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Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience

ADB

Policy Brief No. 23 February 2013

Helping Communities Adapt: Climate Change Perceptions and Policy in Asia

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Background

Recent studies on climate change and the 4th assessment report of the Intergovernmental Panel on Climate Change (IPCC)[1] provide the latest understanding on the status, impacts, and measures required to address the effects of climate change. The global climate change outlook highlighted serious concerns about the future at a macro perspective, ie, continental, national, and regional levels. Further, the state of knowledge available at the regional and sub-regional levels is still inadequate (INCCA 2010). In response to the concerns and advocacy initiatives to improve awareness, "early action" plans are being developed to improve knowledge, learn from experience, strengthen capacity, and confidence to transit to a sustainable climate change resilient agriculture. As part of this global effort, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) together with seven countries in Asia, implemented a project entitled "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience" (Figure 1). The project was financed by the Asian Development Bank (ADB) with a view to contribute to science-based solutions and pro-poor approaches to enable agricultural systems to effectively

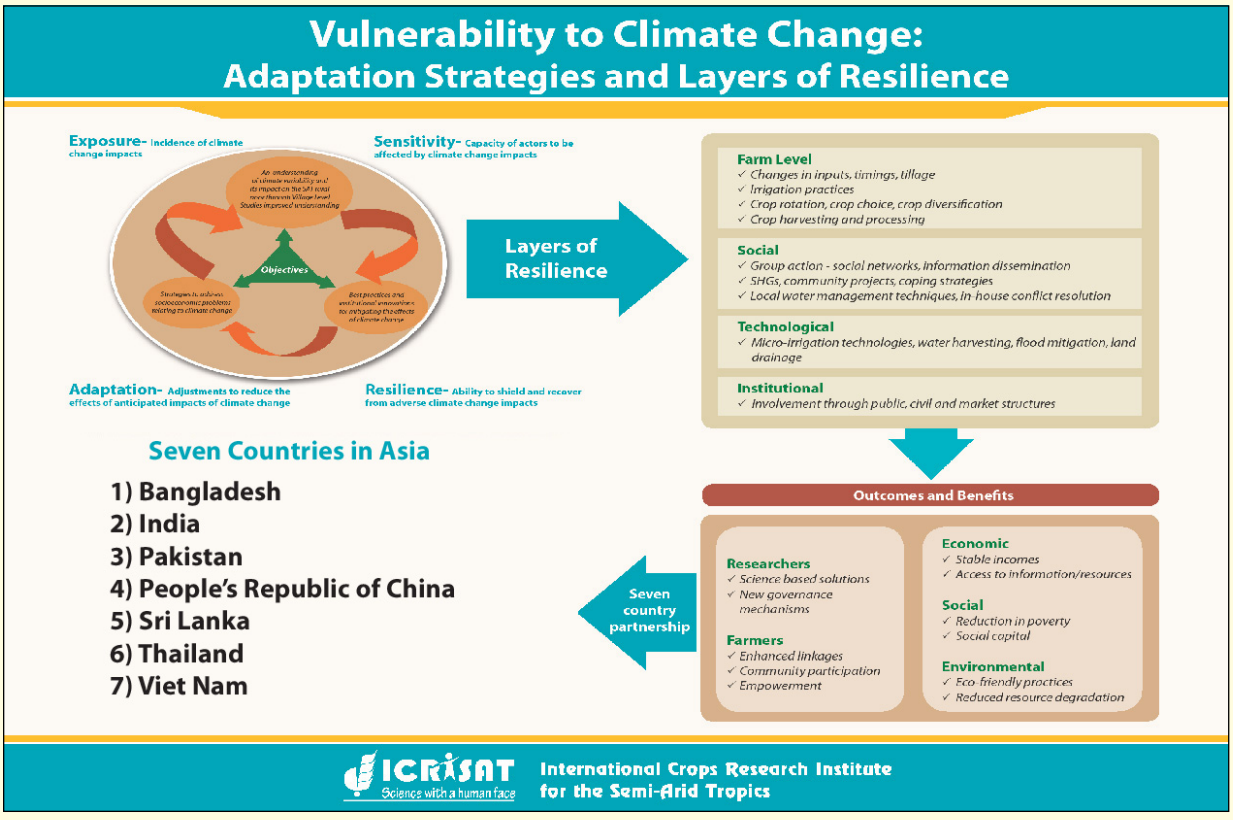


Figure 1. The conceptual model based on which the seven country study was designed.

[1] IPCC 2007; INCCA 2010; GoB 2008; GoS 2011; AKP 2010; PRC 2007.

deal with climate change so that the rural poor and the most vulnerable farmers in the semi-arid regions of Asia are benefited.

