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Assessment of Knowledge and Adaptation Strategies of Farmers on Climate Change Regarding Turmeric Cultivation

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Authors' contributions

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

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ABSTRACT

An alarming global phenomenon that refers to the long-term shifts in temperature and weather patterns on earth is climate change. It has recently been widely discussed in all spheres of society. Climate change has a huge impact on turmeric cultivation which prefers rich and wet soils in a protected and shady location. At the same time, climate change has become major concern for turmeric growing cultivars in Manipur as its contribution in the production of the turmeric is

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decreasing. Adaptation strategies to cope up with climate change and the related impacts have drawn a considerable attention. This paper was carried out to study the socio-economic profile of the turmeric farmers and how it affects the farmers' knowledge and adaptation strategies on climate change in turmeric cultivation in Thoubal District of Manipur. Data for the study were collected from 111 turmeric growing farmers through personal interview. The ex-post-facto research deign was used and the respondents were selected purposively. The study found that only 88 farmers were using adaptation strategies and 23 farmers were not adopting anything in accordance with the climate change. Correlation was calculated in order to find out the relationship of the socio-economic characteristics with the farmers knowledge and adaptation strategies. The study has shown that occupational engagement, level of education and mass media exposure had more positive correlation with the farmers' knowledge on climate change. Similarly, mass media exposure, level of education and social participation had shown more positive correlation with the farmers' adaptation strategies respectively than other variables.

Keywords: Adaptation strategies; climate change; farmers; impact and knowledge.

ABBREVIATIONS

MT : Metric Tonne
IPCC : International Pannel on Climate Change
CD Blocks : Community Development Blocks
IJEE : International Journal of Extension Education
GOI : Government of India

1. INTRODUCTION

Climate change has recently become the subject which is most widely discussed in all spheres of society. Everyone has already felt the effects of climate change in some way. On a local or regional scale, we have observed changes in the distribution and pattern of rainfall, an increase in high intensity rainfall events, drought or drought-like conditions, heat waves in the summer, shorter winters, etc. For the almost 700 million Indians living in rural areas whose life and livelihoods are directly dependent on climate-sensitive industries including agriculture, forests, fisheries, and natural resources etc. in order to maintain productivity in the event of extreme climatic variability in our country, a robust agricultural production system is necessary. Climate change is affecting agriculture in a variety of ways as agriculture is extremely vulnerable to climate change. In 2022, 12.8 percent (17.0 million households) were food insecure. These households faced a lack of resources that resulted in difficulty providing enough food for all their members. U.S. households with above-average food insecurity including those with an income below the poverty threshold, those headed by a single woman, and those with Black or Hispanic owners and lessees (Rabbitt et al. 2023).

India is struggling to maintain its rapidly expanding agricultural sector while addressing the threat posed by global climate change. There are two main strategies for policy involvement in agriculture in response to these dangers and difficulties. The first strategy is to slow down the pace and severity of climate change by reducing emissions that contribute to it, such as greenhouse gas reduction, soil erosion prevention, and other human-caused climate change related activities. The second alternative strategy is to encourage adaptation to climate change in order to lessen effects and seize new opportunities. For instance, improving current production systems by utilising new procedures (such as altering sowing patterns) and technological advancements (*e.g.,* irrigation systems, adapted varieties etc.).

In India, North-Eastern states have experienced more issues as a result of climate change. For example, in 2009, this region experienced one of the most severe droughts in 2012, 2014, and 2017; these states experienced severe floods in 2018, the majority of these states were affected by large hailstorms and a lack of rainfall; and most recently in 2019, the monsoon arrived later than usual (Saikia and Hazarika, 2020). International Panel on Climate Change (IPCC) has projected that by the end of the 21st century, overall rainfall in India will increase by 10-21 percent with more frequent and heavy rainfall days while the mean annual temperature will rise by 3-6 ^{0}C.

