any given location showed much greater year-to-year variation than the air temperature, evidence for rainfall reductions was not as conclusive as to that for the increase of air temperature [3].

1.3 Ratnapura District and Tea Small Holdings Sector

Agricultural activities found to be more vulnerable to climate change which in turn affect the livelihoods of people [4]. In Sri Lanka plantation crops, especially tea plays a pivotal role in the development of the country's economy. However, tea smallholdings sector has the highest contribution (74.5%) [5] to the total tea production while Ratnapura District of Sri Lanka which is a better place for low country tea, having the highest number of tea smallholders (92038) [5] in the country. As mentioned in the literature, Ratnapura is highly vulnerable to CC [6].

1.4 Impacts of Climate Change on Tea

Like many other crops, tea is also highly influenced by rainfall and temperature variations [7]. Further, tea yield is greatly influenced by weather, and especially by droughts, which cause irreparable losses because irrigation is seldom used on tea plantations. On the other extreme, heavy rains erode topsoil and wash away fertilizers and other chemicals [8]. Research findings show that 13.15% of tea extent as highly vulnerable to current climate change. The land extent of 20.54% and 66.31% were categorized as moderately and less climate-vulnerable, respectively, which could also become vulnerable in the future, if present trends continue [9].

1.5 Perception and Attitudes towards Climate Change

People's understandings of CC provide a base to support public policies, response to it and their willingness to act [10]. The effects of CC are uncertain. As a result of geographic variations and differences in resources available for adaptation, it is also place-specific [11]. Hence it was challenging to create an accurate understanding of the complexity of CC among the stakeholders [12]. Further, knowing the perception, knowledge, and attitudes of people about CC is beneficial in taking necessary actions to adapt to CC and mitigating it.

Research findings of the study, "farmers' adaptations to CC in Limpopo River Basin of South Africa" have shown that the farmers' perceptions of climatic variability were in line with actual climatic data [13]. A study done on the perceptions of local people on climate variability in the Mid-Mountain Region of Nepal were found to be in line with actual climatic data [14]. But, in

rural mid-hills of the Chepang community in Nepal, only one-third of the respondents were able to perceive the changes of the climate accurately to match with recorded actual data [15]. Further, they also found that access to information and extension services are the most important factors facilitating climate change perceptions [16].

A survey on Public Perception of CC in Sri Lanka has revealed that the majority (64%) have felt that the rains are unpredictable and they are no longer received on time in the locality [17].In addition to that people have perceived temperatures are higher compared to past (90%), increased frequencies of droughts (61%) over the last 5 to 10 years. Some studies have shown that, although the majority (58%) was unaware of the concept of global CC, they have perceived the changes in the climate like increased rainfall intensity (60%), change of rainfall pattern (70%), increase in the dry season (63%), increased air temperature (80%) etc. Further, according to Marambe et al. [18], the majority of farmers who owned dry zone home gardens have a perceived decrease in rainfall and changes in rainfall patterns whereas wet zone farmers have a perceived increase in rainfall and rains come later than previous years.

1.6 Adaptation to Climate Change

CC adaptation are the initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects [19]. Adaptations can be in three ways on the basis of adaptive responses to climate change, such as reactive (measures which are made by institutions, individuals, animals and plants as response) or anticipatory (carried out as preparations against potential effects), autonomous (adjustments which are occurring naturally or spontaneously as response) or planned (adaptations need conscious intervention) [20].

The adoption of adaptation strategies depends upon several other variables. According to Khanal and Kattel [21] age, education, household income were major explanatory variables found positively significant in farmers' decision to the adaptation to different CC coping strategies.

1.7 Adaptation Strategies for Tea Growers

The impact of bad weather could be averted to a certain extent with the timely adoption of good agricultural practices. This can be in two ways such as long-term and short term strategies. As long term strategies, selection of most suitable areas, use of tolerant cultivars, establishment, and management of medium and high shade trees and rainwater harvesting for use during dry spells have been introduced to tea cultivators. In addition to that there are various practices under land management like proper mulching of tea inter rows, proper tea bush management following suitable pruning practices incorporation of organic matter such as compost, weed compost and refuse tea, establishment of green manure crops and regular lopping of branches before rains, establishment of cover crops and cutting them back to ground level before the onset of drought etc.

Weed management before dry spell to reduce the competition for moisture, application of 2% SOP or MOP to reduce water loss by leaves during the dry spell, light skiffing to remove topmost 2-3" of foliage are some of the short term strategies that have been introduced to tea growers to be adapted. (Prematilake, 2014).

1.8 Objectives of the study

The study aimed to assess the actual changes of the climate in the locality using long term meteorological data. Further, this was extended to see the perception of tea smallholders on short term trends of rainfall and temperature and impacts of extreme weather events. Paying a special attention on adaptation practices, the study focused on the level of adaptation of climate smart technologies by tea smallholders while making recommendations on possible interventions to manage the impacts of CC.

2. METHODOLOGY OF THE CASE STUDY

2.1 Study Area

Ratnapura is the capital of Sabaragamuwa Province. It is located at 101 km southeast of the country's capital, Colombo (Coordinates: 6°35′N 80°35′E). The elevation is around 130m from the mean sea level. The total area of Ratnapura District is around 3275 km2 and it comprises seventeen Divisional Secretariat Divisions (DSDs). Out of the four Divisional Secretariat Divisions, which have been facing droughts and floods were selected for the study. Kuruvita, Elapatha, Ayagama DSDs belonged to low country wet zone whereas Godakawela DSD belonged to low country intermediate zone.

2.2 Collection of Primary Data

A sample of 100 tea smallholders (25 from each DSD) was selected using a multistage sampling method for the questionnaire survey. The variables measured included demographic variables of the tea smallholders such as age, education, and income, and the perception, knowledge, and attitudes on climate change causes and the effects on tea cultivation, and the level of adaptation of appropriate technologies. Primary data was collected through interview schedules by conducting a social survey.

As secondary data, daily rainfall data and daily maximum and minimum temperature data from 1976 to 2017 were collected from the Natural Resource Management Centre, of the Department of Agriculture in Sri Lanka.

2.3 Data Analysis

Primary data were analyzed by using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel software package. Both descriptive and inferential statistics were used in the analysis. Secondary data for 42 years of period (1976 – 2017) was analyzed using RClimDex software which has been developed jointly by the WMO CCI / CLIVAR Expert Team on climate change detection and monitoring and Microsoft Excel Package.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Respondents

All the respondents were involved with tea cultivation and they were smallholders who were having tea lands, less than ten acres. The majority of respondents (80%) had more than ten years of experience in tea cultivation and importantly, 71% of them were practicing this as their main source of income.

3.1.1 Age distribution

The mean age of the respondents was 53 years. There were 34% of respondents aged 60 years or over in the study area. This indicates that the younger generation is moving away from tea cultivation.

More than 85% of the respondents have been living in the corresponding areas for 25 or more years in all four DSDs.

