International Journal of Environment and Climate Change

Volume 13, Issue 11, Page 1738-1745, 2023; Article no.IJECC.108481
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Climate Change Adaptation in Chandrapur District of Vidarbha Region of Maharashtra, India: An Investigation into Individual and Collective Agricultural Actions

Atul Anil Gawhare [a++], Sachin Rathour [a++], Vaishnavi Singh [a++*], Prakash Singh Badal [a#] and Virendra Kamalvanshi [a†]

[a] Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, 221005, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i113329

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/108481

Original Research Article

Received: 14/08/2023
Accepted: 20/10/2023
Published: 28/10/2023

ABSTRACT

Climate change impacts are global, countries like India are particularly vulnerable due to their large populations and heavy reliance on agriculture. Climate change has substantial economic effects on agriculture, including shifts in productivity, crop patterns, profitability, prices, supply, and trade. Adaptation involves measures to adjust to present or anticipated future conditions, differing from

[++] Research Scholar;
[#] Professor;
[†] Associate Professor;
**Corresponding author: E-mail: Vaishnavisingh2811@gmail.com;*

mitigation, which focuses on risk reduction. This study focused on adoption rates and influencing factors for climate change adaptation measures in Maharashtra's Vidarbha region. Data from 120 farmers in Chandrapur district showed that over 50% implemented strategies like crop diversification, land fallowing, well installation, integrated fertilization, and agroforestry. These choices were influenced by local conditions and socioeconomic factors, with a positive connection to climate awareness, land size, weather information access, cropping practices, institutional support, and assets. Notably, awareness, land size, cropping patterns, and institutional support significantly affected farmers' adaptation levels.

Keywords: Climate change; adaptation; crop diversification; profitability.

1. INTRODUCTION

As per IPCC (Intergovernmental Panel on Climate Change) usage climate change refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and or the variability of its properties, and the persists for an extended period, typically decade or longer. This usage differs from that in the UNFCCC (United Nations Framework Convention on Climate Change) where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

1.1 Why Climate Change is Concern in Agriculture

Agriculture contributes to climate change both by anthropogenic emissions of greenhouse gases and by the converting forests into cultivable land. The impacts of climate change are seen everywhere in the world, but countries like India are vulnerable in view of its large population and huge dependence on agriculture. Climate change has significant economic effects on agriculture including changes in farm productivity cropping pattern, profitability price, supply and trade. The variability of climate poses major challenge for the large numbers of marginalized and small farmers. Report of International panel on climate change [1] predicts a rise in global temperatures of between 0.3 and 4.8 degree Celsius and a rise of up to 82 cm. in sea levels by the late 21st century due to melting ice and expansion of water as it warms. Agricultural productivity is sensitive to global climatic changes in the country and therefore, its impacts need to be evaluated as climate affects many aspects of plant and animal biology, the effects of climatic elements and their extremes will significantly alter the productivity of agriculture sector. The disturbance to “Eco systemic balance" may generate negative impacts on the socio-economic condition of many societies, especially for the developing countries like India where agriculture used to contribute little less than a quarter of the country's GDP but providing source of livelihood for half of its population. The global warming is expected to lead to other regional and global changes in the climate-related parameters such as rainfall, soil moisture and sea level [2,3]. Climate change also impacted agricultural biodiversity and thereby threatening the food security of the nation.

1.2 Adaptation Strategies to Climate Change in Agriculture

Adaptation refers to measures or techniques which can be used to adjusted to actual or expected situation in the coming future. It is different from mitigation such that mitigation involves measures to reduce the risk. The study was conducted to know the adaptation strategies by individual farmer and group or collective actions.

1.3 Farmer’s Adaptation Measures to Climate Change

To deal with the impact of climate change, the potential adaptation strategies area) crop production measures b) soil and water conservation measures Farmer adopts those measures which are economical and efficient. The adoption of these measures depend upon the cropping pattern followed by farmer, agro climatic situation prevailed in the region, size of land holdings and awareness about climate change. It varies from farmer to farmer, region to region and crop to crop.

1.4 Collective Actions for Adaptation to Climate Change

These adaptation measures address the common problems faced by more number of

people. These are institutional as well as community involved measures serving the common goal of number of people. These includes access to crop insurance, early warning weather forecasting system, voluntary group /organization, Participation and organization of training programmes, access to financial resources, social forestry plantation, community water harvesting measures, solar farming, watershed management programmes, availability of technical information, etc.

Access to crop insurance and early warning system provide some relief in case of adverse climatic situation in the form of financial aid and facilitating decision making in crop production.

Voluntary group organization, training programs help to build adaptive capacity of farmers so that they can make proper decisions regarding use of adaptive practices at proper time.