The seven countries and major collaborating institutes that participated in the project are:

- Bangladesh: Centre for Policy Dialogue (CPD)
- China: Guizhou Academy of Agricultural Sciences (GAAS)
- India: Central Research Institute for Dryland Agriculture (CRIDA)
- Pakistan: Pakistan Agriculture Research Council (PARC)
- Sri Lanka: Council for Agricultural Research Policy (CARP)
- Thailand: Department of Agriculture, Chiang Mai Field Crops Research Centre, (DOA, FCRC)
- Viet Nam: Viet Nam Academy of Agricultural Sciences (VAAS)

The Asian challenge

The countries that participated in the study, account for 43.6% of the global population, and 10.5% of the total land mass. Poverty is rampant in these countries, ranging from 1.3-32%[2] of the total population. The semi-arid tropics in the six countries account for more than 30% of inhabited land mass. On the other hand, China and India are the two main economic giants in the world with enormous wealth generation capacity, along with Bangladesh, and have large regions and populations that are affected by climate change.

Farmers in this region are facing several challenges in agriculture including farm fragmentation, price fluctuation, degrading natural resource, etc. In recent times, significant changes in the climate and its variability have increased their income instability, thereby casting a shadow on their livelihood and impeding overall socio-economic development. Depleting water resources, droughts, erratic heavy rainfall resulting in floods and rising sea levels, add greater constraints to the state agencies and contribute further to impoverishment and rural-urban migration (Jodha et al. 2012, Singh et al. 2011).

The region is also characterized by a few commonalities such as of community kinship and ethos and shared agro-ecological characteristics. However, there are numerous unique differences within the countries and regions. These mosaics of differences are not well understood. There is a dearth of effort at developing typologies and classifications combining the spatial, cultural and environmental parameters to develop models for management and governance.

South and Southeast Asian countries are extremely vulnerable to climate change

A survey conducted in 2010 by global risk analysis firm, Maplecroft, identified 16 countries that are extremely vulnerable to climate change. The vulnerability indexes were computed based on 42 socio, economic and environmental indicators, identifying each country's position in the next 30 years in terms of climate change impacts. The Asian countries including Bangladesh, India, Viet Nam, Thailand, Pakistan and Sri Lanka were identified as extreme risk countries along with poor African countries.

Sources: http://maplecroft.com/about/news/ccvi.htm

The study

The project had two key features: a) taking a multi-dimensional approach, focusing on agro-climatic, technological, socio-political-institutional and policy dimensions; and b) prioritizing those most at risk and identifying grassroots level adaptation strategies as an integral part of agricultural development programs (Figure 2).

The efforts are designed to have an impact on policy and livelihoods through (i) an improved understanding of the climate variability and other related factors that may be influencing changes in cropping patterns, crop yields, structures of income and employment, and adaptation-coping strategies of the rural poor and equitable welfare in semi-arid tropical (SAT) villages, (ii) best practices and institutional innovations for mitigating the effects of climate change and related shocks, and (iii) strategies to address socioeconomic problems relating to the changing weather patterns and availability of a range of initiatives for their alleviation.

Key questions addressed:

- What are the key changes in climate that have a bearing on farmers in the SAT regions?
- How do farmers perceive the changes and how do they adapt?
- What lessons can be learnt from the resilience shown by farmers for wider relevance and application?

[2] World Bank (2012).