3.1.2 Education level

The majority (69%) of the respondents had education up to G.C.E. (Ordinary Level) or higher. But the highest level of education of majority families was up to G.C.E. (Advanced Level) or higher. This meant that children of the majority of families (58%) have done their education, more than what their parents have done. Further, there was a significant difference between the education level of respondents and the highest education level of their families.

3.1.3 Income

The average income from tea was LKR 14,350 (USD 79) and it ranged LKR 1500 (USD 8) to LKR 100000 (USD 550). This huge variation resulted in consequences of different land sizes, different management practices, cultivars, adaptation strategies adopted by tea smallholders, etc. Only 5% of the households depended only upon tea cultivation while the majority (57%) were having two or more other regular sources of income.

3.2 Long Term Changes of the Climate of the Study Area

For visualization, the annual series has plot by dots, trends computed by linear least square by a solid line and locally weighted linear regression by a dashed line.

3.2.1 Changes in Temperature

Cool nights	T_{min} is less than 10th percentile
Cool days	T_{max} is less than 10th percentile
Warm nights	T_{min} is more than 90th percentile
Warm days	T_{max} is more than 90th percentile
Warm spell duration	Annual count of days with at least six consecutive days when T_{max} is more than 90th percentile

The percentage of cool nights per year showed a slightly increasing trend over the past 42years. As depicted in Fig. 1 year to year variation was higher in the 1990 – 2000 period and also after 2010. But the percentage of cool days showed a slightly decreasing trend for the period of 1976 – 2017. Fig. 2 has shown that year to year variation is becoming less after 2010 compared to the 1990 – 2000 period. Yearly distribution of the percentage of warm nights showed a significant decreasing trend (Fig. 3) whereas the percentage of warm days showed a significant

increasing trend (Fig. 4) with increasing year to year variation after 2009. Warm spell duration has been increasing significantly over the last 42 years as depicted by Fig. 5 which means consecutive days with high temperatures are increasing day by day.

3.2.2 Changes in precipitation

Annual total wet day precipitation	Annual total precipitation
Number of wet days	Days with at least 1mm precipitation
Consecutive wet days	Maximum number of consecutive days with precipitation is equal or more than 1mm.
Consecutive dry days	Maximum number of consecutive days with less than 1mm precipitation

Although there was no significant increasing or decreasing trend in annual total precipitation and number of wet days per year, Figs. 6 and 7 respectively showed that year to year variation was becoming more apparent after 2010. Further

consecutive dry days (Fig. 8) showed a slightly decreasing trend over the past 42 years whereas consecutive wet days showed a slightly increasing trend.

3.3 Comparison of Tea Smallholders Perception with Actual Short Term Changes in the Climate

Majority of respondents perceived that there were changes or irregularities in annual day temperature, annual night temperature, annual rainy days and rainfall distribution and they have been stressed by those changes approximately over the last decade. Further details on the above changes are given .

3.3.1 Comparison of perception of annual day temperature with corresponding meteorological data

The majority (70%) said that day time temperature has increased while 21% of respondents denied such a change. The mean period of the difference was 4.6 years.
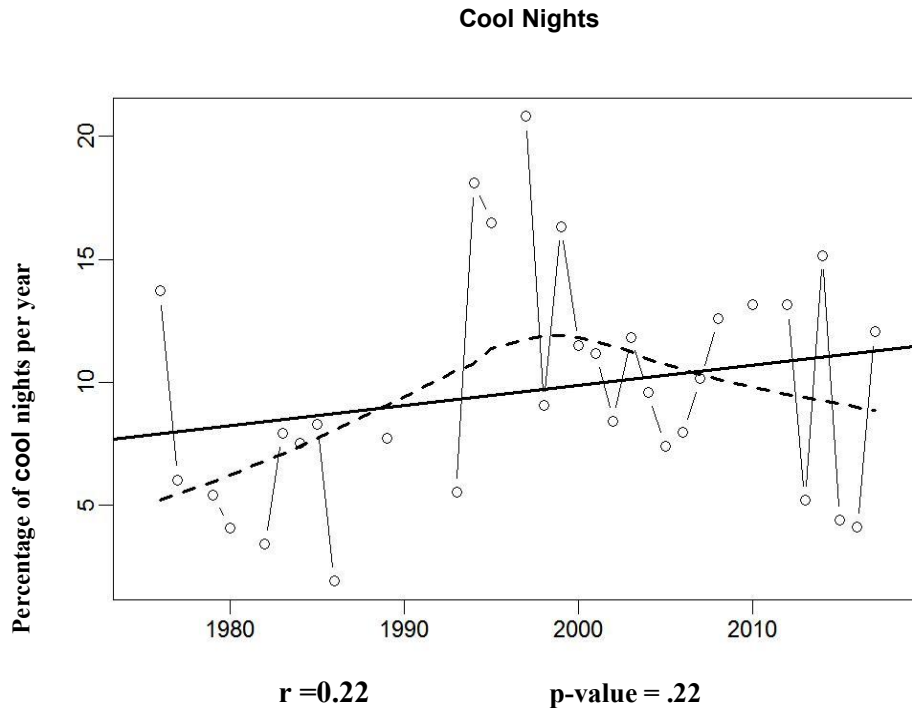
Cool Nights

r =0.22   p-value = .22

Fig. 1. Yearly distribution of percentage of cool nights (1976-2017)

Cool Days

r = -0.53   p-value = .316
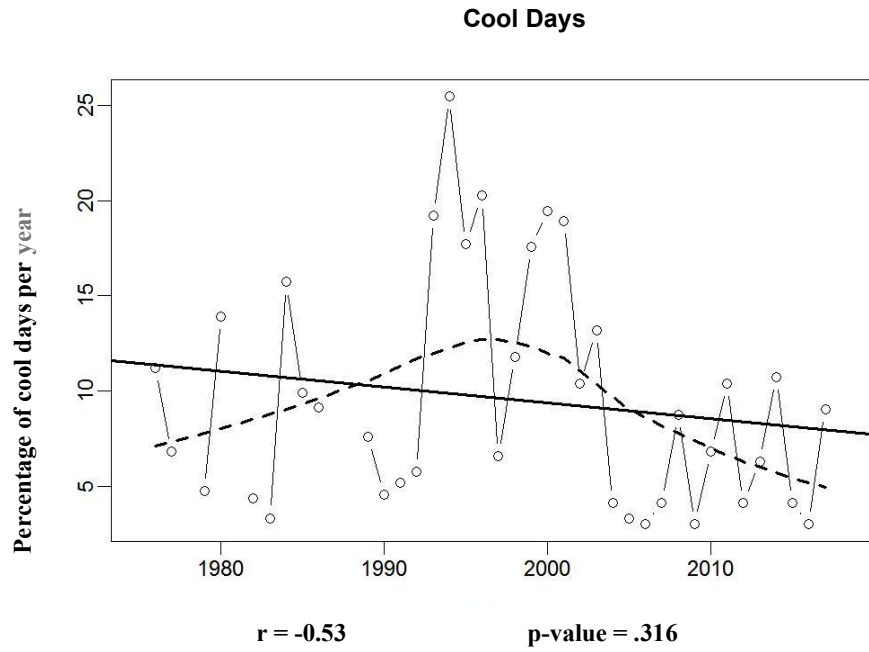
Fig. 2. Yearly distribution of percentage of cool days (1976-2017)

