COPING STRATEGIES OF FARMERS IN MAJOR IRRIGATION SCHEMES IN PUTTALAM DISTRICT TO CLIMATE CHANGE IMPACTS IN SRI LANKA

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ABSTARCT

The main objective of the study is to understand the resilience of farmers in the major irrigation scheme of Puttlam District to climate change impacts. The study was conducted in Puttlam district. Data were collected from August 2014 to August 2017 through two complementary approaches, namely (i) focus group discussions (FGDs) and (ii) farmer interviews using semi-structured household questionnaires. Majority of the farmers felt the variability if rainfall and temperature during the past decade and also faced extreme conditions such floods and droughts. One third of the farmers didn't do any adapatation measures but two third of the farmers used different methods such as sousing different varieties of crops for cultivation, soil conservation measures, early planting to avoid rainless period and providing additional irrigation. Major barriers for adaption were lack of information, lack of money, insufficient and water. Coping strategies were, renting the agricultural tools, work as labour, reduce consumption, getting loans and selling household assets. Further farmers move to non farm income sources such as working in retail shops, working as labourers in other farms, while majority are unable to do anything. This study shows that there are no preplanned strategies to cope with climate change impacts in the study area. Therefore coping strategies towards extreme events could be introduced through awareness among communities. Further, introduction of appropriate adaptation methods, facilitating the availability of credit, investing in yield-increasing technology packages to increase farm income, and creating opportunities for off-farm employment are necessary. Conducting research on use of new crop varieties and livestock species that are better suited to drier conditions are also essential for communities to cope with climate change.

***Keywords**: climatic variables, irrigation, adaptation, livestock.*

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1. INTRODUCTION

Global climate change is one of the most critical challenges facing the international and national communities today. Climate change is threatening to undo decades of development efforts due to its negative impacts in agriculture, health, environment, roads, and buildings especially in developing countries. Climate change is expected to have serious environmental, economic, and social impacts on Sri Lanka. In particular, rural farmers, whose livelihoods depend on the use of natural resources, are likely to bear the brunt of the adverse impacts. The extent to which these impacts are felt depends in large part on the extent of adaptation in response to climate change. Adaptation to climate change requires that farmers first notice that the climate has changed, and then identify useful adaptations and implement them (Maddison 2006). Agricultural change does not involve a simple linear relationship between changes in a farmer's decision making environment and farm-level change. One important issue in agricultural adaptation to climate change is the manner in which farmers update their expectations of the climate in response to unusual weather patterns.

2. LITERATURE

Climate change (CC) issues impacting on the water sector has emerged during the recent past and is a key discussion point among Agriculturists, Irrigation Experts, Development Planners, and community leaders. Significant climate change impacts not only rainfed farming, but also for irrigated agriculture, causing crop damages, poor yields and reduced cultivated extents have been highlighted. In addition, the shortage of good quality drinking water has become a critical problem. Though uncertainties prevail, the climate related impact will continue to grow due to both development and climate drivers (IPCC, 2013).

Unless measures are taken to reduce risks, climate change is likely to weaken poverty goals and aggravate inequality for decades. Therefore, the importance of taking immediate appropriate actions to create awareness on climate change and impacts on the agricultural sector and day to day life of the farming community has become necessary. Climate change-related extreme events can retard the

economic growth, and cripple agricultural production market value of the products and profit. However, the degree of effects depends on how the communities have prepared and the level of their resilience capacities. If the people are living in the water scarce and marginal areas or in coastal and flood prone valleys, they are more at risk. According to the IPCC (2012), the resilience is defined as "*the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions".* In short, resilience is a measure of how quickly a system recovers from failures.

Agriculture, especially crop production, is highly sensitive to both short and long-term changes. 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 to 7.8% % of Gross Domestic Production in the year 2017 (CBSL, 2017). Today environmental conditions are so unpredictable due to various reasons. Drought and temperature stress are the most limiting factors for crop production. According to a report of the Intergovernmental Panel on Climatic Change (IPCC) (IPCC Expert Meeting Report, 2007) the global mean temperature will rise 0.2 ºC per decade in the coming years. Porter in 2005 reported that the change in global temperature may alter the geographical distribution and growing season of agricultural crops. Cruz *et al.*,in 2007 reported that, during recent decades, the observed increases in some parts of South Asia such as India, Bangladesh, Nepal, Pakistan and Sri Lanka have ranged between 0.07-1°C per decade and some parts of South Asia recorded increasing and decreasing trends in the seasonal rainfall, in general, the rainfall fluctuations in South Asia have been largely random over the years, with no clear trend in the rainfall pattern. According to the Second National Communication (2011), in Sri Lanka temperature is expected to rise from 1.1– 2.4 °C by 2100, depending on the emission scenario. De Silva *et al* in 2007 estimated that, by 2050, rainfall will decrease by 9% to 17% in the main *maha* cultivation season. The expected changes may lead to an increase in the *maha* (wet) season irrigation water requirement for