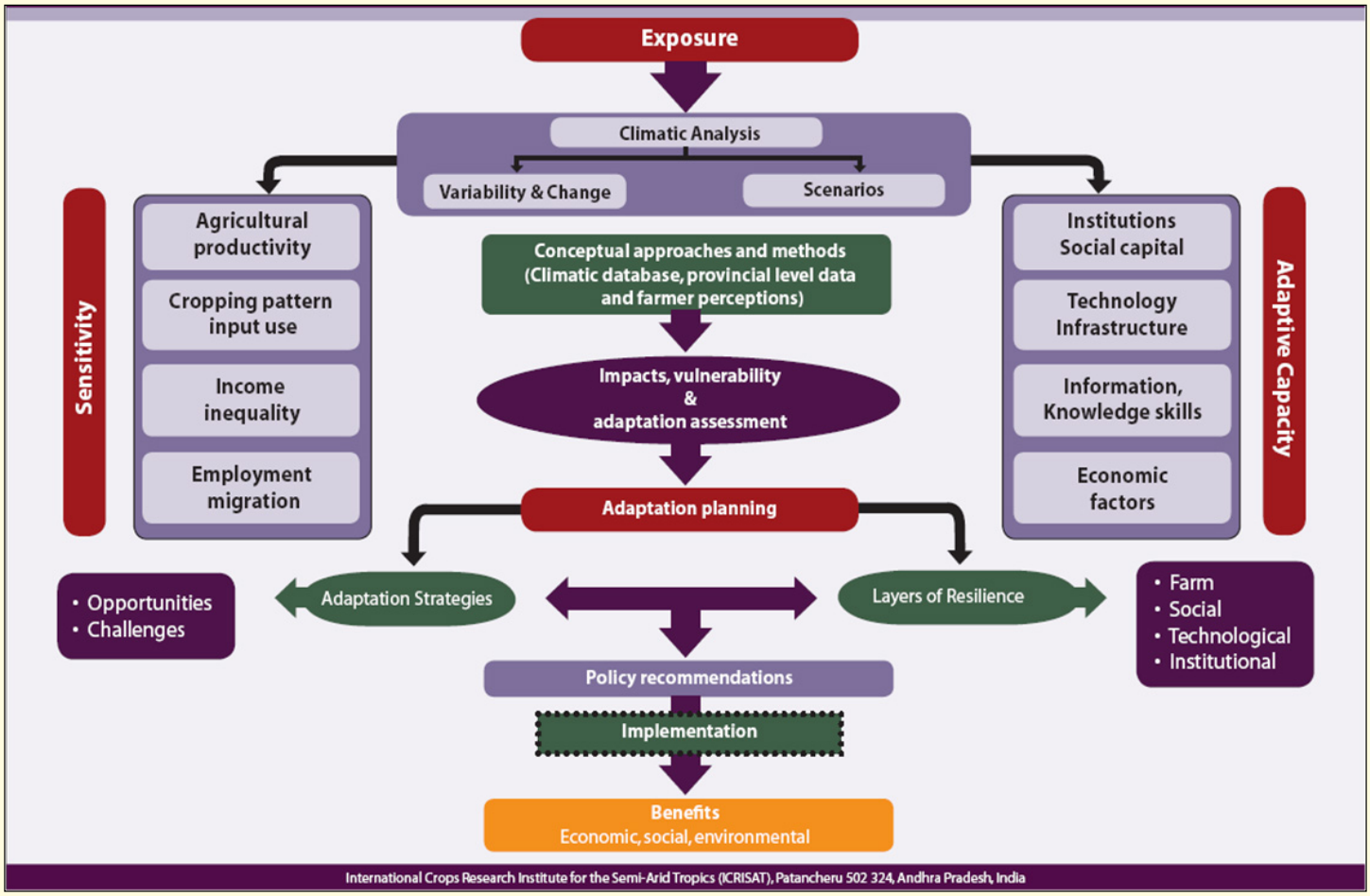


Figure 2. Conceptual frame for addressing climate change at grassroots level.

Methodology

A comprehensive design was developed in a consultative manner and relevant training was provided to all the partners. The effort was to identify the various intricacies associated with impacts, adaptation and resilient capacity at micro level. Analysis of long-term trends in climate at national, regional and sub-regional levels were undertaken. (Key parameters such as temperature and rainfall, that have direct implications for farmers in the SAT of south and southeast Asia, were analyzed using data collected from government meteorological agencies). Regions vulnerable to climate change were identified and prioritized using indicators representing exposure, sensitivity and adaptive capacity (IPCC 2001). Micro level information[3] was collected from the selected districts, sub-districts and villages from the vulnerable regions to obtain information about trends, perceptions, impacts, adaptation practices, constraints faced due to climate change and variability. The micro level dynamics were captured by a combination of qualitative and quantitative techniques. Insights from the study villages, requiring transformation to resilient communities against climate change were identified. The recommendation elucidated through this study was echoed in national and international policy circles highlighting the various options/interventions to strengthen the adaptive capacity of the rural communities against climate risks.

Climate change evidence

A significant increase in ambient temperature and occurrence of extreme events such as drought, intense rain and floods was observed. An increase in the annual rainfall associated with more erratic distribution of rain is predicted, while regions dependent on monsoons experience delays and increased unpredictability.

The analysis of past rainfall trends for the countries studied did not show significant trends for India, Sri Lanka, Thailand and China; whereas in Bangladesh and Viet Nam there was an increasing trend. When the analysis was done for regions and sub-regions, clear patterns emerged. In India's eastern Andhra Pradesh, a decreasing trend was found. In northern Sri Lanka, a decreasing trend was observed, but in Thailand,

[3] Micro level: Households, village and community.

a significant increasing trend was seen during the February to April season.

In the SAT regions of India, the temperature increased by 0.4^{0}C for the period 1901-2003.

In Sri Lanka, a rise of 0.2^{0}C was observed for 1951-2006 period, with both Tmin and Tmax showing an increasing trend in the central hills and coastal areas, respectively.

The Tmax and Tmin showed an increasing trend in Bangladesh and Thailand.

The annual mean temperature showed a steady increase of 0.15^{0}C per decade in Viet Nam; while in China, the annual increase was 1.1^{0}C in the last 50 years.

The frequency of occurrence of droughts has increased in India, Sri Lanka and China. Significant definite trends in droughts were not discerned from the analysis in India, whereas for Sri Lanka, Thailand and China, the picture was more convincing. There is a variability among and within the countries. The trends observed and predicted for the whole country mask the actual situation at the ground level where there are significant differences in the trends as well as predictions of quantum, intensity and occurrence of rainfall and temperature (Table 1). The observed divergence between the macro and micro level trends indicates the need for systematic analysis of data for higher spatial resolution units in order to determine more effective responses to varying local needs.