Warm Days

r = 0.61   p – value = .05
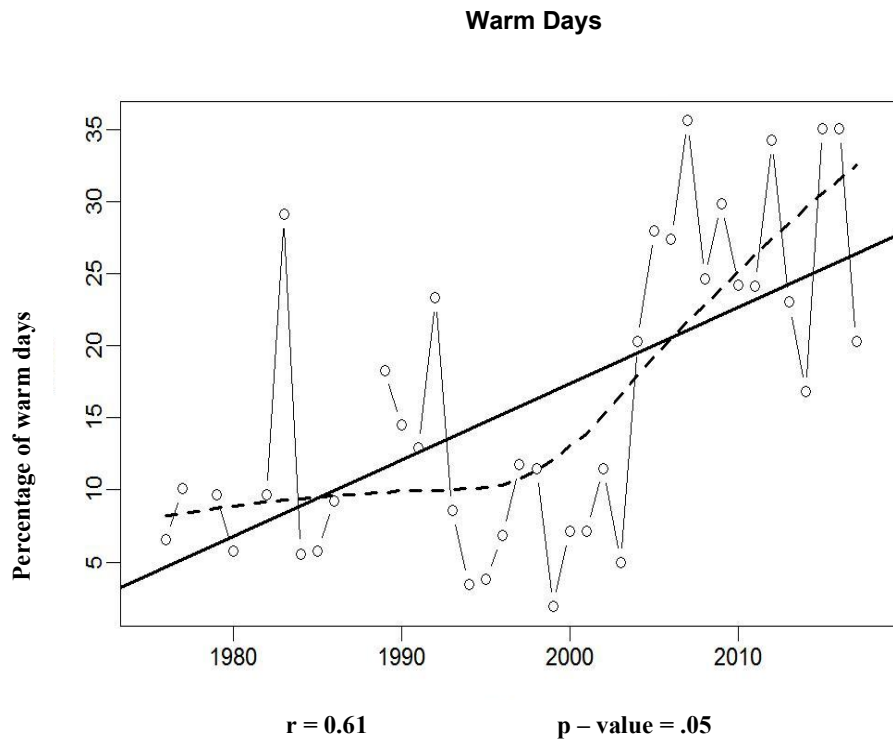
Fig. 3. Yearly distribution of percentage of warm nights (1976-2017)

Warm Spell Duration Indicator

r = 0.57   p-value = .05
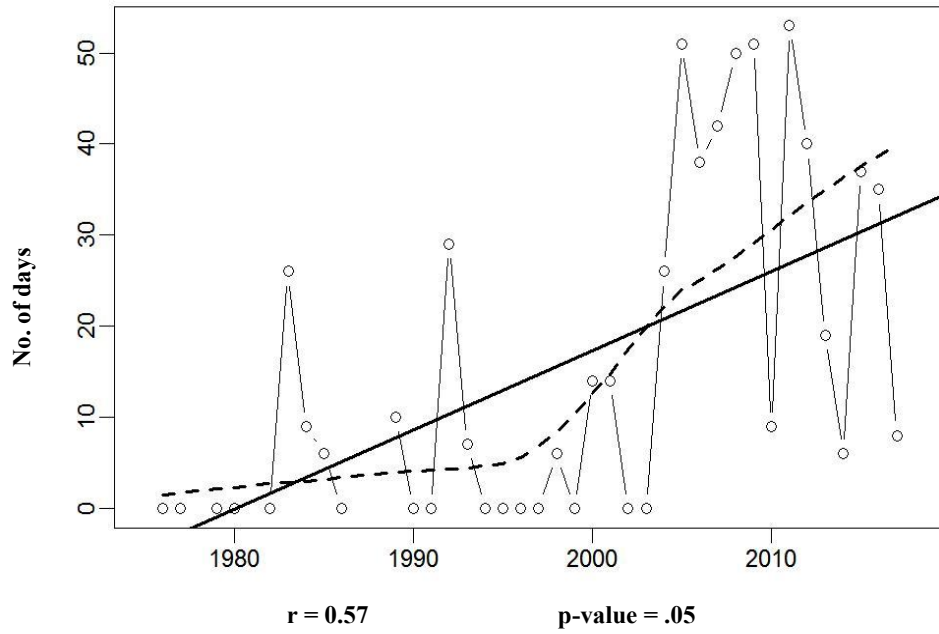
Fig. 4. Yearly distribution of percentage of warm (1976-2017)

Warm Nights

r = -0.61   p- value = .05
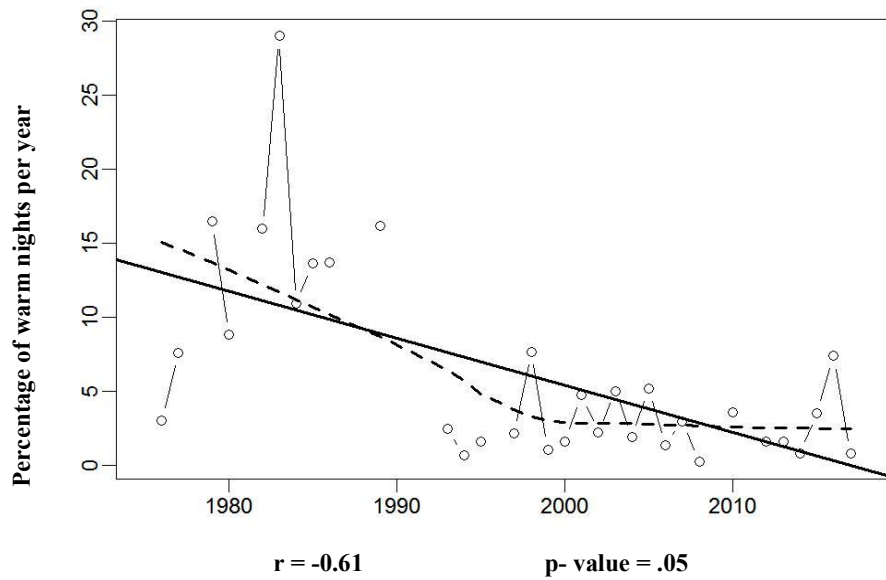
Fig. 5. Warm spell duration (1976-2017)

