

Climatic variability associated with tea cultivation: A case study of Nuwaraeliya Pedro Tea Estate in Sri Lanka

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Abstract: *The tea cultivation highly depends on the prevailing weather conditions and is extremely sensitive to climate variability and changes both short and long term. The excessive rainfall and high temperature can cause the low productivity and low quality of the tea. This study has attempted to understand the perception of tea estate workers about the impact of climate variability and change on tea cultivation in Pedro tea estate which is the highest tea estate located about 3 km east of Nuwaraeliya in Sri Lanka. James Taylor has established this tea estate in 1885 and it had 668.38 hectares with the elevation about 1910 m. But the tea areas extent is now decreased due to various factors. The main objective of this study is to identify the public perception of tea working community towards the climate variability and change on tea cultivation and compare with some original climate data analysis. The primary data have been collected from a questionnaire survey, observations and focus group interviews with tea estate community. Rapid Rural Participatory Appraisal is used to gather for further information. 25 tea estate workers were randomly selected for the survey. Focused group discussions are also held with tea estate manager and other officers to get an in-depth preview of the impact of climate variability on tea cultivation. Two field surveys have been conducted in the month of October 2011 and February 2015. The experiences gain from both field surveys is added to the results and discussions where necessary. The climate data of rainfall and temperature have been collected from various secondary reports and Department of Meteorology, and analyzed through the various statistical methods. Questionnaire data is tabulated, coded and analyzed using various graphical methods. Increases of temperature, dry spells, frequency of drought, high intensity of rainfall, soil water deficit and dry soil condition have affected the tea cultivation in the study area. Planting of the drought tolerance tea, growing of high shade trees, introduce rainwater harvesting, proper land preparation, and soil moisture conservation practices can be introduced in the study area. Adaptation practiced should be encouraged because preliminary assessments showed that climate variability will have a significant impact on future tea cultivation of high elevation in Sri Lanka.*

Keywords: Tea cultivation, Climate variability, Climate change, Impact, Perception

1. Introduction

Tea is one of the major plantation crops which contributes a significant percentage to Gross Domestic Products (GDP) and provides direct or indirect employment to a reasonable proportion of the population in Sri Lanka. Tea is one of the most important plantation crops and plays a significant role in rural development, poverty reduction and food security in Sri Lanka. Tea is highly depended on the prevailing weather conditions and is highly sensitive to climate variability and change in both short and long term. The number of climatic impacts on tea is determined by the temperature and rainfall changes. Temperature can change the leaves, bark features, stem, collar, bud, and bud scorch. The high intensity of rainfall mainly affects the tea production, breaking the tea buds and shoots, creating soil erosion around the tea roots; reduce water holding capacity and soil nutrition, poor drainage, and increase the fungus. Therefore, the excessive rainfall and high temperature can cause the low productivity and low quality of the tea.

Tea is grown mainly under the rain-fed mono-cropping system in Sri Lanka. Climate and weather condition basically determine the optimal growth, yield, and production. However, the effect of climate change on tea cultivation and the economy of the country are not well estimated. The impact of climate change on the tea cultivation and mitigating measures that should be adapted are also not well studied. This study has attempted to understand the perception of tea estate workers about the impact of climate variability and change on tea cultivation in Pedro tea estate which is the highest tea estate located about 3 km east of Nuwaraeliya. James Taylor has established this tea estate in 1885 and it had 668.38 hectares. Its elevation is 1910 m from the sea level. The tea areas extent is now being decreased in the study area. Nuwaraeliya was the highest tea cultivation district in Sri Lanka and the cultivation area has been decreased from 1982-1993 (Rekha, 2012). The

yearly tea production is around about 900000 kgs. The production of tea from Pedro tea estate is exported to Japan, Korea and China. Climate change adaptation is highly concern today, and therefore, the public perception of climate change on tea cultivation is essential to identify the current situation of the tea cultivation issues. This paper examines the impacts of climate variability/change on tea cultivation in Pedro tea estate in Nuwaraeliya in Sri Lanka.

