Farmers' perception and adaptation to climate change in Agriculture:

A case study of rain-fed and irrigation based paddy farmers in Mahawilachchiya DS division of the Anuradhapura district, Sri Lanka

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Abstract

Climate change introduces numerous uncertainties over the livelihoods of farming communities that depend heavily on weather conditions. Farmers in developing countries are among the most vulnerable. This study attempts to identify the farmers' perception on climate change and to explore the strategies used by farmers to cope with climate change. This study was conducted with active farmers who are involved in paddy farming activities for more than thirty years and are above fifty in age. Forty percent of this active farming community was selected by using random sampling technique. Questionnaires, focus group discussions and key informant interviews were conducted for collecting primary data. Secondary data was collected from a number of relevant institutions. The farmers' perceptions and strategies for managing climate change were identified through the primary data and simple statistical techniques were used for the analysis. Majority of the farmers' perceptions on climate change were temperature increase and rainfall decrease and the associated bad weather experienced by farmers over the last 10 - 15 years. These perceptions were parallel with statistical record of meteorological data. However, they have already identified that climate is changing and have already identified their own methods to face these changes. Consequently, they use adaptation strategies individually (farm level) and collectively

(community level) to cope with climate change. However, they have barriers in implementing these strategies. This study has identified some recommendations to improve the farmers' adaptation strategies for managing climate change such as, relevant institutions should collaborate with each other in sharing resources and information, weather forecasting on time, enhanced loan facilities, improved water storing capacity and off-farm training.

Introduction

Climate change introduces numerous uncertainties over the livelihoods of farming communities that depend heavily on weather conditions. Farmers in developing countries are among the most vulnerable communities. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as "a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer" (IPCC, 2007)**.** However, farmers perceive climate change as a change in rainfall and temperature patterns, their variability as well as extreme weather events.

Agriculture has been the backbone of the Sri Lankan economy with one third of the population being dependent on it. The Agricultural sector contributes about 12.1 percent of the country's Gross Domestic product (GDP) and 32.7 percent of total employment (Central Bank, 2008, cited in: Sandika, 2009). Rice is the main crop cultivated by the majority of farmers in rural areas and it is the staple food of the 20.4 million inhabitants in Sri Lanka. Further, it is the livelihood of more than 1.8 million farmers. Rice contributes to 1.8 percent of the country's GDP (Central Bank, 2010).

Dry zone rice farming in Sri Lanka can be divided into two major categories as major irrigation schemes and the rain-fed systems which consists of village tanks or minor irrigation systems. In major irrigation schemes, farmers carry out paddy farming, the main farming activity using water supplied from large irrigation reservoirs on a year round basis. Rain-fed systems depend heavily on local rainfall. Being dependant on local rainfall without access to any substantial sources of supplementary water, rain-fed farmers are naturally more vulnerable to climate uncertainty than farmers in irrigated schemes. They are in a continuous struggle for livelihood security under water stress conditions due to rainfall uncertainty (Senaratne and Scarborough, 2011).

Climate change will cause a severe setback to agricultural development in developing countries (Wassmann, 2007). It has greater negative impact on poorer farming households as they have the lowest capacity to adapt to changes in climatic conditions. Some of the studies on climate change argue that with adaptation farmers' vulnerability can be significantly reduced (Gwimbi, 2009).

A better understanding of farmer perceptions regarding climate change, current strategies for managing climate change and their determinants will be important to form policy and planning to identify successful adaptation strategies in agricultural sector. However, limited information exists on the impact and adaptation to climate change in rice farming in Sri Lanka, especially at the micro level. Given this knowledge gap, there is a need to carefully evaluate the rain fed and irrigation based paddy farmers' perceptions on climate change and to explore exiting strategies for managing the climate change which can reduce farmers' vulnerabilities to such change.

Materials and Methods

This study was carried out in Thantirimale and Mahavilachchiya Grama Niladhar (GN) divisions in Mahavilachchiya Divisional Secretariat Division (DSD) in Anuradhapura District in Sri Lanka (Figure 1).

Both Thanthrimale and Mahavilachchiya is located in the dry zone, which receive less than 1800 mm average annual rainfall during Yala and Maha seasons. The mean annual temperature is 30^0 C although maximum temperature may even exceed 37^0 C occasionally. Thanthrimale's paddy farmers depend on rain fed system (dependent on local rainfall without access to any substantial sources of supplementary water) and Mahavilachchiya's paddy farmers depend on an irrigation system (water is supplied from large irrigation reservoirs on a year round basis).

