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Perceived impact of climate change and coping strategies among paddy farmers

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Abstract
The study was conducted in Chandrapur and Bhandara districts of Vidarbha region in Maharashtra state. Chandrapur and Bhandara districts are considered as progressive agricultural belt in Vidarbha region. For the present study random sampling method was used. From each tehsil four villages were selected. Thus, from Sindewahi tehsil of Chandrapur district four villages were selected and from Sakoli tehsil of Bhandara district four villages were selected. In this study 8 villages were covered. For the present study from each selected village 45 paddy farmers were selected randomly; i.e. total 180 respondents were selected from each district. Thus total 360 respondents were selected for the study. The research design ex post facto were used.
The result revealed that majority of the paddy farmers i.e. 58.61 per cent were in 'middle age group' (36 to 55 years); nearly paddy farmers i.e. 37.23 per cent had completed their higher secondary education, majority of paddy farmers i.e., 68.61 per cent had medium-sized families, 73.05 per cent of the paddy farmers had a medium annual income, 68.89 per cent had a medium level of farming experience, 56.38 per cent of the paddy farmers had a medium level of extension contact, 82.23 per cent had medium area under paddy cultivation, 76.67 per cent, used the transplanting method of paddy sowing, majority of paddy farmers i.e. 51.67 per cent were in the moderately vulnerable group, majority of the paddy farmers i.e. 77.77 per cent know about Pradhan Mantri Fasal Bima Yojana. The collected data were processed through primary and secondary tables and statistically analysed. The Karl Pearson's correlation coefficient method was computed to find out the relationship between the selected independent and dependent variables.

Keywords: Perception, paddy farmers, coping mechanisms, climate change, adaptation

Introduction
The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed to natural climate variability observed over comparable time periods."
A change in the condition of the climate that may be detected by changes in the mean and/or variability of its attributes and that lasts for a long time, generally decades or longer. Climate change can be caused by natural internal processes or external forcings such as solar cycle modulation, volcanic eruptions, and long-term anthropogenic changes in atmospheric composition or land use. (IPCC's Special Report on Global Warming 2018) [4].
Climate variability refers to the variations in climate conditions over a specific period of time, typically ranging from months to decades. Climate variability is the way aspects of climate (such as temperature and precipitation) differ from an average. The average range of temperature for a location, as indicated by minimum, maximum and average temperature values, is an example of a measure of climate variability. Climate variability occurs due to natural and sometimes periodic changes in the circulation of the air and ocean, volcanic eruptions, and other factors. Adopting to climate variability would reduce the adverse livelihood impacts at household level and food security at the national level. Coping mechanisms vary not only across locations but also across different socio-economic groups of the farming community. Often poor (small, marginal, and vulnerable sections) suffer most due to climate variability. (Kumari 2014) [6].

Mitigation and Adaptation

The Intergovernmental Panel on Climate Change (IPCC 2023) [5] highlighted the importance of both mitigation and adaptation in addressing climate change. The IPCC emphasizes in its Sixth Assessment Report (AR6), particularly the Synthesis Report, March 2023, the importance of rapid and ongoing mitigation actions to reduce global warming and its associated dangers. Concurrently, adaption methods are critical for managing the existing and predicted implications of climate change. The AR6 Synthesis Report emphasizes that delaying action in both mitigation and adaptation will result in increased costs and worse effectiveness. It emphasizes the significance of combining various techniques in order to boost resilience and achieve sustainable development. These recent IPCC findings highlight the critical need for comprehensive plans that combine mitigation and adaptation to successfully address the numerous challenges posed by climate change.

Coping strategies

Magwegwe (2024) [7], defines coping strategies as "behaviors and practices adopted by individuals and households to manage and mitigate the adverse effects of climate-induced food shortages, frequently involving adjustments in agricultural practices, dietary intake, and reliance on social support networks. Coping mechanisms are also defined by Baptista *et al*. (2023) as "adaptive responses employed by households to counteract the impacts of climate shocks, which may include altering cropping patterns, utilizing communal resources, and diversifying income sources." These categories highlight how coping mechanisms used by communities to deal with the effects of climate change are dynamic and context-specific.

