

**FARMERS' PERCEPTION AND ADAPTATION TO CLIMATE CHANGE:
A CASE STUDY IN VULNERABLE AREAS OF KURUNAGALA DISTRICT**

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ABSTRACT

Climate is a key factor influencing agricultural production and its fluctuations largely affect the food security. Smallholder farmers who have enormous constraints are the most susceptible to climate change, and have no alternatives but to adapt their livelihood to changing climate. Therefore, this study aims to examine the impact of climate change on farm income, farmer awareness, adaptation options and determinants and barriers to adaptation. The study was based on a primary survey conducted with a sample of 107 farmers in the most vulnerable three Divisional Secretariats (DS) in Kurunagala District in April 2013. Data were analyzed using logistic regression model. The results indicate that 97 % of farmers are affected by climate change and drought is the prominent climatic hazard in the area. Further 44 % of agriculture income lost by each of the 4 seasons due to drought. The awareness of climate change among the farmers is high but the adaptation is poor. Lack of knowledge on adaptation methods, unavailability of prior information on climate change, absence of suitable cultivars and lack of funding are the factors hindering adaptation. Therefore, focused extension programmes to empower farmers with knowledge on climate change and inputs, research on tolerant varieties and education on crop cultivation planning guided by weather forecasting are envisaged.

KEYWORDS: Adaptation strategies, Awareness, Climate change, Logit model, Vulnerable areas.

INTRODUCTION

Climate change is defined as statistically significant variation in either mean state of the climate or its variability, persisting for an extended period typically decades or longer (Basnayake, 2011). Even though Sri Lanka is a negligible contributor to global warming, it is highly vulnerable to the impact of climate change as a nation. The impact of climate change on weather in Sri Lanka indicates that air temperature has increased by 0.64 °C over the past 40 years and 0.97 °C over the last 72 years, which revealed a trend of 0.14 °C per decade (ME, 2010). However, the assessment of more recent time band has shown a 0.45 °C increase over the last 22 years, suggesting a rate of 0.2 °C per decade (ME, 2010).

Further, consecutive dry days are increasing in the Dry and Intermediate Zones, ambient temperature (both minimum and maximum) has increased and the numbers of warm days and warm nights have increased, while the numbers of cold days and cold

nights have decreased (ME, 2010). Rainfall variability indicates that the precipitation patterns have changed, but conclusive trends are difficult to establish. A trend for rainfall decrease has been observed historically over the past 30-40 years, but this is not statistically significant (ME, 2010). There is a trend in the increase of one day heavy rainfall events, and an increase in the frequency of extreme rainfall events is anticipated, which would in turn lead to more floods (ME, 2010). Further, the increased frequency of dry periods and droughts are expected and the general warming trend is expected to increase the frequency of extreme hot days (ME, 2010). Accordingly, minimizing climate change impact on food security is one of the key strategic thrusts in National Climate Change Adaptation Strategy for Sri Lanka 2011-2016 (ME, 2010).

Agricultural production remains the main source of livelihoods for the most rural communities in Sri Lanka as it provides employment for 31 % of the population and contributes 11.1 % of Gross Domestic Production in the year 2012 (CBSL, 2012). Climate change will have greater negative impact on poor farm households as they have the low adaptive capacity to climatic change. In spite of the technological advances made on improved crop management, irrigation, plant protection and fertilization, weather and climate remain the key factors of agricultural productivity in any country. Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions. It often involves a combination of various individual responses at the farm-level and assumes that farmers have access to alternative practices and technologies available in the region (IFPRI, 2007). Further, adaptation is the ending result of how perception of climate change is translated into agricultural decision making process.

