Original Research Article

How Well Are Farmers Prepared for the Impacts of Climate Change on Agriculture? Farmer's Perception towards Climate Change in Southern Parts of Tamil Nadu

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ABSTRACT

The goal of this research was to look into farmers' perceptions of climate change in agriculture. An ex post facto research design was used in the study. The research was carried out in wetland, dryland, and garden land farming systems in the Tamil Nadu districts of Madurai and Sivagangai. A total of 120 farmers representing three farming systems were chosen and surveyed for the study using a proportionate random sample procedure. Personal interviews with respondents were conducted using a well-structured and pre-tested interview schedule. Descriptive statistical tools were used to analyze the data. According to the findings, more than half of the respondents in the wetland (65.00%), dryland (50.00%), and garden land (55.00%) were perceived climate change in agriculture at a medium level. The majority of the garden land respondents (72.50%) had perceived the increased pest and disease incidence due to climate change than the respondents of wetland (52.50%) and drylands (30.00%). More than three-fifths of the respondents in the study area had perceived the income from agriculture was adversely affected (69.17%) due to climate change followed by the change in crop yield (64.17%) and cost of cultivation was increased (61.67%) due to the climate change. As a result, any intervention that supports the use of climate change adaptation measures may take into account location-specific factors that influence farmers' perceptions of climate change and adaptive responses to it.

Keywords: Adaptation, climate change, coping mechanism, impact, perception

1. INTRODUCTION

Climate change, with its unpredictable turn of events, could have major implications. Agriculture has been proven to be the most vulnerable to its consequences in all sectors. Agriculture is the sector most vulnerable to the dangers and repercussions of climate change because it is naturally sensitive to it. Agriculture and climate are so inextricably linked that Indian agriculture is frequently referred to as a "monsoon gamble". Climate change, agriculture, and food security appear to be intensifying and getting more complex, with severe repercussions for developing countries [14] [12] [13]. India has been listed as one of the developing countries most vulnerable to climate change threats [4] [16]. Several socioeconomic, topographical, and meteorological variables inhibit adaptation in developing countries, making coping with climate change difficult [6] [15]. The farmer’s adaptation decision to cope with climate change has drawn considerable attention and recognition of the local and global scale’s human-environmental approach [7]. Recognizing the need for adaptation demands the farmer's observation and realization of actual climate changes [1], as well as the alteration of old agricultural techniques to maximize returns in each new environment [17]. Analyzing farmers' perceptions of climate change is required before evaluating their adaptation decisions. Farmers' decision-making under constraints is particularly difficult due to the time lag between getting and digesting information and adopting adaptation [3]. Climate change perceptions of farmers are regularly acknowledged in farm-level adaptation literature [8] [19]. Temperature and precipitation rises and declines, regional monsoon variations, and the local occurrence of climate extremes are all examples of climate influences (e.g., flood, drought, cyclones, and frosts). Understanding and understanding the climatic characteristics considered by farmers when formulating their climate change views is crucial [10] [20] [21]. Finally, because perception is a subjective process, different people in the same location may have varied perceptions of climate change despite experiencing the same weather patterns [18]. In this context, understanding farmers' perspectives of climate change is crucial for understanding their current situation, how they are vulnerable to climatic risks, and risk management approaches. Farmers' perspectives on many elements of climate change are therefore critical not only for short-term preparedness and effective adaption measures (short-run initiatives) but also for context-specific mitigation methods (long run initiatives) to successfully battle climate change [2]. As a result, several stakeholders, including policymakers and other development organizations, will be able to integrate this knowledge into climate risk management [11]. Understanding the consequences of climate change on agriculture at both the global and regional levels is critical, particularly in terms of feeding vulnerable populations. As a result, the goal of this study was to determine farmers' perceptions of the effects of climate change in diverse agricultural systems in Tamil Nadu's southern region.

