AATCC Review

25 March 2025: Received
15 May 2025: Revised
22 May 2025: Accepted
24 June 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Coping with Climate Variability: A Study of Indigenous Agricultural Practices in the Semi-Arid Region of Karnataka

Ravi Dupdal*[1], B. L. Patil[2], B. K. Rao[1] and B. S. Naik[1]

[1]*ICAR-IISWC,Research Centre, Ballari, Karnataka-583104, India*
[2]*University of Agricultural Sciences (UAS), Dharwad, Karnataka-580005, India*

ABSTRACT

This study aimed to assess and understand the knowledge of farmers and the indigenous coping mechanisms adopted by the farmers to mitigate the climate variability in the Semi-arid region of Karnataka.This paper insight into tradiational agriucultral technologies adopted by rainfed farmers to mitigate effects of clamate change. The pre-tested and structured interview schedules were employed for collecting data from 240 representative farmers from Vijayapura and Bagalkot districts using a multistage sampling technique and data were analyzed and interpreted using appropriate statistical tools. The findings of the study show that most farmers reported experiencing climate variability, particularly the declining rainfall (70%) and rising temperatures (48%) in recent years. Nearly 3/4th of the farmers perceived that climate variability has adversely affected farming because of frequent crop failures and decreasing crop yield due to lack of water for irrigation as a result of declining groundwater in the region. The farmers employed indigenous knowledge and coping strategies to reduce the adverse impacts of climate variability. Farmers adopted traditional coping mechanisms like adjusting planting dates, adopting early maturing and drought-resistant varieties, and practicing intercropping or mixed farming to mitigate the effects of climate change. They also diversified their cropping systems and livelihood enterprises to alleviate climate change risks and enhance resilience. Farmers with greater experience, higher education levels, large land holdings, and access to irrigation are better equipped to manage climate variability.

Keywords: *Climate variability, Coping mechanism, Indigenous knowledge, risk, climate resilience, Perception, Semi-arid region*

1. Introduction

Communities across the globe are experiencing climate variability, with significant negative impacts on agricultural activities, though these impacts are not evenly distributed among farmers [1]. Climate change poses a significant global challenge, with developing countries especially being vulnerable owing to their limited resources and greater reliance on agriculture [2]. It is expected to alter farming systems forcing the rural community to adapt and enhance their capacity to cope up with these changes [3]. In India, farmers' vulnerability to the negative effects of changing climate is exaggerated by the poor socio-economic situations of the farmers [4]. The variability in climate causes considerable defiance to Indian agriculture profoundly dependent on its agrarian economy as it is identified as most susceptible to climate variability [5]. India's agricultural sector with its diverse geography and climate is relentlessly exposed to the detrimental effect of changing climate, particularly on account of shifting of weather trends, increasing temperatures, and irregular precipitation. These changes have disrupted and threatened crop yields and food security leading to aggravating rural poverty. The effects of climate variability were varied and intricate on the country's agriculture and it impacting crop productivity, water and soil health, and the livelihoods of millions of farmers.

Corresponding Author: **Ravi Dupdal*

DOI: https://doi.org/10.21276/AATCCReview.2025.13.03.285

Despite the considerable efforts made by the Intergovernmental Panel on Climate Change (IPCC) to understand the global risks of climate change and develop frameworks for adaptation planning, there remains a significant gap in collective international action when it comes to developing and implementing coping and adaptation strategies. [6].

