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Climate Change and Agricultural Adaptation in South Asia

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Abstract

Purpose – The chapter elaborates the adaptation initiatives undertaken by farmers in South Asia and advocates the need for strong policies to support agricultural adaptation.

Methodology/Approach – The chapter elicits the farmers' perceptions and adaptation measures toward climate change and extent of adaptation through computing an index and supports strong extension and policy initiatives to enhance agricultural adaptation for combating food insecurity.

Findings – Rise in temperatures, decrease in rainfall, and frequent incidence of pests and diseases are the common perceptions of farmers toward climate change both for drought and floods. Adaptation measures practiced by farmers' for drought are buying insurance, change in planting dates and planting times, work as labor, and construct water harvesting structures. For floods, early sowings, saltwater spray for harvested paddy stalks, strengthening of riverbanks, and improved drainage are the adaptation measures.

Practical Implications – The chapter would draw implications that would assist policymakers to decrease the vulnerability of farming communities to adverse impacts of climate change.

Originality/Value – South Asia could face severe food insecurity and distress as a result of climate change. The results of this chapter will be useful as a guide in the formulation and design of agricultural adaptation strategies. A better understanding of how farmers perceive climate change, ongoing adaptation measures, and the factors influencing the decision to adapt farming practices is needed to craft policies and programs aimed at promoting successful adaptation of the agricultural sector.

Keywords

South Asia; Climate change; Perceptions; Adaptation measures; Policy

Introduction

The impacts of climate change on agriculture are being witnessed all over the world, but countries especially like India in South Asia are more vulnerable in view of the large population depending on agriculture and excessive pressure on natural resources. Rainfed agriculture is likely to be impacted severely in view of its high dependency on monsoon and the likelihood of increased extreme weather events due to aberrant behavior of southwest monsoon in this part of the world. While reducing the greenhouse gas emissions holds key in addressing the problem, successful adaptation to

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climate change is important to stabilize the productivity. Adapting to climate change is a continuous process, and communities have wealth of information. Climate change is becoming a major driver of disasters, with increasingly frequent and intense floods and storms affecting more people globally. Increased forced displacement is an extremely likely consequence of such events. Heightened drought risk, desertification, sea-level rise, and changes in the availability of water and fertile land, coupled with reduced access to basic resources, will also fuel longer-term migration and forced displacement. As a first step, there is a need to document all the indigenous practices farmers have been following over time for coping with climate change. A better understanding of the farmers' perceptions toward climate change, the practices they adopt, and the factors that contribute to the decision-making help in formulating policies and programs aimed at minimizing the losses and reducing the risk due to climate variability and change. Understanding how and why farmers have responded to climatic change is a necessary step to informing how to support current and future adaptation.

Climate Change Impacts on Agriculture in India

Agriculture is one of the largest contributors to India's gross domestic product (GDP), approximately 20 %. It is the main source of livelihood for almost 60 % of the country's total population. The impacts of climate change on agriculture will therefore be severely felt in India. It has been projected that under the scenario of a 2.5–4.9 °C temperature rise in India, rice yields will drop by 32–40 % and wheat yields by 41–52 % (GOI 2011; Guiteras 2007; OECD 2002). This would cause GDP to fall by 1.8–3.4 %. Despite the gloomy predictions about the negative impacts for India's agricultural sector, changing climate is expected to bring opportunities as well, e.g., production gains through the CO_2 fertilization effect or the expansion of cultivated land to higher altitudes and northern latitudes. The share of Indian livestock in the GDP is about 7 %. Indian livestock are responsible for about 54 % of total methane emission in India. Increasing sea and river water temperature is likely to affect fish breeding, migration, and harvests. A rise in temperature as small as 1 °C could have important and rapid effects on the mortality of fish and their geographical distributions, and hence climate change effects could be very significant for fisheries (Climate Change and 12th Five Year Plan 2011).

