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Awareness and Adoption of Climate Resilient Horticulture Technologies by Farmers in Ri Bhoi District of Meghalaya

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Abstract

A study was undertaken during the year 2020–2021 in Kyrdem and Sohriewblei villages, Ri-Bhoi district, Meghalaya, India to find out the level of awareness and adoption of climate resilient horticultural technologies. The selected villages had been adopted under National Initiative on Climate Resilient Agriculture (NICRA) project since 2011-2020. A sample size of 100 farmers (50 from each village) who were actively involved in horticultural activities was selected randomly. A well-structured, pre-tested interview schedule was employed for the data collection. The study revealed that the awareness level was recorded highest in institutional measures (94.2%) followed by horticultural practices (92.4%) and soil and water conservation (89%) measures. The highest adoption level of resilient practices was observed in horticultural practices (83.9%). Out of all respondents 89% were classified as medium category farmers for adoption of climate resilient technologies in both the villages. There was no statistical difference in the adoption level of resilient practices among the farmers of both the villages. Spearman rank correlation (0.730) depicted correlation between awareness and adoption level of horticultural technologies among the selected farmers in both the villages. It could be concluded that in an area like Meghalaya where small size of land holding and fragmented land emerged as main constraint for adoption of modern horticultural technology. Rigorous awareness programme to orient farming community towards scientific proven methods will be able to minimize the adverse effects of climate change.

Keywords: Adoption, awareness, climate change, horticulture, mitigation, NICRA, resilient

1. Introduction

Agricultural production system in North-East India is mostly rainfed and at subsistence level. The hilly terrains of North Eastern India are facing climatic vulnerability due to heavy and erratic rainfall, hailstone, frost and intermittent drought, which results into crop loss (Malla, 2014, Greg et al., 2011) and it remains a major obstacle to achieve food security in India (Naik et al., 2023, Pabba et al., 2022). Use of local varieties, porous soil, soil acidity, aluminum toxicity, iron toxicity, phosphorous unavailability, rainfed cropping along with traditional management practices have already resulted in low crop productivity and cropping intensity. Horticulture plays an important role in subsistence farming, practised by majority of the small and marginal farmers. But this sector is very sensitive and considerably impacted by climate change because of less adoption of resilient mechanisms. Therefore, to mitigate the ill effects of climate change and to increase and maintain food security, a holistic approach needs to be optimized as horticultural crops can play an important role in mitigation of climate change.

Estimation of impacts of climate change on agriculture is critically important and technology is the critical input for its mitigation (Anseera and Alex, 2019, Khan et al., 2009). It is also important to explore linkages between agricultural ecosystems, future climate and land use changes over periods of time so as to create synergies and reduce vulnerability (Islam and Sarma, 2023, Meinke et al., 2006, Parry and Carter, 1989). Over the years, both farmers as well as research community developed an extensive range of agriculture and horticultural practices which could augment farming systems' resiliency to climate change (Medhi et al., 2018, Wezel et al., 2014). Technological intervention for climate smart agriculture is an integral part for modern day agriculture. Effective climate smart technologies like crop diversification, conservation agriculture, bio-organic management, rain water harvesting, climate-ready crop varieties, changing planting date, growing resistant/tolerant crops varieties, intercropping/ mixed cropping, integrated farming system, integrated pest and disease management, improved integrated nutrient management, precession farming, waste land management, etc. have been developed and are required to be disseminated among the farming community (Pathak, 2012, Roy et al., 2018, Tol, 2018). Weather based agro-advisory, creation of seed bank, popularization of crop insurance and use of indigenous technical knowledge can help to mitigate climate change. The contingent crop planning with major emphasis on horticultural crops, protected cultivation of high value horticultural crops is another viable option for climate resilient agriculture to increase farm profitability (Harikrishna and Naberia, 2021, Verma et al., 2020, Verma et al., 2022).

Adaptation to climate requires comprehensive strategy, first step being to create awareness and capacity building. Rao et al. (2020) emphasized on engaging communities though community driven programmes, village level institutions to create awareness on climate resilient technologies. Access to extension services, such as training, farm field schools and demonstrations, make farmers aware and knowledgeable about the climate smart agricultural practices (Makate et al., 2019, Mgendi, et al., 2022, Osumba, 2021, Tanti et al., 2023, Zakaria et al., 2020). A range of other factors including the size of landholding, asset ownership, savings, income from secondary occupations, age, gender, experience in farming activities, number of family members, level of education influence farmers' decision on adopting climate smart agricultural practices (Chauhan and Kumar, 2016, Jena et al., 2023, Mashi et al., 2022).

