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RESEARCH ARTICLE

Farmers' Resilience to Climate Change in the North Eastern Hill Region of India

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ABSTRACT

The study was conducted in the three North Eastern Hill (NEH) States of India viz., Arunachal Pradesh, Manipur and Meghalaya. Three district viz., East Siang, Bishnupur and East Khasi Hills were selected purposively based on the most vulnerable to climate change of the selected states respectively. A total of 257 vulnerable farmers were selected for the study. The study followed descriptive research design. The study testified that majority of the farmers had 'Adaptive Capacity' of resilience to climate change while 'Coping Strategies to Shocks' was found very low among the farmers. Majority of the farmers belonged to medium level of 'Resilience to Climate Change in Agriculture'. The farmers' resilience to climate change had moderate to weak statistically significant correlations with the independent variables of the study. The study suggest that the farmers need to be proficient for strategies to Cope with climatic Shocks and need to enhance their Socio-economic capacity to deal with the shocks. For this, encouraging farmers to augur well in agriculture through application of suitable indigenous and scientific agricultural knowledge and techniques alongside the administration of Climate Smart Agricultural (CSA) Practices in the agriculture and associated systems are needed.

Key words: *Climate Change; Resilience to climate change; Adaptation; Vulnerable.*

Climate Change is a major challenge that the world faced today. It has become a serious threat to the environment and also to the mankind. It is the increasing of frequency and intensity of the extreme weather and climate events that are distressing ubiquitously. It is a mega problem (*Harper, 2012*) and a wicked issue (*Rayner, 2006*). Draught, flood, dry spell, variation in rainfall, change in temperature, landslides, *etc*., are repeatedly occurred in almost all the corner of the world. Agriculture exclusively depends on Climate and most vulnerable sector to Climate change, the impact of it is felt in the sector in the form of reduction in the yield of crops, failure of crops, increase incident of pest & diseases, depletion of resources, affects livelihood, recession in the Economy, etc. In India, various studies observed an increasing trend in temperature (*Pant et al., 1999*; and *Singh & Sontakke, 2002*) and a surge in temperature by 2–4ºC is predicted for India by 2050s. The Climate Change impact on Agriculture comes through fluctuations in variability, seasonality, fluctuations in mean precipitation and water availability and the advent of new pathogens and diseases (*Fischlin et al., 2007*). Rural farmers, whose livelihoods depend on agriculture and associated enterprises are likely to bear the adverse impacts as resilience is characteristically low in rural areas as the existing asset base is limited, and services are often insufficient. Farming activities rely on favourable climate conditions and are at risk under a changing climate; thus, it may be expected that farmers will have a long-term perspective on climate because of its direct impact on their livelihoods (*Kumar et al., 2022*).

The North Eastern Hill states of India are well famous for its rich heritage and hot biodiversity spots. Farming community constitutes nearly eighty five percent (85%) of population whose livelihood is depending on agriculture. Besides, the tribal states of the region are highly vulnerable to Climate Change which will have direct negative consequences on

production and productivity, causing serious descent of rural livelihoods and increase food insecurity. The region faced varied natural calamities including frequent flood, drought like situation and landslide almost all the years. Frequency of rainy days is most likely to decrease by 1–10 days and the amount of rainfall is expected to increase by 1–6 mm/day (*INCCA, 2010*). The productivity of various crops are much lesser than their national averages; hence, hill farming becomes more susceptible to the variability in climatic parameters (*Feroze et al., 2018*).

Resilience to Climate Change is the intentions to lessen climate change vulnerability. Building resilience requires not only recognizing potential hazards like extreme weather events, but also understanding the underlying vulnerabilities that may affect recovery from them. To deal with the varying climate and to resilient to it, farming community necessitates to anticipate, preparedness, respond and taking steps to better cope with climate related disturbances or risk in Agriculture. Enhancing the farmers' ability to rebound following a shock is need of the hour. Adapting to the varying climate, taking up mitigation strategies, building up resiliency to climate change will achieve sustainable growth in the agriculture and associated enterprises. More productive and more resilient hill agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently (*Kirwa et al., 2020*). To culminate poverty of the farmers and indorsing sustainable crop production, farmers' resiliency and adaptation approach need to be comprehended and implement in earnest.