As a result of changing climate, India is facing enormous challenges such as rising temperatures, erratic monsoons, water scarcity, and crop losses threatening livelihood and ecosystems. The climatic variability, particularly changes in temperature, rainfall and extreme weather events, can significantly affect agricultural production, with farming communities whose livelihoods primarily depend on agriculture facing the greatest burden of these negative impacts. Similarly, the degree of impact will be higher in the rainfed region because most of the farming activities in these areas depend on monsoon rainfall. Besides, the adverse impact of climate variability will be particularly severe on dryland and rainfed crops which are grown on more than 50% of land area in the country. Under this situation, farmers' traditional knowledge and adaptation strategies to climate change are better options to counter the negative impacts. The coping strategies at the community level are the foundations for adapting to long term climate change [7]. Indeed, indigenous knowledge and coping mechanisms were considered as best alternative to deal with existing and impending events of climate variability [8] and [9]. Local communities have embraced these strategies on the basis of their understanding of continuous changes in the natural environment over the years. The findings of [10] and [11] revealed that insight about indigenous climate change holds equal importance to scientific understanding.

As a result, rich practical experience of Indigenous communities is essential for planning effective strategies to cope up with the negative impacts of changing climate. Further, Farmers' insight and adaptation to changing climatic conditions are crucial for framing effective policies to combat climate change impact [12] In this milieu, the present study was conceived and conducted to assess the role of indigenous knowledge and farming practices to cope-up with climate variability and adaptation strategies followed by the farmers in the Semi-arid region of Karnataka.

2. Materials and Methods

2.1 Study area and data source

The rainfed districts of Vijayapura and Bagalkot, which are part of the Northern Dry Zone of Karnataka, were selected for the present study. A multistage sampling technique was employed to select farm household samples. The data was gathered through pre-tested interview schedules from 240 farm households during 2016-17. Vijayapura and Bagalkot districts were purposively selected based on their high climate change vulnerability index among all the districts in the state [13]. Later, in each district, two taluks namely Vijayapura and Sindagi in Vijayapura district and Bagalkot and Hungund in Bagalkot district were selected in consultation with the respective state department of agriculture for primary data collection. From each taluk, two villages i.e. Hittinahalli and Jumnal village in Vijayapura taluk, Devarahippargi and Bommanjogi in Sindagi taluk; Bevoor and Hallur in Bagalkot taluk and Hirebadawadgi and Bannihatti in Hungund taluk were selected for the present study following random sampling method. The study area has a semi-arid climate with mean annual rainfall of around 660mm with more than 50% of it occurring during post-monsoon season. The region experiences deficit unimodal rainfall, predominantly features vertisols, and supports a variety of cropping systems [14]. The average elevation of Vijayapura district is 606 metres while that of Bagalkot district was 533 metres above MSL. The elevation difference between both districts is meager but even moderate change in elevation can subtly influence climate and agricultural practices, especially in Semi-arid regions of northern Karnataka. Moreover, both regions are equally exposed to climate risks, primarily due to erratic rainfall, poor water management and unsustainable crop choices. Furthermore, elevation alone does not significantly buffer climate impacts but farmers' adaptive practices such as choice of climate-smart crop, soil conservation and water harvesting practices etc were critical to enhance resilience.

In addition to personal interview, the Focus Group Discussions (FGDs) were employed to gather both qualitative as well as quantitative data insights into climate variability and farmers' views on its causes and effects. For conducting FGDs, farmers were selected purposefully based on important criteria such as farm holding size, type of crop cultivated, access to irrigation, gender, education level, farming experience, and climate vulnerability. The primary objective of conducting FGDs was to assess village group dynamics to validate previously collected information and to understand many previously unanswerable questions related to their perceptions on the changing climate. The participants in FGDs willing to share accurate information about issues and problems discussed during the meetings. The data collected included various aspects such as the socio-economic characteristics of the farmers, their perception about climate variability, its impact on farming and their indigenous knowledge, and coping mechanisms to deal with adverse effects of climate change.