Turmeric (*Curcuma longa)* is the underground rhizome of a perennial herb. It belongs to the family Zingiberaceae. Turmeric is a native to Tropical South Asia. Turmeric is a highly commercial spice of India and it is locally known

as *haldi, manjal* etc. Sometimes, it is also called as 'Indian Saffron' or 'Golden Spice' because of its yellow colour. In Manipuri, it is known as Yaingang. India is reckoned as the "Spice Bowl" of the world due to its position in world spice trade. Rhizome of the turmeric spice contains yellow pigments called curcumin. It is a colouring agent and has some therapeutic properties. Turmeric is considered as "Healer Spice", also auspicious in Indian households (Singh, 2019).

In India, turmeric crop occupies about 6.05 percent of total area under spices and condiments grown. Turmeric ranks fourth in production in the country with a total production of 1133 thousand MT under a total area of 238 thousand ha in the year 2017-18 (Government of India, 2018a). Turmeric is an important cash crop in North-East region and shares about 8.30 per cent of the total production in the country. In terms of area, turmeric is the 3rd largest crop in this region. However, its productivity in the region is only 1.5 tonnes as against 3.9 tonnes per hectare in the country. In terms of area and production, Manipur (15.40 thousand MT) is the 3rd largest turmeric growing state in the north east region after Mizoram (29.82 thousand MT) and Meghalaya with16.50 thousand MT (Government of India, 2018b).

Improved varieties like Lakadong and Megha Turmeric-1 are cultivated by the farmers in majority whereas, a number of other local cultivars also exist in North-Eastern region. Knowledge on the climate change acts as an information and farmers devise different ways to adapt to the changing climatic condition. People do not actually pay attention to it, unless something severe happens to their surroundings or their daily life. A farmer's knowledge and experience with the repercussions may differ from that of another's due to varying demographic, social and economic circumstances. Therefore, there is a critical need for farmers to accept, understand and adapt to the changing environment but in most of the cases, farmers don't believe in scientific expertise but believe their personal opinions only. This can be changed by proper guidance through social participation, extension agents etc. Only after the underlying social participation of the farmers are investigated for structural patterns, it shall be possible to involve farmers in climate change initiatives on adaptation methods for climate change in agriculture. This is due to the fact that agriculture's adaptation to climate change is primarily a social endeavour. Network structure plays a crucial role in local natural resource governance systems as well as in coping the changing environment. A major challenge in climate change is adaptation which does not fit equally for all phenomenon; adaptation strategies and farmers responses will vary across regions based on agro-ecological contexts and socio-economic factors.

2. METHODOLOGY

Ex-post-facto research design was used for the investigation. The research study was conducted in order to determine the extent of relationship of socio-economic characteristics with farmers' knowledge and adaptation strategies on climate change in turmeric cultivation in Thoubal district of Manipur during the year 2022.A multi stage sampling procedure was adopted in this study. There are 16 districts in Manipur, out of which, Thoubal district has highest area and production under turmeric and therefore, it was selected. There are three (3) C.D. blocks in Thoubal district – Thoubal, Lilong, and Wangjing. Out of these three C.D. blocks, Wangjing CD block was selected purposively as it has highest number of turmeric cultivators. From the office of the Krishi Vigyan Kendra of the district, a list of villages and number of turmeric cultivators in each village of Wangjing C.D. Block was obtained. There are 63 villages in this C.D. Block. From this block, nearly 10 per cent (6) villages were selected randomly. From these selected six villages, all turmeric farmers (111 nos.) were selected. The statistical tools - Mean, Standard Deviation, Frequency, Percentage and Correlation were applied to interpret the information gathered.

3. RESULTS AND DISCUSSION

The socio-economic profile of the selected respondents and its relationship with the farmers' knowledge and adaptation strategies on climate change in turmeric cultivation is given bellows:

Socio-economic profile of the farmers: Ten (10) numbers of socio-economic factors *i.e*., independent variables were selected for the study and are explained as follows:

Age: It could be inferred from the Table 1 that out of total 111 farmers, majority of the farmers *i.e*., 60.36 per cent belonged to middle age group (36-55 years) followed by 21.62 per cent and 18.02 per cent in old age group (above 55 years) and young age group (up to 35 years),

respectively. This might be due to the lack of interest of the present youth in agriculture. The present findings were similar with the findings of Neethi (2014). However, the findings of Billah et al. (2015) were contradictory to the present study.