2. MATERIAL AND METHODS

2.1. Research design

Research design encompasses the full process of designing and conducting research. The plan, structure, and technique of investigation are used to gain answers to research questions and control variation [9], which serves as a blueprint for the research project. In this study, the expose-facto and exploratory research designs were used. The *Ex post-facto* design was chosen because research, rather than developing a cure, evaluate the influence of a naturally occurring phenomenon after it occurs. For this study, a purposive random sampling method has been followed in the selection of district, taluk, block and village levels.

2.2. Selection of district

The districts of Madurai and Sivagangai in Tamil Nadu are being studied for the following reasons: (i) the districts have a wide range of variability in rainfall and temperature (Since 10 years) (ii) the districts are among those with the more area of wetland, dryland, and garden land (iii) the researcher's familiarity with the local accent and culture.

2.3. Selection of respondents

The proportionate random sample method was used to select 120 respondents from the five villages selected. The steps are listed below. 40 respondents were selected from the identified communities representing each of the three farming systems, namely wetland, dryland, and garden lands. The number of respondents from each of the selected villages was determined using the following calculation based on the probability proportionate random sampling method.

$$ni = \frac{Ni}{N} \times n$$

Where,

ni = The number of farmers who would be chosen from the i^{th} village.

Ni = The number of farmers in the i^{th} village is referred to as.

N = The total number of people who responded in the five communities.

n = Total number of farmers from the five villages to be chosen.

The village wise number of respondents in three farming systems was furnished in Table .1 The villages were chosen after discussions with officials from the Department of Agriculture and KVK scientists in the districts of Madurai and Sivagangai. The following villages were chosen to represent three farming systems: wet, dry, and garden lands.

Table 1. Selection of respondents from the study area

District	Block	Village	Farming system	Number of farmers	Number of selected respondents
Madurai	Vadipatti	C.Pudur	Wetland system	114	24
		Ramaianpatti	Wetland system	79	16
	Kallikudi	Sengapadai	Dryland system	176	40
Sivagangai	Thiruppuvanam	Sengulam	Garden land system	98	22
	Kalayarkovil	Valayampatti	Garden land system	91	18
TOTAL				**558**	**120**

2.4. Data collection and analysis

For data collection, an interview schedule that was well-structured and pre-tested was used. A complete, systematic interview schedule spanning all elements was established in light of the objectives and variables under investigation. The schedule includes just the most relevant, straightforward, and practical questions that were appropriate for all groups of respondents while avoiding irrelevant ones. The questionnaire was preliminary testing in a non-sampling region before it was finalized. Following pre-testing, any irregularities discovered were corrected, and the timetable was finalized.

Data were gathered through personal interviews using a well-structured interview schedule from farmers. The data were analyzed using descriptive statistics, which was done with SPSS 19. Farmers' perceptions of temperature, rainfall, nutrient management, cropping pattern, plant protection, crop yield, and farm revenue were explained using descriptive statistics.

3. RESULTS AND DISCUSSION

3.1. Farmers overall perception towards climate change in agriculture

The process of perceiving and interpreting sensory stimuli is known as perception. This aids human comprehension of external circumstances. Farmers' perceptions of climate change in agriculture would go a long way toward honing their skills in climate change adaptation. The overall perception of farmers toward climate change was assessed first, followed by an in-depth assessment of the perception through relevant statements under four headings: changes in temperature and rainfall, changes in nutrient management and cropping pattern, changes in plant protection, and changes in crop yield and income. Table 2 displays the findings on respondents' overall perceptions about climate change.

Table 2. Distribution of respondents based on their overall perception towards climate change (n=120)

S. No.	Perception Level	Wetland		Dryland		Garden land		Total	
		Count	%	Count	%	Count	%	Count	%
1.	Low	8	20.00	7	17.50	10	25.00	25	20.83
2.	Medium	26	65.00	22	55.00	22	55.00	70	58.33
3.	High	6	15.00	11	27.50	8	20.00	25	20.83
	Total	**40**	**100**	**40**	**100**	**40**	**100**	**120**	**100**
	F value : 0.100^{NS}								