It is desirable that any such strategy considers farmers' beliefs, perceptions, responses, policy preferences, etc. Since Indian agriculture is diverse and climate change is complex, the nature of problem and the farmers' responses will be diverse and heterogeneous. Understanding what farmers think with respect to climate change is also essential for mainstreaming adaptation into development planning which is considered as key to enhancing resilience.

The main aim of the study was to investigate into:

1. To study adoption percentages of different adaptation measures to climate change
2. To identify factors influencing adaptation measures to climate change in each region

2. METHODOLOGY

The study was conducted in nine villages from three different blocks of the chandrapur district. The sample of 120 farmers across different landholdings was selected. Multi stage sampling was used for selecting the primary sampling unit. Multi-stage random sampling was used for the selecting the primary sampling units. The sampling framework is provided in Table 1, where it involves selection of the block, villages from each block and then respondent farmers. The total sample size is 120.

Data was collected directly interviewing each farmer and by recording their responses in structured survey schedule. Interview schedule was used to collect required information for the study.

Considering the stated objectives of the study, different statistical models like functional and tabular analysis have been applied for the analysis of collected data. Simple statistical techniques such as averages, percentages were applied to achieve first objectives. Basic statistical tools are used to strengthen the links with the multivariate statistical analysis when discussing climate change impacts.

Multiple regression model is used to achieve second objective of the study. The factors influencing adaptation measures are analyzed with the help of it.

2.1 Multiple Regression Model

The multiple regression model attempts to set relationship between individual's choice of adopting particular adaptation measures and factors influencing to adopt that measure. To

Table 1. Sampling design

State	District	Block	Village	No.of farmers
Maharashtra	Chardrapur	Warora	Wadadha	13
			Ralegaon	13
			Shegaon	14
		Chimur	Khadsnagi	13
			Bhisi	13
			Hirapur	14
		Pombhurna	Dewada kh	13
			Jamkhurd	13
			Wadoli	14
			Total	120

describe the multiple regression model, let Y_i be a random variable representing the adoption index of adaptation measures chosen by particular farmer. Each farmer has a set of adaptation measures which are influenced by factors such as awareness about climate change, land holding, institutional support, cropping pattern and assets of farmers. These factors are explanatory variable which are represented by X_j.

$$Y_i=\beta_0+\beta_1X_1+ \beta_2X_2+\ldots\ldots +\beta_jX_j$$

where

$$j=0,1,2,\ldots..n$$

Where,

β_j is the vector of coefficients on each of the independent variables.

The independent variables are

X_1=Farmer's awareness about climate change
X_2= Land holding
X_3= Access to weather information
X_4= Cropping pattern
X_5= Institutional support
X_6= Assets

3. RESULTS AND DISCUSSION

3.1 To Study Adoption of Different Adaptation Strategies to Climate Change in Each Selected Block of District

The adoption of these strategies was recorded during the primary survey. Considering the shortage of water due to high evaporation losses in the district, micro-irrigation is identified as an adaptation strategy. Field level enquiry revealed that farmers used irrigation as a method to overcome heat stress during dry spell of the monsoon. The various strategies were grouped into four classes viz. crop centric adaptation measures, soil and water conservation measures and collective measures.

An adoption index was calculated for each farmer by summing up responses of farmer about each mentioned adaptation strategies. The response of farmer is taken as dummy variable based on whether farmer adopts particular strategy or not. Affirmative response of farmer i.e. yes is mentioned as 1 and negative response *i.e.* No is mentioned as 0.

3.2 To Identify Factors Influencing Adaptation Measures to Climate Change by Farmers

The collective adoption index of all the 23 adaptation measures has been calculated for each farmer. Farmers' responses regarding factors influencing adaptation measures were recorded during filling the schedule. The responses were recorded using dummy variable for each factor. The affirmative response or Yes was taken as 1 and negative response or No was taken as 0.

The relationship between adoption index and responses of farmer in the form of dummy variable was analyzed using multiple regression model in which adoption index is taken as dependent variable (Y) and factors influencing adaptation measures are taken as independent variable (X_i). The coefficients (Table 3) of multiple regressions give an idea about the direction of effect of independent variables. The relative regression coefficient presented in Table 4 and 5.12 shows the effects of individual explanatory variables on the adoption of various climate adaptation measures collectively. In the following sub-sections, the study describes the impact of various explanatory variables on the probabilities of adopting different adaptation measures in each selected block of the district. Results of regression analysis are presented.