paddy by 13-23 percent by 2050 compared to 1961- 1990 as predicted by De Silva *et al* (2007). And also The National Climate Change Adaptation Strategy (NCCAS) Sector Vulnerability Profile for Health outlines (2010) the main climate change induced threats, which include rising temperatures and droughts. De Costa in 2008 reported that the analysis of long-term air temperature data shows that significant warming has taken place in all climatic zones in Sri Lanka, while most locations exceed the global average rate of warming.

People are severely affected by periodic droughts, especially those in the dry zone of Sri Lanka and approximately 55% of the land area, mostly in the dry and intermediate zones, received less than 10% of the normal rainfall. A downward trend in rainfall can be seen as the annual average rainfall during 1931-1960 estimated at 2005 mm, declined to 1861 mm during 1961-1990 in Sri Lanka (Chandrapala 1996; Domroes 1996; Domroes and Schaefer, 2000; Jayatillake 2005).

Recent global estimates predict that, by 2080, climate change will reduce world agricultural production capacity as much as by 16% and when considering Sri Lanka, reported that the reduction is projected to be more severe, with production losses of up to 20% (Cline 2007). Kurukulasuriya and Ajwad, (2007) reported that the most of the farmers in Sri Lanka are small holders and dependent on rain for their irrigation needs and they suffered from such climatic variations. Evidence shows a strong correlation between climatic conditions and national agricultural growth and the growth rate declined to 1.5% in 2011 due to adverse climatic conditions (Central Bank of Sri Lanka, 2009, 2011). Therefore solutions are very important to overcome such impacts on agriculture imposed by high temperature and water stress.

Environmental stress is the primary cause of crop losses worldwide, reducing average yields for most major crops by more than 50%. Reduced rainfall on the other hand can affect seasonal flows of the rivers that originate and flow entirely in the dry zone (minor, medium and major reservoirs) is the key factor for the success of cultivation with minimum risk and this depends on the rainfall pattern prevailing during the season and any basin or inters basin transfers. As per studies done, regular droughts and floods have occurred with increasing frequency

in the recent past which badly affected in the farming community. Sometimes a flood immediately followed by a drought has made many of the farmers destitute.

The climate change research community has identified different adaptation methods. The adaptation methods most commonly cited in literature include the use of new crop varieties and livestock species that are more suited to drier conditions, irrigation, crop diversification, mixed crop livestock farming systems, change of planting dates, diversification from farm to nonfarm activities, increased use of water and soil conservation techniques, changed use of capital and labour, and trees planted for shade and shelter (Bradshaw *et al*, 2004; Maddison 2006; Nhemachena and Hassan, 2007).

Puttlam has a tropical climate with average rainfall of 1200mm spread along the months and the dry season from June to September and a second dry season from January to April. The wet season is mainly from October to December. Temperatures remain steady throughout the year with little variations in between. Farmers in Puttlam are mainly depended on irrigation water for their paddy and other field crop cultivation. However they faced severe problems over the past two decades due to the impacts of climate change. Therefore the main objective of the study was to understand how famers cope with climate change in the major irrigation schemes and the coping strategies and to suggest adaptation measures. The study was conducted at Thabbowa, Sengaloya and Karawita which were categorized as major irrigation schemes in Puttlam district by the Irrigation department.