Level of Education: The Table 1 depicts the different educational level of the farmers in the study area. About 28.82 per cent of the farmers attained education up to the level of higher secondary followed by graduate (19.82%), secondary (18.02%), middle (9.91%), illiterate (8.11%), primary (7.21%) level and followed by literate without formal education (6.31%) while, postgraduate and above (1.80%), respectively. This shows the increased awareness on importance of education in the society. The findings were similar with Muthulaxmi (2016) but contradictory with the findings of Mohanraj and Karthikeyan (2014) and Neethi (2014).

Farming experience: The farmers were grouped into three categories as low, medium and high based on their experience of farming. It was found that majority of the farmers (45.04%) had medium experience followed by high (32.44%) and low (22.52%) experience, respectively. This might be because most of the respondents belonged to middle and old age group. The present findings were similar with findings of Rao (2016).

Operational land holding: The above Table 1 depicts that majority of the farmers (38.73%) belonged to the marginal land holding category followed by semi-medium (30.63%), small (27.93%) and medium (2.71%) land holding categories, respectively. The decrease in the land holding might be due to increase in population resulting to fragmentation of land holdings. Present findings were similar with those of Shadap (2014), Meghwal (2016) and Muthulaxmi (2016). However, it was contradictory to the findings of Kankate et al. (2018).

Annual income of the farmers: Farmers were grouped into three categories based on their total annual income as presented in Table 1. It reveals that 51.35 per cent of the farmers belonged to the medium income category followed by high income category (41.44%) and low-income category (7.21%). This indicates the strong economic background of farmers. The farmers with low income were the female farmers who were engaged in limited farming due to non-availability of time for farming owing to household chores. These findings were similar with findings of Muthulaxmi (2016) and in contrast with Neethi (2014) and Meghwal (2016).

Occupational engagement: The distribution of farmers based on their occupation are presented in Table 1. It reveals that majority of the farmers (55.85%) had non-farm job in addition to farming while, 44.15 per cent farmers had farming as the only source of income. Along with farming, the respondents were engaged in other activities like government jobs, business, private services etc. in order to earn more. The present findings were found at par with findings reported by Kharjana et al. (2017).

Social participation: Farmers were grouped into three categories based on their social participation. A majority of 49.54 per cent of the farmers were involved in one organization/group. However, 31.53 per cent of the farmers were not involved in any social organization/group which might be due to lack of knowledge on the importance of organizations while 18.93 per cent farmers were involved in more than one organization. Findings were found to be related with Lad and Deshmukh (2014), however contradictory with findings of Neethi (2014).

Mass media exposure: Table 1 depicts that majority of the farmers (71.17%) had medium exposure to the mass media followed by high exposure (18.92%) and low (9.91%). The possible reason for majority of the respondents' exposure to mass media might be due to increase in the role of mass media in the society. At the same time, increase in access to internet made it more feasible to access the information. The present findings were similar to those of Rao (2016).

Contact with extension agents: Table 1 reveals that majority of the farmers had contact with extension agents. As per the data shown in the Table 1, 44.14 per cent of the farmers had medium contact with the extension agent followed by low contact (38.74%) and high (17.12%). The reason for higher contact of the farmers with the extension agent might be due to their cosmopoliteness and also due to active role of the extension agent. The present findings were similar with the findings of Kankate et al. (2018).