2. Methodology

Pedro tea estate (also has a Tea Factory) is situated at the high elevation of Nuwaraeliya district of Central Highland in Sri Lanka. The number of tea workers of this tea estate is around 1400 and office staff members are 58 and 04 executive officers. This study is based on the primary and secondary data and information. The primary data have been collected from a questionnaire survey, observations and focus group interviews with tea estate community. The questionnaire is focused basically for capturing the impact of climate variation on tea cultivation. Rapid Rural Participatory Appraisal (RRPA) approach was used to gather more information. 25 tea estate workers were randomly selected to gather data and information from the questionnaires. Focused group discussions are also held with tea estate manager and other officers to get an in-depth preview of the impact of climate change on tea production. Two field visits have been done in the month of October 2011 and February 2015. The experiences gain from both field surveys are added to the results and discussions where necessary. The secondary data and information have been collected from the various sources like the internet and some published reports. The climate data of the study area have been collected from various secondary reports and analyzed through the various statistical methods. Questionnaire data is tabulated, coded and analyzed by various graphical methods.

3. Results and Discussion

3.1 Impacts of climate on tea cultivation

Rainfall is most important climate factor for tea cultivation. An annual rainfall of 2500-3000 mm is considered optimal with the minimum requirements of 1200 mm. It is more important than the total annual rainfall distribution over the year and an even distribution without any marked seasonality is ideal. The maximum monthly rainfall requirement has been quoted as 50 mm (Sivapalan, et al, 1986). Excessive rains in some years have reduced the tea production in Pedro tea estate. Most of the tea farmers said that the rainy seasons and the rainfall patterns have been changing in the Pedro. The Pedro tea estate has been collecting the daily rainfall data from the rain gauge installed in the estate (Figure 1). Figure 2 shows how the annual rainfall patterns are varied with the average value in the Pedro.



Figure 1: The rain gauge at the estate (2015.02.07)

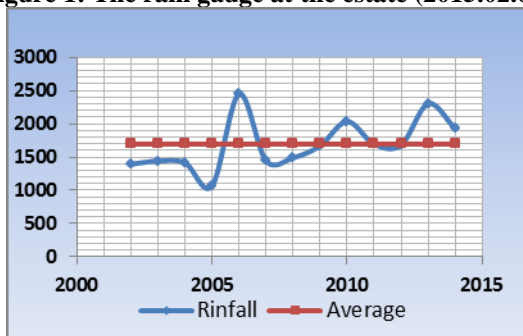


Figure 2: Rainfall (mm) variability from the average

The main monsoon rainfall has changed over the past few years and this result in prolonged droughts and intensive rainfall occurred in short durations. Some seasons this area gets unexpected droughts as well as heavy rainfall. Therefore a very erratic climate is being experienced. Since recent years the rainfall intensity and variability is increased in Sri Lanka and it is evidenced in Pedro also. Tea estate people felt that the rainfall is not receiving on time in this area as normally expected.

About 83% of tea farmers said that the rainfall variability has been increasing during the past few years (Figure 3 and 4). Most of the tea workers (72%) said that the rainfall intensity has increased in this area (Figure 8). Rests of the workers are not having a good idea about this change. Unfavorable climate condition breaks the tea buds and decreases the shoot development. Sometimes during the heavy rain, the soil is eroded with runoff water resulting in the loss of top soil layer and lowering the soil depth. The respondent said that due to the excess rain in some years the tea leaves are smashed. The soil erosion takes place in some areas in the estate and

sometimes the growth rates is also changing shortly to responding to heavy rainfall.