Agricultural Adaptation to Climate Change

Food production is vulnerable to climate shifts because crops and cropping systems are adapted to local conditions: slight perturbations such as temperature fluctuations at critical points in crop development can have substantial impacts on productivity (Hatfield et al. 2011). Climate change also threatens the long-term capacity for food production through increased soil erosion and reduced soil fertility (Lal et al. 2011). The certainty of increased need for food to feed a burgeoning global population and the uncertainty of the short- and long-term impacts of climate change on agriculture combines to make efforts to enhance the resilience of agricultural systems a top societal priority (IFPRI-International Food Policy Research Institute 2010). The recognition that climate change-related threats to agriculture also represent threats to quality of life on a global scale has led to an increasing amount of attention to adaptation and mitigation strategies for agriculture (e.g., Howden et al. 2007; McCarl 2010). Calls for adaptive action have acknowledged that farmers are both among the most vulnerable groups to climate change and the ones on whom the task of adapting to climate

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change and mitigating agriculture's contribution to it largely falls (Berry et al. 2006). At the same time, farmer willingness and capacity to respond to climate change is a social process based on the social construction of the risks and vulnerabilities of increasingly variable climate conditions. The farmer is a critical decision maker if agricultural lands are to be effectively managed to adapt to changing climate conditions (Gordon et al. 2013).

Agriculture in developing countries is one of the most vulnerable sectors of the global economy to climate change (Kurukulasuriya et al. 2006; Seo and Mendelsohn 2008a). Farmers whose livelihoods depend on the use of natural resources are likely to bear the brunt of adverse climate impacts. Farmers will be hard hit if they do not adjust at all to new climates (Mendelsohn et al. 1994; Rosenzweig and Hillel 1998; Reilly et al. 1996). Adaptation to climate change requires that farmers first notice that climate has changed and then identify useful adaptations and implement them (Maddison 2006). Adaptation is widely recognized as a vital component of any policy response to climate change. Studies show that without adaptation, climate change is generally detrimental to the agriculture sector, but with adaptation, vulnerability can largely be reduced (Easterling et al. 1993; Reilly and Schimmelpfennig 1999; Smit and Skinner 2002). The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. The adaptive capacity of a system describes its ability to modify its characteristics or behavior so as to cope better with changes in external conditions. Adaptive capacity is determined by various factors including recognition of the need to adapt, willingness to undertake adaptation, and the availability of, and ability to deploy, resources (Brown 2010). Recent empirical studies indicate that farmers have already adapted to the existing climates that they face by choosing crops or livestock or irrigation (Kurukulasuriya and Mendelsohn 2007, 2008; Nhemachena and Hassan 2007; Seo and Mendelsohn 2008b, 2008c) ideal for their current climate. The adaptation strategies must not be used in isolation. For example, the use of early-maturing crop varieties must be accompanied by other crop management practices such as crop rotation or the use of cover crops. This, however, requires additional institutional support, such as credit and access to input, markets, and information. Information about farmers' awareness of climate change and current adaptation approaches would assist policymakers in their efforts to decrease the country's vulnerability to the adverse impacts of climate change (Deressa et al. 2008). However, limited information exists on the impact, vulnerability, and adaptation to climate change, especially at household levels. Given this knowledge gap, there is a need to carefully evaluate the impact of climate change on rural livelihoods in order to provide authorities with timely information for adaptation strategies.

The objective of the present study was to identify farmers' perceptions toward climate change (both drought and floods) along with their farm-level adaptation measures in South India with a view to suggest appropriate research/policy issues which help in facilitating farmers' adaptation. Role of extension in facilitating adaptation to climate change is discussed.

