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Vulnerability to Climate Change: Adaptation Strategies & Layers of Resilience

ADB

Policy Brief No. 18 May 2012

Adapting to climate change in Agriculture: Building resiliency with an effective policy frame in SAT India

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Background

Climate change has emerged as the biggest threat to livelihood sustainability of our times, posing an imminent danger to our food security and a challenge for improving agricultural productivity. Presently, scientists are identifying and refining the projections of future location specific climate scenarios that farmers might have to deal with. In India, annual mean surface air temperature is projected to rise by 1.7°C to 2.0°C by 2030 (INCCA 2010). These projections further imply that there can be a predicted decrease in rainy days in most parts of the Indian subcontinent by 2030.

Climate change projections for the next 50 to 100 years, are alarming. Indian agriculture will have to face these climatic changes in the coming decades. The semi-arid tropics (SAT) of India already face multiple challenges of low and uncertain rainfall, poor soil fertility, inadequate infrastructure, high population pressure as well as high levels of poverty. The future governments of India must grapple with the changed climate and associated productivity decline, while at the same time meeting the demands of increasing productivity to feed the increasing population.

To ensure that farmers are able to face the challenge, it is essential to use the time available to develop the required technology, institutional arrangements, policy options and other components. Farmers are a repository of innovation and experiential knowledge as they have been practicing agriculture for their livelihood for generations. A notable degree of variability exists in the weather patterns, particularly rainfall and onset of monsoons. Farmers also face periodic occurrence of droughts. With this background, a prudent option will be to understand the adaptation measures used by farmers to cope with these extreme events. The insights gained from such investigations will help identify strategies that can be widely applied to empower a larger segment of farmers who are affected by climate change in different locations.

ICRISAT has conducted the study, "Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience" under the funding support of The Asian Development Bank (ADB) to capture the grassroots level responses and to understand the adaptation measures that the farmers are practicing across SAT regions of Asia especially in India, Peoples Republic of China (PRC), Sri Lanka, Bangladesh, Pakistan, Thailand and Vietnam. The results from SAT regions of India form the basis of this policy brief.

Farmers' perceptions of climate variability in SAT India

Rainfall variability over the years is the major cause of yield uncertainty and makes rainfed agriculture one of the riskiest enterprises in SAT India. Long-term analysis of rainfall data showed a decreasing trend in seasonal, quantum and heavy rainfall events in the Southwest monsoon season in parts of SAT India (ICRISAT a. In press). Farmers have to deal with annual and seasonal rainfall variability in quantum and distribution as well as the onset of rainy season. In addition to this, a majority of the

SAT farmers have to face frequent droughts. The frequency of droughts in the semi-arid tropics is quite high and the resource poor rainfed farmers are quite often unable to cope with the effects of these extreme events. These indicators point to the fact that in future, the climate for farming will be more uncertain and the risk of rainfed agriculture will be confounded further for the SAT farmers. Farmers across several villages in the states of Andhra Pradesh and Maharashtra unanimously perceived that there was a major decrease in the quantum of rainfall and number of rainy days (Table 1). They felt that the arrival of the monsoon has got delayed over time and the distribution of rainfall has become more erratic. They felt that in general the temperatures have increased over time (ICRISAT b. In press; Banerjee et al. 2011).

Table 1. Farmers' perception of climate variability in Andhra Pradesh and Maharashtra states.

Parameters	Farmers' perceptions	
	1970-1990	1990-2008
Rainfall	Decreased	Major decrease
Number of rainy days	Decreased	Major decrease
Arrival of monsoons	On time	Delayed
Distribution of rainfall	Less erratic	Erratic
Temperature	Increased	Major increase

Source: ICRISAT (b).

Table 2. Frequency of droughts in twenty-year periods (droughts are computed based on long term averages).

Period	Andhra Pradesh		Maharashtra	
	Anantapur	Mahabubnagar	Akola	Solapur
1971-1990	9	5	6	7
1991-2009	8	7	9	11

Source: ICRISAT (a).

Extreme events

Rainfed agriculture in the SAT region has become more uncertain with the increasing uncertainty of rainfall and increasing temperatures. The frequency of droughts in the semi-arid tropics is quite high; and the resource poor rainfed farmers are often unable to cope with the effects of these extreme events (Table 2). These climatic shocks render resource poor SAT farmers to lose their livelihoods and quite often they end up in a perpetual debt trap. Farmers were able to recollect the years of drought more accurately during the last decade; however, their recollection was not very accurate about the drought events that took place before that (Figure 1). This observation was similar in all the villages.