Table 2. Adoption of adaptation strategies to climate change by farmers

S.N.	Adaptation strategies	Adoption(in %) in each Block			
		Warora	Chimur	Pombhurna	Total
1	Change in variety of crop/improved variety	66.66	53.33	53.33	57.77
2	Crop diversification	80.00	53.33	13.33	48.88
3	Integrated farming system	53.33	33.33	40.00	42.22
4	Integrated use of fertilizer	73.33	46.66	53.33	57.77
5	Micro-irrigation (Sprinkler/Drip)	60.00	33.33	13.33	35.55

S.N.	Adaptation strategies	Adoption(in %) in each Block			
		Warora	Chimur	Pombhurna	Total
6	Fallow the land during summer	66.66	53.33	73.33	64.44
7	Polyhouse/greenhouse farming	09.09	09.09	09.09	06.66
8	Fruits/perennial crops	46.66	26.66	33.33	35.55
9	Farm pond	46.66	20.00	20.00	28.88
10	Bunding	86.66	66.66	73.33	75.55
11	Ridges and Furrows across the field	53.33	60.00	20.00	44.44
12	Well/Tubewell/Borewell	53.33	60.00	66.66	60.00
13	Mulching	13.33	6.66	00.00	6.66
14	Agroforestry	53.33	33.33	66.66	51.11

Table 3. Regression analysis for whole sample

Regression Statistics	Value
Multiple R	0.841
R Square	0.708
Adjusted R Square	0.670
Standard Error	0.15
Observations(n)	120

From the above Table 3, it is clear that the coefficient of determination ($R^{2)}$ is 0.708. It means that 70% change in adoption index is caused by six factors such as awareness about climate change, land holdings, access to weather information, cropping pattern, institutional support and farm assets. The actual change in adoption index caused by individual factor is discussed in the Table 4.

a. Awareness about climate change: It is most influencing factor for adopting a particular adaptation measures. Farmer's awareness about climate changes is important in the adaptation decision making process [4]. The regression analysis revealed that the farmers who have information on climate changes had a significant and positive impact on the almost all the adaptation technologies. The results indicated that farmer's awareness about climate variability in temperature and rainfall is one of the factors influencing adaptation measures. The positive coefficient of awareness about climate change indicates increase in adoption index with increase in farmer's awareness about climate change.

b. Land holdings: Farmers having more land under cultivation seems to have more capacity to try out and invest in adaptation strategies. The size of landholding is positively related with change in adaptation level because they will use more part of their land for trying out various adaptation measures. Larger farm size leads to use of other innovative technologies which are more expensive. The significant positive relationship between size of land holding and adaptation level indicates increase in adoption of innovative adaptation measures either increase in land holdings. The various studies [5,6] showed that household with larger size of land holding may be more willing to adapt technologies that require high cost of installation.

Table 4. Regression analysis of factors influencing adaptation measures for whole sample

Variable	Regression Coefficient (b)	Standard Error	P-value
Intercept	0.04036	0.06082	0.5109
Awareness	0.213482	0.07898	0.0102
Land holdings	0.146049	0.05067	0.0064
Weather info.	0.060964	0.05779	0.2981
Cropping pattern	0.154922	0.05490	0.0075
Institutional support	0.145755	0.05814	0.0165
Assets	0.078025	0.05547	0.1677

c. Weather information: Access to weather information is one of the explanatory variables that influence adaptation measures. Farmers can access weather information through SMS. Krishi Vigyan Kendra and research centres provide weather information to farmers in their region. Although it does not have significant influence on adaptation measures but it is positively related with adaptation level. It means that if farmer receive weather information. He can more adapt to climate change.

d. Cropping pattern: Cropping pattern followed in an area is also one of the deciding factor in adaptation measures. Farmer adopt such cropping pattern which is less vulnerable to climate change. The cropping pattern in an area has significant impact on adaptation level of farmer. The major crops of the district are cotton, soybean, wheat, paddy and redgram. Farmers adopt specific cropping scheme based on the amount of rainfall, type of soil and climate.

e. Institutional support: Institutional support such as government schemes and NGO's initiatives encourage farmers to adapt to climate change. Government's initiatives such as low interest credit, scheme of tube well or bore wells, farm pond, MGNREGA programmes in agriculture; crop insurance scheme helps farmers to minimize the risk of changing climate and better adapting to it. The result reveals positive relationship between institutional measures and adaptation level. It is one of the significant factor influencing adaptation measures to climate change. It means that increase in institutional support increases adoption index of farmer. This is true for the whole sample and it differs from region to region. The result implies the important role of institutional support in encouraging the use of adaptation options to reduce the negative impact of climate change. Similar findings have been given by Charles and Rashid [7] and Apata et al. [8] and Ayanwuyi et al. [9] that institutional support facilities had positive and significant relationship with adaptation options.

f. Assets: It includes both on farm and off farm assets. Majority of farmers do not avail credit facilities so that the off farm income and wealth plays an important role in adapting to climate change. The result of this study reveals positive relationship between adaptation level and assets of farmer. Although it is not significantly influence the adaptation decision of farmer, but it is positively correlated with adaptation level. The farmers with large assets have access to newer technologies of adaptation and have high level of adaptation. Kim et al. (2012) found that household income positively influences the adoption of adaptation to climate change while Gebitobo [10] explained that wealthier farmers are more interested to adapt by changing crop management practices. Further, Nhemachena and Hassan [11] indicate that per capita income has a positive influence on farmers to decide on adaptation strategies. This result is true only for whole sample as it may differ from block to block which is discussed later.