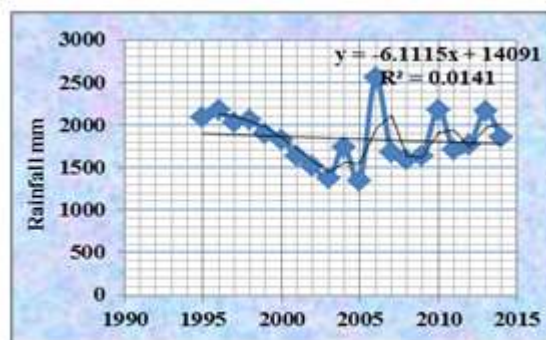


Figure 3: Rainfall variations in the study area

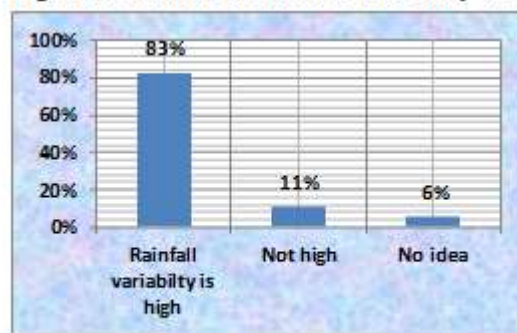


Figure 4: Tea farmers' idea about rainfall variability

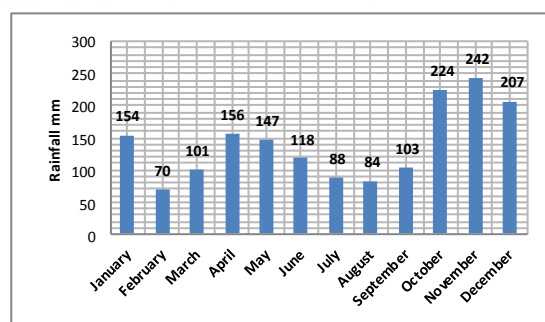


Figure 5: Average monthly rainfall in Pedro

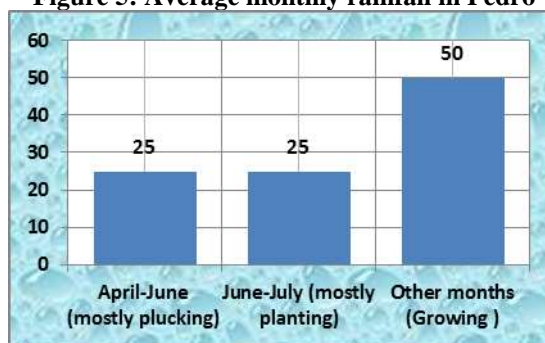


Figure 6: Main tea seasons in the Pedro tea estate

Tea is normally vulnerable to climate change and could be affected by many ways. When unfavorable weather condition takes place in some years the tea bud used to break and shoot development become weak leading to low production.

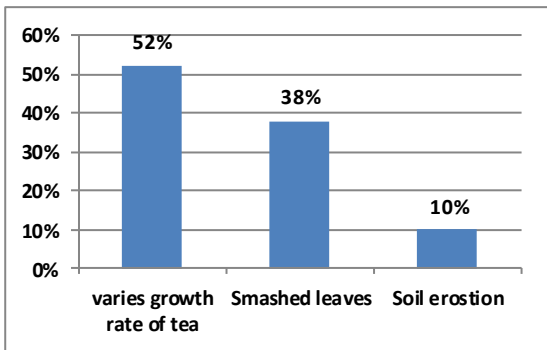


Figure 7: Damage to tea estate due to excess rainfall

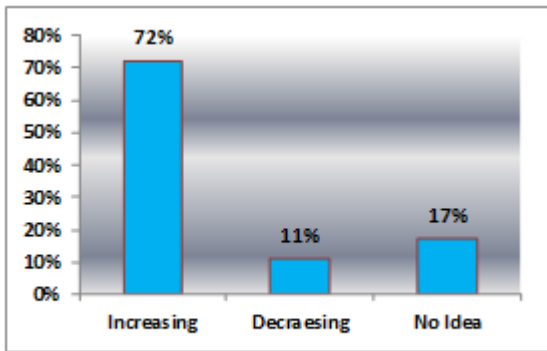


Figure 8: Rainfall intensity at Pedro

The average maximum temperature at *Nuwaraeliya* is about 22.8°C in the month of April (highest) and the average minimum temperature is 9.4°C in January (lowest). The minimum temperature at *Nuwaraeliya* falls below the freezing point only very occasionally (Statistical abstract, 2015). The ideal ambient temperature required for tea is considered to be 18-25°C. Seasonal temperature should not be lower than 13°C (average for coldest month) or higher than 30°C (average for highest month) (Sivapalan, et al, 1986). Tea farmers also said that since last few years the temperature has been increasing than previous years. According to the earlier studies, an increasing temperature and high variability of rainfall is the most projecting picture in *Nuwaraeliya*. As a result of this variation the dry spells and heavy rainfall in sometimes have badly affected the tea in the study area. According to the results of the questionnaire survey, the study revealed that normally tea is planting in June to July and plucking is April to June.