3. METHODOLOGY

Data were collected in August 2014 through two complementary approaches, namely (i) focus group discussions (FGDs) and (ii) farmer interviews using semi-structured household questionnaires. An FGD was held in each ward to collect qualitative information on the farming systems and farmer perceptions on climate variability, use of seasonal climate forecasts and on how they cope with variable climate. A total of 150 farmer households distributed in the major irrigation schemes in Puttlam district (Thabbowa, Sengaloya, Karawita) was interviewed to assess how farmers perceive the effects of changes in climatic variables, and

how they have adjusted their farming practices to cope with the changes in climate. The questionnaire assessed perceptions of changes in rainfall, temperature and extreme weather events in the last 10 years, how changes in climate have affected crop production in the last 10 years. Rainfall data from 1951 to 2010 were collected from Meteorological Department, Colombo. Data was entered using MS Excel for basic descriptive statistical analyses for this study; examines the farmers' perceptions of and adaptations to climate change in the Major irrigation schemes in puttalam district (Thabbowa, Sengaloya, Karawita).

4. FINDINGS AND DISCUSSION

Basic Information of farmers in the study area

Average year of education in the study area is Grade 8 and some have achieved G.C.E (O/L) education too (Table 1). Higher level of education is believed to be associated with access to information on improved technologies and higher productivity (Norris and Batie, 1987). Therefore, farmers with higher levels of education are more likely to adapt better to climate change. The average age of the house hold in the study area is 43 years and majority of farm families are male headed households. Male - headed households are more likely to get information about new technologies and undertake risky businesses than female-headed households (Asfaw and Admassie, 2004). Age of the head of household can be used to capture farming experience. The average size of the household is 5 members. The influence of household size on use of adaptation methods can be seen from two angles. The first assumption is that households with large families may be forced to divert part of the labour force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family (Yirga, 2007).

The statistics on the education of the respondent farmers show that the 50 percent have received formal education from Grade eight to G.C.E (O/L) and 15 percent have received primary education. Among the respondent farmers, none have university education and even the G.C.E. (A/L) qualified are very low. Therefore the farming community has the basic educational background to capture the climate awareness programs and

to be empowered to implement necessary adaptation measures.

Table .1. Description of the independent variables

Explanatory variable	Mean
Years of education	8.7321
Size of household	5.1421
Gender of the head of household	0.8953
Age of the head of household	43.2917

Farmers' Perceptions about Changes in Climatic Variables

Nearly all the households (98%) of 150 interviewed had observed a change in the climate in the last 10 years. Nearly half of the sample population reported that rain came late (52.3%) and the rest reported that came early (46.4%). Twenty two percent reported that rain increased in amount and intensity while 18.6% perceive rain to be extreme (Figure 1). The highest proportion of farmers (41% households) perceived an increase in temperature in the last 10 years, while 16% of the households did not observe any change in temperature (Figure 2). Extreme climatic events like floods, drought/prolonged dry seasons were reported to have increased in the last 10 years (Figure 3). In general farmers feel the change in rainfall, temperature and extreme events. Impact of climate change was indeed experienced by the farming households in the Major irrigation schemes in Puttlam district.

According to farmers' point of view, major climatic factors were hindering their crop cultivation during the last decade. Water Scarcity or drought was the major constraint in all the locations and it was expressed by more than 80% of the respondents even they were in major irrigation schemes due to shortage of water. Impacts of floods also have been realized by 60 % of the farmers in major schemes mostly during monsoon rainfall season. Key informant discussions indicate that scarcity of water experienced by farmers is due to reduction in rainfall, high intense rainfall within a short period of time, reduced number of rainy days and rainfall outside the rainy season as the primary climatic factor affecting crop productivity during this decade. High intense rainfall and flash floods not only cause crop damages by submerging, but also causes dropping of flowers.

Although people have comprehended the changing climatic pattern, the majority of them have

not received formal awareness on climate change effects, causes and consequences. Due to lack of awareness communities are expected to suffer more by climate changes.

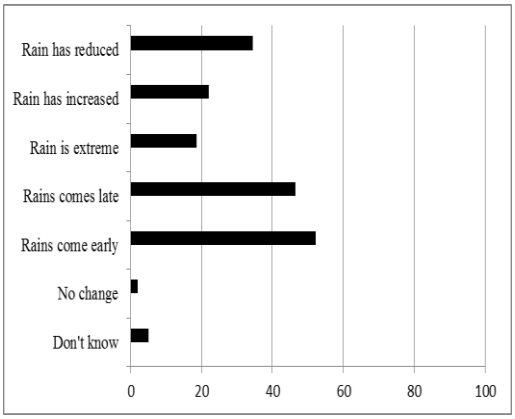

Figure .1.Farmer perception of changes in rainfall in the last 10 years (% households)