Adaptation strategies

In its 2022 report, the Intergovernmental Panel on Climate Change (IPCC) defines adaptation as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities." This illustrates proactive, long-term tactics meant to lessen susceptibility to the effects of climate change. Coping mechanisms, on the other hand, are usually temporary fixes for current climatic stresses and do not always support long-term resilience. Coping techniques include, for instance, selling assets or temporarily moving after severe weather disasters. The IPCC stresses that although coping strategies can offer short-term respite, they could not be long-term and might even make people more vulnerable.

Objective

To study the coping mechanisms followed by the paddy farmers to deal with impact of climate change.

Methodology

The study was conducted in Chandrapur and Bhandara districts of Vidarbha region in Maharashtra state. Chandrapur and Bhandara districts are considered as progressive agricultural belt in Vidarbha region. For the present study random sampling method was used. From each tehsil four villages were selected. Thus, from Sindewahi tehsil of Chandrapur district four villages were selected and from Sakoli tehsil of Bhandara district four villages were selected. For the present study from each selected village 45 paddy farmers were selected randomly; i.e. total 180 respondents were selected from each district. Thus total 360 respondents were selected for the study.

Coping mechanisms was operationalized as the capacity of the paddy farmers to adapt themselves against the adverse effects of climate change on paddy crop by adopting the adaptation practices (both traditional practices and scientific practices). For this, a set of practices were framed based on practices collected during pre-testing in the sample area to cope up with climate change in paddy and the practices were classified as adaptation (A) which are the changes in paddy cultivation practices made by the farmers, mitigation (M) which reduce the emission of GHGs from paddy cultivation and both adaptation + mitigation (A+M) practices which have benefits of both. Response of the paddy farmers for the framed statements was taken in two continuums i.e. 'Yes' and 'No' for which arbitrary score '1' and '0' was assigned, respectively. The extent of coping mechanisms followed by the paddy farmers towards climate change were classified into three categories based on quartile deviation as: low, medium, and high.

Sr. No.	Category	Coping mechanisms (Score)
1	Low	Up to 8
2	Medium	9 to 11
3	High	12 and above

Results and Discussion

Table 1: Distribution of paddy farmers according to their coping mechanisms to deal with impact of climate change

Sr. No.	Statement	Frequency	Percentage	Rank
1.	Land levelling (M)	296	82.22	II
2.	Change in the crop calendar (A)	200	55.55	VI
3.	Increasing seed rate (A)	240	66.67	IV
4.	Planting of aged seedlings (one week more than normal age) (A)	195	54.17	VII
5.	Increasing space between the rows (A)	186	51.67	IX
6.	Alternate wetting and drying (A+M)	104	28.89	XVI
7.	Optimum application of fertilizers (M)	191	53.05	VIII
8.	Diversifying the cultivation of many crops (A+M)	47	13.05	XVII
9.	Use of drought resistant and early maturing varieties	154	42.67	XIII
10.	Avoiding crop cultivation from vulnerable areas (M)	160	44.45	XI
11.	Cropping system with green gram or black gram (A+M)	120	33.33	XV
12.	Practices of SRI method (A+M)	36	10.00	XVIII
13.	Reduced tillage practices (A+M)	158	43.89	XII
14.	Preventing straw burning (M)	350	97.22	I
15.	Construction of water tanks in the field (A)	140	38.89	XIV
16.	Adopting IPM methods for pest management (M)	200	55.56	V
17.	Reducing plant population during stress season (M)	260	72.22	III
18.	Crop residues and weed management (A+M)	174	48.33	X
19.	Recycling of waste water and solid wastes (M)	00 (0.00)	0.00	XIX

A= Adaptation to climate change,
M = Mitigation of climate change and
A+M = Both adaptation and mitigation to climate change

1. Land levelling

It is observed that, 'Land levelling' as coping mechanism followed by 82.22 per cent of the paddy farmers. The most likely reason for this is that land levelling in paddy fields enhances water use efficiency, grain productivity, and grain quality. It also emits less CH_4 than undulated land. The majority of paddy farmers levelled their ground for consistent crop establishment, although being unaware of methane emissions.

These findings are similar to Singh (2018) [13], who examined how land leveling increases water efficiency and crop output in paddy farming. It also emphasizes that leveling reduces methane emissions when compared to undulated soil, which is consistent with the measures used by paddy farmers to cope with climate change.