2.2 Analytical tools and techniques

Analytical tools such as descriptive statistics, the Garret Ranking Technique, and Binary Logit Model were employed to analyze the data collected from farmers. To identify and rank farmers' coping strategies to climate change Garret ranking technique was used in the study. The formula of Garrett's ranking technique is mentioned as below:

Percent position = $100 \times (R_{ij} - 0.5) / N_j$

Where,

R_{ij} = Rank given for i^{th} statement by j^{th} respondents

N_j = Number of statement ranked by j^{th} respondents

Binary Logistic Regression was used for analyzing the forces determining farmers' usage of indigenous adaptation strategies to deal with climate variability. The probability model is used to determine whether adaptation is undertaken in response to the observation to climate change and wherein the binary dependent variable is a dummy for undertaking any adaptation at all (i.e. Y_i has only two possible values 1 or 0, for either adapting or non adapting to climate change) (Table1). Thus,

$$Y_i = X_i œ + e_i$$

These indicate the likelihood of "i" farmer adopts an alternative strategy (Y_i=1) rely on a vector of predictor variable (X_i), unknown factor (œ), and the stochastic disturbance term (e_i).

Table 1: Depiction of explanatory parameters for a binary logistic regression

Variable	Description	Anticipated direction
x_1	Respondent age (continuous)	+
x_2	Respondent education (=1 if literate and 0 if not)	-
x_3	Family size (continuous)	+
x_4	Farm experience (continuous)	+
x_5	Land acreage (continuous)	+
x_6	Possession of livestock (continuous)	+
x_7	Facility of Irrigation (=1 if yes and 0 if not)	+
x_8	Monthly farm income (continuous)	+
x_9	Diversity of income (=1 if income diversity and 0 if not)	+
x_{10}	Non-farm activity (=1 if yes and 0 if not)	+
x_{11}	Climate change perception (=1 if climate variability perceive and 0 if not)	+

3. Results and discussion

3.1 Socio-economic characteristics of farm household respondents

The study found that the majority of farmers was old aged in the sample group with the average age of 57 years and farming experience of 36 years (Table 2). The knowledge and experience about farming and its associated risks is expected to be higher among old aged farmers as compared to younger ones. The farmer education has significantly influenced technology adoption and its usage. Nearly 1/3rd of sample farmers fall into the categories of illiterates, primary education, and higher school education. The composition of family members was five in each household and around 20% of family members have engaged in either one or other social organization. More than half of sample farm households have assured sources of irrigation either through open wells or through bore wells. Although agriculture remains their primary occupation, 45% of farm households are engaged in non-farming economic activities and work as farm laborers within the village, whereas 55% rear livestock as an alternative source of income. Around 53% of farmers used institutional credit for their farming activities. [15] also reported that access to crop loans helps farmers to purchase costly farm inputs like fertilizers and pesticides and also eases credit constraints.

Table 2: Socio-economic characteristics of farm households (N=240)

Sl. No.	Particulars	Vijayapura *f*	Bagalkot *f*	All farmers *f*
1.	Average age (years)	55	58	57
2.	Average farming experience (years)	34	38	36
3.	Family size (No.)	5.6	4	5
4.	Member of social group (yes=1; otherwise=0)	21	16	37 (18.5)
5.	Access to irrigation (yes=1; otherwise=0)	83	45	128 (64)
6.	Off-farm occupation (yes=1; otherwise=0)	43	47	90 (45)
7.	Access to institutional credit (yes=1; otherwise=0)	57	49	106 (53)
8.	Possession of livestock (yes=1; otherwise=0	57	53	110 (55)
9.	Land holding type (No.)			
	Marginal (< 1 ha)	35	38	73 (36.5)
	Small (1 – 2 ha)	45	36	81(40.5)
	Large (> 2 ha)	40	46	86 (43.0)
10.	Education (No.)			
	Illiterate	43	40	83 (41.5)
	Primary	36	40	76 (38)
	High school	36	33	69 (34.5)
	Graduation	5	7	12 (6)

Note: Figures in the parentheses indicate percentage to total.

3.2 Farmer perceptions about climate variability

Perceptions of farmers about climate variability show that most farmers face climate variation in the study area as the majority of sample farmers have wide experience in farming over many years (Fig.1).