The total land extent in Mahavilachchiya is 1213 acres where paddy land extent is 486 acres. It consists of two villages, Yaya 2 and Yaya 3 and an estimated population of 699 and 502 respectively (Mahawilachchiya DSD, 2012). Most of the people of the population are educated and at the very least, all have attained primary education. Approximately 62% of the population has obtained secondary education (grade 5 to A/L) and 1% of the population is degree holders (Grama Niladhari, 2012).

Thanthirimale consists of seventeen hamlets with an estimated population of 1,043 and total number of 320 households. About 44% of the people is illiterate, among whom the majority of them are farmers and 0.67 percent of the people have obtained higher education (Grama Niladhari, 2012).

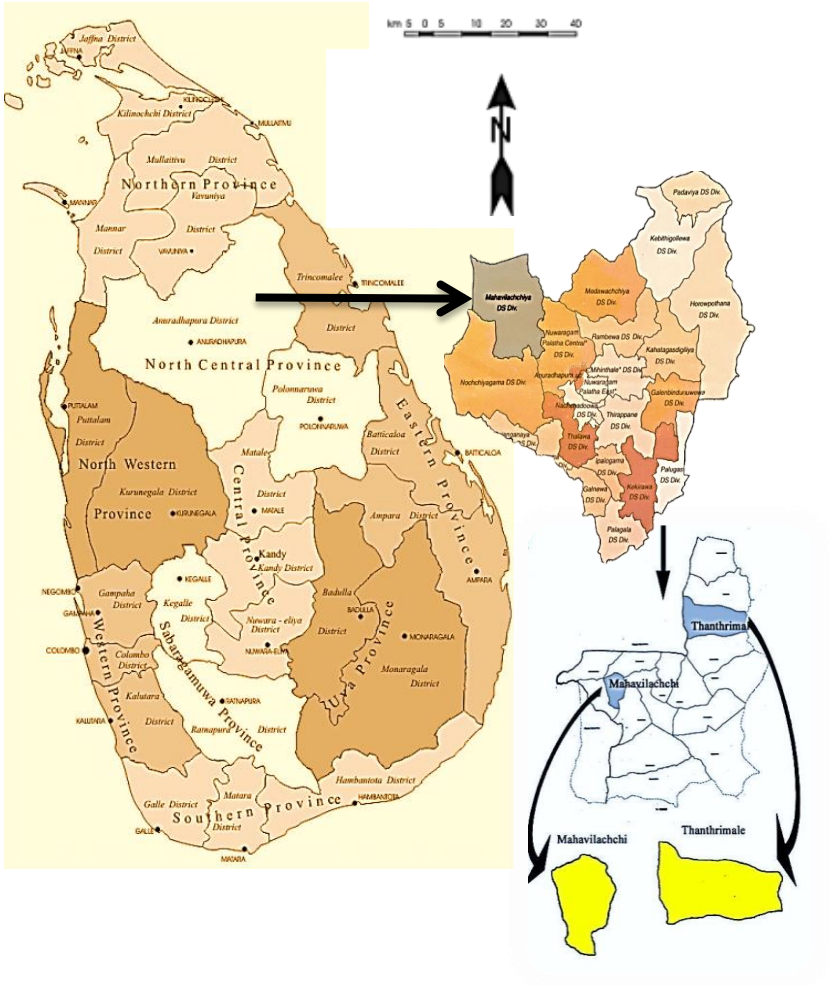


Figure 1: Location of the study area

(Source: Divisional Secretariat, Mahawilachchiya)

This study was conducted with the active farmers who are involved in paddy farming activities for more than thirty years and are above fifty in age Among them forty percent (40%) of paddy farmers were selected as a sample for this study. Random sampling technique was applied to draw the samples and selecting the samples was based on electoral lists using a random table. The characteristics of the sample is given in Table 1.

Table 1: Details of the sample

Name of the study area	Population (above fifty in age + 30 years' experience in farming)	Sample (40%)
Mahawilachchiya	87	35
Thanthrimale	82	33
Total	169	68

Data was collected through both primary and secondary sources and the following methods were used.