In addition, the climate vulnerability assessment showed that arid and semi-arid regions are extremely vulnerable. However, there is variability within regions and among localities, calling for better targeting of interventions and relief programs based on vulnerability assessments and prioritization of local spatial units (Table 2).

Table 1. Climate change projections for Asian partner countries.

Country	Annual Rainfall	Annual Mean Temperature
Bangladesh	Increase by 3.8% in 2030, 5.6% in 2050 and 9.7% in 2100 compared to baseline year (1990)	Increase by 1°C in 2030, 1.4°C in 2050 and 2.4°C in 2100 when compared to the baseline year (1990)
China	Increase to 611 mm during 2050 when compared to 1950-2000 average of 467 mm	Increase by 2.6°C in 2050 over the base period average (1950-2000)
India	**Andhra Pradesh** Annual : 8% (2021-2050) ; 10% (2071-2100); SWM : 6% (2021-2050); -6% (2071-2100) **Maharashtra** Annual: 11% (2021-2050); 19% (2071-2100); SWM – 12% (2021-2050); 13% (2071-2100)	**Andhra Pradesh (Max)** Annual – 1.7 (2021-2050); 3.6 (2071-2100); SWM – 1.5 (2021-2050); 3.8 (2071-2100) **Maharashtra** Annual – 1.8 (2021-2050); 3.4 (2071-2100); SWM – 1.4 (2021-2050); 3.2 (2071-2100) **Andhra Pradesh (Min)** Annual – 2.1 (2021-2050); 4.5 (2071-2100); SWM – 1.7 (2021-2050); 3.8 (2071-2100) **Maharashtra** Annual – 2.2 (2021-2050); 4.5 (2071-2100); SWM – 1.5 (2021-2050); 3.4 (2071-2100)
Pakistan	Increase to 317 mm during 2050 when compared to 1950-2000 average of 224mm	Increase by 2.7°C in 2050 over the baseline average (1950-2000)
Sri Lanka	Southwest monsoon rainfall would increase by 173 mm in 2025, 402 mm in 2050 and 1061 mm in 2100 when compared to the baseline year. The Northeast monsoon rainfall would increase by 23 mm in 2025, 54 mm in 2050 and 143 mm in 2100 when compared to the baseline year.	Increase by 0.4°C in 2025, 0.9°C in 2050, 1.6°C in 2075 and 2.4°C in 2100 compared to baseline year.
Thailand	No clear information is available for the country as a whole but there are positive and negative projections depending on the region.	Average monthly maximum temperature will increase by 3°C-4°C and average monthly minimum temperature is expected to increase by over 4°C throughout the country by 2045-2065
Viet Nam	Increase by 1.6 to 14.6% by 2100 when compared to 1980-1999.	Increase between 1.1 -1.9°C and 2.1 -3.6°C by 2100

Source: ICRISAT a, d, g, j, m; Azeem Khan and Irfan Mehmood (a); Yin Dixin and Cui Wei (a).

Table 2. Vulnerability to climate change of study countries of Asia.	
Country	Findings of the vulnerability analysis. Regions identified as most vulnerable to climate change
Bangladesh	Heavily flooded and tidal prone; coastal districts
China	Arid and semi-arid regions of northwest, the Qinghai plateau; the Karst uplands of southwest and densely populated peri-urban coastal zones
India	Majority of the districts of Andhra Pradesh and Maharashtra states are classified as vulnerable and show changes over time.
Sri Lanka	Situation has worsened in all the districts over time with the southern and northern districts becoming more vulnerable
Thailand	Northeast region–twelve provinces in the northeast region.
Viet Nam	Five out of the eight agro-ecological zones and the Mekong river delta, the "rice bowl"
Source: ICRISAT c, f, i, l, o.	

Farmers' perception of climate change and trends

In all the countries studied, farmers commonly experienced a decrease in annual rainfall, erratic distribution of rainfall, decrease in number of rainy days, delayed arrival of monsoon and an increase in temperature. Farmers' perceptions of climate change and experience of extreme events matches closely with the inferences drawn from scientists data analysis (Figure 3). However, there were a few exceptions to this general pattern. A similar pattern was seen for all six countries where there was a close similarity between farmers perceptions of past climate experience and what was inferred from analyzing the long-term weather data (Table 3).