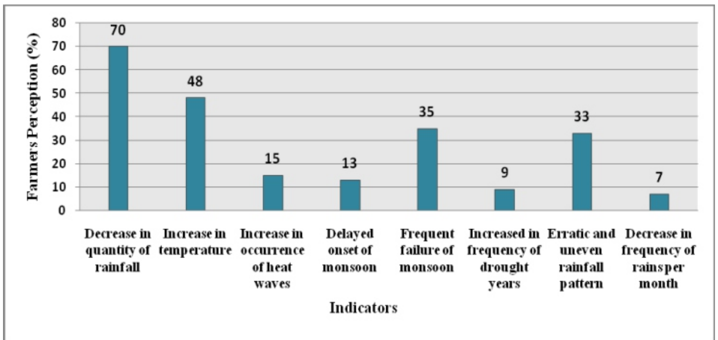

Fig.1: Farmers perception about changing climatic variability
***Note:** More than one response was expressed by the farmers.*

Majority farmers (70%) perceived that rainfall is decreasing and becoming more erratic leading to dry spells, particularly during the cropping season. Climate variability was perceived by farmers and revealed that temperature was increasing (48%) in last one or two decades and it was unbearable. Farmers also perceived that frequent failure of monsoon (35%) leads to erratic and uneven rainfall pattern (33%). Farmers also opined that there is higher severity in intensity and occurrence of heat waves (15%) due to the delayed onset of monsoon in the region (13%) as perceived by the farmers. [16] reported that the changing climate is perceived by farmers, and citing rising temperature, delayed onset of monsoon, irregular dry spells, and reduction in soil moisture are important elements impacting farm cultivation.

3.3 Perceived impact of climate variability on agriculture

The farmers experienced the climate variability and its impact on farming and 73% of farmers perceived that their farming was adversely affected due to climate variability leading to a decline in crop yields (Fig. 2). Most farmers (59%) perceived that unpredicted rainfall and prolonged dry spells leads to frequent failure of crops in the study area. Farmers also recall that there is dearth of water for irrigation (33%) due to changing climate as a result there is a reduction of water level in most of the bore wells, tanks and canals (23%). In another perception of the farmers, the climate variability in recent years also leads to a resurgence of new pest and diseases (20%) and facing problems in choosing appropriate crop (19%) in the region. Further, farmers reported that climate variability and its consequences lead to a reduction in fodder availability (17%) and consequently decline in livestock productivity in the study region. Similar findings have been reported by [17] and [18].