Adaptive capacities of the farmers

Adaptation is defined by the IPCC (2001) as adjustments in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change. The Department for International Development (DFID) in 2006 defined adaptation as reducing

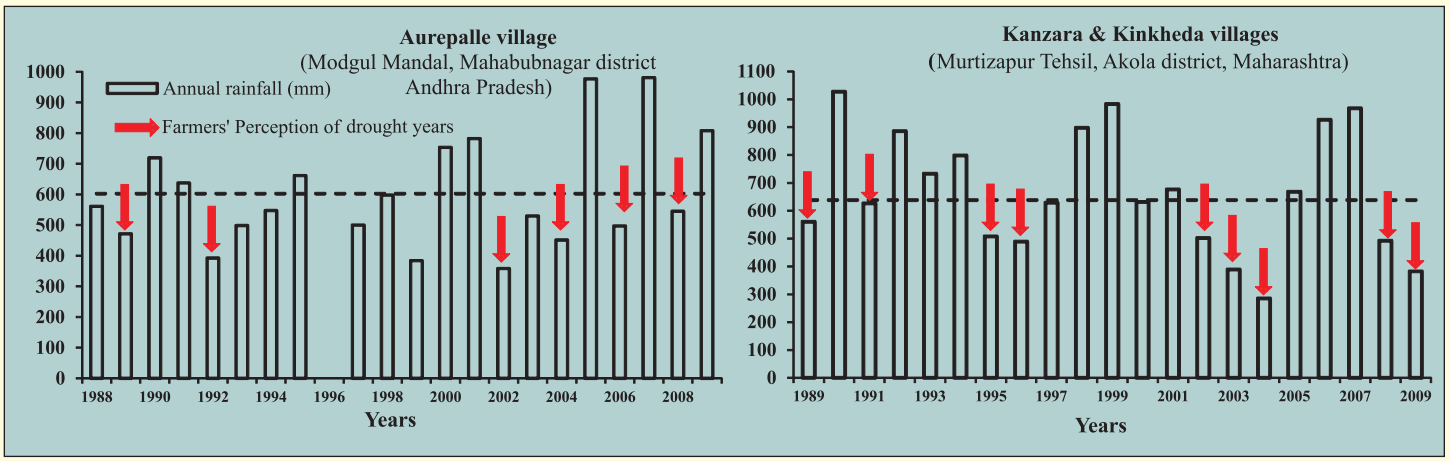

Figure 1. Farmers' perception of rainfall and actual situation based on meteorological information.

Table 3. Farmers recovery from impact of severe drought (years).

	Andhra Pradesh		Maharashtra	
	Dokur	Aurepalle	Kanzara	Shirapur
Large farmers	2-3	1-2	1-2	1-2
Medium farmers	2-3	2-3	2-3	3-4
Small & marginal farmers	3-4	2-3	4-5	3-4
Laborers	3-4	2-3	3-4	3-4
Women	Depends on Households			

Source: Banerjee (2010).

the risks posed by climate change to people's lives and livelihoods.

Adaptive capacity is influenced by the support environment that is in place. Several Focus Group Discussions (FGDs) conducted among the farmers in villages showed that after the occurrence of drought, farmers generally took about one to four years to recover from the shock and the loss. In general, smallholder farmers and laborers are the worst affected and they took the longest time of 3 to 5 years to recover from the shock and loss (Table 3). The variability of rainfall and extreme events like droughts cause loss of investment as well as livelihoods for all the farmers in general and severely affects smallholder farmers and laborers (Box 1).

Over the last several decades, farmers in villages have been adjusting continuously and reacting by following several adaptive measures and coping strategies (Bantilan and Anupama 2006). However, the ability to cope efficiently has been different among various socio-economic strata within the same rural village. This calls for equity in action plans and programs, enabling equal access to benefits with the support from governmental and other developmental agencies.

Box 1.

Venkatanna, Dokur village, Mahabubnagar District, AP.

"In case the rains fail we have to migrate, which means more expenses. We need transport, and to find a place to rent even in nearby villages or in the city. When we go, there is no guarantee that we will get a job, even if we go to the city. Therefore, such adjustments and expenses become reasons for the time that we take to recover, which is about three to four years".

Recommendations

Equity in access to credit….

- Marginal, smallholder and tenant farmers fail to produce collateral to access credit from formal sources such as banks. To ensure equity in access to formal credit, relaxed terms of credit sanction should be designed.
- Subsidized interest rates on the credit taken by resource poor farmers will help the farmers in recovering from adverse climatic shocks.
- Crop contingency plans drawn at mandal/ sub-district level must be in place to support the farmers in the event of climatic shocks like droughts.
- Easy access to technology and highly subsidized inputs are made available in time to the affected farmers.