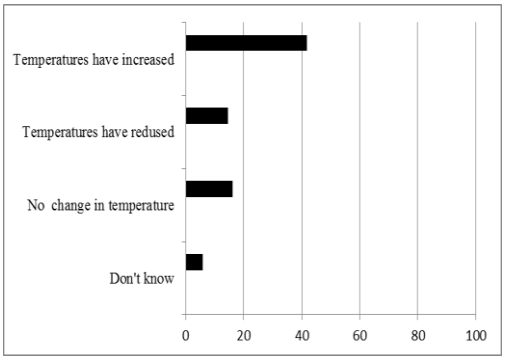

Figure .2.Farmer perception of changes in temperature in the last 10 years (% households)

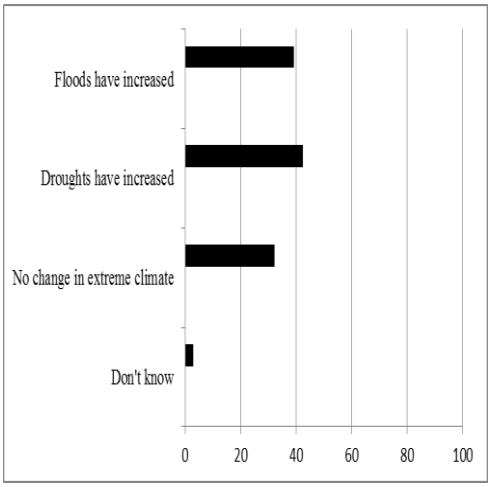

Figure .3. Changes in the occurrence of extreme climatic events in the last 10 years (% households).

Rainfall data (1951-2010) collected from Meteorological Department, Colombo showed that the annual rainfall has high variability as the average rainfall was 1200mm but there were years with lower and higher rainfall compared to the average annual rainfall (Figure 4). Therefore farmers perceptions on extreme events such as floods and droughts agrees with the Meteorology data obtained. Further there was a decrease in South West and monsoon (May-September) and second inter monsoon rainfall (October to November) were also observed during the past 2 decades due to the climate change impacts (Figure 5 and 6). These results also

agree with farmers perception on rainfall variability in the study area.

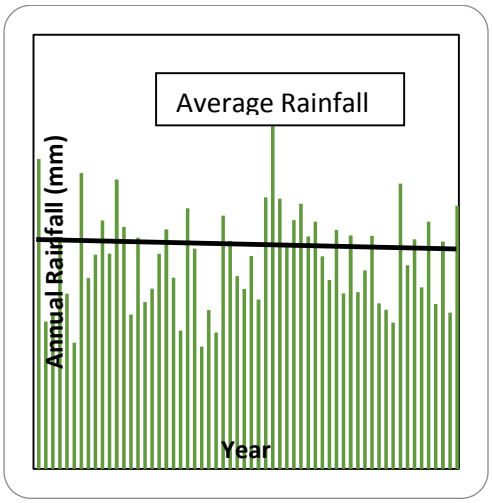

Figure 4. Annual Rainfall in Puttlam district from 1951 to 2010.

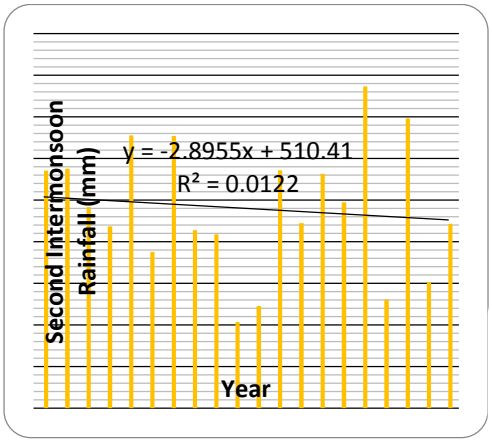

Figure 5. Second Inter monsoon Rainfall in Puttlam District from 1991-2010.