Annual Total Wet Day Precipitation

r = 0   p-value = .92
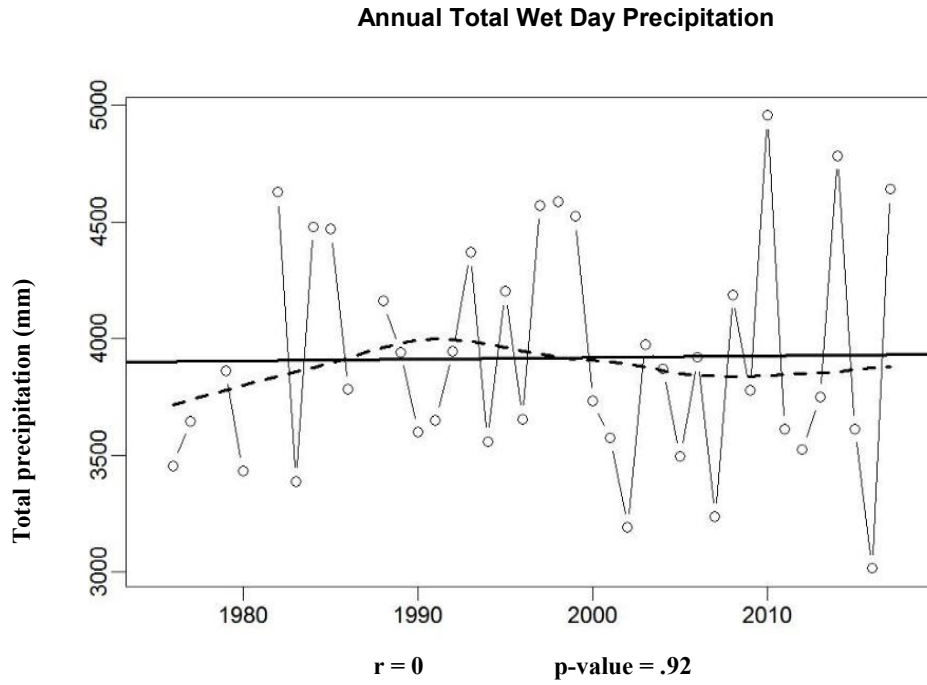
Fig. 6. Annual precipitation (1976-2017)

Number of Wet Days

r = 0.04   p-value = .78
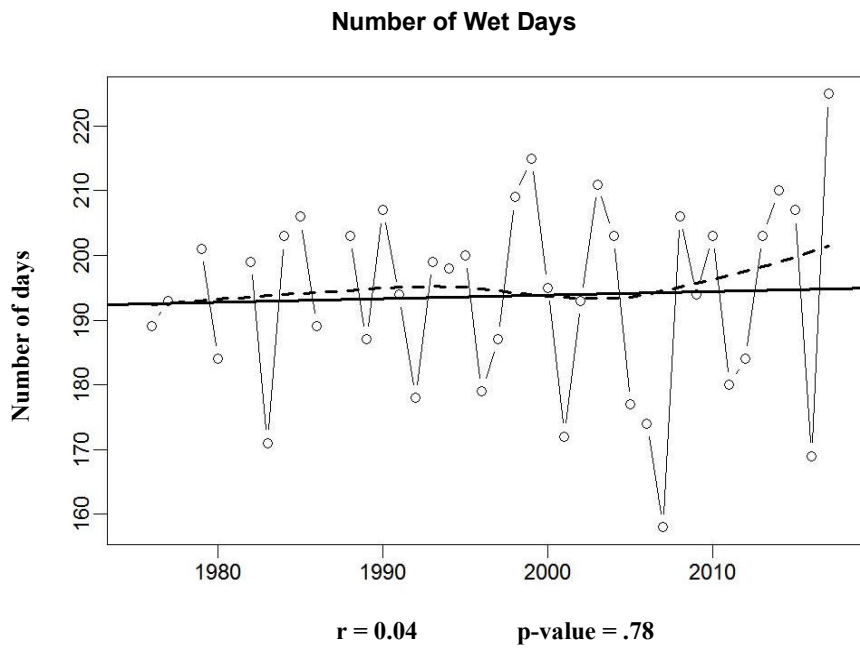
Fig. 7. Yearly distribution of number of wet days (1976-2017)

Consecutive Dry Days

r = -0.3   p-value = .06
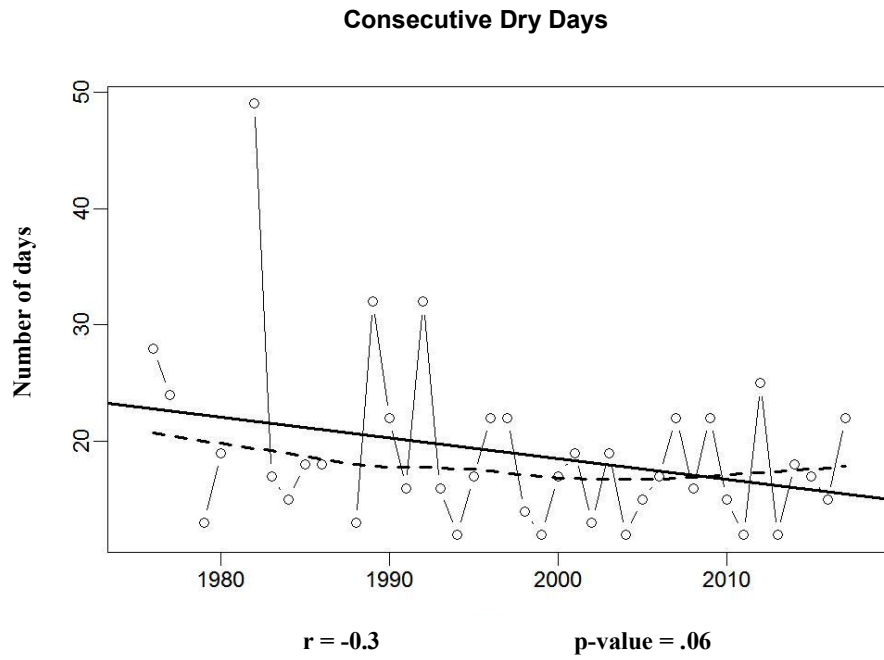
Fig. 8. Yearly distribution of consecutive dry days (1976-2017)