Table 1. Distribution of farmers according to the category in various socio-economic characteristics

Sl. No.	Category	Respondents (N=111)	
		F	%
1.	**AGE**		
	Young age (up to 35)	20	18.02
	Middle age (36-55)	67	60.36
	Old age (> 55years)	24	21.62
	Total	111	100.00
2.	**LEVEL OF EDUCATION**		
	Illiterate	9	8.11
	Literate without formal education	7	6.31
	Literate but below primary	-	-
	Primary	8	7.21
	Middle	11	9.91
	Secondary	20	18.02
	Higher secondary	32	28.82
	Diploma/Certificate course	-	-
	Graduate	22	19.82
	Post graduate and above	2	1.80
	Total	111	100.00
3.	**FARMING EXPERIENCE**		
	Low (1-10 years)	25	22.52
	Medium (10-20 years)	50	45.04
	High (>20 years)	36	32.44
	Total	111	100.00
4.	**OPERATIONAL LAND HOLDING**		
	Marginal (<1 ha)	43	38.73
	Small (1-2 ha)	31	27.93
	Semi medium (2-4 ha)	34	30.63
	Medium (4-10 ha)	3	2.71
	Large (>10 ha)	-	-
	Total	111	100.00
5.	**ANNUAL INCOME**		
	Low (<33,750)	8	7.21
	Medium (33,750-1,44,000)	57	51.35
	High (>1,44,000)	46	41.44
	Total	111	100.00
6.	**OCCUPATIONAL ENGAGEMENT**		
	Farming+	62	55.85
	Farming	49	44.15
	Total	111	100.00
7.	**SOCIAL PARTICIPATION**		
	No participation	35	31.53
	One participation	55	49.54
	More than one participation	21	18.93
	Total	111	100.00
8.	**MASS MEDIA EXPOSURE**		
	Low/never access	11	9.91
	Medium/sometimes access	79	71.17
	High/frequently access	21	18.92
	Total	111	100.00
9.	**EXTENSION AGENT CONTACT**		
	Low contact	43	38.74
	Medium contact	49	44.14

Sl. No.	Category	Respondents (N=111)	
		F	%
	High contact	19	17.12
	Total	111	100.00
10.	**SOURCE OF INFORMATION**		
	Personal localite	59	53.15
	Personal cosmopolite	39	35.14
	Impersonal cosmopolite	13	11.71
	Total	111	100.00

Table 2. Relation of farmers' knowledge on climate change and independent variables

Sl. No.	Independent variables	Correlation value	p-value
1.	Age	0.249***	0.008
2.	Level of education	0.370***	0.000
3.	Occupation	0.380***	0.000
4.	Farming experience	0.218**	0.021
5.	Land holding	0.018 (NS)	0.848
6.	Annual income	0.106 (NS)	0.267
7.	Social participation	0.196**	0.039
8.	Mass media exposure	0.270***	0.004
9.	Extension agent contact	0.242***	0.010
10.	Source of information	0.240*	0.069

**** 0.01 level of significance* *** 0.05 level of significance*
** 0.10 level of significance* *NS- indicates non-significant*

Table 3. Relation of the farmers' adaptation strategies in turmeric cultivation and independent variables

Sl. No.	Independent variables	Correlation value	p-value
1.	Age	-0.134 (NS)	0.161
2.	Level of education	0.277***	0.003
3.	Occupation	0.215**	0.023
4.	Farming experience	0.265***	0.005
5.	Land holding	0.202**	0.034
6.	Annual income	0.007 (NS)	0.940
7.	Social participation	0.228**	0.021
8.	Mass media exposure	0.282***	0.003
9.	Extension agent contact	0.204**	0.032
10.	Source of information	0.054 (NS)	0.576

**** 0.01 level of significance* *** 0.05 level of significance*

Source of information: It is revealed from Table 1 that personal localite were the major source of information (53.15%) followed by personal cosmopolite (35.14%) and impersonal cosmopolite (11.71%). The reason for higher percentage of personal localite could be due to sharing of information among fellow farmers. The present findings were similar with those of Yohanna et al. (2014).

Farmers knowledge on climate change: The study reviewed farmers' knowledge on climate change based on their observation and experience in the past 10 years. It was found that 89.19 per cent of the respondent farmers were aware of climate change and to some extent, they had knowledge on more than one climatic variable. The remaining, 10.81 per cent respondents were aware about climate change but had low knowledge on climate change variables. The findings were similar with those of Belay et al. (2022).