Farmers' Adaptation Strategies

Farmers in the study villages where surveys and focus group meetings were conducted adopt a range of practices to cope with the extreme weather events and the changes that are happening in the environment in terms of rainfall, atmospheric temperature and the onset of the monsoons. These ranged from the choice of crops and varieties, methods of cultivation,

Table 3. Farmers' perception on trends in climatic parameters from the study countries.							
	Bangladesh	India	Pakistan	Sri Lanka	Thailand	Viet Nam	China
Annual Temperature	MII	MI	MII	MII	MII	MID	MII
Rainfall	MID	MD	MID	MID	MID	MII	MID
No. of rainy days	MID	MD	MD	MID	MII	MID	-
Onset of Monsoon	Erratic	Delayed	Changed	Slightly delayed	-	-	Delayed
Distribution of seasonal rainfall				highly erratic			
Source: ICRISAT b, e, h, k, n; Azeem Khan and Irfan Mehmood (b); Yin Dixin and Cui Wei (b). Note: MI=Major Increase, MII=Minor Increase, MD=Major Decrease, MID=Minor Decrease.							

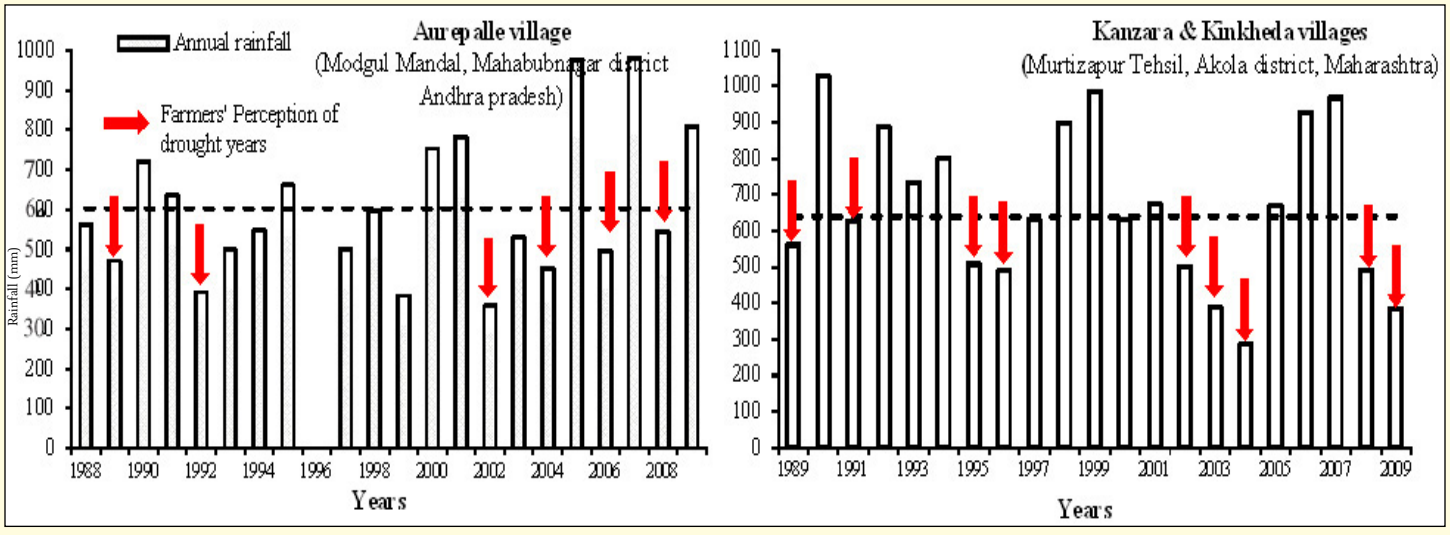


Figure 3. Farmers' perception of rainfall and actual situation based on meteorological information in India.

diversification of income and enterprises, investment in livestock, expanding non-agricultural income sources, rainwater harvesting to collective action for mutual support and migration. The farmers' adaptive capacity is influenced by external factors such as the development and availability of irrigation and other infrastructure, relief and insurance, credit and other types of subsidized income transfer schemes, information and knowledge dissemination.

Micro level adaptation in Southeast Asia

Thailand

- There is reduced cultivation of rice among small and medium farmers during the dry season. They adapt by change in crops and by finding supplementary earnings. Large farmers grow more crops, often near the water source and dig more wells or build farm ponds to supplement water needs.

Viet Nam

- Adaptive response among poor farmers is to work as laborers in the neighboring provinces, and when it starts raining, to select appropriate crops based on local conditions.

Country level key findings

The findings from the project partner countries are based on quantitative analysis of agro-socio-economic change, analysis of trends of climate variables at various spatial levels, and complemented by grassroot level elicitation of farmers' perceptions and adaptation capacities/strategies. The information was gathered from 26 villages/communes drawn from marginal semi-arid environments for the seven countries. The summarized details of trends and constraints identified are presented below.

Part-time business to cushion income risks associated with agriculture - petty shop in Aurepalle village, Andhra Pradesh, India.