- Questionnaire survey was conducted to gather quantitative data for both objectives of this study. The gathered information through questionnaire survey from farmers supports to identify the farmers' perception on climate change and to explore the strategies used by farmers to cope with climate change.
- Focus Group Discussions (FGDs) were conducted with farmer groups of 05-08 in size, from the selected GN areas. Discussions were held in a semi-structured, yet flexible focus guide. The discussions were inquired about the physical profile of the resources in the villages, about the farming systems, local water management, formal and informal institutional arrangements, experience in climate change.

- Key Informant Interviews were conducted with local officers and a few experienced farmers. Local officers included GN, Agricultural officers and village level officers. These interviews and discussions, supplemented the information that was collected from farmers and helped to recognize the

views and perspectives of local officers who are involved in local resource management in the area.

- Secondary data was collected from a number of key institutes. The major types of secondary data collected include: information on water sources, agricultural base data, rainfall, temperature and other meteorological data, physiographic information of resources and studies on socio-economic and institutional aspects.

Farmers' perceptions of climate change and adaptation strategies were identified through primary data and simple statistical techniques were used for data analysis with the help of computer packages such as Statistical Package of Social Science (SPSS) and MS Excel.

Results and Discussion

Farmers' perception on climate change

Farmers perceive climate change as a change in rainfall and temperature patterns and their variability as well as extreme weather events. This is perceived differently at different levels of conceptualization. Through the questionnaire survey and focus group discussion it was understood that weather is continuously changing and it is getting worse over time. The majority of the farmers acknowledge an increase in temperature and a decrease in rainfall.

Among the experienced farmers aged 40 years and above, more than 97% from Thanthrimale and 63% from Mahavilachchiya have perceived that the weather is worse, compared to the past (10 – 20 years before). The result further shows that 82% of the farmers from both GN divisions noted that the weather

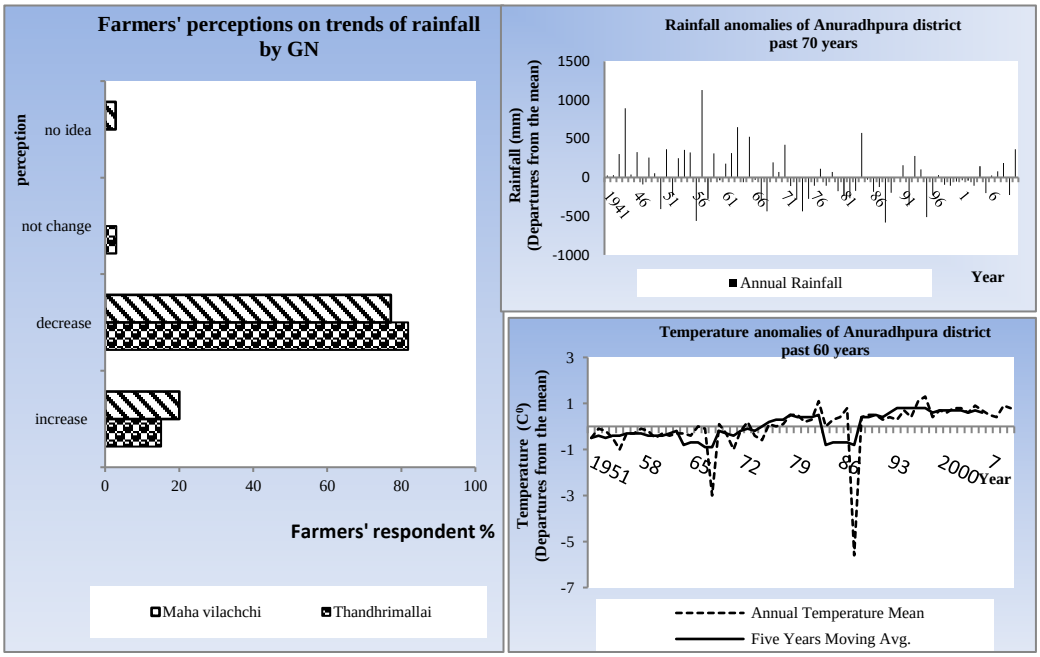
conditions were favorable for paddy cultivation 10 – 20 years before and has become unfavorable at present.

About 82% and 77% farmers from Thanthrimale and Mahavilachchiya respectively noted a decreasing trend in rainfall. At the same time, approximately 90 percent of the farmers from both GN divisions indicated that the increase in temperature is significant (Table 2).

This perception is matched with the rainfall and temperature records (Figure 2) which showed an increase in temperature and a significant decrease in rainfall over the years.