Methodology

Among South Indian states, Andhra Pradesh was chosen as the locale of this study since (a) the farmers in this region are exposed to a great degree of climate variability resulting in high vulnerability and (b) researchers' familiarity with local language and culture. Anantapur, Mahbubnagar, and East Godavari districts representing three different regions of the state were selected randomly. Anantapur and Mahbubnagar have a semiarid climate with average annual rainfall being 560 and 600 mm, respectively, whereas East Godavari has a coastal climate with annual rainfall of 1,100 mm. The predominant crops are groundnut in Anantapur; maize, groundnut,

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Table 1 Selected study mandals with villages in parentheses, for Anantapur, Mahbubnagar, and East Godavari districts

District	Mandals (villages in parentheses)
Anantapur	Bukkarayasamudram (*Bhadrampally, Siddharamapuram*)
	Chenne Kothapalli (*Nagasamudram, Chenne Kothapalli*)
	Mudigubba (*Podarallapalli, Mangalamadaka*)
Mahbubnagar	Mahbubnagar (*Machanpalli, Appaipally*)
	Kothakota (*Nirven, Palem*)
	Ghatt (*Penchikalapadu, Aragidda*)
East Godavari	Gollaprolu (*Gollaprolu, Chendurthi*)
	Peddapuram (*J.Thimmapuram, Kattamoru*)
	Marredumilli (*Narsapuram, Dora Chintalapalem*)

Table 2 Farmers' perceptions regarding climate change in Anantapur

S. no.	Farmers' perception	Number[a]	%	Rank
1.	Rise in temperatures	57	95	I
2.	Decrease in rainfall	56	93	II
3.	Advanced onset of monsoon	54	90	III
4.	Middle long dry spells	53	88	IV
5.	Terminal heavy rains	50	83	V
6.	Uneven distribution of rainfall thereby affecting length of growing season	49	82	VI
7.	Prevalence of pests and diseases	47	78	VII
8.	Indigenous technical knowledge (ITKs) for weather forecast failing	41	68	VIII

[a]Multiple responses

and cotton in Mahbubnagar; and paddy in East Godavari district, so the semiarid districts of Anantapur and Mahbubnagar grow dryland crops, whereas the coastal district of East Godavari grows waterlogged crops like paddy. A sample of 180 farmers at the rate of 60 each from Anantapur, Mahbubnagar, and East Godavari districts of Andhra Pradesh in South India were selected randomly. Three mandals (a mandal is a unit of administration above village and below district level in a state and comprises several villages) each from the selected districts, with two villages under each mandal, were chosen randomly. From each village, ten farmers were selected randomly for collecting data. The selected mandals, with villages in parentheses, for the above three districts are given in Table 1. Data was collected using a pretested interview schedule from the farmers along with focused group discussions. Percent analysis and composite index (adaptation index was computed by the formula: adapted measures/total recommended measures $\times$ 100) developed in the study were used for analyzing data.

Results and Discussion

Farmers' perceptions and Adaptation Measures Toward Climate Change

From Table 2, it is evident that rise in temperatures followed by decrease in rainfall, advanced onset of monsoon, middle long dry spells, terminal heavy rains, prevalence of pests and diseases, and ITKs for weather forecast failing are the major farmers' perceptions in that order of magnitude regarding climate change in Anantapur. Bryan et al. (2009) in their study in Ethiopia and South Africa reported that farmers experienced increased temperature and decreased rainfall. Similar observations were

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Table 3 Farmers' adaptation measures toward climate change in Anantapur

S. no.	Farmers' adaptation measures	Number[a]	%	Rank
1.	Buying insurance	56	93	I
2.	Change in planting dates of groundnut (go for early sowings may be between May end to early June)	55	92	II
3.	Intercropping with red gram in 8:1 or 12:1 ratio	48	80	III
4.	Intercropping with castor contemplated	47	78	IV
5.	Construction of water-harvesting structures under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)	45	75	V
6.	Requiring of quick-maturing, drought-resistant varieties	42	70	VI