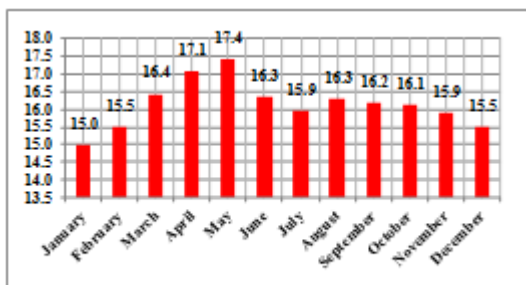


Figure 9: Monthly average temperature

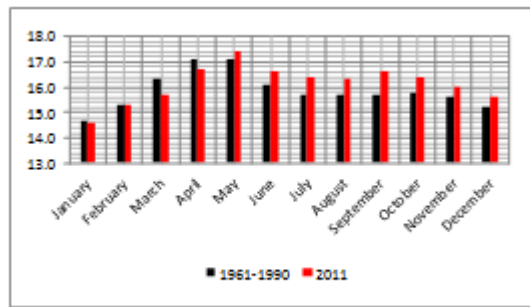


Figure 10: Comparison of temperature increases

The temperature has also been increasing in the study area. It is clearly shown in the figure 10. From May to December each month the temperature has been increased in 2011, compare to same months in 1961-1990 average values. In the questionnaire survey, about 70% of the respondents said that the temperature has been increasing in this area than previous years. Most of the old age people in the estate felt that “the temperature is increased” compare to their past age. High temperature makes desiccated of tea leaves and creates dry weather pests in the estate.

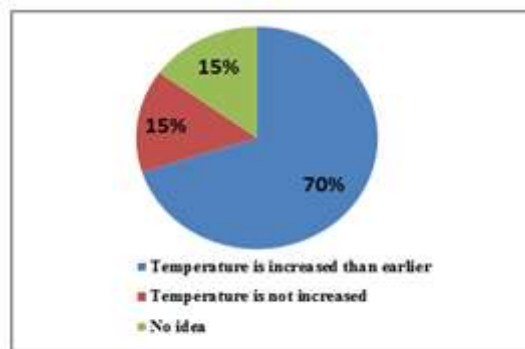


Figure 11: Perception of tea farmers on temperature change

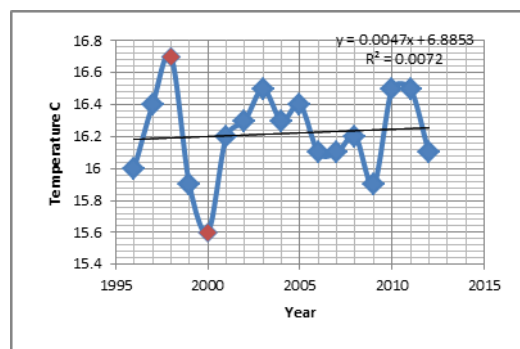


Figure 12: Temperature variability of the study area

Respondents claimed that especially in the month of April the temperature goes up and producing the unexpected drought or dry spells and the frequency is higher than earlier. Main water source in this area is lovers leap waterfall. Survey revealed that in April water in this area drying more than other months and that time the municipal council is supplying water from *Nuwaraeliya* Lake Gregory (Lake Gregory was constructed during the period of British Governor Sir William Gregory in 1873). 89% respondents said that waterfalls are drying and a shortage of water has also been increased. Addressing longer dry seasons and heavier rains, some tea estates, especially in India, have begun using irrigation systems to increase the tea yields (Kaison and Margarita, 2015).

A respondent Ms. Kamatchi said that “drought has increased and waterfalls and other waterways are drying in drought seasons. Like drought condition, the cool weather also affected to tea cultivation”. It was clear that 76% respondents said cool climate is also badly affected to the tea growing and plucking stages especially during the month of December.