4. SUMMARY

Climate change is one of the major challenges before world. Many studies had been conducted to measure its impact on agriculture sector and on rural livelihoods. The study was conducted on mentioned topic as higher vulnerability of Vidarbha region to climate change. The objectives of the study were to study adoption of different adaptation strategies to climate change and to study factors influencing adaptation measures. The data was collected by using multistage sampling technique and analyzed by using multiple linear regression method .These were the major findings –

- More than half of the farmer have adopted improved or drought resistant variety of crop as adaptation measures against climate change
- Maximum number of farmers (75%) has constructed bunds in their fields for soil and water conservation.
- More than 50% farmers also adapted crop diversification, fallow the land during summer, installation of well/tube well, Integrated use of fertilizers and other agro forestry measures.
- Adaptation strategies are adopted according to cropping pattern in an area, climatic factors like rainfall and temperature and socioeconomic background of farmer.
- The study reveals the positive relationship between adaptation level and factors

influencing adaptation measures such as awareness about climate change, size of land holding, access to weather information, cropping pattern, institutional support and assets with farmer.

- Factors such as awareness about climate change, size of land holding, cropping pattern and institutional support have significant influence on the level of adaptation of farmer.
- Socioeconomic factors such as education of farmer have significant impact on the level of adaptation.

5. CONCLUSION

In conclusion, addressing the challenges of climate change and promoting climate adaptation measures in rural communities requires a multi-faceted and proactive approach. The recommendations outlined above highlight the importance of collaboration and innovation to build climate-resilient villages and empower farmers to adapt to changing environmental conditions. By implementing a cluster-based approach for technology sharing, establishing custom hiring centres, and improving weather forecasting systems, we can enhance the capacity of farmers to make informed decisions in agriculture. Furthermore, raising awareness and providing government incentives can incentivize the adoption of climate-smart practices. The integration of modern communication technologies can expedite the dissemination of vital information, while encouraging public participation and diversifying off-farm businesses can reduce vulnerability to climate change.

It is crucial that governments, non-governmental organizations, and communities come together to support and implement these recommendations. By taking collective action, we can mitigate the impact of climate change on agriculture and ensure a more sustainable and resilient future for rural areas. Climate adaptation is not just a necessity; it is an opportunity for growth, innovation, and community development. The time to act is now, and by following these guidelines, we can pave the way for a more climate-resilient and prosperous agricultural sector.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. IPCC report; 2014
2. Maddison D. The perception and adaptation to climate change in Africa, World Bank Policy Research Working Paper, Wold Bank, Washington DC; 2007.
3. Lunagaria MM, Dabhi HP, Pandey V. Trends in the temperature and rainfall extremes during recent past in Gujarat. Journal Agromet. 2015;17(1):118-23.
4. Vijayasarathy K, Ashok KR. Climate adaptation in agriculture through technological option: Determinants and impacts on efficiency of production. Agricultural Economic Research Review. 2015;28:103-16.
5. Charles, Rashid. Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI; 2007.
6. Apata, et al. Analysis of Climate Change Perception and Adaptation among Arable Food Crop Farmers in South Western Nigeria. International Association of Agricultural Economists' 2009 Conference, Beijing, China. 2009; 209.
7. Ayanwuyi, et al. Farmers Perception of Impact of Climate Changes on Food Crop Production in Ogbomosho Agricultural Zone of Oyo State, Nigeria. Global Journal of Human Social Science. 2010;10:22-33.
8. Gebitobo GA. Understanding farmers perception and adaptation to climate change and variability: A case of limpopo basin. IFPRI discussion paper, Environment and Production Technology Dividion, University of Pretoria; 2007.
9. Nhemachena C, Hassan R. Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI Discussion Paper No. 00714 International Food Policy Research Institute, Washington D C; 2007.
10. Biesbroek GR, Klostermann JE, Termeer CJ, Kabat P. On the nature of barriers to climate change adaptation. Regional Environmental Change. 2013 Oct;13:1119-29.

11. Berrang-Ford L, Pearce T, Ford JD. Systematic review approaches for climate change adaptation research. Regional Environmental Change. 2015 Jun;15:755-69.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/108481