A key challenge for decision makers, policy makers, and development partners is to understand the strategies adopted by farmers and other stakeholders in their efforts to address climate change-induced water stress. Smallholder farmers are the most vulnerable to climate change, and they have no alternative but to adapt their livelihood systems to changing climatic conditions. Adaptation methods are therefore important to help these communities to minimize the negative impacts of extreme weather conditions associated with climate change and variability. Adaptation has the potential to significantly contribute reduce the negative impacts from changes in climatic conditions as well as other changing socio-economic conditions such as volatile short term changes in local and international markets. Therefore, an analysis of adaptation options and constraints to adaptation is important for the agricultural communities (IFPRI, 2007). Thus, this paper aims to examine the impact of climate change on farm income, farmer perception on changes of climate, adaptation options and their determinants as well as barriers to adaptation.

METHODOLOGY

This study was based on a primary questionnaire survey conducted in Kurunagala district where conventional agriculture is dominant and crops are regularly affected by drought conditions (ME, 2010). According to the vulnerable maps of Sector Vulnerability Profile Agriculture and Fisheries 2010 (ME, 2010), the most vulnerable three Divisional Secretariats (DS) of Kurunegala district namely, Kuliypitiya West, Panduwasnuwara and Galgamuwa were selected and 36, 39 and 32 paddy farmers, were randomly selected from three DS divisions, respectively. A survey was conducted during year 2013 with a total sample size of 107 farmers. Data on perception of climate change were recalled for the *maha* 2010/2011, *yala* 2011, *maha* 2011/2012, *yala* 2012 and *maha* 2012/2013 seasons.

The consequences of changing climate on farmer income were obtained by mean income loss. Farmer perception on climate change was captured by developing an Awareness Score, using eight statements on climate change. Each precise answer was given one mark and the score varies from 0 (worse) to 8 (best) per individual. The level of awareness of overall sample was obtained descriptively. The adaptation methods were illustrated descriptively and the determinants of adaptation to climate change were estimated using multivariate Logit model as given in Equation 1. The dependent variable (Y) is binary (an individual adapting to climate change = 1 and not adapting to climate change = 0). The Logit model did not predict the precise value of Y, but Logit value of Y ($L_i = \ln\left(\frac{p_i}{1-p_i}\right)$ = log of the odd ratio *i.e.* the probability of an individual adapting to climate change (P_i) with respect to the probability of non-adapting). The coefficients (β_i) of the Logit model expressed the change in Logit (L_i) for unit change in independent variables (x_i). The definitions for the independent variables x_i (A, Edu, L, I, AS, IL, W) are given in Table 1. Barriers to adaption and feasible interventions were obtained descriptively.

$$L_i = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 A + \beta_2 Edu + \beta_3 L + \beta_4 I + \beta_5 AS + \beta_6 IL + \beta_7 W \dots \dots \dots (\text{Eq. 1})$$

Table 1. Independent variables used in the study.

<i>Category</i>	<i>Symbol</i>	<i>Definition of variable</i>
Age of the farmer	A	Age in years
Education level	Edu	Education rated as 0=no education, 1=grade1-5, 2=grade 6-OL, 3=AL, 4= graduate
Total land extent	L	Total land extent in acres
Annual income	I	Total annual income in rupees
Awareness score on climate	AS	Individual score developed as explained above (vary 1-8)
Income loss due to drought/ season	IL	Agriculture income loss due to drought per season (rupees)
Willingness to adaptation	W	W=1 if farmer is willing to adapt to climate change, W= 0 if not

RESULTS AND DISCUSSION

Results have revealed that 97 % of the farmers in the selected vulnerable three DS divisions in Kurunagala district during the last 5 years have been affected by climate change. Drought mainly affect to 89 % of the farmers by all four season and 36 % of the farmers affected by both drought and flood (Table 2). *Yala* 2012 season was the latest season affected by drought and *maha* 2012/13 season was recently affected by flood. Agriculture holds 80 % of the total income and changing climate made 44 % of overall loss to agriculture income (Table 4). Impact of drought was comparatively higher in Panduwasnuwara DS division (Table 4). The mean awareness score being 6.05 indicates that the overall sample is greatly aware on climate change and temperature aspects are more sensitive over the rainfall aspects (Table 2). The descriptive statistics of the overall sample is given in Table 2.