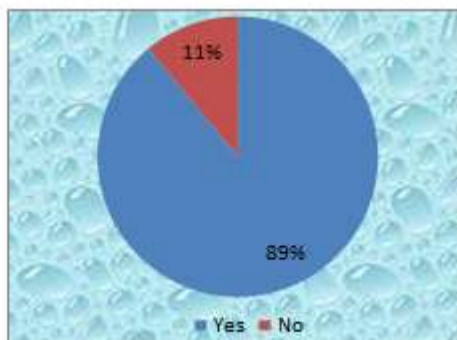


Figure 13: Respondents’ experiences of drying of water fall

During the high intensity of rainfall, the receiving the sun shines hours also low. It negatively affected for tea bud and shoot development. The cloudy and gloomy atmosphere and high humidity condition also negatively impact for tea growth. It creates a fast spread of fungi diseases, and wet weather pests (*Nematodes*).

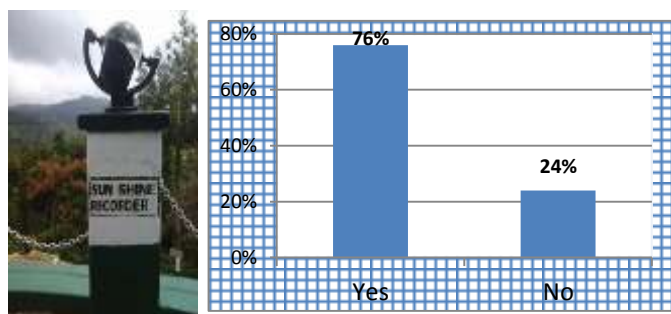


Figure 14: Sunshine recorder at the Pedro tea estate and the perception of cool climate damaged the tea

76% respondents said that the cool season damaged the tea cultivation. When the frost or mist accumulates on the top of the leaves which create the fungal disease like *blister blight* and it is undesirable for tea leaves and caused to yield losses. It causes considerable damage by the scorching effect on the foliage. This is limiting factor in certain high latitudes areas. Ground frost occurs in *Nuwaraeliya* on a few days of the year during the months of January and February. The cool season does not damage the tea but, reduces the production if the temperature goes below 5-6 degrees during February-March. The frost effect is experienced which results in loss of production for about three months if the temperature goes down. This is very common observation due to the adverse weather conditions.

According to the respondents’ perceptions, the cutting, and felling of trees are one of the main reasons to increase the climate variability in this area. During the heavy rainy period, the growth is poor and the production drop and the tea plucking also find extremely difficult in heavy rain condition. This results in a drop in tea productivity of the estate in some years. On the other hand, some years the water in the streams and

waterfalls are decreasing due to less rainfall. The main issues related to the variation of impact on tea is the reducing the tea production especially when erratic weather condition occurs.

Tea varies in its ability to withstand for wind condition. Planting windbreak would help to reduce the adverse effects of wind. Areas prone to strong winds are not suitable for extensive replanting with clonal tea. Heavy winds are experienced in Pedro estate called as “*Katchan*” winds which blow from the upper ridge of the highland complex towards to the eastern sector of the estate. This normally takes place during June, July, and August. Wind belts are being established in Pedro to break the wind velocity otherwise the high wind blows to the tea plants and damage causing the defoliation loss.



Figure 15: Wind breaks trees at Pedro

39% people said that the heavy winds affect the growth of tea leaves (The survey revealed that normally wind damages have occurred in the months of June and July). However, the shade trees planted in this estate support to control the wind speed and damage on tea plants. *Sabukku, Crowly, Selkina, Toona, Grevilia, Ocasia Sabukku, Murunga*, and *Cyprus* are planted as shade trees in this estate.

Enhancing the community awareness about climate change would be essential to mitigation and adaptation to climate change. In this estate the majority of the people are Indian Tamils. Their education background is not to the satisfaction level. However, according to this survey, 72% of the respondents have heard about the climate change as a general issue. They have some idea about the climatic events such as floods, droughts, unexpected heavy rain in short period of time, storms, and cyclones happening in the world today. This knowledge is basically obtained this community from the television watching.

The forest cover of the surrounding area is also decreasing mainly due to increasing the settlement patterns. Forest cover is also decreasing due to the indiscriminate felling of trees. The respondents had some suggestion to reduce climate impacts on tea cultivation. They have said that protecting remaining forest in the surrounding area is very important and also planting trees in the catchment area are also need to implement for reducing the climate variably and change.