The climatic vulnerability in Ri-Bhoi district of Meghalaya poses a serious threat to crop yields, food security and farm income. The purpose of present study was to investigate the level of awareness and adoption of climate resilient horticultural technologies by the farmers of Kyrdem and Sohriewblei villages in the district.

2. Materials and Methods

The Ri-Bhoi district of Meghalaya lies between 25° 40′ N to 25° 2′ N and 90° 55′ E to 91°16′ E with an elevation of 100 m to 1150 m above MSL. The Kyrdem and Sohriewblei villages were adopted under the National Innovation on Climate Resilient agriculture (NICRA) project for undertaking demonstration on climate resilient technologies from 2011 to 2020. The Kyrdem village lies between 25° 41.487′ N and 92° 04.308′ E with an elevation of 864 m above MSL whereas, Sohriewblei village lies between 25° 41.302′ N and 92° 04.512′ E with an elevation of 870 m above MSL. The data on climate resilient horticultural technologies demonstrated under the project at these two adopted village were collected during 2020-2021 by using a well-structured, pre-tested interview schedule and focused group discussions. A sample size of 100 farmers (50 from each village) who were actively involved in horticultural activities selected randomly for the study. The total tribal population of the two villages was 1,465 (as per 2011 census). The secondary data were used along with the primary data to supplement and triangulation of the study through NICRA annual reports, KVK data and block level data. The Kyrdem & Sohriewblei village of Ri Bhoi district represent rainfed agro ecosystem and mostly affected by terminal drought, frost, cold wave, hail storm and high intensity and erratic rainfall. Twenty-two items identified from review as climate resilient technologies/mitigation practices were categorized under three heads namely, soil and water conservation measures, horticultural practices and institutional measures with 7, 10 and 5 items under each category, respectively. Awareness and adoption of farmers on the possible climate resilient techniques was found out by recording their responses on a two-point nominal scale. These frequencies of their responses were further used to find out the importance ascribed to each technique/strategy and the relative importance of different categories of practices by calculating their weighted score. This would clearly indicate the specific component which has to be emphasized in developing the content and focus of development interventions to mitigate climate change impacts. The adoption index for each farmer was also calculated by using the following formula (Anseera and Alex, 2019).

Adoption Index=(Respondent total score/(Total possible score)×100

Based on the mean adoption score obtained and the standard deviation (meanS.D.), farmers were categorized as low, medium and high in adoption of climate resilient practices. '*t'-test* was conducted in order to compare and find out the difference in adoption of climate resilient practices among the farmers of Kyrdem and Sohriewblei. Spearman's Rank Correlation was performed to find the factors affecting awareness as well as adoption of resilient practices among the farmers. The information seeking behaviour of the respondents were measured using the scale developed by Singha and Baruah (2011) to draw meaningful conclusion of this psychological variable.

3. Results and Discussion

The technologies developed through Indian Agricultural Research System which are suitable for mitigation of climate change and brought into the knowledge of farmers through various awareness programme. However, some of the technologies may not be adopted due to non-availability of materials, remoteness of area, etc. Awareness and sources of technology information perceived by a farmer leads to adoption of a technology.

3.1. Level of information sources on horticultural technologies

The sources of information gathered by the responded farmers of both the villages are presented in Table 1. The data revealed that the maximum (100%) of NICRA farmers relied on information available from Krishi Vigyan Kendra, Ri-Bhoi, while 68, 56, 45, 38 and 21% of the respondents acquired information from the sources like ICTs, friends and community, field officer (Horticulture Department), farmers of other villages and representatives of input agencies/ dealers, respectively. The outreach of KVK for dissemination of information and sharing knowledge was more due to implementation of NICRA project through training, method demonstrations, field days, diagnostic visits and easy accessibility of KVK personal. Acheampong et al. (2018) in a

Table 1: Distribution of respondents according to their Information seeking behavior

Sources of information	n=100	Frequency (%)
KVK, Ri-Bhoi	100	100
ICTs	100	68
Friends and community	100	56
Field officer (Horticulture Department)	100	45
Farmers of other villages	100	38
Representative of input agencies/ dealers	100	21

study conducted in Ghana reported that the farmers acquire knowledge and awareness about the new technology through extension services or other channels with input support, demonstrations, field days for publicity through electronic media such as radio and television. Similar trends were also reported by Simtowe et al. (2016) in a study conducted in Malawi.