METHODOLOGY

The study was led in the three North Eastern Hill States of India *viz.,* Arunachal Pradesh, Manipur and Meghalaya to represent the three major Agro-Climatic Zones *viz.,* Tropical, Sub-Tropical and Temperate respectively. Three district *viz*., East Siang, Bishnupur and East Khasi Hills were selected purposively based on the most vulnerable to climate change of the selected states respectively. The selection of villages were performed purposively as per recommendation from the respective agriculture/horticulture departments of the three states by prioritizing agriculturally importance and vulnerability to climate change. Villages *viz.,* Mirsam, Napit, Oyam-Sille, Ayeng and Mebo were selected from East Siang district. Villages *viz.,* Moirang Khunou, Chairel, Haotak, Wangoo Naodakhong, Sagolpat, Kumbi Irengbam and Keinou were selected from Bishnupur district. And Villages *viz.,* Sadew, Laitjem, Mawri and Lyngkien were selected from East Khasi Hills district. In the present inquiry, taking into consideration the following statistics *viz.,* $\alpha = 0.05$, $\beta = 0.95$ and Effect size = 0.40, the size of sample 'n' of the study has been determined to be 257 respondents by applying the procedure of proportionate random sampling without replacement. The study followed descriptive research design. The study had accentuated independent variables in three categories *viz.,* personal & socio-economic characteristics, communication characteristics and psychological characteristics of farmers. under personal & socio-economic characteristics of farmers, variables 'age', 'operational land holding', 'farming experience', 'annual income' and 'level of education' were premeditated. Under communication characteristics of farmers, variables 'mass media exposure', 'extension contact/services', 'exposure of farmers to long term stresses or shocks', 'access to climate change mitigation & adaptation services' and 'training on csa practices' were selected. Under psychological characteristics of farmers, variables *viz.,* 'awareness on consequences of climate change in agriculture', 'risk perception on climate change', 'knowledge on csa', 'climate change adaptation intention', 'climate risk management', 'utilization of credit support systems', 'climate change mitigation', 'scientific orientation', 'livelihood sustainability' and 'innovativeness of csa practices' were studied. The dependent variable 'Resilience to Climate Change in Agriculture' was quantified by standardize Composite Resilience Index developed for the study. The variable consists of eight measures *viz.,* 'exposure to shocks', 'inherent resilience', 'absorptive capacity', 'adaptive capacity', 'transformative capacity', 'socio-economic', 'coping strategies to shocks' and 'social participation'. To study the relationship of the dependent variable – 'Resilience to climate change in agriculture' with independent variables, Spearman rank-order correlation coefficient (ρ) was employed for the study.

Spearman rank-order correlation : The Spearman rank-order correlation is a statistical procedure that is premeditated to measure the relationship between two variables on an ordinal scale of measurement. To determine a Spearman rank-order correlation

coefficient r_s (ρ), the following formulae is used-

$$r_s = 1 - \left[\frac{6\sum d_i^2}{n(n^2-1)}\right]$$

Where, n= number of rank pairs, and

di= difference between ranks of i^{th} pair of the two variables

RESULTS AND DISCUSSION

The Table 1 below shows the details about the personal & socio-economic characteristics, communication characteristics and psychological characteristics of farmers. Apropos of personal & socio-economic characteristics of the farmers, it was found that majority of farmers belonged to 'old age'(<50 years), had small 'land holding', low level of' farming experience'(10 to 25 years) and low 'annual income' (₹0.15 to ₹3.4 lakh). With regard to 'level of education', majority of the farmers had education up to high school level (10th standard passed). With regard to communication characteristics of farmers, it was concluded that majority of the farmers had medium level of 'exposure to mass media', low level of

Table 1. Personal & socio-economic, communication and psychological characteristics of farmers