Table 4 Farmers' perceptions regarding climate change in Mahbubnagar

S. no.	Farmers' perception	Number[a]	%	Rank
1.	Rise in temperatures	55	92	I
2.	Decrease in rainfall	53	88	II
3.	Advanced (some places timely) onset of monsoon	51	85	III
4.	Middle long dry spells accompanied by cloudy weather during flowering	48	80	IV
5.	Terminal heavy rains	46	77	V
6.	Prevalence of pests and diseases (powdery mildew, mold in castor; smut and jassids in paddy)	41	68	VI

reported by Vedwan and Rhoades (2001), Hageback et al. (2005), and Dejene (2011) in their studies. Results of a study conducted in Bundi district of Rajasthan, India, revealed farmers' perceptions to climate change as increase in temperatures, decreased rainfall, and long dry spells. The chief adaptation measures followed by farmers are change in planting time, intercropping, soil and water conservation, and planting drought-tolerant crops (Dhaka et al. 2010).

Table 3 illustrates that buying insurance, changing planting dates of groundnut, intercropping with red gram, construction of water-harvesting structures, and requiring of quick-maturing, drought-resistant varieties in that order of magnitude are the major adaptation measures followed by farmers toward climate change in Anantapur. This finding is consistent with that of Swanson et al. (2008) who reported that crop insurance was widely used by farmers in Foremost region of Canada (which is similarly dry), and the common feeling was that even though it might not provide sufficient returns for losses incurred, it does offer some protection. It has allowed them to continue farming. Agricultural insurance can help people to cope with the financial losses incurred as a result of weather extremes. Insurance supports farmers in their adaptation process and prevents them from falling into absolute poverty. Apart from stabilizing household incomes by reducing the economic risk, insurance can also enhance farmers' willingness to adapt, make use of innovations, and invest in new technologies (Anna et al. 2011). Agricultural adaptation involves two types of modifications in production systems. The first is increased diversification that involves engaging in production activities that are drought tolerant and/or resistant to temperature stresses as well as activities that make efficient use and take full advantage of the prevailing water and temperature conditions, among other factors. Crop diversification can serve as insurance against rainfall variability as different crops are affected differently by climate events (Orindi and Eriksen 2005; Adger et al. 2003). The second strategy focuses on crop management practices geared toward ensuring that critical crop growth stages do not coincide with very harsh climatic conditions such as

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Table 5 Farmers' adaptation measures toward climate change in Mahbubnagar

S. no.	Farmers' adaptation measures	Number[a]	%	Rank
1.	Staggered sowings (dry paddy, castor, red gram, and cotton in kharif), (groundnut, paddy, chilies, and tobacco in rabi)	50	83	I
2.	Change in planting dates and planting different crops	49	82	II
3.	Requiring of drought-resistant varieties	45	75	III
4.	Construction of water-harvesting structures started under MGNREGA	41	68	IV

Table 6 Farmers' perceptions regarding climate change in East Godavari

S. no.	Farmers' perception	Number[a]	%	Rank
1.	Rise in temperatures	54	90	I
2.	Decrease in rainfall	53	88	II
3.	Pest and disease incidence is high for kharif paddy like BPH, BLB, and stem borer (at transplanting stage)	51	85	III
4.	Terminal heavy and unseasonal rains	49	82	IV
5.	ITKs for rain forecasts are failing	45	75	V

mid-season droughts. Crop management practices that can be used include modifying the length of the growing period and changing planting and harvesting dates (Orindi and Eriksen 2005).

From Table 4, it is clear that rise in temperatures followed by decrease in rainfall, prolonged dry spells in between rains, terminal heavy rains, and prevalence of pests and diseases (powdery mildew, mold in castor; smut and jassids in paddy) are the major farmers' perceptions in that order of magnitude regarding climate change in Mahbubnagar. It is striking to note that farmers across the world show a remarkable unanimity in observations of seasonal change, particularly regarding rain falling in most intense bursts, and generally higher temperatures and longer hot, dry spells within rainy seasons, with effects on soil moisture (Jennings and Magrath 2009). Kemausuor et al. (2011) reported that a large percentage (93 %) of farmers was of the opinion that the timing of the rains is now irregular and unpredictable.