India

- Long-term rainfall analysis of India indicates that rainfall has become more variable during the monsoons both in terms of timing as well as intensity within and between the main cropping seasons.
- Farmers perceived that there has been significant variations in the quantum, distribution and onset of rainfall over the years. They also experience a rise in atmospheric temperature. The occurrence of extreme events such as drought and high temperatures are more frequent.
- Smallholder farmers and daily wage laborers were the most vulnerable groups. The limited resource base, ineffective governance structures, and limited awareness increased the vulnerability. The lack of access to formal financial sources and inadequate information about the schemes and benefits available, made the laborers and the smallholder farmers dependent on middlemen and moneylenders. These factors diminish their capabilities to cope with the challenge of climate change. Furthermore, the farmers with no access to irrigation were the most vulnerable as they incurred maximum losses in the event of inadequate and untimely rains.

Constraints to resilient adaptation

- Non-availability of stress tolerant varieties, lack of improved technology and uncontrolled widespread use of groundwater extraction technologies, minimum incentives to adopt soil and water conservation practices
- Inadequate support to diversify income from agriculture, inefficient safety nets, absence of efficient collective action and poor infrastructure development
- Limited access to credit, markets, information, non-farm income opportunities, labor and natural resources, efficient collective action, and poor infrastructure development.

Sri Lanka

- Climate data analysis confirmed an increasing variability in rainfall and temperature together with

Wells get deeper and drier as exploitation of ground water increases, India.

Domestic rainwater harvesting tank, Sri Lanka.

a high probability of occurrence of drought; these closely correspond to farmers' perceptions.

- Marginal households responded to climatic shocks by i) selling their assets and obtaining loans from friends and relatives, ii) selling their livestock, iii) controlled use of collected resources and iv) reduced consumption. Farmers having larger holdings responded to climatic shocks by diversifying their cultivation from risky seasonal crops to perennial crops.

Constraints to resilient adaptation

- Lack of recognition of the relevance of indigenous technologies with adaptation potential for climate related stress.
- Marginalization of smallholders from knowledge management, related to climate change and adaptation
- Inadequate institutional support to diversify rural income and improve indigenous methods of conserving water
- Limited subsidies, improved varieties, credit and technical support to adapt more efficiently to the climate vagaries.

Glimpses from farmers' response in Sri Lanka

"Farming in Yala season has ceased due to lack of rain. Therefore, the income too has decreased due to the effects of droughts. The income generated from agriculture is not sufficient for a whole year" (Mangalapura, male adult). "When the rains are delayed, a good harvest cannot be expected. Lack of rain affects farming as it destroys the crops and reduces our harvest" (Galahitiyawa, adult male).

"The effect of climate on the lifestyle of people has been significant. Due to changes, it is difficult to reach the expected yields" (Mangalapura, adult male). "It is difficult to see what the income would be. So, there are lots of hindrances to the livelihood. Cultivations were destroyed. The period of paddy cultivation got lengthier" (Mahagalwewa, adult male).

Bangladesh

- Both in the drought and flood prone regions, rainfall variability and occurrence of drought and flood are rising along with an increasing trend in atmospheric temperatures.
- Impact of climate extremes are dominant; and there is a need for efficient adaptation measures required to improve resilience and the underlying reason of vulnerability, lack of access to coping opportunities, and improved technologies (eg, improved varieties, credit, Resource Conservation Technologies (RCTs))

Constraints to resilient adaptation

- Inadequate rural infrastructure including irrigational facilities, non-availability of suitable crop varieties, seeds, credit and crop insurance, and inefficient extension services.

Thailand

- Agriculture has been significantly affected by the occurrence of dry spells or drought, flooding and high temperature, which caused increasingly

unstable crop yields. However, more rainfall has been noted during the recent years.

- Farmers recognize impacts in terms of lower and unstable/uncertain crop yield, food shortage, income decline, and out-migration for non-farm occupation.
- There are efforts to relieve the impacts of climate extreme events. However, some recommended adaptation strategies did not fit the specific priority needs of farmers. It was also observed that subsistence farmers have less opportunity to adapt due to lack of assets.
- There is reduced cultivation of rice among small and medium farmers during the dry season. They adapt by changing the cropping pattern and by finding supplementary earnings. Large farmers grow more crops, often near the water source and dig more wells or build farm ponds to supplement water needs.

Constraints to resilient adaptation

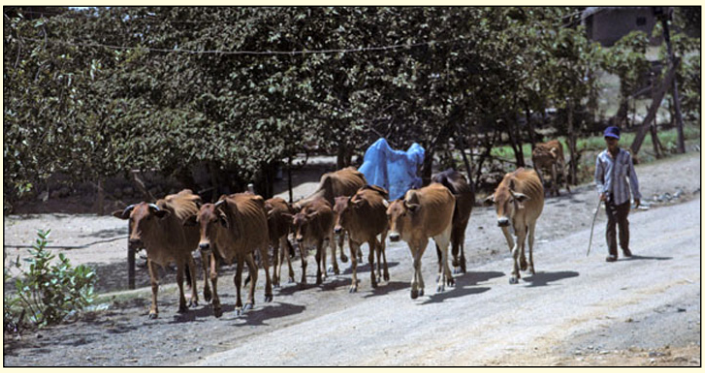
- Existing strategies are not within the priority needs of farmers; lack of adequate water resources, lack of information on new soil and water conservation technologies
- High opportunity cost for shifting to different crops
- Lack of evidence based technology and dissemination for wider adoption among the rural communities
- Limited access to technologies, input and programs in the remote villages and communities.