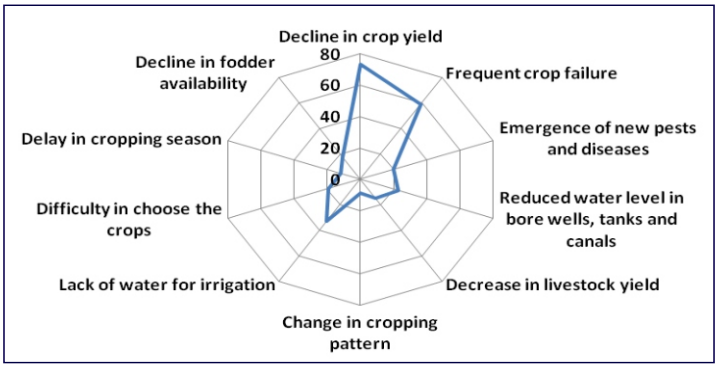

Fig.2: Farmers perceived impact of climate variability on agriculture

3.4 Indigenous knowledge and coping mechanisms to climate variability

The farmers in rural areas are highly susceptible to the effects of climatic variability because of their over-reliance on climate-sensitive natural resources, their locale within the vulnerable ecosystem, and their long-standing history of poor socio-economic base in the rural area. In this study, we found that climate variability has significantly impacted farm activities and farmers readily applied their indigenous knowledge and adaptation strategies to adapt to the changing climate. The farmers plan their cropping season and farming activities with staggered sowing periods and crop selection in accordance with weather and climatic conditions prevailing in the local area. The results show that adjusting planting dates and diversifying cropping systems towards horticultural fruits and vegetables, and planting of drought and heat-tolerant varieties are the foremost adaptation strategies to climate variability (Table 3). Diversification reduces the risk and resilience to highly variable weather conditions resulting from climate change and also secures income for farmers. Indigenous practices such as mixed farming and intercropping with legumes (Groundnut +Pigeonpea) are very important coping strategies that enhance resource efficiency, reduce the risk of crop failures during abnormal weather, and stabilize both crop yield and farm income. Further, strategies like planting of early-maturing varieties, enterprise diversification, and adopting soil and water conservation practices help mitigate the negative impacts of climate variability as planting of early-maturing varieties reduces the prolonged effects of drought. [19] also reported similar results and reported that farmers adopted different climate change adaptation strategies such as the adoption of diverse crop or crop cultivars, planting of trees, adoption of SWCs measures, altering dates of sowing, and irrigation to mitigate climate variability. Farmers' indigenous knowledge and adoption of SWCs particularly rainwater harvesting structures and field bunding acts as very good adaptation strategies to cope up with climate variability as they reduce the impacts of climate vulnerability, conserved soil moisture and stabilize the crop yields, particularly during erratic climate situations. Similar findings were recorded in the study conducted by [20], [21], [22], [23].

Table 3: Indigenous coping mechanisms and adaptation strategies practiced by farmers

Indigenous coping mechanisms	Bagalkot district		Vijayapura district	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Mixed Farming & intercropping	73.1	III	64.0	III
Livelihood diversification	66.3	IV	14.7	XI
Crop diversification	57.2	VI	95.4	I
Contingency crop planning	50.0	VII	32.4	VIII
Change in irrigation intervals	22.4	X	15.1	X
Changing planting date	86.5	I	77.4	II
Planting of drought and heat tolerant varieties	79.5	II	56.5	V
Lowering nutrient application	18.6	XII	11.3	XII
Soil and water conservation practices	63.1	V	47.5	VI
Dry sowing	20.5	XI	20.9	IX
Planting early maturing varieties	31.5	IX	60.9	IV
Insurance scheme	33.2	VIII	34.0	VII

3.5 Factors influencing indigenous coping mechanism in response to climate variability

The descriptive variables influenced indigenous coping mechanisms in response to climate variability. Among 10 independent variables, eight variables were found significant at 1%, 5% and 10% level and had positive effects in relation to indigenous knowledge and coping mechanisms to climate variability. These variables are farmer age, access to irrigation, level of education, the experience of farming, farm monthly income, land holding size, livestock possession and income diversity (Table 4). Moreover, among all the variables, income diversification is a highly effective coping mechanism for climate variability. However, the remaining variables had not shown considerable influence and response to climate variability. The elderly and more experienced farmers with higher education and greater monthly farm income are more inclined to adapt and use indigenous coping strategies, compared to younger, less experienced farmers with lower education and income. Similarly, farmers with access to irrigation, larger land holdings, and livestock are more likely to adapt and apply Indigenous coping strategies and exhibit a higher capacity for risk-bearing, compared to those without irrigation, smaller land holdings, and enterprise diversification. [24], [25], [26] also reported that important factors that significantly influenced adaptation to changing climate were education of household head, size of household, adoption of extension services particularly on crop and livestock production, accessibility to credit, and the surrounding temperature.