Consecutive Wet Days

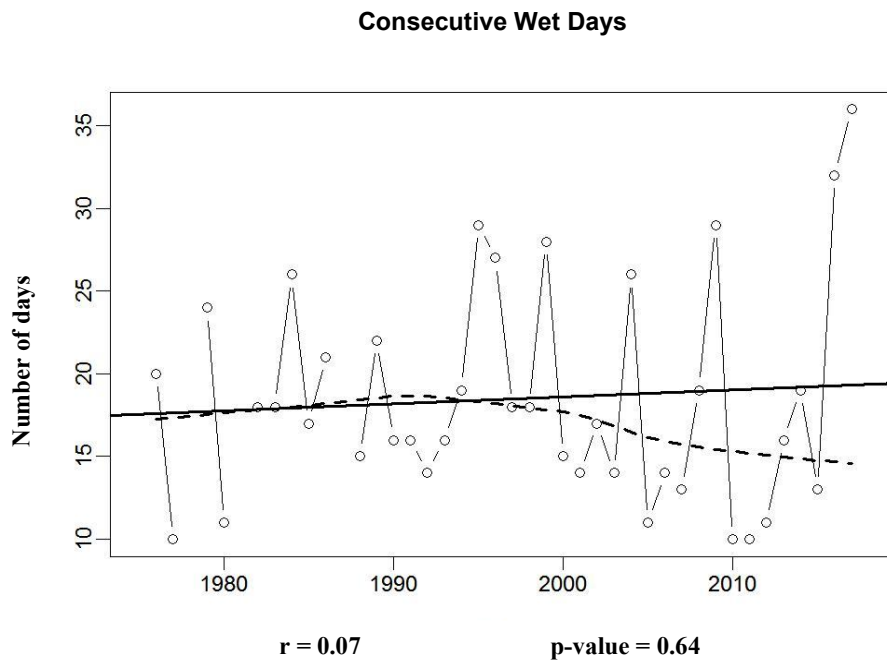r = 0.07   p-value = 0.64

Fig. 9.Yearly distribution of consecutive wet days (1976-2017)

9

As depicted above (Fig. 10), actual weather data showed an increasing linear trend in annual day temperature over the last decade, which was in line with the majority's perception of short term changes in daytime temperature.

3.3.2 Comparison of tea smallholders' perception of annual night temperature with corresponding meteorological data

41% of respondents have perceived that night temperature has increased while 2% felt a decrease in night temperature. But 47% of respondents denied such a change. Since 10% have perceived irregularity in night temperature, altogether 51% (majority) of respondents perceived there were changes in night temperature. However, the mean period of respondents has been feeling the changes was 4.9 years.

Although actual weather data showed an increasing trend in night temperature (Fig. 11), mode response of respondents denies such a change.

3.3.3 Comparison of tea smallholders' perception of annual rainy days with corresponding meteorological data

The majority (82%) perceived that rainy days per year have increased while 8% of respondents denied such a change. The mean years of the period of the difference were 3.8.

3.3.4 Comparison of tea smallholders' perception of rainfall distribution with corresponding meteorological data

Analysis of actual weather data for the last decade (Fig. 12) showed an increasing trend number of wet days which was in line with the majority's perception.

82% of respondents perceived that rainfall distribution has changed while 17% denied such a change.

Yala and *Maha* seasons are the main two cultivating seasons in Sri Lanka, which rains are received from Southwest monsoon and first inter monsoon for *Yala* season and Northeast monsoon and second inter monsoon for *Maha* season. "Onset of rainfall was defined as a spell of at least 30mm per week in three consecutive weeks after pre-specified week for the Maha (Standard week 35) and Yala (Standard week 9) seasons. Similarly, the first occurrence along with dry spell, three consecutive weeks with less than 30mm rainfall after pre-specified week for Maha (Standard week 50) and Yala seasons (Standard week 16) was defined as the end of the season [22].

The majority's perception inlined with actual changes as depicted in Figs. 13 and 14 in which the onset of *Yala* and *Maha* rains have changed over the last decade.
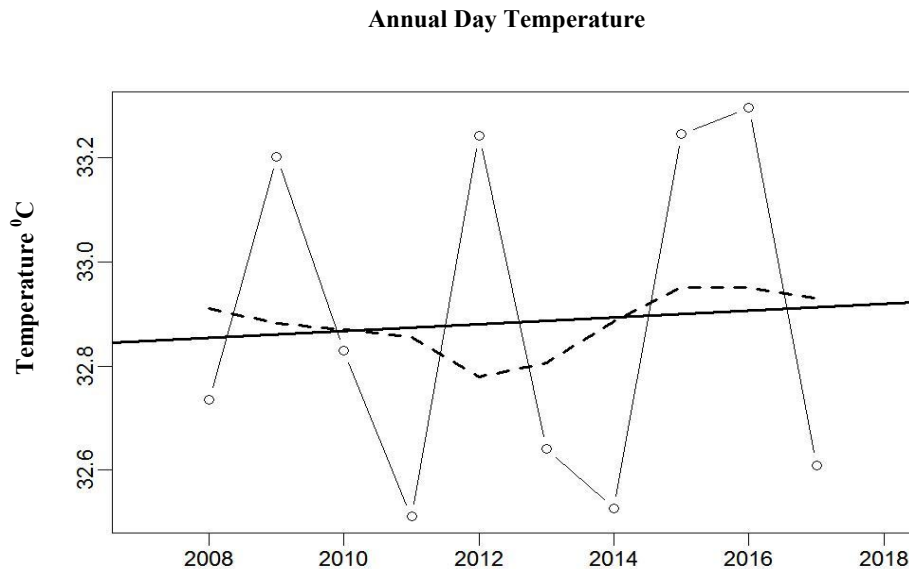
Annual Day Temperature

Fig. 10. Annual day temperature (2008 – 2017)
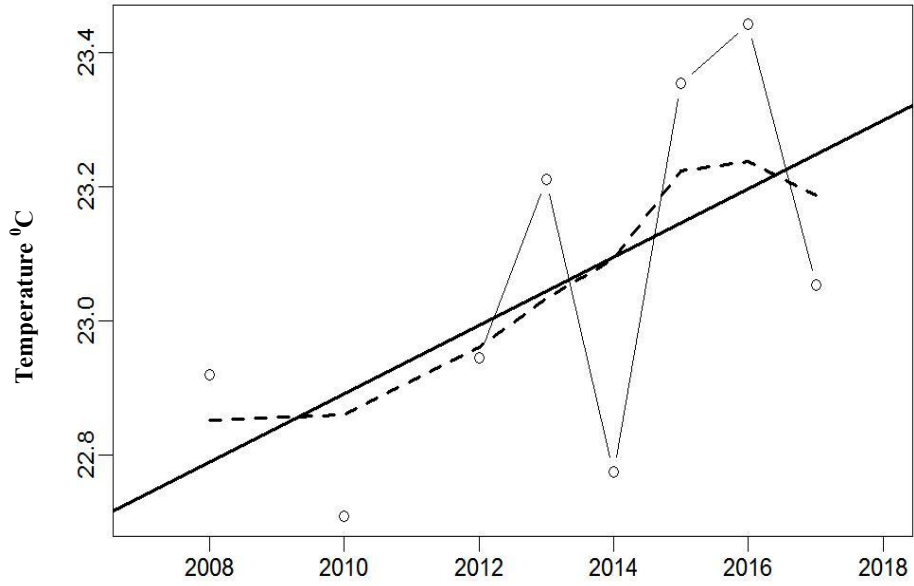
Annual Night Temperature