Viet Nam

- Increasing annual trend in rainfall with expected increase in the occurrence of climate extremes such as drought, flood and sea water intrusion.
- Adaptation strategies followed by the farmers include shifting to non-agriculture, livestock, selling labor and changing cropping pattern.
- Adaptive response among poor farmers is to work as laborers in the neighboring provinces, and when it starts raining, to select appropriate crops based on the local conditions.

Constraints to resilient adaptation

- Technology, subsidies and credit have limited the focus on economically disadvantaged groups and associated low profits, increased risk of crop failure of these groups.



Keeping livestock improves income diversity in Viet Nam.

- Lack of appropriate information and its dissemination at the micro level.
- Financial services remain inaccessible to the poor farmers due to the absence of collateral resources.
- Low educational levels, small farm sizes, remote and inaccessible farms of the vulnerable farmers.

China

- Unexpected changes in climate and extreme events observed
- Adaptation strategies are being followed by villages on government directives for improved resilience
- Centrally planned government intervention ensures wide adoption of conservation practices.

Better micro-level development in China

With the governmental support, a number of adaptation and mitigation activities are being implemented at village level. Afforestation program, bio-gas use, solar water heater, power saving lamps, rainwater harvesting and storage structures, are being used. Village infrastructure such as roads, farm machineries, conservation of common property resources, etc, have developed remarkably over the years, empowering the community to adapt to the climatic changes efficiently.

Rural irrigation infrastructure helps adaptive capacity in China.

Constraints to resilient adaptation

- Over-exploitation of natural resources including forests
- Lack of awareness among the rural folk on climate change impacts and plausible adaptation options and short term goals of optimizing income
- Poor infrastructure in rural areas
- Non-availability of required technology to meet farmers' adaptation needs.

The above country level studies focusing on the village experiences, provide insights of the dynamics of adaptation from which constraints and opportunities to build climate resilience at village level are identified. The adaptation and village level transformation is a continuous process. Periodical assessment of vulnerability is necessary to identify risks. Call for the implementation of identified opportunities as the initial step through policy response or programs, should be undertaken. From these country experiences we infer that micro level governance structure is highly diverse and inefficient. Major innovations are needed to strengthen the local governance system that has a high level of influence on the adaptive capacity of smallholder farmers.

Effective action plans

Adaptation measures must go beyond single and practical solutions, and address human and environmental issues. In most of the study countries,efforts to mainstream climate change adaptation have been initiated. All other countries will need comprehensive, well thought out national action plans on climate change, such as National Adaptation Plan of Action (NAPAs), National Action Plan on Climate Change (NAPCC) and National Initiatives for Climate Resilient Agriculture (NICRA) in India. Similar programs are being implemented in Thailand, Viet Nam, Bangladesh, Sri Lanka and China. These will then need to be supported with financial commitments and the political will to push forward necessary legislative enactments. There is a shortage of funds to cover costs of adaptation strategies, and in developing and up-scaling models/methods/best practices in these countries. The main difficulties are also exacerbated by institutional fragmentation. Absence of an effective mechanism to target and direct resources and investment from international, national, public and private players for climate change adaptation is also a major limitation.

Regional Policy Recommendations

Recommendations were drawn based on the studies conducted in this project and are categorized into general policy suggestions that are generic to the countries, and those that are more country specific. The specifics for each of the countries were identified and refined through extensive discussions; and subsequently shared with policy makers and key persons.

These recommendations need to be considered when policies related to climate change are formulated and associated program interventions are designed at national or sub-national levels. Countries are at different stages in developing their national action plans for climate change and climate resilient agriculture. The regional and country specific study undertaken through this regional technical assistance (RETA-6439) has to be imbibed into national developmental policies and programs.

Recommendations for Climate Resilient Agriculture[4]

Tools, Technologies and Infrastructure for Resilient Agriculture

Develop required technology and knowhow to match local needs, based on local technology needs assessment to cope with climate change. These may include heat and or drought or even flood tolerant varieties, short term early maturing crop varieties, etc. Such technology development must be taking a lead from the vulnerability analysis, prioritization and mapping, so that the local adaptation capacities are strengthened.

Identify adaptation strategies for up-scaling from among those that are location specific but have the potential for wider application for adaptation, especially by smallholder and more vulnerable farmers who face more significant climate change challenges. These location specific models for adaptation considering specific vulnerability contexts can be developed and disseminated as technology/knowledge packs.