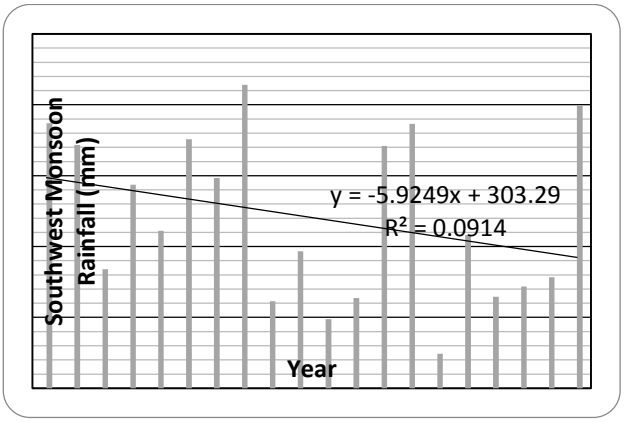

Figure 6. Southwest monsoon Rainfall in Puttlam District from 1991-2010.

Adaptation Options

Farmers were asked about their adaptation measures for climate change especially the changes in rainfall, temperature and the occurrence of extreme events (Figure 1, 2 and 3). Further the adaptation options they have taken to counteract the negative impacts of climate change (Figure 7).

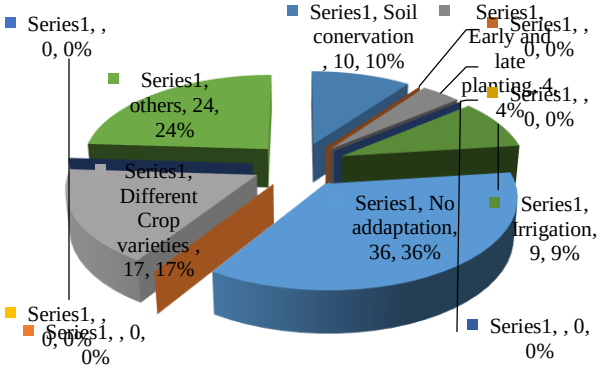

Figure.7. Farmers adapting to climate change

As indicated in Figure 4, the use of different crop varieties (14%) is the most commonly used adaptation method, whereas using early and late planting (4%) is the adaptation least practiced among the farmers in major irrigation schemes. Moreover, about 36 percent of the surveyed farmers reported not to have taken any adaptation method. About 24 percent of the surveyed farmers reported any other adaptation method. As water scarcity due to climate change is evident and experienced by the farmers, attempt was made to find out adoption of different mechanisms to save water in crop cultivation. One of the strategies used to save water in paddy cultivation is commencing the cultivation with the onset of rainfall and saving the tank water to use in later stages of the season. However, the majority of the farmers have begun the cultivation after the seasonal meeting. There are several other techniques adopted by farmers to conserve water and to acquire supplementary irrigation to save crops in the circumstance of water scarcity. Farmers adopted several strategies to overcome the water scarcity conditions. Almost 36 % of the farmers have not adopted any of such techniques to conserve water or overcome the problem of water deficiency despite having experienced negative effects in crop cultivation due to lack of water. Their actions are driven by climatic factors, as reported by farmers themselves in the studies by Maddison (2006) and Nhemachena and Hassan (2007).

Barriers to Adaptation

The analysis of barriers to adaptation to climate change in the major irrigation schemes indicates that there are five major constraints to adaptation. These are lack of information, lack of money, shortage of labour, shortage of land, and poor potential for irrigation (Figure 8). For instance, lack of information on appropriate adaptation options could be attributed to the dearth of research on climate change and adaptation options in the country. Land is an indispensable resource for agricultural production system. Land ownership and availability have become the most crucial factor in the irrigated agricultural systems. In most of the settlement schemes, settlers were given 2.5 acres of irrigated lowland and 0.5 acre of highland for homestead. However, with the population increase the pressure on limited land resources in the settlement schemes has increased in all the areas. In major irrigation

schemes, the percentage of farmers having low land extent below 1.5 ac is accounted for 25%-30%. In addition land leasing out and renting out also contributed in changing land size cultivated by individual farmers.