Adaptation to climate change is poor as only 46 % endeavour to adapt. Comparative high income status made probably the farmers in Kuliyaipitiya West DS division to be more adopted than Galgamuwa and Panduwasnuwara DS divisions (Table 5). The popular adaptation methods are mixed cropping (32 %), cultivation of short duration crops (30 %) and new crop varieties (25 %) (Figure 1).

Table 2. Socio-economic characteristics of the sampled population.

<i>Character</i>	<i>Frequency</i>	<i>%</i>	<i>Mean</i>	<i>SD</i>
Age of the farmer (years)			52.92	11.32
Education level				
< 1	0	0		
1 - 5	12	11		
6 - OL	79	74		
AL	15	14		
Degree	1	1		
Total land extent (acres)			3.995	3.087
Annual income (Rs.)			461,085	592,647
Awareness score on climate			6.047	1.41
Income loss due to drought/ season (Rs.)			81,533	85,422
Willingness to adaption				
Willing to adapt	97	91		
Not willing to adapt	10	9		

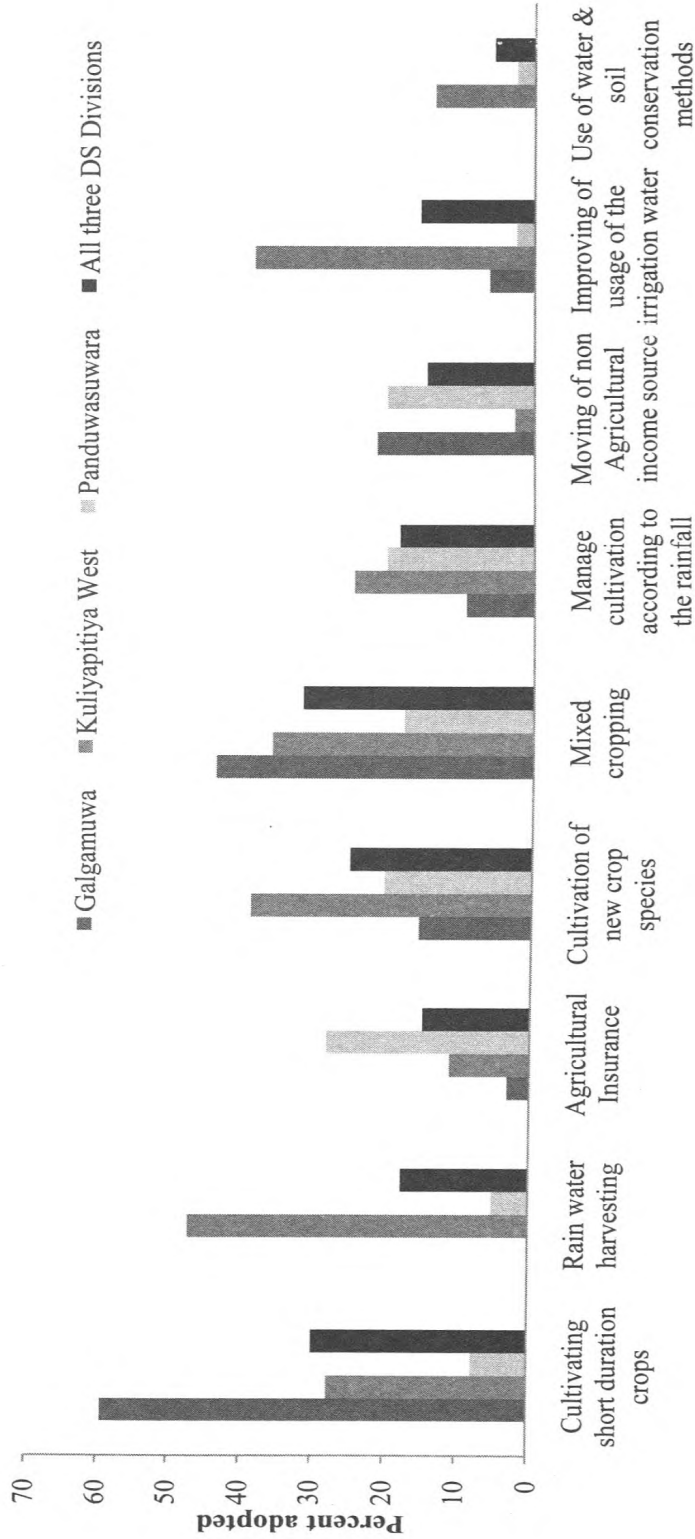


Figure 1. The adaptation methods and percentage adaptation in vulnerable areas of Kurunagala district.

The results of the logistic regression indicate that the farmers who have higher income, higher awareness on climatic variations and more willing to adapt to climate change significantly ($p=0.1$) made adaptation to cultivation on climate change. Conversely, higher income loss due to drought resulted significant ($p=0.1$) negative impacts on adaptation emphasizing more the financial necessity (Table 6).

The major barriers to adaptation are lack of knowledge on adaption methods (48 %), lack of funding (32 %), absence of prior information on climate change (31 %) and absence of suitable cultivars (26 %) (Figure 2). Thus, the farmers demand new varieties, seeds and fertilizer and new technologies to cope with the climate change (Figure 3).