According to Table 2, more than half of the respondents in the research area reported climatic changes at a medium (65.00 %) level. One-fifth of those answered had an equal perception of climate change at high and low levels (25.00 %). The majority of respondents (55.00 %) perceived climatic changes in agriculture as a medium in wetland systems. One-fourth of those polled showed a low level of perception of climate change (25.00 %). Only 15.00% of those polled had a high perception of climate change. In dryland conditions, the majority of farmers (55.00 %) perceived climate change as a medium, followed by a high level of perception (27.50 %). Around 17.50% of those interviewed had a hostile perception toward climate change. In garden land, more than half of the respondents (55.00 %) had a medium level of perception, followed by a low (25.00 %) and a high (20.00 %) level. The respondents in the dryland system showed the highest level of perception of climate change of any of the three systems. It is because the impact of climate is also substantially greater, resulting in larger yield reduction and crop failure. The F value (0.100) was non-significant, indicating that there is no significant variation in respondents' perceptions of climate change in agriculture across the wetland, dryland, and garden land systems. The in-depth analysis of climate change perspective was examined in four dimensions, which are mentioned below.

3.2. Perception towards changes in temperature and rainfall

Temperature and rainfall fluctuations are the most visible manifestations of climate change. Table 3 shows the farmers' response to temperature fluctuations. The following observations about respondents' perceptions of temperature and rainfall changes related to climate change can be drawn from Table 3.

Table 3. Distribution of the respondents based on their perception towards changes in temperature and rainfall (n=120)

S.No.	Statements	Wetland		Dryland		Garden land		Total	
		Count	%	Count	%	Count	%	Count	%
1.	There were changes in number of rainy days /season	21	52.50	34	85.00	27	67.50	82	68.33
2.	There were changes in amount of rainfall	32	80.00	36	90.00	34	85.00	102	85.00
3.	There were changes in distribution of rainfall	27	67.50	23	57.50	35	87.50	85	70.83
4.	There were changes in the onset of monsoon	22	55.00	26	65.00	21	52.50	79	66.67
5.	There were changes number of hot days during the summer season	21	52.50	37	92.50	24	60.00	82	65.83
6.	There were changes in day temperature	26	65.00	29	72.50	24	60.00	79	66.67
7.	More dry spells	31	77.50	34	85.00	27	67.50	92	76.67
8.	Less dry spells	5	12.50	2	5.00	6	15.00	13	10.83
9.	Hot winds during summer	29	72.50	30	75.00	24	60.00	83	69.17
	F value: 3.438*								

(Multiple response *)

The majority of respondents in the dryland system (85.00 %) noticed changes in the number of rainy days every season, followed by respondents in the garden (67.50 %) and wetland system (52.50 %). Changes in rainfall due to climate change were perceived almost at the same level by respondents of the dryland system (90.00 %), garden (85.00 %), and wetland system (80.00 %). The vast majority of respondents in garden land (87.50 %) had perceived changes in rainfall distribution, as had 67.50 % and 57.50 % of respondents in wet and dryland, respectively. The irregular distribution of rainfall, regardless of systems, may be the reason for farmers' awareness of variations in rainfall distribution. More than half of farmers in the dry (65.00 %), wet (55.00 %), and garden land agricultural systems were concerned about changes in the advent of monsoon owing to climate change (52.50 %). The majority of dryland farmers (72.50 %) reported increases in day temperature as a result of climate change, followed by wetland (65.00 %) and garden land farming systems (60.00 %). Changes in the number of hot days during the summer season were perceived by 92.50 % of respondents in dryland settings, but 52.50 % and 60.00 % of respondents in wet and garden land farming, respectively.

The extended summer was noticed in dryland conditions, causing the dryland to detect shifts in hot days during the summer season. Changes in day temperature as a result of climate change were perceived by more than three-fifths of respondents across all three agricultural systems, with dryland conditions scoring higher (72.50 %) than wet (65.00 %) and garden land conditions (60.00 %). More than three-fourths of respondents in dryland (85.00 %) and wetland (77.50 %) saw more dry spells as a result of climate change, and more than three-fifths perceived it in garden land (67.50 %). Less dry spells as a result of climate change were not well received by the farming system as a whole. Hot winds during the summer season were perceived by three-fourths of respondents in wet (72.50 %) and dry areas (75.00 %), but three-fifths of respondents in garden land (60.00 %).