Category	No.	%
Personal & socio-economic characteristics		
Age		
Young age (<35 years)	29	11.28
Middle age (35-50 years)	113	43.97
Old age (>50 years)	115	44.75
Operational land holding		
Small (0.25 to 2.67 Ha)	204	79.38
Medium (3 to 7 Ha)	47	18.29
Large (8 to 13.38 Ha)	06	2.33
Farming experience		
Low (10 to 25 years)	150	58.36
Medium (26-40 years)	94	36.58
High (41 to 60 years)	13	5.06
Annual income (in lakh)		
Low income (₹0.15 to ₹3.4)	208	80.94
Medium income (₹3.5 to ₹6)	38	14.78
High income (₹6.1 to ₹10)	11	4.28
Level of education		
Illiterate	44	17.12
Below matric	39	15.18
High school	101	39.30
Higher secondary	38	14.78
Graduate	31	12.06
Post-graduate	4	1.56
Communication characteristics of farmers		
Mass media exposure		
High	28	10.90
Medium	117	45.52
Low	112	43.58
Extension contact/ services		
High	25	9.73
Medium	52	20.23
Low	180	70.04
Exposure of farmers to long term stresses or shocks		
High	37	14.40
Medium	151	58.75
Low	69	26.85
Access to climate change mitigation and adaptation services		
High	14	5.45
Medium	81	31.52
Low	162	63.03
Training on CSA practices		
High	12	4.67
Medium	82	31.91
Low	163	63.42
Psychological characteristics of farmers		
Awareness on consequences of climate change in agriculture		
High	51	19.84
Medium	142	55.25
Low	64	24.90
Risk perception on climate change		
High	15	5.84
Medium	146	56.81
Low	96	37.35
Climate change adaptation intention		
High	31	12.06
Medium	110	42.80
Low	116	45.14
Knowledge on CSA		
High	67	26.07
Medium	138	53.70
Low	52	20.23
Climate risk management		
High	75	29.18
Medium	122	47.47
Low	60	23.35
Utilization of credit support systems		
High	43	16.73
Medium	132	51.36
Low	82	31.91
Climate change mitigation		
High	66	25.68
Medium	70	27.24
Low	121	47.08
Scientific orientation		
High	61	23.73
Medium	124	48.25
Low	72	28.02
Livelihood sustainability		
High	68	26.46
Medium	92	35.80
Low	97	37.74
Innovativeness of CSA practices		
High	46	17.90
Medium	103	40.08
Low	108	42.02

'extension contact/services', medium level of 'exposure to long term stresses or shocks', low level of 'access to climate change mitigation and adaptation services', low level of 'training on CSA practices'. Pertaining to 'source of information', the majority of respondents proclaimed that friends & relatives as most important 'personal-localite channel', the agricultural institute as prime 'personal cosmopolite channel', mobile phone/ telephone as significant 'mass-media channels'. It was witnessed that majority of the respondents belonged to low category w.r.t the psychological characteristics of farmers viz., 'climate change adaptation intention', 'climate change mitigation', 'livelihood sustainability' and 'innovativeness of CSA'. However, maximum of farmers was in medium categories apropos of the psychological characteristics viz., 'awareness on consequences of climate change in agriculture', 'risk perception on climate change', 'knowledge on csa', 'climate risk management', 'utilization of credit support system' and 'scientific orientation'. Inferring the statistical display of scores and percentage of respondents rendering to indicators of the dependent variable – 'Resilience to climate change in agriculture' as depicted in Table 2 it might perhaps be testified that majority of about seventy six percent (76.42%) of respondents had 'adaptive capacity'; followed by readiness in 'social participation', promptness in 'transformative capacity', latent 'absorptive capacity', firm 'inherent resilience', familiarity in 'exposure to shocks', bolster in 'socio-economic capacity' and capability on formulating 'coping strategies to shocks' with 72.02 per cent, 69.26 per cent, 63.42 per cent, 52.84 per cent, 47.86 per cent, 45.10 per cent and 43.47 per cent, respectively. The highest percentage of about forty percent (40.08%) of the respondents belonged to medium level trailed by low- and high-level categories on '*resilience to climate change in agriculture*' with 38.52 per cent and 21.40 per cent, respectively. During the study, the respondents pooled and shared that they had experienced frequent climatic shocks and shudders for past 10 years on heavy erratic rainfalls, not only in monsoon but during winter season, followed by flash flood and heavy soil erosions from the arable land. Intense temperature during day and chilling cold in night become common phenomena which really stalled the growth of standing crops. Frost bite on succulent crops during winter was most climatic happenings during the last 5-6 years. The fearsome insects, pests and diseases associated to crops become chemical-pesticide-insecticide resistant. Unavailability of irrigation water just after monsoon/rainy season was appealed to be a major concerned of sample subjects in all the three states under the study.