Table 2: Farmers' perceptions on trends of temperature by GN

GN name	Perception			
	increase (%)	Decrease (%)	not change (%)	no idea (%)
Thanthrimale	91	3	6	0
Mahavilachchiya	89	6	3	3



Source: Meteorological Department, Colombo, 2012 (Rainfall and Temperature)

Figure 2: Comparison between farmers' perceptions and the actual rainfall and temperature records.

Farmers' strategies for managing climate change

Farmers in Mahavilachchiya and Thanthrimale face seasonal variability of rainfall and extreme weather events like floods and droughts. Hence, adaptation is important for farmers to achieve their farming objectives such as food and livelihood security. They use strategies individually (farm level) and collectively (community level) to cope with climate change. Several strategies are identified from focus group discussions and questionnaires. The preferred individual strategies identified are shown in Figure 3. Twenty six percent of the farmers from both GN divisions use adjusting timing of farm operations such as adjusting cropping sequence and adjusting timing of irrigation due to delay in monsoon. Crop diversification (24%) and changing cropping intensity

(23%) that includes adjusting fertilizer and other inputs, different varieties, changing land use practices, changing location of crop or changing the timing of activities (of sowing, planting, spraying and harvesting) are also used to overcome the seasonal variations in weather.

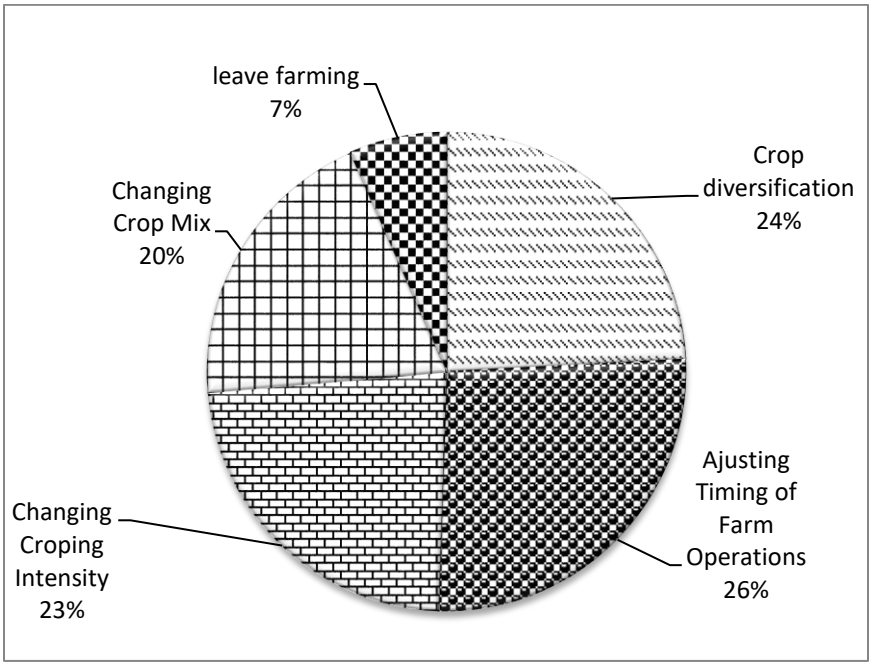


Figure 3: Farmers' preferred strategies to climate change (Farm level)

In addition to this study identified that both areas (Mahavilachchiya and Thanthrimale) more or less followed same adaptation strategies when they face effect of climate change. but comparative with Thanthrimale, farmers in Mahavilachchiya used collective adaptation strategies such as *Bethma* system (divide the land among all the members of the community regardless of the ownership of the respective land plots) during the water shortage periods especially in the *Yala* season. They have used these strategies presently for managing the impacts due to changing weather. Thanthrimale farmers are using temporary migration as one of the individual adaptation strategy when they facing extreme weather events, but farmers in Mahavilachchiya not

having temporary migration because they have diversifications of means for their livelihoods. They mainly engaged in non-farming activities such as carpentry, home guard, as well as teaching etc.

The study has also assessed the farmers' perceived barriers in using various strategies to cope with climate change. The results of barriers to be taken in study areas are presented in Figure 4.