As stated by farmers in Table 5, staggered sowings, change in planting dates, requiring of drought-resistant crops, and construction of water-harvesting structures are the major adaptation measures followed by farmers toward climate change in Mahbubnagar.

Also, the farmers in Mahbubnagar are used to observe the pattern of rainy season, and if it gets copious rains, they will continue farming. Otherwise, they migrate and work as construction labor at Gangavati, Hyderabad, and Bangalore. Higher temperatures and pest and disease attack on crops were the chief perceptions of farmers toward climate change, while planting different crops and water conservation were the main adaptation strategies of farmers in Ogbomosho Agricultural Zone of Oyo State in Nigeria (Ayanwuyi et al. 2010).

Table 6 points to rise in temperatures, followed by decrease in rainfall, incidence of pests and diseases, terminal heavy cyclonic rains, and ITKs for rain forecast failing as the major farmers' perceptions in that order of magnitude regarding climate change in East Godavari.

Table 7 indicates that early sowings, saltwater spray for harvested paddy stalks, strengthening of riverbanks and improved drainage, survey number wise insurance, and loans to tenant farmers are the major adaptation measures perceived by farmers toward climate change in East Godavari. Migration of construction labor if monsoon fails (June–September rains) in rainfed areas of the district is another common phenomenon (Ravi Shankar et al. 2013).

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Table 7 Farmers' adaptation measures toward climate change in East Godavari

S. no.	Farmers' adaptation measures	Number[a]	%	Rank
1.	Going for early (June) sowings to avoid November cyclones coinciding with harvests	56	93	I
2.	Saltwater spray for harvested paddy stalks to avoid discoloration and regermination. For paddy in field, tying with rope and sticks on four sides to keep them erect and not falling down	55	92	II
3.	Strengthening of riverbanks and improved drainage	53	88	III
4.	Survey number wise insurance covering low lands	50	83	IV
5.	Loans to tenant farmers, though introduced, fall short of actual requirements in terms of coverage	48	80	V

Since most smallholder farmers are operating under resource limitations, lack of credit facilities and other inputs compounds the limitations of resource availability, and the implications are that farmers fail to meet transaction costs necessary to acquire the adaptation measures they might want to and at times farmers cannot make beneficial use of the available information they might have (Kandlinkar and Risbey 2000). Lack of access to credit has been observed in previous studies (Nhemachena and Hassan 2007) to be a barrier to responding to climate change. Furthering adaptive capacity is in line with general sustainable development, and policies that help reduce pressure on resources reduce environmental risks and increase the welfare of the poorest members of the society.

A better understanding of how farmers perceive climate change, ongoing adaptation measures, and the factors influencing the decision to adapt farming practices is needed to craft policies and programs aimed at promoting successful adaptation of the agricultural sector (Bryan et al. 2009).

Computation of Adaptation Index to Assess the Extent of Farmers' Adaptation to Climate Change

Each farmer was scored for adaptation by assigning scores of 0, 1, and 2 for non-, partial, and full adaptation of a measure, respectively. In case of drought and floods, total adaptation measures were 8 for each, respectively, and hence maximum adaptation score that can be obtained is 16, while minimum adaptation score that can be obtained by a farmer is 0. Adaptation indices were computed by dividing adapted measures with total recommended measures and multiplied with 100 for assessing the extent of adaptation.

The adaptation indices for the three districts along with their SD (standard deviation) and CV (coefficient of variation) values are presented in Table 8. Table 8 shows that the mean adaptation index value for floods (12.13) (East Godavari) is greater than that for droughts (11.90, 11.65) (Anantapur and Mahbubnagar, respectively).