3.2. Awareness and adoption of soil and water conservation measures

The information received by respondents is the preliminary to the awareness and adoption of technology. The weighted awareness and adoption scores are given in Table 2. The mean awareness level about the soil and water conservation technologies was found to be 89% among the respondent farmers. The respondent farmers were categorized for awareness and adoption level of soil and water conservation measures based seven items showed that 93-95% farmers were aware about crop residue management, crop residue and plastic mulching as effective climate resilient techniques in both the villages. About 89% farmers were found to be aware about minimum tillage, *'Jalkund'* and half-moon terracing as an effective techniques to mitigate the climate change. The farmers found to be least aware (76%) on contour bunding of terraces for vegetable cultivation. The results were in consistent with findings of Anseera and Alex (2019), Gbetibouo (2009), Jasna (2015), who were also reported more awareness on climate resilient technologies like water harvesting structures, mulching and crop residue management.

The mean adoption level about the soil and water conservation technologies was found to be 72% among the respondent farmers. Adoption of crop residue management by the farmers was found to be 91% followed by crop residue mulching (81 %). The famers were using the crop residues either for making compost or ploughing and mixing into soil while preparing land for next crop. Minimum tillage was adopted by 75% farmers closely followed by jalkund (73%) and half moon terracing (70%). The availability of lining material for jalkund making might be a limiting factor for comparatively slower rate of adoption. The technique of contour bunding and plastic mulching for vegetable cultivation had merely accepted with only by 58 and 56% farming community, respectively in both the villages. This might be attributed to non-availability of

Table 2: Awareness and adoption of climate resilient technologies/mitigation strategies

Climate resilient technologies/mitigation strategies	AWS	CMAS	AdWS	CAdS
Soil and water conservation				
Contouring bunding for vegetable cultivation	76		58	
Half moon terracing for fruit cultivation	88		70	
Jalkund' - micro water harvesting for life saving irrigation	89		73	
Crop residue Mulching	93	89	81	72
Plastic mulching	93		56	
Crop residue management	95		91	
Minimum tillage	89		75	
Horticultural practices				
Integrated nutrient management	87		81	
Biotic and abiotic stress resistant varieties	100		88	
Intercropping/Multi-tier cropping	92		90	
Changing sowing time	86		76	
Wind breaks	96	92.4	82	83.9
Crop rotation	99		91	
Weed management practices	93		87	
Polyhouse for vegetable production	98		82	
Community based nursery	100		95	
Organic soil management	73		67	
Institutional measures				
PMFBY	88		0	
Marketing channel awareness	88		80	
Crop management based on weather forecast	95	94.2	82	68.6
Custom hiring centre	100		92	
Seed bank	100		89	

AWS: Awareness weighted score; CMAS: Category wise mean awareness score, AdWS: Adoption weighted score; CAdS: Category wise mean adoption score plastic mulch due to remoteness of the area and more skilled labour intensive, which adds to their cost of production. Shanker et al. (2013) and Naik et al. (2023) also found reported that the soil moisture conservation techniques like mulching with organic residue and cover cropping in rainfed agriculture were adopted by farmers to cope up with climate change. Jha et al. (2015) enumerated rainwater harvesting structure, mulching, polyhouse, crop residue management as some of the effective measures to mitigate adverse effects climate change in the horticulture sector of northeast India.

3.3. Awareness and adoption of horticultural practices

The horticulture-based interventions has the potentiality to increase farm and family income among tribal farmers and bring about positive changes in the socio-economic and nutritional condition (Patel et al., 2023).

The mean awareness level about the climate resilient horticultural practices was found to be 92.4% which were higher than the value of soil and water conservation measures (Table 2). Among 10 horticultural practices listed as climate resilient techniques, all the respondents (100%) showed their awareness on biotic and abotic stress resistant varieties and community-based nursery as a strategy for climate resilience. The distribution of farmers based on level of awareness on different items listed showed that crop rotation, polyhouse for vegetable cultivation, wind break, weed management practices and intercropping were known to more than 90% farmers. The slight change in sowing time of vegetables and integrated nutrient management could be one of the good options to mitigate adverse effects of climate change with 86 and 87% of respondent showed cognizance of these technologies.