Table 4: Factors affecting the farm households' adoption of adaptation strategies

Sl. No.	Parameters	Coefficients	SE	p-value
	Constant	1.469	2.312	0.859
1.	Age of farmer	0.072	0.028	0.003***
2.	Education of farmer	2.401	0.553	0.042**
3.	Size of family	0.518	0.630	0.147
4.	Farm experience	0.211	2.255	0.008***
5.	Farm monthly income	2.733	0.276	0.009***
6.	Land acreage	-0.031	0.046	0.001***
7.	Possession of livestock	-0.631	0.024	0.092*
8.	Facility of irrigation	2.277	0.022	0.002***
9.	Income diversity	-3.699	2.024	0.001***
10.	Non-farm activity	0.462	0.666	0.756
	χ^2 statistic	123.068***		

*Note: ***, **, * and denotes significance level at 1%, 5% and 10% respectively.*

4. Conclusion

It can be concluded that the majority of farmers perceive climatic variations and their potential impact on farming. Farmers adopt traditional knowledge and employ various indigenous coping strategies such as adjusting planting dates, selecting appropriate crops and varieties, and adopting intercropping, mixed farming systems, and enterprise diversification to deal with the negative impacts of climate variations. Farmers' indigenous knowledge was considered one of the most efficient strategies for responding to climate variability. However, this knowledge was not effectively integrated into climate change planning and government policies which are crucial for addressing the negative effects of climate variability. Integrating Indigenous knowledge and traditional farming practices in climate change planning and government policies can effectively bridge traditional wisdom with modern innovation, enhancing climate resilience through reducing inputs, enhancing carbon sequestration and strengthening community empowerment. In addition, creating awareness and improving education among farming community and stakeholders is crucial for building resilience to climate variability and promoting sustainable agriculture.

Conflict of interest

The authors declared that there are no conflicts of interest.

Acknowledgement

The auther would like to acknowledge the State Department of Agriculture Vijayapura and Bagalkot for their support and assistance for selelction of study area and sample fammers.

Authors' contribution

Ravi Dupdal: Conceptualization, methodology, data collection, and compilation, original manuscript preparation, data analysis; **B.L.Patil:** Conceptualization, guiding for research work and study area selection; **B.K. Rao:** Supervision and correction; **B.S.Naik:** Manuscript review and editing.

5. References

1. Parrotta, J.A. and Agnoletti, M. (2012). Traditional forest-related knowledge and climate change - traditional forest-related knowledge: Sustaining communities, ecosystems and biocultural diversity. eds. Parrotta, J. A and R. L. Trosper, *World Forest*, 12: 491-533.

2. Sheikh, Z.A., Ashraf, S., Weesakul, S., Ali, M. and Hanh, N.C. (2024). Impact of climate change on farmers and adaptation strategies in Rangsit, Thailand. *Environ. Challenges,* 15: 100902.

3. Liwenga, E.T. (2008). Adaptive livelihood strategies for coping with water scarcity in the drylands of central Tanzania. *Phys. Chem. Earth (Pt A/B/C)*, 33(8-13): 775-779.

4. Dupdal R. and Patil, B.L. (2019). Constraints experienced and suggestions by farming community in adaptation to climate change in Karnataka: An Economic Analysis. *Int. J. Curr. Microbiol. Appl. Sci.,* 8(2): 376-383.

5. INCCA (2010). Indian network for climate change assessment, India: Greenhouse gas emissions 2007. Ministry of Environment and Forestry, India.

6. Adger, W.N., Huq, S., Brown, K., Conway, F. and Hulme, M. (2003). Adaptation to climate change in the developing world. *Prog Dev. Stud.*, 3(3): 179-195.

7. Smit, B. and Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustain. Dev.*, 8(9):9.

8. Kangalawe, R., Mwakalila, S. and Masolwa, P. (2011). Climate change impacts, local knowledge and coping strategies in the Great Ruaha River Catchment Area. *Tanzania. Nat. Resour.,* 1(2): 212-223.

9. Kpadonou, R.A., Adégbola, P.Y. and Tovignan, S.D. (2012). Local knowledge and adaptation to climate change in Ouémé valley, Benin. *Afr. Crop Sci. J.*, 20: 181-192.