What farmers perceive about their common property resources (CPRs)

Farmers across several villages in Andhra Pradesh and Maharashtra perceived that their natural resource base has been degrading over the past four decades. Their common property resources are being degraded over the years. For example, ponds, wells and tanks are getting drier and inaccessible; and common grazing land is shrinking with immense population pressure and excessive use. They attribute these to poor management of common grazing property coupled with reduction of common property lands due to increasing population pressure, increased grazing, increased cropping intensity, increased use of chemical fertilizers and a decrease in the use of organic inputs and an overexploitation of groundwater resources (Jodha et al. 2012). In some of the villages like Dokur in Andhra Pradesh, common properties like grazing lands decreased with time as the government allotted some of these lands to

Recommendations

Collective action in the management of common property resources….

- Management of grazing lands by the farmers to be institutionalized through capacity building programs and supportive legislation.

Table 4. Perceptions of farmers on common property resources 1970-2008.			
Farmers' perceptions	**1970**	**1990**	**2008**
Quality of cultivated land-Soil fertility status	High	Low	Major Decrease
Quality of cultivated land-Soil erosion problem	High	Low	Major Decrease
Quality of grazing land	High	Low	Major Decrease
Quality of other CPRs	High	Low	Major Decrease
Quality of natural water resources	High	Low	Major Decrease
Area degraded through special problems	High	Low	Major Decrease
Source: ICRISAT (b).			

the landless poor, indirectly increasing the grazing pressure (Table 4).

Perceptions on managing water resources

In general, farmers observed that up to the nineties, the main sources of water were open wells, tanks and canals in some villages. However, with the availability of technology and the government support to a certain extent, farmers in the villages started exploiting groundwater for irrigation through installation of tube-wells. This was a major form of their adaptive strategy

Table 5. Growth of tube-wells in selected villages, 1970-2008.			
	No. of tube-wells		
	1970	**1990**	**2008**
Andhra Pradesh			
Dokur	0	16	220
Aurepalle	0	20	212
Maharashtra			
Shirapur	10	35	350
Kanzara	0	0	44
Kinkhed	0	0	2
Source: ICRISAT (b).			

Recommendations

Collective action and training …..

- Farmers must be made aware of sustainable management of groundwater through training programs
- Collective management of tanks and ponds through regular de-silting should be institutionalized
- As groundwater does not follow geographical boundaries of farmers' holdings, suitable institutionalized mechanism of community management of groundwater must be explored.

to answer the variability of the onset of the monsoon and the variability of rainfall during the crop season. Exploitation of groundwater shot up drastically over the last two decades in a majority of the study villages (Table 5). These changes are highly conspicuous and farmers experience non-availability of water as a major problem. The groundwater levels dropped drastically and most of the open wells went dry over the last decade. Some of the tube-wells also failed and new deeper tube-wells are being dug.

Crop diversification and technology adaptation

Farmers across the villages are diversifying crops. In general, farmers are giving up growing cereals, particularly coarse cereals and are diversifying into cotton, soybean and other commercial crops. Wherever the government has developed irrigation infrastructures like dams and canals as in the case of Shirapur village in Solapur district of Maharashtra, farmers switched over to more

Box 2: Progressive Farmer

(Shankar Narayana Giri, Kanzara village, Akola district, Maharashtra)

"I initially used the long duration old variety of Turi (pigeonpea), which took 175 days to grow and mature. I then shifted to the 120 day variety given to me by ICRISAT. By growing it I saved on time, money, amount of water required and still got a good crop. Now I have been informed that there is a further short duration one, which takes 75 days to mature; given the present situation, the latter seems to be the best option and it is worth a try."

Box 3: Small Farmer

(Mr Bapu Rama Mali, Kalman village, Solapur district, Maharashtra)

"We cannot take the kind of risks that people with money can. It requires a lot of courage and a lot of risks, which we cannot afford. Being smallholder farmers, and being in debt, we really do not have the resources or the options of trying some of the new things that are available or to check whether they are really drought resistant or pest resistant. Whatever the middlemen tell us, we simply have to listen and follow as they are the ones who are providing us with the loans. So, even if I am interested in trying out something new from somewhere else, I cannot, as I will not have sufficient money."

profitable and water intensive crops like sugarcane. Farmers also followed adaptive measures like choosing short duration varieties and changing the crop calendar to suit the uncertainty of the arrival of monsoon and the rainfall (Box 2). Farmers across the villages in SAT India feel that with the uncertainty of rainfall and increasing temperatures, reducing the crop growth period will be a major requirement to help cope with the moisture stress situation. Along with the *climate risks*, farmers are looking towards maximization of profits by opting for cash crops that are drought tolerant, and are of a shorter duration. Marginal farmers and other resource poor farmers sometimes feel that testing new technologies and cultivars is beyond their means as they are perpetually under financial constraints (Box 3). Experimenting with the new technological developments is considered risky. Small and marginal farmers feel that their risk bearing ability is reduced due to the perpetual debt traps, a result of recurring droughts.