Table 2. Resilience of farmers to climate change in agriculture.

Indicators	Score	%
Exposure to shocks	123.67	47.86
Inherent resilience	135.8	52.84
Absorptive capacity	163	63.42
Adaptive capacity	196.4	76.42
Transformative capacity	178	69.26
Socio-economic capacity	115.92	45.10
Coping strategies to shocks	111.73	43.47
Social participation	185.09	72.02

Relationship of the dependent variable – 'Resilience to climate change in agriculture' with independent variables : The study had accentuated in administering *Spearman rank-order correlation* analysis in attempting to inspect the relationship between dependent variable – 'Resilience to climate change in agriculture' with the independent variables. Inferring the display of data in Table 3, it could be narrated that the dependent variable had positive and moderate statistically significant correlations even below 1% level of significance with the independent variables *viz.,* 'climate change mitigation', 'scientific orientation' and 'utilization of credit support systems' with the respective 'ρ' values of 0.319, 0.255 and 0.229. Nevertheless, the same dependent variable had negative and moderate statistically significant correlations even below 1% level of significance with the independent variables *viz.,* 'annual income', 'training on CSA practices', 'extension contact/services', 'operational land holding' and 'access to climate change adaptation and mitigation services' with the respective 'ρ' values of – 0.342, – 0.278, – 0.274, – 0.259 and – 0.222. Further, the dependent variables had positive and weak statistically significant correlations at 5% level of significance with the independent variables *viz.,* 'climate risk management', 'livelihood sustainability' and 'climate change adaptation intention' with the 'ρ' values of 0.150, 0.139 and 0.126, respectively. Yet again, the dependent variable had negative and weak statistically significant correlations at 5% level of significance with the independent variables *viz.,* 'risk perception on climate change' and 'mass media exposure' with the 'ρ' values of – 0.147 and – 0.123, respectively. During the data collection, it was witnessed that those

Table 3. Spearman rank-order correlation coefficient between 'Resilience to climate change in agriculture' and independent variables

Independent variables	Correlation Coefficient (ρ)	p-value
Age	-0.110	0.078
Operational land holding	-0.259**	0.000
Farming experience	-0.078	0.212
Annual income	-0.342**	0.000
Level of education	-0.043	0.488
Mass media exposure	-0.123*	0.050
Extension contact/ services	-0.274**	0.000
Exposure of farmers to long term stresses or shocks	-0.118	0.060
Access to climate change mitigation and adaptation services	-0.222**	0.000
Training on CSA practices	-0.278**	0.000
Awareness on consequences of climate change in agriculture	0.001	1.000
Risk perception on climate change	-.147*	0.019
Climate change adaptation intention	0.126*	0.044
Knowledge on CSA	-0.078	0.215
Climate risk management	0.150*	0.016
Utilization of credit support systems	0.229**	0.000
Climate change mitigation	0.319**	0.000
Scientific orientation	0.255**	0.000
Livelihood sustainability	0.139*	0.026
Innovativeness of CSA practices	-0.067	0.282

**Significant at 1%, *Significant at 5% level of significance

respondents who always had only negative perception on climate change in spite of the repeated exposure and instructions the opportunities associated to agriculture due to climate change, also maligned by less exposure to mass media, which were in their proximity, might perhaps lead to negative relationship with the resilience to climate change in agriculture.

CONCLUSION

The study shows of farmers resilience to climate change in agriculture higher in 'adaptive capacity' and low capability on formulating '*coping strategies to shocks*'. Also, the farmers have medium to low level categories on 'resilience to climate change in agriculture'. The study suggest that the farmers need to be proficient for strategies to cope with climatic shocks and need to enhance their socio-economic capacity to deal with the shocks. For this, encouraging farmers to augur well in agriculture through application of suitable indigenous and scientific agricultural knowledge and techniques alongside the administration of climate smart agricultural practices in the agriculture and associated systems are needed.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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