2. Change in the crop calendar

It was seen that, 55.55 per cent of the paddy farmers had followed 'Change in the crop calendar' as coping mechanism. Paddy farmers adjusted their crop calendar as a coping mechanism for climate change during the late monsoon season and the late release of water from the dam. The most likely explanation is that paddy farmers modify their crop cycle based on the availability of water. That is why paddy farmers must alter their crop calendars based on rainfall or canal water availability.

These results are in line with Shah (2021) [10], who investigated the adaptive tactics used by Indian paddy farmers, such as modifying planting periods in response to changing monsoon patterns and water availability.

3. Increasing seed rate

Most of the paddy farmers i.e. 66.67 per cent had followed 'Increasing seed rate' as coping mechanism to climate change. Unpredictable rainfall patterns, high temperatures, and other stressors can lower the pace at which seeds germinate as a result of climate change. Paddy producers can counteract the possible loss by ensuring that enough plants take root and produce a harvestable paddy crop by raising the seed rate. The adoption of this coping method by paddy farmers is likely due to this reason.

This result is in line with Lobell (2020), who explored how increasing seed rates can be a smart reaction to climate-induced stressors including unpredictable rainfall and temperature fluctuations, which impair seed germination and crop establishment.

4. Planting of aged seedlings (one week more than normal age)

Approximately 54.17 per cent of the paddy farmers had followed 'Planting of aged seedlings' as coping mechanism to climate change. Planting aged seedlings is a strategy that enhances crop survival, growth, and productivity in the face of climate-related challenges, making it a valuable adaptation practice for paddy farmers. Hence, more than half of the paddy farmers might have adopted this coping mechanism.

This result is similar to Bhandari (2021) [1], who addressed several adaptation tactics used by paddy farmers, including the use of older seedlings to boost resilience to environmental stressors including drought and variable rainfall patterns.

5. Increasing space between the rows

Near about half i.e. 51.67 per cent of the paddy farmer had followed 'Increasing space between the rows' as coping mechanism to climate change. Increasing the distance between rows helps crops become more resilient to the different stresses brought on by climate change, such as heat waves, disease pressure, and water stress. Because of this, it's possible that nearly half of paddy farmers have used this coping technique.

This finding is similar to Sahoo (2020), who indicated that increasing the spacing between paddy plants is a useful agronomic approach for boosting resistance to water stress, high temperatures, and disease. Paddy farmers use this method as part of a larger set of strategies to adapt to climate change.

6. Alternate wetting and drying

Approximately 28.89 per cent of the paddy farmers had followed 'Alternate wetting and drying' as coping mechanism to climate change. In irrigated lowland rice, alternate wetting and drying (AWD) is a management technique that conserves water and lowers greenhouse gas (GHG) emissions without sacrificing yields. As such, it is regarded as a climate change adaptation and mitigation strategy. Because they are unaware of alternate wetting and drying methods, very few paddy farmers have embraced this coping strategy.

7. Optimum application of fertilizers

More than half of the paddy farmers i.e. 53.05 per cent had adopted 'Optimum application of fertilizer' as coping mechanism to climate change. Because the majority of paddy farmers earn a low to medium annual income, increasing their fertilizer spend and purchasing organic manures is out of reach. Another issue is a lack of information about the appropriate amount of fertilizer to use. As a result, half of the paddy farmers may not have implemented this coping method.

8. Diversifying the cultivation of many crops

Only 13.05 per cent of the paddy farmers had adopted 'Diversifying the cultivation of many crops' as coping mechanism to climate change. The technique of solo cropping is common in India's low-relief zones, although it is dangerous and frequently leads to low yields or, in rare cases, crop failure because of irregular monsoon rainfall and unbalanced distribution. Crop diversification is a workable solution in these places to reduce crop production risk and guarantee fair returns. Since paddy is the primary crop grown in the research area, not many paddy farmers have used this coping strategy.

9. Use of drought resistant and early maturing varieties

Majority of the paddy farmers i.e. 42.67 per cent had adopted 'Use of drought resistant and early maturing varieties' as coping mechanism to climate change. Adopting drought-resistant and early maturing varieties is a proactive approach to safeguarding agricultural productivity and food security in the face of climate change. Hence, paddy farmers have adopted this coping mechanism to deal with the impact of climate change.

This result is likely to Mishra (2021) [8], who investigated the use of early-maturing and drought-tolerant rice varieties as effective coping mechanisms for climate unpredictability. Farmers select these types because they lessen exposure to climatic threats, such as water scarcity and yield loss.