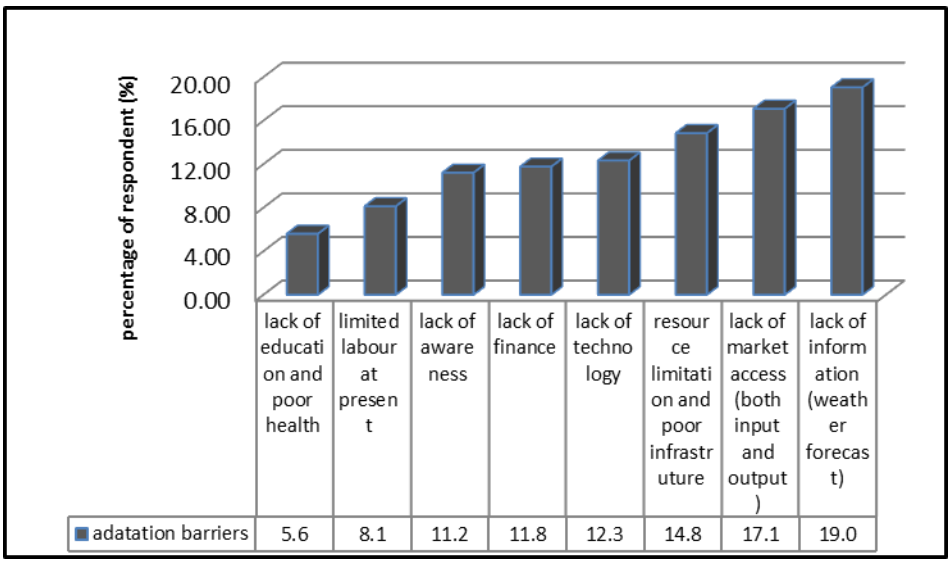


Figure 4: Barriers to implying strategies for manage the climate change

Lack or limitations in information (weather change and agricultural production) increase high downside risks from failure associated with the uptake of new technologies and adaptation measures (Nhemachena & Hassan, 2007). Nineteen percent of the farmers have perceived lack of information as a major barrier for their farm-level strategies.

The lack of market access (17.1%) has also limit the potential for strategies to climate change. Farmers with access to both input and output markets have more chances to implement strategies which they have used currently. Input markets allow farmers to acquire the necessary inputs they might need for their farming operations such as different seed varieties, fertilizers and irrigation technologies.

Conclusions and recommendations

This study assesses paddy farmers' perception on climate change as well as exploring the strategies used by paddy farmers to cope with climate change in Mahavilachchiya and Thanthrimale. The majority of the farmers acknowledge an increase in temperature and a decrease in rainfall. This perception is in parallel with statistical records of meteorological data. They perceived that the weather has become hotter and the rains are less predictable and shorter in duration.

Also, they have used the strategies to reduce their vulnerability. Paddy farmers have experience in managing climate risks and employ a variety of measures to reduce their vulnerability. In both areas farmers use farm-level strategies such as adjusting the timing of farm operations due to delays in the monsoons. Crop diversification and changing cropping intensity that include adjusting fertilizer and other inputs, different varieties, changing land use practices, changing location of crop or changing the timing of activities (of sowing, planting, spraying and harvesting) are used to overcome the seasonal variations in climatic factors. Apart from that, the *Bethma* system which is considered as a community level strategy also used in Mahavillachchiya.

However, they both face barriers to implementing these strategies such as the lack of information and market access, limited resources and poor infrastructure, lack of technology, finance and awareness as well as limited labour and lack of education and poor health.

In order to improve the farmers' strategies for managing climate change the following recommendations may be considered in both areas:

- Farmer organizations, Department of Irrigation, Department of Agriculture and Department of Disaster Management should collaborate with each other in sharing resources and information to support the government to formulate appropriate policy and planning of agricultural management to overcome climatic disasters.
- Farmers can cope with climatic risk with their experience and indigenous knowledge. However, lack of information (weather forecasting) has limited their coping ability. Hence, necessary steps should be taken to enhance climate risk forecasting such as possible occurrence of droughts and floods in the future and information must reached the farmers on time.
- Farmers face financial difficulties when starting their agricultural activities on time. Therefore, existing loan facilities should be revised according to current expenditures and the grant which is provided by the government is insufficient for their needs. Farmers have to follow-up on many procedures and have to spend more time to get this support.
- Depending entirely on agriculture as a primary income source makes farmers more vulnerable particularly during climatic risk periods. Therefore, it is better to provide off-farm trainings which can be used to earn some income especially during climatic risk period.

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