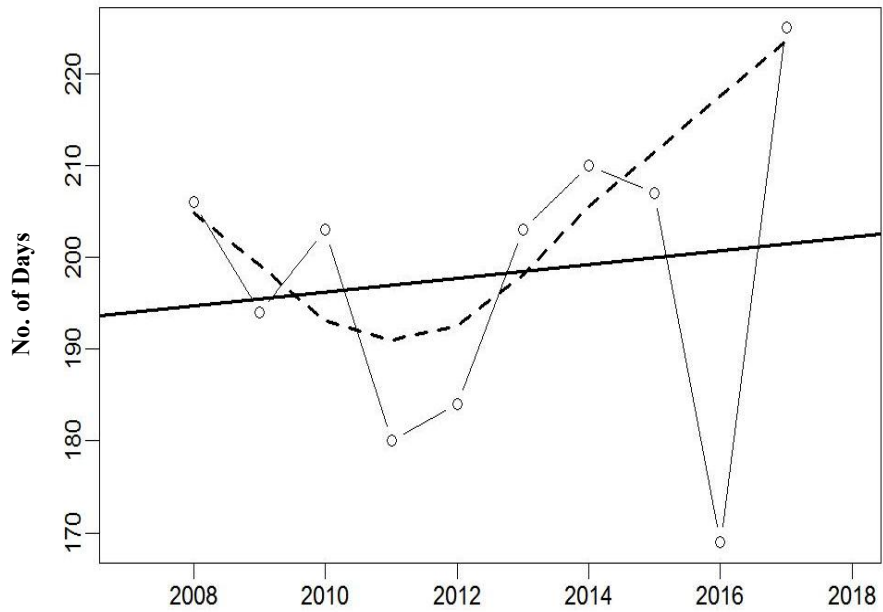**Fig. 11. Annual night temperature (2008 – 2017)**

Annual Rainy Days

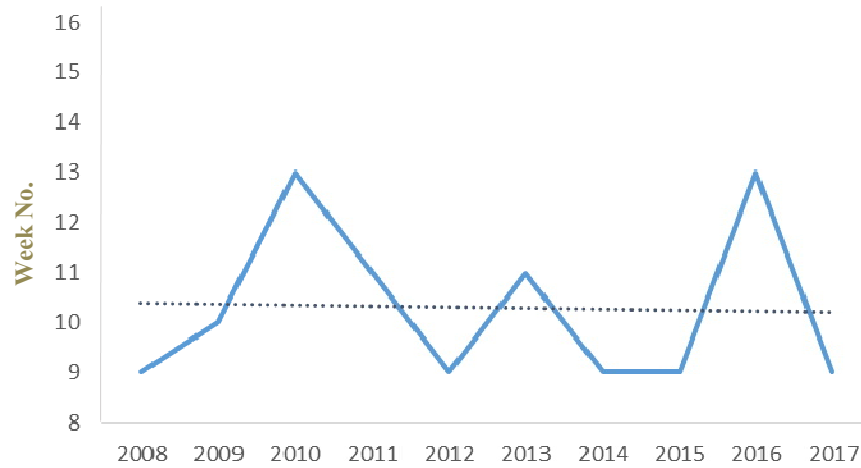**Fig. 12. Annual rainy days (2008 – 2017)**

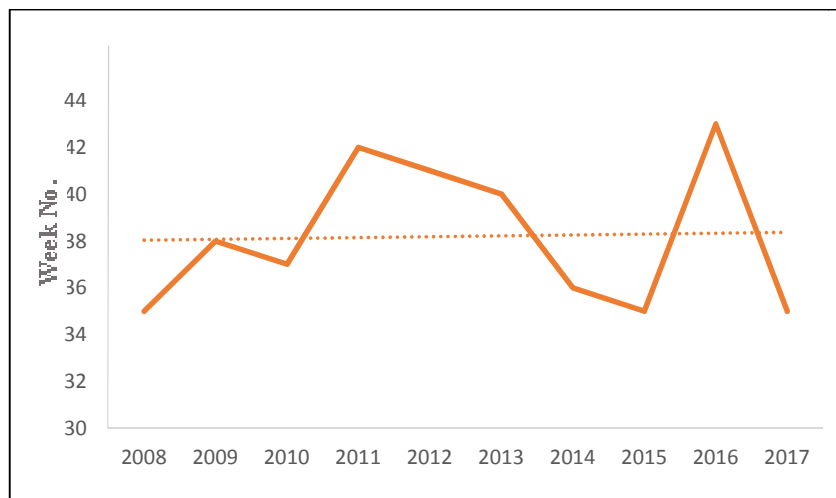**Fig. 13. Onset of *Yala* rains (2008 – 2017)**

Fig. 14. Onset of *Maha* rains (2008 – 2017)

3.4 Perception of Tea Smallholders on Extreme Weather Events

The majority (61.6%) of respondents mentioned that the frequency of floods has increased. Perception on the duration of flood and time taken by tea cultivations to recover after flood according to Divisional Secretariat Divisions are shown in Table 1.

Since Godakawela was in the low country intermediate zone, it was not a flood-prone area. As shown in Ttable 1 when it goes from Kuruvita to Ayagama, the duration of flood and time taken to recover after the flood has increased.

Nearly half of the respondents (48.8%), didn't have a clear idea about whether the frequency has increased or decreased. 28.6% perceived the frequency of occurring droughts has decreased while 22.6% have perceived that it has increased. The perceived duration of flood and time taken by tea cultivations to recover after drought according to Divisional Secretariat Divisions are shown in Table 2.

According to Table 2, Godakawela had the highest duration of drought. But the perceived time taken to recover after the drought was highest in Kuruvita.

Table 1. Summary of perception on floods

Divisional secretariat division	Duration of flood (Mean days)	Time taken to recover after flood (Mean days)
Godakawela	-	-
Kuruvita	1 ± 1	52 ± 51
Elapatha	3 ± 2	87 ± 42
Ayagama	13 ± 4	174 ± 150

Table 2. Summary of perception on droughts

Divisional secretariat division	Duration of drought (Mean days)	Time taken to recover after drought (Mean days)
Godakawela	56 ± 37	54 ± 35
Kuruvita	42 ± 20	68 ± 48
Elapatha	45 ± 17	56 ± 31
Ayagama	42 ± 17	50 ± 34

3.5 Perceived Impacts of Drought and Flood

Almost all respondents who faced floods mentioned that silt deposition on tea leaves is a major problem that they were facing after the flood. Silt deposition is a root cause for diseases and it leads to low-quality tea which in turn affects the income of tea smallholders. In addition to that majority of respondents mentioned leaf fall (70%), wilting and rotting of tea leaves (85%), plant casualties (88%), increased intensity of Horsehair Blight (86%) and soil infertility (80%) as some of the negative impacts occur as results of flooding.

Same as floods, droughts also cause some negative impacts on tea cultivations. The majority stated wilting of leaves (100%), leaves turning to yellow or brown (100%), soils getting harder (95%), plant casualties (100%) and bud dormancy (94%) as some of the major issues that they were facing as results of droughts.

3.6 Tea Smallholders Knowledge on Causes and Effects of Climate Change and Adaptation Strategies which are Important to Cope with Extreme Weather Events

As depicted in figure the majority of respondents had high knowledge of the causes and effects of climate change. They were aware of how human activities have contributed to climate change. They knew that climate change is becoming problematic day by day. As well as there will be more negative effects of CC on future generations than them.