10. Avoiding crop cultivation from vulnerable areas

Majority of the paddy farmers i.e. 44.45 per cent had adopted 'Avoiding crop cultivation from vulnerable areas' as coping mechanism to climate change. Paddy farmers can increase crop productivity by concentrating cultivation on more favourable and resilient locations. Because they are not as subject to the strains brought on by climate change, crops cultivated in less vulnerable places have a higher chance of thriving. This may be

the cause of the coping strategy that paddy farmers have used.

11. Cropping system with green gram or black gram

Approximately 33.33 per cent of the paddy farmers have adopted coping mechanism 'Cropping system with green gram or black gram' to climate change. The improved soil structure and organic matter content caused by these crops improves the soil's capacity to hold onto moisture and withstand erosion. To lessen the effects of climate change, such as increased soil erosion and diminishing soil quality, this is essential. Paddy farmers have therefore adapted this coping strategy.

12. Practices of SRI method

very few paddy farmers i.e. 10.00 per had adopted 'Practices of SRI method' this coping mechanism to climate change. The probable reason for this lower adopted might be that most of the paddy farmers were not aware about System of Rice Intensification (SRI).

This finding is like Sarkar (2020) [9], who showed that farmers' inadequate knowledge and awareness of the SRI method are significant barriers to its adoption. The study found that, while SRI can boost production, farmers' unfamiliarity with the technology causes a delayed adoption of this climate-resilient farming strategy.

13. Reduced tillage practices

Most of the paddy farmers i.e. 43.89 per cent had adopted 'Reduced tillage practices' as coping mechanism to climate change. Most paddy farmers earned low to medium incomes annually, hence they are unable to afford to invest more in tillage techniques. Therefore, it is possible that most paddy farmers use this coping technique.

These results are in line with Kumar (2021) [12], who evidenced from Indian farmers, particularly those with medium-to-low incomes, who used reduced tillage as a technique to cut input costs while enhancing soil health and production.

14. Preventing straw burning

Majority of the paddy farmers which is 97.22 per cent had adopted this coping mechanism to climate change. Using straw to manure or feed animals helps cut down on greenhouse gas emissions. As there was no other supply of animal feed, paddy farmers fed the paddy straw to their cattle instead of burning it, which would have caused pollution. Thus, the majority of paddy farmers adopted it.

This result is like Bhattacharyya (2021) [2], who addressed several techniques of handling rice straw, such as using it for animal feed or composting. It underlines how using rice straw as feed or organic manure reduces greenhouse gas emissions as compared to burning, which is a major cause of air pollution in rice-growing regions.

15. Construction of water tanks in the field

Only 38.89 per cent of the paddy farmers had adopted 'Construction of water tanks in the field' as coping mechanism to combat effect of climate change. It is not feasible for most paddy farmers, who earn a median annual income, to build water tanks in their fields. As a result, fewer paddy farmers used this coping technique.

16. Adopting IPM methods for pest management

About 55.56 per cent paddy farmers were followed 'Adopting IPM methods for pest management' as coping mechanism to climate change. The probable cause is that paddy farmers used cultural, mechanical, and chemical pest management approaches. Thus, most paddy farmers may have used this coping method.

17. Reducing plant population during stress season

Majority of the paddy farmers i.e. 72.22 per cent had adopted 'Reducing plant population during stress season' as coping mechanism to combat climate change. Reducing plant population during stress seasons requires less water, fertilizer, and pesticides, which is especially useful when resources are scarce or expensive. This reduction in input requirements might result in cost savings for farmers while also preserving crop output. As a result, most paddy farmers may have implemented this coping strategy.

18. Crop residues and weed management

Near about half 48.33 per cent of the paddy farmers had adopted 'Crop residues and weed management' as coping mechanism to climate change. Effective crop residue and weed management are critical strategies for dealing with climate change and improving agricultural sustainability because they improve soil health, preserve water, reduce greenhouse gas emissions, and promote sustainable crop production. As a result, approximately half of all paddy farmers have adopted this coping approach.

19. Recycling of waste and solid wastes

None of the paddy farmers had used 'Recycling of waste water and solid waste' as a coping method against climate change. The most likely explanation is that this coping mechanism necessitates the use of a sewage water treatment plant. Such a facility did not exist in the research area. Hence, paddy farmers did not follow this coping method.

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