The majority of farmers in the study area (85.00 %) perceived changes in the amount of rainfall, followed by more dry spells (76.67 %), changes in the distribution of rainfall (70.85 %), changes in the amount of rainfall (70.83 %), hot winds during summer (69.17 %), and changes in the onset of monsoon and day temperature (66.67 %). The 'F' value (3.438) was significant at the 5% level, indicating that there was a substantial variation in the distribution of respondents depending on their impression of temperature and rainfall changes owing to climate change.

3.3. Perceptions of climate change's impact on nutrient management and cropping patterns

Soil and farming patterns are being harmed as a result of climate change. As a result, the perception of changes in soil condition and cropping pattern was studied, with the results displayed in Table 4. The majority of wetland farmers saw a shift in fertilizer and manure use as a result of climate change (72.50 %). This was followed by perceptions of increased weed growth (60.00 %), soil nutrient loss owing to climate change (40.00 %), and cropping pattern changes due to climate change (35.00 %) in wetland farming.
Wetland crops require more fertilizers and manures than other farming systems, which eventually led to soil nutrient loss owing to climate change, which was perceived more in the wetland farming system. More than half of dryland farming system respondents (57.50 %) perceived soil nutrient loss (57.50 %) and changes in fertilizer and manure consumption (52.50 %) as a result of climate change. One-fourth of dryland respondents reported an increase in weed growth (27.50 %) and cropping pattern alterations (25.00 %) as a result of climate change.

According to Table 4, the majority of garden land farmers noticed a shift in fertilizer consumption (77.50 %) and increased weed growth (70 %) as a result of climate change. More than half of garden land farmers reported changes in cropping patterns (62.50 %) and soil nutrient loss (52.50 %) as a result of climate change. The use of fertilizers was more prevalent in vegetable growing, which may have caused farmers to be more aware of the change in its consumption as a result of climate change in the garden land farming system. The 'F' value (2.376) was non-significant, indicating that there was no significant difference in farmers' perceptions of changes in nutrient management and cropping patterns caused by climate change in all three agricultural systems.

Table 4. Respondents were divided into groups depending on their perceptions about changes in nutrient management and cropping patterns (n=120)

S. No.	Statements	Wetland		Dryland		Garden land		Total	
		Count	%	Count	%	Count	%	Count	%
1.	There is a loss of soil nutrients due to climate change	16	40.00	23	57.50	21	52.50	60	50.00
2.	There is a change in the use of fertilizers and manures due to climate change	29	72.50	21	52.50	31	77.50	81	67.50
3.	There is a change in cropping pattern	14	35.00	10	25.00	25	62.50	49	40.83
4.	Weed growth was increased due to climate change	24	60.00	11	27.50	28	70.00	63	55.00
	F value: 3.438*								

(Multiple response *)

It could be concluded that the majority of farmers in the study area perceived a change in fertilizer and manure use due to climate change (67.50 %), followed by increased weed growth (55.00 %), soil nutrient loss due to climate change (50.00 %), and cropping pattern changes (40.83 %). In a summary, perceptions of changes in fertilizer and manure usage were nearly the same across all three farming methods. The perceived loss of soil nutrients as a result of climate change was comparably large in arid places.

3.4. Perception towards changes in plant protection due to climate change

The information about the perception of respondents regarding changes in plant protection due to climate change was collected and presented in Table 5. The majority of garden land respondents (72.50 %) perceived increased pest and disease incidence owing to climate change more than wet (52.50 %) and dryland respondents (30.00 %). The occurrence of a new pest or disease incidence owing to climate change was also perceived by the majority of garden land respondents (47.50 %), but it was perceived by 27.50 % and 15.00% of wet and dryland respondents, respectively. The majority of respondents in garden land (85 %) and nearly three-fourths of respondents in wet (72.50 %) and dryland (62.50 %) said that climate change has increased the use of pesticides, fungicides, and other chemicals.