According to figure the majority of respondents had high knowledge of adaptation strategies. People were aware of there are some agronomic practices that can be used to face negative effects of extreme weather events such as planting resistant cultivars, mix cropping, soil moisture conservation, etc. Further, majority (74%) of them believed that diversification of sources of income as a better way to be resilient even in extreme weather conditions.

3.7 Adoption of Adaptation Strategies to Climate Change Impacts

To reduce the severity of climate change impacts on agriculture and food production, adaptation is a key strategy. Adaptation strategies that are applicable for the Sri Lankan Tea Sector, for insufficient rains and high temperatures and excess rains and temporary inundations of the land are listed out in Table 1 and Table 2 respectively. Depending on the level of adaptation to each strategy by tea smallholders, they were given marks as follows.

- 0 - Not done at all
- 1 - Done partially for a part of the cultivation
- 2 - Done successfully for part of the cultivation / done partially for total extent of cultivation
- 3- Done successfully for total extent of cultivation

3.7.1 Adaptation to insufficient rains and high temperatures

Shade management has been a common practice, which was important to control light conditions fallen on tea bushes. The most common spacing of shade trees, observed in the study area was 10 x 10 m and the species

was *Gliricidia (Ladappa).* Although compost was a good medium to maintain the wetness of the soil and a source of nutrients, none of the respondents in the sample weren't using compost as an organic matter. They just add branches of shade trees that were lopped and prunings of tea bushes. However, in the dry season, maintaining wetness was not sufficient by adding compost and green manure. Therefore it was good to irrigate the land when rains are absent. According to respondents, it was very costly to establish an irrigation system and hence, very few are irrigating their tea lands during the dry spell. In addition to that mulching was commonly used to reduce water evaporation from the ground. The most common type of

mulch they use was removed weeds and straw. Another major problem that tea smallholders were facing was increased intensity and diversity of weeds. Since weeds are competing with tea bushes for water and nutrients, especially in the dry spell it was important to suppress weeds to control moisture stress. According to respondents, weeding was done manually or using mammoties. A very less number of respondents were applying weedicides to suppress weeds. Further, the soil should be loosened to improve infiltration and moisture retention. Although it is advisable to fork th soil, very few were practicing that and what the majority was doing; adding dolomite to loosen the soil.
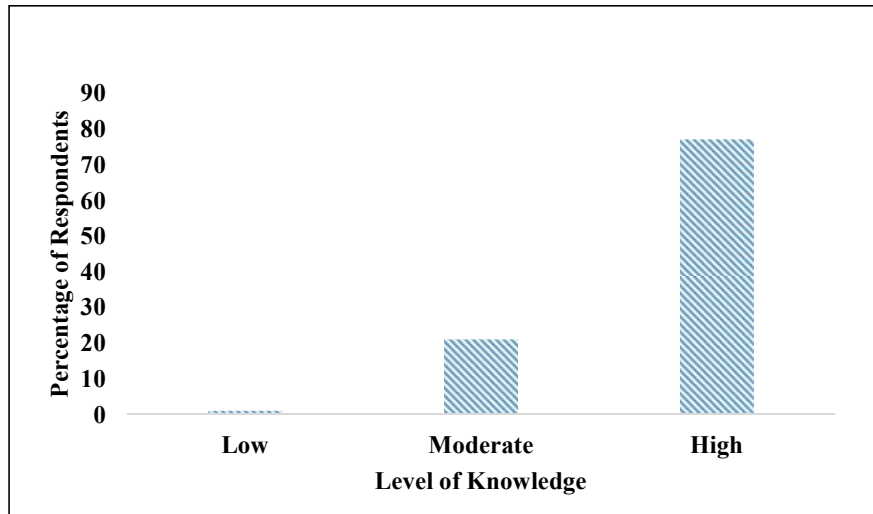

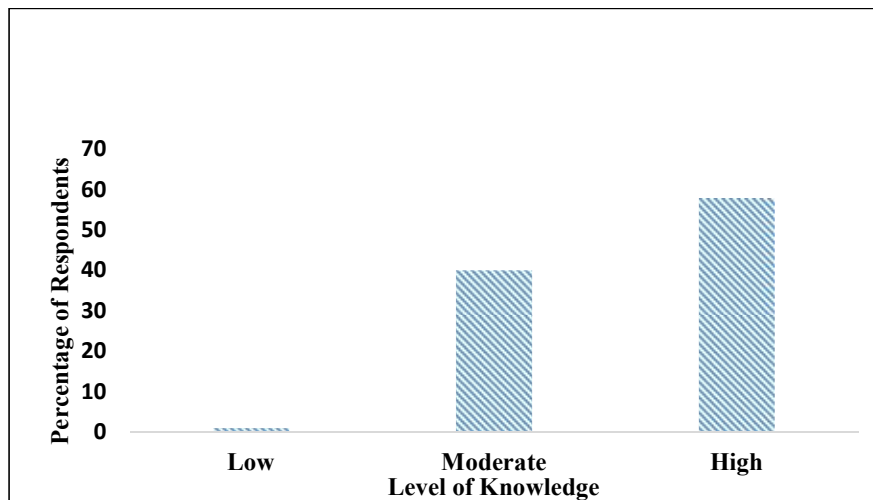**Fig. 15. Tea smallholders' knowledge on causes and effects of climate change**

Fig. 16. Tea smallholders' knowledge on adaptation strategies for extreme weather events

Table 3. Technologies which are important to adapt to insufficient rains and high temperatures

Code	Technologies to adapt to insufficient rains and high temperatures
D1	Establishment and management of high or medium shade trees.
D2	Maintaining the wetness of the soil by adding compost, refuse tea, green manure etc.
D3	Irrigating the land when rains are absent.
D4	Decreasing the evaporation by mulching the ground
D5	Ceasing the lopping of shade trees during the dry spell.
D6	Taking necessary actions to suppress weeds, before starting the dry spell.
D7	Forking the soil to reduce negative impacts that can be taken place, as a result of building up the hard pan.