Table 3. Percentage farmers affected by drought and flood conditions in selected DS divisions.

<i>Village</i>	<i>Only affected by drought</i>	<i>Only affected by flood</i>	<i>Affected by both drought and flood</i>	<i>Not affected by climate change</i>
Galgamuwa	63	16	12	9
Kuliyapitiya West	92	0	8	0
Panduwasnuwara	10	8	82	0
All three DS divisions	53	7	36	3

Table 4. Income status and income loss due to drought condition of the selected DS divisions.

<i>Village</i>	<i>Total annual Income (Rs)</i>	<i>Income from agriculture for normal season (Rs)</i>	<i>Agriculture income as a % of total income</i>	<i>Effect from drought</i>	
				<i>Income loss of season (2012 yala)</i>	<i>Income loss as a % of agriculture income</i>
Galgamuwa	452,525	176,950	80	71,786	41
Kuliyapitiya West	628,036	252,851	76	87,147	34
Panduwasnuwara	314,000	130,077	84	84,348	65
All three DS divisions	461,085	185,402	80	81,533	44

Table 5. Percentage adapting and not adapting to climate change in selected DS divisions.

<i>Village</i>	<i>Adapt to climate change (%)</i>	<i>Not adapt to climate change (%)</i>
Galgamuwa	38	63
Kuliyapitiya West	67	33
Panduwasnuwara	33	67
All three DS divisions	46	54

Table 6. Factors affecting adaptation to climate change in vulnerable areas of Kurunegala district.

<i>Variables</i>	<i>Coefficient</i>	<i>SE</i>	<i>P value</i>	<i>Odds ratio</i>
Age of the farmer	-0.009	0.021	0.652	0.99
Education level	0.402	0.461	0.384	1.49
Total land extent	0.115	0.141	0.415	1.12
Annual income	0.000002*	0.000	0.098	1.00
Awareness score on climate	0.3424*	0.128	0.053	1.21
Income loss due to drought/ season	-0.000006*	0.000	0.098	1.00
Willingness to adaptation	1.803*	0.770	0.019	6.07
Constant	-4.164*	1.982	0.036	
No of observations	107			
Log likelihood	-57.697			