10. Audefroy, J.F. and Sánchez, B.N.C. (2017). Integrating local knowledge for climate change adaptation in Yucatán, Mexico. *Int. J. Sustain. Built Environ*., 6: 228-237.

11. Zambrana, N.Y.P., Lerét, R.C., Bussmann, R.W. and Macía, M.J. (2014). The influence of socioeconomic factors on traditional knowledge: a cross scale comparison of palm use in northwestern South America. *Ecol. Soc.,* 19(4): 9.

12. Datta, P., Behera B. and Rahut D.B. (2022). Climate change and Indian agriculture: A systematic review of farmers' perception, adaptation, and transformation. *Environ. Challenges,* 8(8):100543.

13. Rama Rao C.A., Raju, B.M.K., Subba Rao, A.V.M., Rao., K.V., Rao, V.U.M., Kausalya Ramachandran, Venkateswarlu, B. and Sikka, A.K. (2013a). Atlas on vulnerability of Indian agriculture to climate change. Central Research Institute for Dryland Agriculture, Hyderabad, p. 116.

14. Dupdal, R., Patil, B.L., Manjunatha, B.L. and Patil S.L (2022). Climate change mitigation and adaptation strategies in drylands of Northern Karnataka*. Indian J. Agric. Sci.,* 92(1): 80-84.

15. Varadan R.J. and Kumar, P. (2014). Indigenous knowledge about climate change: Validating the perception of dryland farmers in Tamil Nadu. *Indian J. Tradit. Knowl.,* 13(2): 390-397.

16. Dhanya, P. and Ramachandran, A. (2016). Farmers' perceptions of climate change and the proposed agriculture adaptation strategies in a semi arid region of south India *J. Integr. Environ. Sci.,* 13(1): 1-18.

17. Brown, M. E. (2006). Assessing natural resource management challenges in Senegal using data from participatory rural appraisals and remote sensing. *World Dev.,* 34(4):751-767.

18. Dieye, A.M. and Roy, D.P. (2012). A study of rural Senegalese attitude and perceptions of their behavior to the climate. *Environ Manage.,* 50(5):929-941.

19. Bryan, E., Deressa, T.T., Gbetibouo, G.A. and Ringler, C. (2009). Adaption to climate changes in Ethiopia and South Africa: options and constraints. *Environ. Sci*. *Policy*. 12(14):413-426.

20. Nyong, A., Adesina, F. and Elasha B.O (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in African Sahel. *Mitigat. Adapt. Strat. Global Change*. 12:787-797.

21. Mertz, O., Mbow, C., Reenberg, A. and Diouf, A. (2009). Farmers perceptions of climate and agricultural adaptation strategies in rural Sahel. Environ Manage., 43(5): 804-816.

22. Magesa, B.A., Mohan, G., Matsuda, H., Melts, I., Kefi, M. and Fukushi, K. (2023). Understanding the farmers' choices and adoption of adaptation strategies, and plans to climate change impact in Africa: A systematic review. *Clim. Serv.,* 30:100362.

23. Dupdal, R., Naik, B.S., Ramesha, M.N., Ravi, K.N. and Rao, B.K. (2024). Water harvesting structure-farm pond for increasing crop yields and farm income in rainfed semiarid ecosystem of Karnataka. *Indian J. Soil Cons.,* 52 (Global Soils Conference - 2024 Special Issue): S68-S73.

24. Deressa, T.T., Hassan, R.M. and Ringler, C. (2011). Perception of an adaptation to climate change by farmers in the Nile basin of Ethiopia. *J. Agril. Sci.,* 149(1):23-31.

25. Mardy, T., Uddin, M.N., Sarker, M.A., Roy, D. and Dunn, E. S. (2018). Assessing coping strategies in response to drought: A micro level study in the north-west region of Bangladesh. *Climate*. 6:23.

26. Uddin, M.N., Bokelmann, W. and Entsminger, J.S. (2014). Factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: A farm level study in Bangladesh. *Climate*. 2: 223-241.