Village-Wise and Practice-Wise Adaptation Scores of Farmers

Adaptation to climate change is the adjustment of a system to moderate the impacts of climate change to take advantage of new opportunities or to cope with consequences (Adger et al. 2003).

From Tables 9, 10, and 11, the villages, namely, *Podarallapalli* in Anantapur (13.2), *Machanpally* in Mahbubnagar (12.6), and *Gollaprolu* in East Godavari (13.9), showed highest mean adaptation values for droughts and floods, respectively.

The code and the adaptation practice it represents are given in Tables 12 and 13.

From Table 14, practices A3 (construction of water-harvesting structures), A4 (drought-resistant crops), A7 (crop management by adjusting planting dates), and A8 (soil management by mulching,

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Table 8 Adaptation indices of farmers for drought and floods

Statistic/category	Anantapur (drought)	Mahbubnagar (drought)	East Godavari (floods)
Mean	11.90	11.65	12.13
SD	2.14	2.22	1.97
CV	17.96	19.02	16.23
Max.	15	15	16
Min.	6	6	6

Table 9 Village-wise adaptation scores of farmers for drought in Anantapur district of Andhra Pradesh (AP)

S. no.	Village	Minimum	Maximum	Mean	SD	CV
1.	*Bhadrampally*	6	15	12	3.2	26.4
2.	*Siddharamapuram*	6	15	11.1	2.5	22.3
3.	*Nagasamudram*	9	15	12	2	16.7
4.	*Chenne Kothapalli*	12	12	12	0	0
5.	*Podarallapalli*	12	15	**13.2**	1.5	11.7
6.	*Mangalamadaka*	9	15	11.1	2	18.2

Table 10 Village-wise adaptation scores of farmers for drought in Mahbubnagar district of AP

S. no.	Village	Minimum	Maximum	Mean	SD	CV
1.	*Machanpally*	9	15	**12.6**	1.9	15.1
2.	*Appaipally*	6	15	11.1	2.5	22.3
3.	*Nirven*	12	15	12.3	0.9	7.7
4.	*Palem*	6	15	11.7	2.6	22.5
5.	*Penchikalapadu*	6	12	9.9	2.8	28.7
6.	*Aragidda*	12	15	12.3	0.9	7.7

Table 11 Village-wise adaptation scores of farmers for floods in East Godavari district of AP

S. no.	Village	Minimum	Maximum	Mean	SD	CV
1.	*Gollaprolu*	12	16	**13.9**	1.7	12
2.	*Chendurthi*	9	15	11.7	2.2	18.9
3.	*J. Thimmapuram*	6	12	11.1	2	18.2
4.	*Kattamuru*	9	16	12.7	2.1	16.2
5.	*Narsapuram*	9	12	11.4	1.3	11.1
6.	*Dora Chintalapalem*	9	15	12	1.4	11.8

conservation tillage) showed highest adaptation in Anantapur. This amply illustrates the need for water harvesting, storage, and reuse.

From Table 15, practices A3 (construction of water-harvesting structures), A4 (drought-resistant crops), A7 (crop management by adjusting planting dates), and A8 (soil management by mulching, conservation tillage) showed highest adaptation in Mahbubnagar. This amply illustrates the need for water harvesting, storage, and reuse.

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Table 12 Code and adaptation practices for drought in Anantapur and Mahbubnagar

Code	Adaptation practice
A1	Improved irrigation
A2	Minimized irrigation loss
A3	Construction of water-harvesting structures (WHS)
A4	Drought-resistant crops
A5	Timely supply of inputs
A6	Contingency crop planning
A7	Crop management by adjusting planting dates
A8	Soil management by mulching, conservation tillage

Table 13 Code and adaptation practices for floods in East Godavari

Code	Adaptation practice
A1	Water storage
A2	Strengthening of riverbanks
A3	Flood forecasting and early warning systems
A4	Drainage aspects
A5	Better soil and crop management practices
A6	Credit
A7	Insurance
A8	Community-based water management