3.7.2 Adaptation to excess rains and temporary inundation of the land

Excess rains and temporary inundations of the land cause falling tea bushes and silt deposition on tea leaves. If plants were uprooted, it was impossible to expect the life of those plants. But, it was advisable to re-erect partially fallen or uprooted plants by providing the necessary support. Since there is a high economic loss carried out by uprooted plants, people try hard to protect those plants. But they perceive that there's nothing they can do to remove silt, deposited on tea leaves. Hence they wait until rains are present and silt was washed off. Another problem that respondents had faced was the accumulation of debris in the collar region. This lead to insufficient aeration and the spread of diseases. Understanding this situation basically through tea smallholders' experiences, they tend to remove debris and clean the surrounding collar area of tea bushes. One of the common reasons for temporary inundation of lands in the absence of drainage structures in the standard which they are expected to be. Therefore it was important to establish a god drainage system including the leader and lateral drains and maintaining the quality of them. Anyone who visits the study area could observe, drainage structures that have been established at the beginning of the cultivation and they have been rarely maintaining. Further, increasing the level of sunlight fallen on tea bushes is very much needed in the rainy season for better production and suppress the spread of diseases like Horsehair Blight. This disease has become a major problem for tea smallholders. Very few numbers of respondents were applying the lime solution to suppress the disease. What the majority did was the manual removing of infected leaves and uprooting and burning of tea bushes, if the whole plant is infected. When there are excess rains and conditions like temporary inundations, plants undergo stressful conditions and plucking also creates stress on plants. Therefore it was advisable to provide a rest period for plants to recover from stress. Although the majority were practicing this, they didn't have the correct idea about the reason for doing this. That meant, they keep the bush without plucking for some period after a temporary inundation, not to recover the bush from stress but until silt was washed off, deposited on tea leaves and until generating new leaves.

Table 4. Technologies which are important to adapt to excess rains and temporary inundation of the land

| Code	Technologies to adapt to excess rains and temporary inundation of the land
F1	Re – erecting partially fallen or uprooted tea bushes by providing necessary supports.
F2	Conditioning the drainage structures (lateral and leader drains) in the tea land in a way that the excess water is drained out.
F3	Removing debris and waste material accumulated in the collar region of the bush to enhance the aeration.
F4	Gradually increasing the level of sunlight which falls on tea bushes by gradual lopping of medium and high shade trees.
F5	Providing a rest period for tea bushes without plucking, after a flood, until they re-foliate adequately and recover from the stress.
F6	Practicing "selective light plucking" for at least 3-4 rounds after resting period.
F7	Suspending the application of fertilizer, until the regrowth is initiated.
F8	Application of 10% - 20% lime solution to prevent spreading of horsehair blight and other secondary parasites
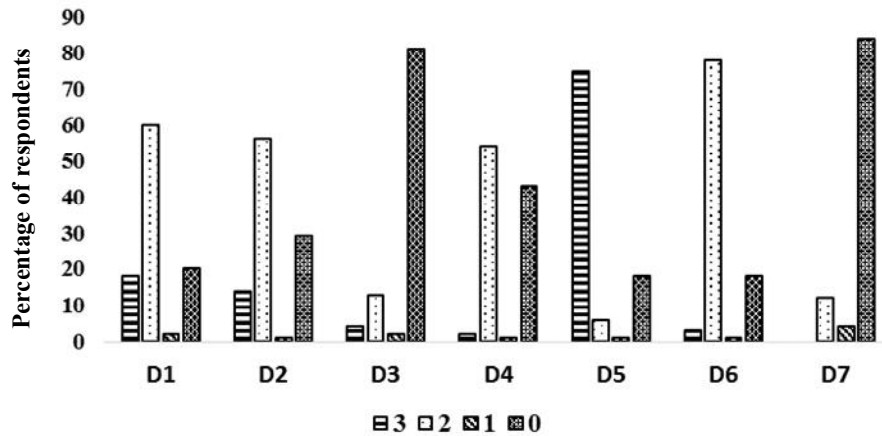
Fig. 17. Distribution of respondents according to the level of adaptation to insufficient rains and high temperatures
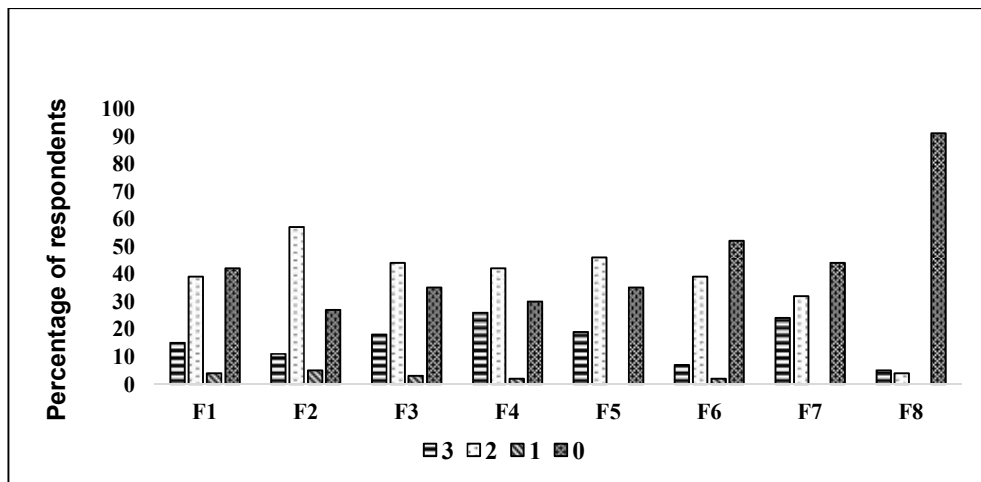

Fig. 18. Distribution of respondents according to the level of adaptation to excessive rains and temporary inundations

4. CONCLUSIONS AND RECOMMENDA-TIONS

4.1 Conclusions

The analysis of long term meteorological data showed that the climate has been changing in the study area. There is a significant increasing trend in daily maximum temperature while having very important apparent trends in precipitation. Tea smallholders' awareness about short term changes in rainfall and temperature patterns were in line with actual changes, except for minimum temperature. According to the perception of respondents, the frequency of occurring floods has increased whereas they didn't have a clear idea about the frequency of drought incidents. However, they had got significant negative impacts from extreme weather events. Further, the majority had a high level of knowledge on causes and effects of climate change and about adaptation strategies which are important to cope with extreme weather events. The overall level of adaptation of climate-smart technologies was at a moderate level. The level of adaptation of shade

management practices were at a high level while adaptation to moisture conservation practices were at a lower level. However, while tea smallholders are having a correct idea about the changes in the climate, why they do not adopt or partially adopted certain technologies are questionable.

4.2 Recommendations

In the context of sustainable development of developing countries such as Sri Lanka, climate change adaptation should be considered more as a process of transformation, which covers biophysical, technological, social values, legislative and bureaucratic adjustments with financial institutions to facilitate the community-level changes [23].

However, according to the findings, implementation of climate-smart practices will be easier since the respondents have perceived correctly the changes in the climate in the area. Therefore it is recommended to make people aware of the real changes in the climate and its possible impacts on their livelihood. Further, introducing climate-smart technologies to manage the negative impacts of changing climatic events will be helpful for the farmers to go for a good yield even in bad climatic conditions.

In addition to that formulation of communication strategies and conduct climate smart-extension and training programs to increase awareness, change attitudes and, motivate farmers towards important adaptation strategies, especially the promising technologies that have slow diffusion rates will be beneficial. Furthermore, there could be many other factors and characteristics of the farmers affecting as pros or cons for changing the behavior of farming communities, and hence, it is recommended to study them further in relation to different farming circumstances and use their cause and effect relationships in developing adaptation strategies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://sdiarticle4.com/review-history/51976