Promote improved use of climate information for local planning through scientific monitoring of weather patterns at local level, and making information readily available to smallholder farmers for decision making

[4] Project synthesis report (2012), "Tracking Adaptation Pathways and Identifying Strategies for Enhancing Grass-root Resilience to Climate Change".

related to livelihoods. This may require increasing the density of weather observatories; establishing rain gauges at village level; enabling access and efficient management of weather related information (Remote sensing and GIS) and repository. Institutionalize mechanism to collect and analyze micro level information (climate, crops, socio-economic, natural resources, etc) and efficiently transmit it to be used as an input in formalizing macro level policies.

Optimize the use of farmers' traditional, indigenous knowledge on resource conservation, coping strategies, etc, by evaluating, assessing scalability and integrating with advanced technological interventions that may consist of improved varieties, crop management, community resource conservation, rainwater harvesting and storage to maximise the outcome of knowledge management and developing models for dissemination.

Allocate resources for the research focusing on (i) developing local livelihood models to effectively adapt to climate change considering the intensity of vulnerability and the local socio-institutional and environmental conditions, (ii) identifying local technology requirements to enhance adaptation and improve household incomes, (iii) identifying the most effective institutional management and governance models for effective and equitable adaptation.

Encourage the adoption of location specific conservation techniques (cover cropping, *in-situ* moisture conservation, rainwater harvesting, groundwater recharge techniques, locally adapted cropping mixture, etc) for water efficient agriculture and demonstration of these available technologies in the farmers' fields.

Strengthen the weather based agro-advisory services to enable farmers manage climate risks effectively, and develop equally accessible weather insurance products.

Mainstream climate change perspectives into agriculture development planning and programs.

The impact of changing trends and consistent unpredictability of climate parameters on agriculture productivity, food production and storage, rural incomes and its distribution, migration, natural and common property, collective action must be considered in agricultural planning. Different programs implemented at the village level to enable farmers adapt to climate change should be coordinated to eliminate duplication and improve effectiveness. These may be related to relief, agriculture, livestock and fisheries, health, natural resource management and infrastructure as well as regional development.

Prioritize regions of climate change vulnerability in the arid and semi-arid tropics and flood-prone areas. The most vulnerable must be prioritized for implementation of comprehensive agriculture and livelihood contingency action plans for effectively coping with climate risks and to target relief. Intra community and variances in local vulnerability should be considered to ensure equitable distribution of relief or adaptation support to ensure equity.

Stimulate diversification of rural household incomes. Promote multi-enterprise household units incorporating context specific enterprise possibilities where livestock, cottage industries, trade or services or part time work and non-farm employment are available to enhance income opportunities. In locations where livestock enterprise will supplement incomes and cushion climate related shocks, there is a need to strengthen location specific support for their promotion of livestock, fisheries, poultry and related enterprises among smallholder farmers.

Strengthen common property management by the communities especially for sustainable use of water sources.

Ensure equity in accessing government support and relief programs. These include relief, food, agricultural and enterprise subsidies, rural finances, poverty reduction programs and technology adoption support.

Financing and Partnerships for Transformational Change

Strengthen professional knowhow of officials to work effectively in a context of climate change sensitivity through increased awareness and training for development officials, scientists, extension workers and farmers. Interdisciplinary dialogues and programs to enable scientists, policy makers, development practitioners and farmers to discuss and share research findings and experiential knowledge is necessary.

Provide incentives to farmers to adopt natural resource conservation measures that enhance forest cover, replenish groundwater and use renewable energy.

Provide support to improve the existing indigenous technologies that are eco-friendly and sustainable, through research on efficacy, documentation and up-scaling.

Strengthen social and institutional capital engaged in improving adaptation and climate change preparedness. Encourage the role of non-governmental organizations, public and philanthropic organizations working with local communities. This could also forge international or regional partnerships to develop technologies to suit local requirements by pooling finance and intellectual resources.

Improve infrastructure in vulnerable regions.

Focus on adaptation to climate change in regional planning and infrastructure development ensures equity in regional development, especially in the climate vulnerable areas.There is a potential for wider application for adaptation, especially by small and more vulnerable farmers who face more significant climate change challenges. These location specific models for adaptation considering specific vulnerability contexts can be developed and disseminated as technology/knowledge packs.

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Acknowledgments: The authors would like to thank NS Jodha (ICIMOD, Nepal), K Palanisami (IWMI, India), Mruthunjaya (NCAP (ICAR), India), GGSN Rao (CRIDA, ICAR), KL Sahrawat (ICRISAT, India), and Geetha Mohan (University of Tokyo, Japan) for their comments and suggestions on the earlier draft of the policy brief. This policy brief was developed based on the findings from the project "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience" supported by the Asian Development Bank (ADB) through RETA – 6439.

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International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

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