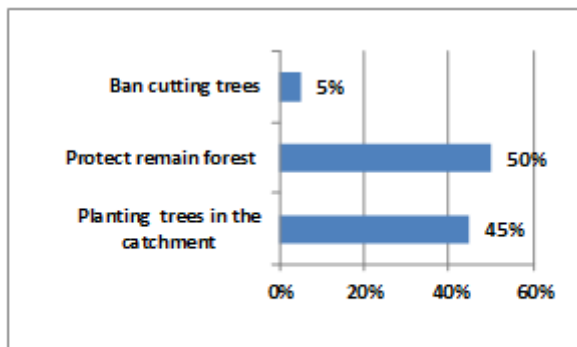


Figure 16: Tea workers suggestions for mitigate the climate change

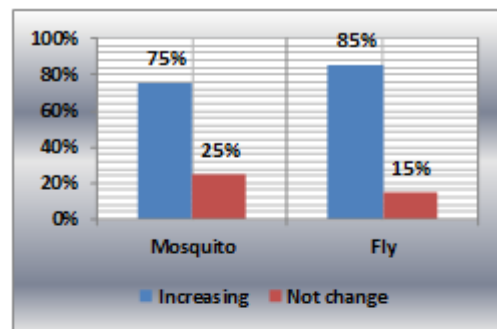


Figure 17: Mosquitos and fly population

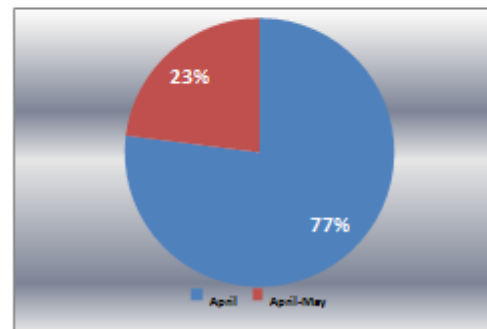


Figure 18: Mosquitos and flies populations increasing months

3.2 Other impacts

Some animals such as wild pig and porcupine destroy the tea roots due to their digging habit. There are some other damages from animal like i.e. wild brow. Soil erosion is not seen to a large extent in this estate. Lateral drains, terracing planting of live fences are practiced to minimize the existing soil erosion. The salt method and contour system should be introduced to control the soil erosion. Landslides risk could be observed in small extent due to unplanned vegetable cultivation on slope areas. Mosquito population has been increasing gradually in this area. During the dry period and when excessive cow dung is used for cultivation the mosquitoes are wide spreading in this estate. *Nuwaraeliya* is famous for flies during the dry season. Encroachment and increased population are resulted more land occupied for human habitation and settlements are one of the main human activities affecting tea cultivation.

Some respondents said that during heavy rain, some places in the estate soil are heavily eroded with runoff water resulting in the loss of top soil layers and lowering the soil depth. The subsoil layer which is left has a poor water retention capacity and poor nutrients status and that makes an unfavorable soil condition for crop growth. The survey revealed that sometimes the excess rain water damage the tea roots due to soil erosion or more runoff. But there is no high landslide risk in this estate.

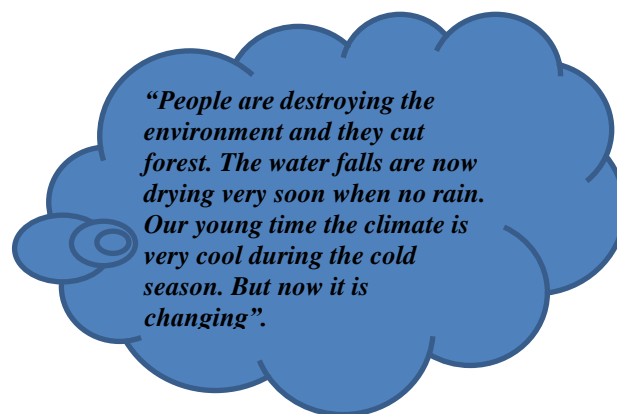
The fly population is also increasing during the dry seasons and the fly population is high in the month of April. Normally cool climate of *Nuwaraeliya* had very little mosquitos and flies population in the past but now both mosquitos and flies populations have been increasing (Figure 18). 75% of the respondents said that the mosquito population has been increased. 85% of the respondents are said that the flies' population is also being increased in this estate (Figure 17).