Note: * The coefficients are significant at p=0.1

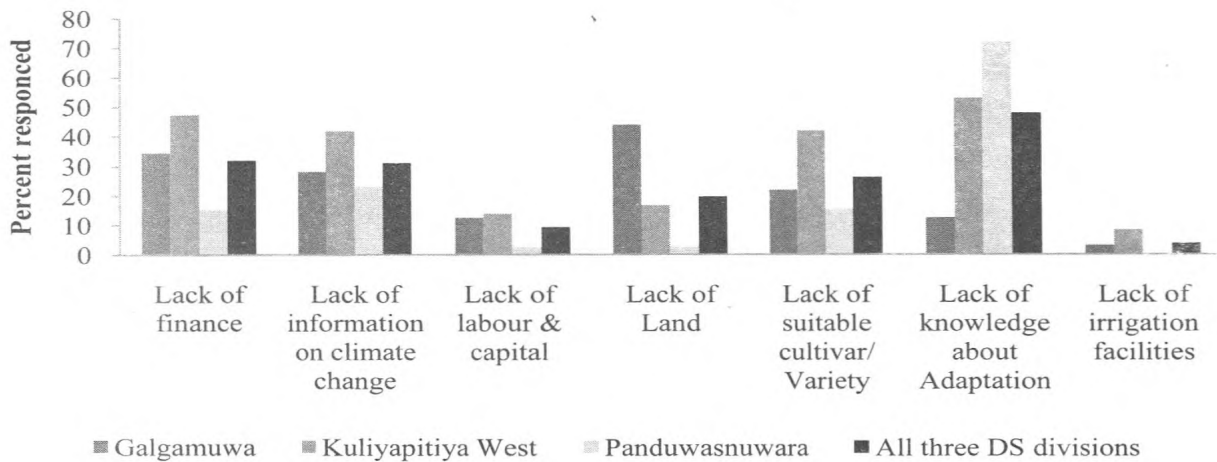


Figure 2. Barriers to adaptation in vulnerable areas of Kurunagala district.

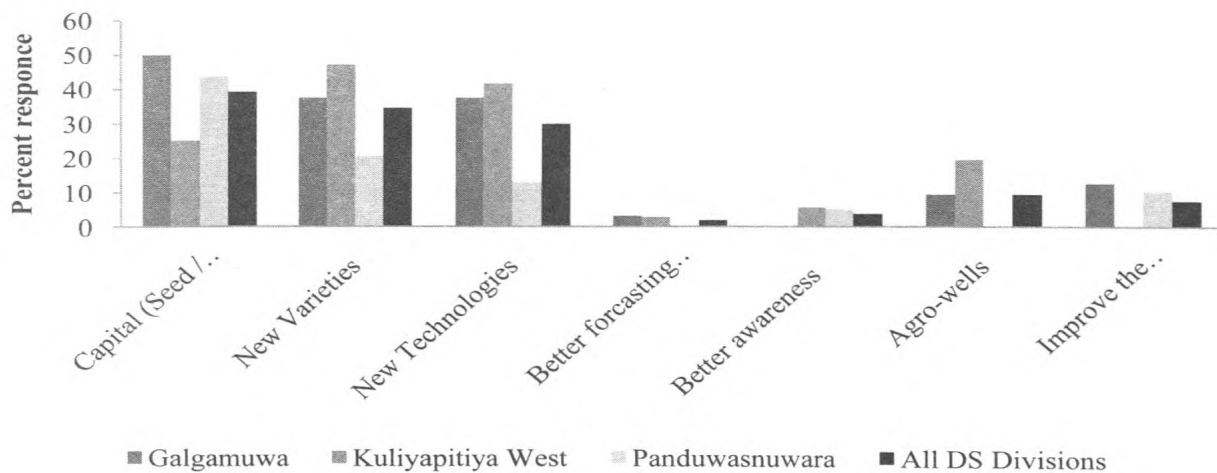


Figure 3. Farmer demands to cope climate change in vulnerable areas of Kurunagala district.

Table 7. Perceptions of farmers on climate change parameters.