Table 14 Practice-wise mean adaptation scores of farmers for drought in Anantapur district of AP

Statistic	A1	A2	A3	A4	A5	A6	A7	A8
Mean	1.12	1.0	**1.97**	**1.97**	0.85	1.20	**2.00**	**1.80**
SD	0.52	0.64	0.18	0.18	0.36	0.40	0.00	0.40
CV	46.90	63.78	9.20	9.20	42.36	33.61	0.00	22.41

Table 15 Practice-wise mean adaptation scores of farmers for drought in Mahbubnagar district of AP

Statistic	A1	A2	A3	A4	A5	A6	A7	A8
Mean	1.05	0.97	**1.92**	**1.92**	0.83	1.13	**2.00**	**1.83**
SD	0.47	0.55	0.28	0.28	0.38	0.34	0.00	0.38
CV	44.45	57.03	14.54	14.54	45.10	30.25	0.00	20.50

Table 16 Practice-wise mean adaptation scores of farmers for floods in East Godavari district of AP

Statistic	A1	A2	A3	A4	A5	A6	A7	A8
Mean	1.02	1.18	**1.85**	**1.85**	**2.00**	1.20	1.20	**1.83**
SD	0.22	0.43	0.36	0.36	0.00	0.40	0.40	0.42
CV	22.12	36.46	19.46	19.46	0.00	33.61	33.61	22.83

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From Table 16, practices A3 (flood forecasting and early warning systems), A4 (drainage aspects), A5 (better soil and crop management practices), and A8 (community-based water management) showed highest adaptation in East Godavari. The problem here is managing excess water.

Conclusion

Common perceptions of climate change across the three regions in AP are rise in temperatures, decrease in precipitation, and incidence of pests and diseases to crops. Adaptation measures practiced for drought are insurance, change in planting dates, working as migrant laborer, and construction of WHS. For floods, early sowings, saltwater spray for harvested paddy stalks, strengthening of riverbanks, and improved drainage are the chief adaptation measures. The mean adaptation index value for floods (East Godavari) is greater than that for droughts (Anantapur and Mahbubnagar). Practice A7 (crop management by adjusting planting dates) showed highest adaptation in Anantapur and Mahbubnagar. Practice A5 (better soil and crop management practices) showed highest adaptation in East Godavari.

Rise in temperatures is almost always echoed by farmers irrespective of season and place. Decreasing precipitation is yet another common concern, which usually when occurring in severe intensity bursts does an impression of pricking on human skin. Water conservation is the need of the hour, to avoid runoff of excess rainwater in a short period of time. Farmers believe that it has great potential in addressing the impacts of climate change. Incidence of pests and diseases on crops complement with varying humidity levels in the atmosphere deserves attention. Until now minor crop pests, be it on dry sorghum or castor and paddy, are becoming major is another important observation by farmers.

Adaptation/adjustments to climate change at household level by farmers which are carried single handedly through experience and observation require greater support in terms of continuance with or without slight modifications. Insurance, changing planting dates, and planting different crops in a staggered manner come under this household adaptation category. Construction of water-harvesting structures under MGNREGA in dry districts of the study is an encouraging sign and should be promoted wherever possible. Since crop management strategies are ad hoc and immediate, farmers show a great degree of preference to it to tide over the situation, for example, change in planting dates, intercrops, etc. However, in attaining greater resilience toward climate change, soil management concepts and practices should be instilled among farmers like conservation tillage, mulching, recycling of nutrients, etc. For floods, proper drainage system for the floodwaters to empty into the sea is lacking. Drainage systems often suffer from inadequate maintenance and need improvement works like desiltation, lining of the walls, and weed removal. There is need for imparting greater awareness, education, and training about climate change issues to farmers in supporting adaptation efforts. The challenge which remains for scientists is developing quick-maturing, drought- and lodging-resistant crop varieties to surmount the current and future climate change in agriculture.

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