However, people said that they like the month of April because it is very comfortable for their life as well as for tea growth. During the rainy days, they face numerous difficulties to do their daily work.

Especially due to the fluctuation of yield and market price of the tea, tea cultivated lands are decreasing in this area while vegetable lands are increasing. The high intensity of rainfall and high humidity largely affected the tea productivity and quality. The fast spread of fungal diseases and wet weather pests are the results of which leads to the low yield and poor quality in some years. 7% of the respondents said that the tea land is decreased in this area. *Grevillea*, *Calliandra*, *Accasia* are planted as shade trees for tea plant and those are acting as wind belt for tea plants. These shade trees provide various benefits for the tea plants.

3.3 Some respondents views of the climate and its impacts:

(a) Mr. P. Govinda (age 70) 2011:



(b) Mr. Sinnathammi, (age 63) 2011: "In our childhood, we felt very cool climate especially in winter season. We are now having drinking water problem too. Because when droughts come the waterways are drying quickly."

(c) Mr. Madasami, 2015: "We feel that the climate has been changing. We do not know the reasons for climate change. But we cannot stop it because these are natural."

(d) Mr. Arumugam, 2015: “Climate has changed. Life also needs to adapt to this change.”

(e) Manager (Mr. Ram Ramakrishnan) of Pedro tea estate, 2011: Pedro estate is the highest tea estate in Sri Lanka. This estate receives the rainfall from the western and eastern side. He stated that the rainfall intensity has been increasing. He said that the estate is prone to the high variability of rainfall. People have water for the day today drinking purposes but when drought comes the supplying of drinking water is a problem. 2011 drinking water is distributed for this area by browsers. He said that when the rainfall occurs time to time interval period, it is good for tea rather than receiving the heavy rainfall during short period. He said that when the temperature is in the favorable degree the tea production is also positive. When the temperature is much lower, it is not good due to mist and fog effect. When February and March get low temperature the tea leaves get burnt. It has happened in 2010 and about 150 acres are burnt. If the temperature decreased by 5-6 degree it is also not good. Normally sunshine hour needs at least nearly 5 hours for receiving good tea. Fluctuating of climate is not good for tea, but some years the temperature circumstance is appropriate for the tea.

Even though the Pedro estate workers basically depend on the tea cultivation, they also engaged in other various income generating activities due to unpredictability of their income from tea. Some land portion is converted to vegetable land. The lifestyle also changed. 82% respondents said that the vegetable planting is the other common income generation activity in the estate. Some people said that estate people move to alternative jobs such as various farming practices and some small industry work (Figure 19).

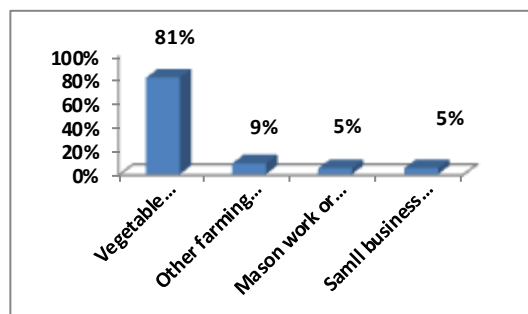


Figure 19: Alternative income of tea workers

4. Conclusions

The rainfall variability has been increasing in *Nuwaraeliya* and Pedro estate. The temperature has also been increasing. Increasing temperature, excess and high intensity of rainfall, soil water deficit and dry soil condition affected tea cultivation, and increases of the frequency of drought and dry spells are also badly affected the tea growth and yield in some years. Most of the people said that they are aware of the climate change and it is take place in the world and locally. The respondents are felt that the rainfall intensity and temperature have been increasing. People are suffered from water shortage in some months of the year. The current tea land has been decreasing and vegetable cultivation has been increasing in the estate. To minimize the risk of the wind and high temperature, shade trees are planted sparsely in the tea estate. Building rock hedges are also practiced to reduce soil erosion. Planting of drought tolerance tea, an establishment of high shade trees, build in rainwater harvesting, use of proper land preparation, weed management, soil moisture conservation practices should be encouraged. Adaptation practiced should be encouraged because preliminary assessments showed that

climate variability and change will have a significant impact on future tea production of high elevation in Sri Lanka.

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Author Profile



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