Income diversification

Farmers opt for income diversification as an adaptation strategy to reduce their exposure to risk due to crop loss with increased climatic variability. During the mid-seventies, farming solely contributed to the income for the farmers in most of the villages. Their incomes from agriculture varied from 59 to as high as 96% (Table 6). The situation has changed in the last three and a half decades. With the increased uncertainty of rainfall and recurrence of climatic extremes such as droughts in the rainfed SAT in India, farmers are increasingly diversifying their income to cushion against uncertainties in agriculture. Now the dependence on agriculture for their income has been reduced from 66 to 28% across the villages. Farmers are increasingly deriving a fraction of their incomes from caste occupations, petty businesses, migration, regular employment and working as non-farm labor.

Table 6. Changes in income of farmers in the study villages, 1975-2007 (percent).

	Andhra Pradesh		Maharashtra	
Sources	1975	2007	1975	2007
Agriculture	59 - 96	28 - 42	83 - 96	41 - 66
Non-farm	3 - 11	41 - 58	4 - 17	26 - 55
Caste occupation	1 - 29	5 - 13	1	1 - 2
Govt. welfare programs	-	3 - 4	-	2
Others	-	1 - 5	-	3

Source: ICRISAT (b).

Recommendations

- Suitable infrastructure to be in place to develop village-based industries that will increase opportunities for income diversification and avoid migration.
- Access to credit in easy terms and subsidized interest should be available to farmers for income diversification.
- Training farmers in entrepreneurial skills.

Emerging importance of Self-Help Groups (SHGs) as an adaptation strategy

Studies indicated that in recent times several SHGs were organized in the villages by various entities. Farmers found them to be helpful as an adaptive measure. Through these collectives, they had easy access to credit and in some cases knowledge to address yield losses due to climate

Box 4: Women SHGs

(Lakshmi Narsamma, Dokur village, Mahabubnagar district, Andhra Pradesh)

"As a group we just look after our own welfare. If one of the members is in need of money and the group has Rs 1 lakh, then the whole group comes to a consensus to give the whole amount to that particular member. In this way we help each other out. Each group is responsible for their own activities. Though we indulge mostly in money transactions, it is also a place where we share information with each other on the kind of programs available for the women. Information from the banks and all the group members are updated on the programs during their meet, when they gather once a month."

variability. Self-finance groups tend to emerge as a good collective adaptive strategy. Across the villages, several SHGs and more particularly, women's SHGs have come up in the last decade.

How far are we from efficient adaptation?

Several FGDs brought out insights on the constraints that the farmers are facing while adapting to climate variability (Table 7; Box 4). These constraints are faced by the various rural socio-economic strata differently. To address climate variability and future climate change, understanding the constraints and creating an environment where such constraints are effectively eliminated should be a key intent of streamlining the country's policy environment. Many of the recommendations that find place in the above sections, also relate to these constraints and the ways to tackle them.

Government programs on the ground

Several government programs such as Drought prone area programs (DPAP), National social assistance programs, MGNREGA[1], Integrated Agricultural Development Program, National Food Security Mission, Watershed development program, Integrated wasteland development program (IWDP), etc, have been designed and implemented to target growth and development on multiple scales together with an aim of improving the rural household economy. Even though a number of policies and programs are underway, there is a lack of efficient delivery systems. Studies indicate that many of these programs launched often end up helping the farmers who are better off, due to lack of initial capital and poor access to credit among the small and marginal farmers. Poor households get benefitted mostly from food and nutritional security programs and rural employment schemes such as MGNREGA. Land and water resources together with other natural resources are depleting and deteriorating. Government policies should aim at an inclusive accessibility to cater to all and the help should percolate to the lower levels among the community. Continuing to support farmers in stress through subsidies and rations will only keep them in perpetual dependency. Strategic support to expand their asset base and diversify their enterprise portfolio, will provide more sustained means for adaptation.

Table 7. Constraints that prevent effective adaptation identified by villagers during FGDs.