	Galgamuwa				Kuliyapitiya West				Panduwasnuwara				All three DS divisions			
	IC	DC	NC	DNK	IC	DC	NC	DNK	IC	DC	NC	DNK	IC	DC	NC	DNK
Temperature																
Normal daily temperature	88	6	0	6	97	0	0	3	95	0	3	3	93	2	1	4
Long dry period	63	16	22	0	89	0	3	8	95	0	5	0	83	5	9	3
Day temperature	91	0	6	3	89	0	3	8	95	0	3	3	92	0	4	5
Night temperature	91	3	3	3	81	3	8	8	97	0	0	3	90	2	4	5
Precipitation																
Rainfall	47	34	0	19	14	69	0	17	36	51	5	8	32	52	2	14
Changes in																
monsoon rainfall	63	9	3	25	42	8	6	44	85	5	0	10	64	7	3	26
Unexpected rainfall	84	0	0	16	42	0	3	56	95	0	0	5	74	0	1	25
Unusual rainfall	63	0	3	34	36	3	3	58	33	3	3	54	57	1	2	40

Note: IC=Increased, DC=Decreased, NC=No change, DNK=Do not know

Increasing global warming has caused various climatic related disasters thereby adversely affecting agriculture, food security, water resources, bio-diversity and overall economy as a whole. Irrespective of production systems, climatic related events such as drought, cyclones, floods, frost, high winds and extreme temperature contribute to farmers' vulnerability and impact on national food security. In this context, the impact of climate change on agriculture is an issue of great significance to the livelihoods of poor people who depend on agriculture.

A study done by IFPRI (2007) in Southern Africa found that enhanced access to credit, information on climate and agronomy as well as input and output markets can significantly increase farm level adaptation to climate change. In Ghana, even though farmers are well aware of climate change, only a few actively took steps towards adjusting their farming activities. The main adaptation strategies are changing crop types, planting short season varieties, changing planting dates and crop diversification. Land ownership, better access to credit facilities and lower soil fertility are the main determinants of adaptation (Benedicta *et al.*, 2010). According to Temesgen *et al.* (2008) age of household head, wealth, information on climate change, social capital and agro-ecological settings had impact on perception of farmers on climate change and education of the household head, household size, owning livestock, availability of credit are the factors affecting adaptation to climate change in Ethiopia. A study done by Mustapha (2012) in Central Agricultural Zone of Borno State of Nigeria, found that the perceived climate change was greatly influenced by their socio-economic characteristics. Lack of current knowledge and information on climate, lack of credit facilities and poor extension services were the major constraints of adaptation.

In rural Sahel the communities have high awareness of climatic issues, and adaptation climate appears not to be an important factor. Therefore, it is suggested that the policy making on agriculture and economic development will be focus on providing flexible options rather than specific solutions to uncertain climate (Ole *et al.*, 2008). In Bundi district of Rajasthan in India, majority of farmers have changed their agricultural management practices in response to climate conditions. Farmer experience, more extension advice, high education and larger farm size significantly affect adaptation (Dhaka *et al.*, 2010), whereas in Tamil Nadu, the adaptation of technologies was significantly influenced by the extension services and land tenure (Ashok and Sasikala, 2012). The vulnerability of homegardens for climate change in Sri Lanka, India and Bangladesh indicates the composition of homegardens has not changes substantially over past two decades (1991-2010) and it showed resilience to climate change. The type of employment, age, sex, education level of household head, experience in farming, homegarden size, diversity of homegardens, and perceptions towards climate change

influenced the decision of home gardeners to adopt different strategies such as, changes in planting dates, agronomic practices, and technology (use of new varieties and irrigation equipments, use of soil and water conservation measures), to cope up with climate change (Weerahewa *et al.*, 2012).

CONCLUSIONS

Climate change is a crucial determinant of agricultural income in farming communities in vulnerable areas of Kurunagala district. Even though the farmers are well aware on climate change, the level of adaptation is poor. Lack of knowledge on risk-averse technologies, unavailability of proper varieties and adequate funding hinders the adaption. Therefore well focused extension programmes to empower farmers on knowledge on changing climate and inputs, research for breeding best tolerant varieties and education on crop cultivation planning guided by weather forecasting are envisaged.

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