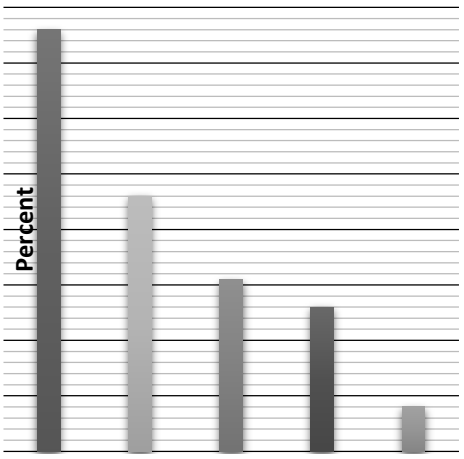

Figure.8. Barriers to adaptation

Coping Mechanisms

To escape climatically bad years the farming community has been using a wide range of inbuilt coping mechanisms (Figure 9). All climate hazards end up either in eroding the asset of the farmers, or the natural base on which their livelihood depends. Hence, coping strategies adopted are not specific to the climate hazard. Inter household transfers and loans (31.1%), reducing household consumption (26.5%), store grains (12.4%), rent tools/ animals (16.3%), Wage labour (42.8%), sale of household assets (22.3%) were the main coping mechanisms demostrated by the farming community in the study area. These are the various adjustments those farmers in the survey area made in their farming activities in response to climate change and variability.

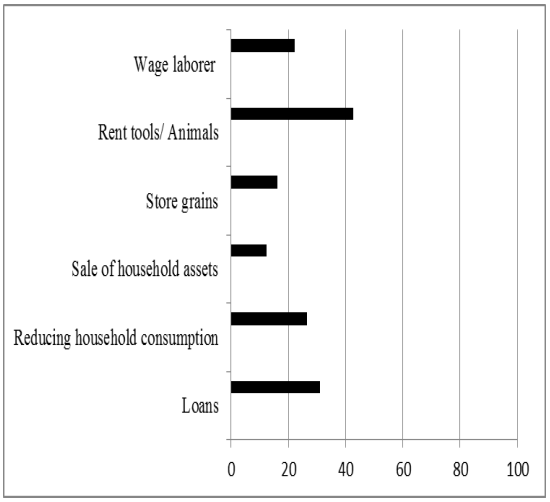

Figure.9. Farmers adapting to climate change

Changes made in non-Farm Income Sources

Information on the non-farm activities which farmers had taken on to diversify their income sources and therefore spread the risk associated with farming like total crop failure was analyzed (Figure 10). A number of activities had been launched to increase household cash income and included stone quarrying, retail business, working

as a causal worker at another farm and securing salaried employment. No house hold had any new additional cash income activity in Puttlam district. Retail business was the most common type of activity started by household (14%) across Puttlam district.

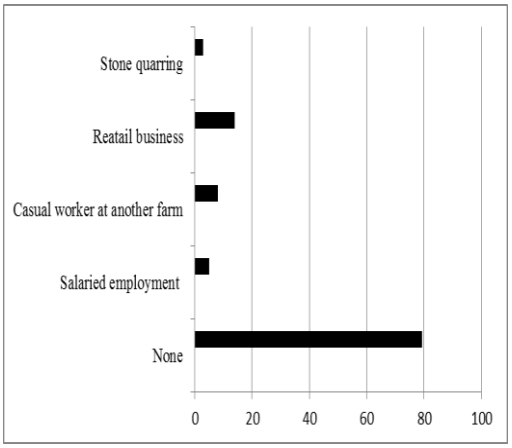

Figure .10. Changes made in non-Farm Income Sources (% households)

Savings and insurance

Households with a higher income or savings can readily help themselves in an extreme event and hence are less vulnerable to disaster impacts (Green *et al.*, 1994). However, the majority of the farmers in the study areas being smallholder subsistence farmers, about 50 to 60% of the households have declared themselves no savings or as reluctant to state their amount of savings. In addition, 27 to 30% of the households are having less than Rs. 75,000.

5. CONCLUSIONS AND RECOMMENDATIONS

Farmers experienced the change in rainfall variability and extreme events during the past two decades due to climate change. These impacts had made changes in their agricultural activities and livelihood. Farmers adapted to climate change by using different methods such as using different varieties of crops, soil conservation measures, and additional irrigation while others have tried other adaptation measures. Barriers of adaption measures were lack of information, lack of money, lack of land and water. As coping strategies farmers used non- farm activities in addition to selling the house hold assets, reducing consumption and working as wage labourers.

This analysis of the constraints to adaptation and the factors that influence farmers' perceptions of adaptation to climate change in the major irrigation schemes suggests a number of different options. These options include raising awareness of climate change and the appropriate

adaptation methods, facilitating the availability of credit, investing in yield-increasing technology packages to increase farm income, creating opportunities for off-farm employment, conducting research on the use of new crop varieties and livestock species that are better suited to drier conditions, encouraging informal social networks, and investing in irrigation.Further policy makers may have to consider subsidy, insurance and other financial assistance for farmers to cope with climate change impacts

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