Field Level
- Non-availability of drought tolerant varieties
- Scarcity of supplementary irrigational facilities

Farm Level
- Lack of access to information
- No capacity for crop diversification
- Non availability of potential technologies including varieties

Institutional Level
- Lack of efficient co-operatives/ associations to address risks
- Lack of effective governance mechanisms
- Absence of efficient market access

Technological Level
- Lack of water efficient crop varieties
- Decreased groundwater availability

Social Level
- Rise in the population level
- Lack of collective approaches
- Labor shortage
- Fragmentation of farms

Economic Level
- Inability to access formal credit because of the requirement of collateral.

1. Mahatma Gandhi National Rural Employment Guarantee Scheme.

Policy Recommendations

The following policy recommendations are the outcomes of the grassroot level and the macro climate data analysis. They are also based on the perceptions and expectations of the stakeholders especially of the farmers, the final beneficiary of SAT India.

- **Coordination**: An all-India climate change support program coordination body be established for effective coordination of all programs to avoid local level duplication and waste of efforts and resources.
- **Target relief support**: Ensure that the relief that is provided by the government through various programs and agencies are delivered at village level to the appropriate target groups through a coordinating mechanism, established panchayat, mandal and district levels, where the beneficiaries including women participate. Information of such programs be made available at village level.
- **Villagers as active stakeholders in climate change information management**: All villages be integrated to a network of climate data collecting and management system for effective monitoring of local changes to target interventions where the villages act as active members of the climate change information management system of the country. The required training on climate/hydrological cycle, global warming, etc, for farmers be provided.
- **Safeguard minimum thresholds of common property as a mitigatory measure**: Common property at village level such as grazing lands, groundwater, community forests, etc, be mapped and demarcated with appropriate participatory management strategies. Reallocation of common property be done only after safeguarding common interests.
- **Rational use of available water resources**: Regulate groundwater extraction through a system of licensing to ensure balance with natural replenishment rates.
- **Validate, upscale farmer adaptive strategies as socio-technological models**: The measures adopted by farmers to cope with the local situations of extreme weather conditions or climate changes be catalogued, scientifically validated, tested for scalability and recommended for wider application. Learning from the grassroots be made a key approach in adaptation research and development.
- **Reorient SAT farm strengthening programs:** SAT farm livelihood models be developed considering the farmers as multi-enterprise entities that incorporate the service sector, labor markets, trading, etc.
- **Credit support for income diversification**: Credit programs targeting the small and medium holdings in SAT villages to diversify farm enterprises to increase adaptive capacity be provided. Such support programs be supplemented with appropriate enterprise training and education for farmers as well as village level agro-climate extension and development workers.
- **Participatory governance**: The small and medium holders be actively engaged in governance so that the local planning and distribution of relief and mitigatory interventions are done considering their needs and requirements; such collective engagements be supported through local organizations (NGOs).
- **Strengthen collective action**: Strengthen participation of villagers in collective action such as participating in local governance bodies to highlight climate change issues and promote SHGs as an adaptive measure.
- **Strengthen competence of professionals**: Mainstream climate change sensitivity to policy makers, government officials, development practitioners and scientists in various disciplines through ongoing training and development information disseminating programs.
- **Strengthen research:** Support research activities focused on (i) evaluating the effectiveness of adaptive strategies used by farmers (ii) barriers to equitable distribution of relief programs to identify remedial measures (iii) local level climate or weather assessments to improve the quality of interventions.

Need to build grassroot resilience capacity – Enabling Policy Environment

The root causes of climate change and erratic weather patterns are beyond the influence and control of small village communities (Table 7). However, the lives of SAT villagers are intimately linked to deleterious effects of climate change. On the other hand, adaptation occurs at the local level. Building the capacity at various levels enables the rural community to adapt to climate variability and extremes. Improving the existing policy initiatives and the delivery mechanisms of the existing developmental programs to ensure sensitivity to climate variability and extremes, is the first step. Policy integration and harmonization to address the needs of farmers with regard to issues at field, farm, social, technological, and institutional levels is important. Policy support must be equity oriented and mainstreamed into the general policy framework, while being sensitive to the many layers of constraints faced by farmers.

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Acknowledgments: *The authors would like to thank NS Jodha (ICIMOD, Nepal), K Palaniswami (IWMI), Wijaya Jayatilaka (University of Peradeniya, Sri Lanka), Mruthunjaya (NCAP, ICAR), GGSN Rao (CRIDA, ICAR), KL Sahrawat (ICRISAT, India) and Geetha Mohan (Tokyo University, 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 Asian Development Bank (ADB) through RETA - 6439.*

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Patancheru 502 324, Andhra Pradesh, India
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