Table 5. Distribution of the respondents based on their perception towards change in plant protection due to climate change in agriculture (n=120)

S. No.	Statements	Wetland		Dryland		Garden land		Total	
		Count	%	Count	%	Count	%	Count	%
1.	There are more pest and disease incidence due to climate change	21	52.50	12	30.00	29	72.50	62	51.67
2.	Occurrence of new pest or disease in the field	11	27.50	6	15.00	19	47.50	36	30.00
3.	Application of pesticides, insecticides, fungicides and other chemicals were increased	29	72.50	25	62.50	34	85.00	87	72.50
4.	Conversion of minor pest or disease into major pest or disease due to climatic change	8	20.00	3	7.50	5	12.50	37	30.83
	F value: 3.492*								

(Multiple response *)

According to Table 5, the conversion of minor pest or disease into major pest or disease was not well perceived by respondents in all three farming systems, with 20.00%, 12.50%, and 7.50% of respondents in the wet, dry, and garden land farming systems, respectively. At the

5% level, the 'F' value (3.492) was significant. It demonstrates that there is a considerable variation in farmers' perceptions of changes in plant protection owing to climate change in all three agricultural systems. It was concluded that farmers observed an increase in pest and disease incidence and increased their use of plant protection chemicals as a result of climate change. Farmers in the research area encountered significant pest and disease infestations in onion, brinjal, paddy, and banana due to the negative consequences of climate change. As a result, it was reflected in the above findings.

3.5. Perception towards changes in crop yield and farm income

Table 6 shows farmer's perceptions of crop yield and income changes as a result of climate change. The majority of respondents in wetland thought that climate change harmed agricultural revenue (57.50 %), followed by a change in crop yield (45.00 %) and an increase in cultivation costs (52.50 %).

Table 6. Respondents were distributed depending on their perceptions of crop yield and farm income changes as a result of climate change (n=120)

S. No.	Statements	Wetland		Dryland		Garden land		Total	
		Count	%	Count	%	Count	%	Count	%
1.	There is a change in the crop yield due to climate change	18	45.00	28	70.00	31	77.50	77	64.17
2.	Income from agriculture is adversely affected due to climate change	23	57.50	33	82.50	27	67.50	83	69.17
3.	Cost of cultivation has increased	21	52.50	19	47.50	34	85.00	74	61.67
	F value: 0.987^{NS}								

(Multiple response *)

In dryland circumstances, the majority of respondents (82.50 %) said that climate change harmed agricultural revenue, and approximately 70.00 % believed that crop production had changed as a result of climate change. More than two-fifths of dryland farmers (47.50 %) observed an increase in cultivation costs as a result of climate change. In garden land conditions, more than three-fourths of respondents (85.00 %) observed an increase in cultivation costs and changes in crop production (77.50 %) as a result of climate change. Climate change has a negative impact on the income of more than three-fifths of garden land respondents (67.50 %). The 'F' value (0.987) was non-significant, indicating that there is no substantial difference in farmers' perceptions of climate change on crop yield and farm income. Overall, it could be deduced that farmers from all three farming systems have perceived the impact of climate change on crop productivity and farm income.

4. CONCLUSION

According to the study's findings, there is a need for readily available location-specific adaptation options that could assist to mitigate the negative consequences of climate change on already sensitive agricultural and smallholder farmers' livelihoods. If such collaboration is successful, the results could lead to recommendations for the development of adaptation policies that are more tailored to local conditions, less costly, more efficient, and beneficial to rural development. The complexities of the analysis of farmers' perceptions of climate change need collaboration among academics from numerous disciplines, including Agricultural Extension, Agronomy, Agricultural Meteorology, Agro Informatics. Increased local weather station placements improve access to weather information, hence enhancing adaptive tactics in the face of unfavourable climate change implications. Farmers need to used social networks sites to find weather information as a result of untimely climate information dissemination; as a result, local governments should improve the capability of social networks and establish links with local public organizations [5]. To strengthen the capacity of rural agricultural extension workers and farmers, the government organizations are expected to communicate and distribute meteorological information in newspapers and on the internet.

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