Effect of climate change on turmeric cultivation: The core problem identified was 'decline in the yield of turmeric'. The primary causes of the problem were diseases and pests, decline in soil fertility, water scarcity, damage of crop and use of traditional cultivation practices. The secondary causes were also generated from

the primary causes. Heavy rainfall during monsoon season, high summer temperature, low rainfall, soil erosion and diseases and pests were the secondary causes responsible for the primary cause. Overall, it was observed from the changes in climatic variables were indirectly or directly related to the cause of the problem. Besides, majority of the farmers (56.75%) felt that diseases like leaf blotch, curcuma fungal disease were increased due to climate change while some of them claimed that it could be due to pollution. Different adaptation strategies taken up by the farmers to cope with the problems, were also identified. Conservation agriculture, change in harvest time, alley cropping, cropping sequence, land preparation and water management during dry season were the major adaptation strategies taken up by the farmers in the study area

Farmers' adaptation strategies in turmeric cultivation in accordance with climate change: The study reveals that majority of the farmers (79.28%) had taken up various adaptation strategies against the impact of climate change while the remaining, 20.72 per cent of the farmers had not taken any adaptation measures in which majority of the farmers were having medium level (44.14%) of adoption of the adaptation strategies.

Correlation of the socio-economic profile of the farmers with the knowledge and adaptation strategies on climate change in turmeric cultivation: In order to find the relationship between socio-economic factors and significance with the farmers knowledge and adaptation decision, correlation analysis was done and the obtained findings are presented below in Table 2 and Table 3.

Relationship between farmers' knowledge on climate change with independent variables: It can be observed from Table 2 that out of 10 independent variables in the analysis, eight variables *viz*., age, education, occupation, experience, social participation, mass media exposure, contact with extension agents and source of information were found to be significant among which age, education, occupation, mass media exposure and contact with extension agent were significant at 1 per cent level of significance whereas the variables- experience and social participation were found significant at 5 per cent level. Only source of information was seen significant at 10 per cent level. The positive sign of the variable education implies that with the increase in education, farmers were likely to have more knowledge on climate change.

In the same way the eight significant variables age, level of education, occupation, farming experience, social participation, mass media exposure, contact with extension agents and source of information had positive relationship with farmers' knowledge. However, land holding and annual income had positive bearing but were not significant to the dependent variable.

Relationship of the farmers' adaptation strategies with independent variables in turmeric cultivation: It can be observed from Table 3 that out of 10 independent variables in the analysis, seven variables *viz*., education, occupation, experience, land holding, social participation, mass media exposure and contact with extension agents were found to be significant among which education, experience and mass media exposure were significant at 1 per cent level followed by occupation, land holding, social participation and contact with extension agents at 5 per cent level. The positive sign of the variable 'education' implies that with the increase in education and land holding of the farmers, they were more likely to adapt adaptation strategies.

In the same way the seven significant variables had positive relationship between them and farmers adaptation strategies. However, the variables - source of information, annual income and age were non-significant with adaptation strategy. The findings were similar with those of Belay et al. (2022) and Haque et al. (2020).

4. CONCLUSION AND POLICY IMPLICATIONS

The study on effect of socio-economic characteristics of the farmers on their knowledge and adaptation strategies on climate change in Turmeric cultivation revealed that even though, 90% of the farmers were aware of the changes in climatic variables only, 79% of the farmers were adopting in which only 65% of the farmers were properly adopting the adaptation strategies. However, most of the farmers in the study area were practising traditional methods of crop cultivation, although farmers were aware of the long-term effects of climate change, many do not implement the solutions because of the lack of knowledge or immediate results. So, conducting awareness, trainings and demonstration programs through social participation or through

village farmers' clubs is to be implemented. New interventions and policies need to be implemented and supported by the government for getting positive results. Such studies can be replicated in other areas of the State of Manipur and other states as well so that mass awareness can be made among the farming communities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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