The mean adoption level about the climate resilient horticultural practices was found to be 83.9% which were higher than the value of soil and water conservation measures. More than 90% farmers expressed for their adoption of technologies like community-based nursery (95%), crop rotation (91%) and intercropping (90%) to avoid the adversities of climatic vagaries of erratic rain fall, frost, hailstone, heavy wind. The higher adoption might be due to production of healthy vegetable seedlings in reduced time, energy and expenditure, soil amelioration and generate extra income for the farmers. About 81-88% farmers were found to be adopting biotic and abiotic stress resistant varieties (88%), weed management practices (87%), wind breaks (82%), polyhouse for vegetable cultivation (82%) and integrated nutrient management (81%). This might be due to the fact that many old tribal farmers of remote areas are reluctant to leave their traditional varieties because of taste, seed availability, believes, etc. The considerable lower adoption rate for changing sowing time (76%) and organic soil management (67%) might be due to non-availability of improved seeds and adequate organic nutrients in time and place. Reddy et al. (2015); Singh (2016); Pathak (2012), Dhaka et al. (2010), Shanker et al. (2013) and Gopal et al. (2014) reported that more awareness and adoption of climate resilient technologies like intensification of multi-tier cropping, intercropping, rotation, substitution by crop diversification, changing planting dates, drought resistant crops by the farmers due to frequent fluctuation in rainfall pattern to mitigate changing climate.

3.4. Awareness and adoption of institutional measures

The mean awareness about the institutional measures were 94.2% among the farmers with 100% known to farming community about the custom hiring centre (CHC) and seed bank to mitigate the climatic vagaries (Table 2). Ninety five per cent farmers were aware of weather forecast based crop management while 88% showed cognizance to PMFBY and marketing channels. The results were in consistent with findings of Anseera and Alex (2019) who was also reported more awareness on institutional measures like seed bank and weather insurance to mitigate climate change.

The mean adoption score (68.6%) was less due to non-adoption of Pradhan Mantri Fasal Bima Yozana (PMFBY). All farmers showed their cognizance of custom hiring centre (CHC) and seed bank with adoption per cent 92 and 89, respectively which might be due to use of farm tools and implements by small and marginal farmers on hiring basis paying very nominal amount decided by Village Climate Resilient Management Committee (VCRMC). Farmers were benefited from weather based crop management to reduce loss and marketing channels ensured good price for their farm produce with 82 and 80% adoption, respectively. Malwa and Jain (2015) also observed that cultivation according to weather based warning enhanced farm productivity and reduced crop vulnerability to climate change. Although there was considerable effort was given to make farmers aware of PMFBY (88%), yet none of the respondents showed interest to adopt it since it's launching in the year 2016-2017 by Govt. of India. The small land holding, subsistence multiple cropping, lackadaisical attitude towards approaching bank, etc might be the cause of non-adoption of PMFBY scheme. Anseera and Alex (2019) who was also reported adoption of weather insurance as strategy for mitigating the impact of climate change.

3.5. Distribution of farmers based on adoption index

Adoption index for each farmer was calculated by dividing the total adoption score obtained for that farmer with the total possible score. Depending on the mean ± standard deviation (mean±S.D.) of the adoption score obtained, the farmers were classified as low, medium and high category as shown in Table 3. From the study, it was understood that majority of the farmers (89%) had medium level of adoption of climate resilient practices. The mean adoption score obtained was 76.63 and adoption index ranges from 54.14 to 95.45. Farmers who had high and medium adoption level constituted only 9% and 2%, respectively. This might be due to low to medium

Table 3: Classification of farmers based on their adoption of climate resilient practices (N=100)

Category	Farmers	
	Score range	No. (%)
Low (<Mean–S.D.)	<56.42	2
Medium (Mean±S.D.)	56.42–96.84	89
High (>Mean+S.D.)	>96.84	9
Mean=76.63	S.D.=20.21	

level of awareness and adoption of climate change mitigation strategies like organic soil management PMFBY, plastic mulch and contour bunding**.** Anseera and Alex (2019) who was also reported the medium level of adoption of climate resilient practices.

3.6. Adoption of climate resilient practices by farmers

An attempt was made to find whether any significance difference could be observed among the farmers on adoption of climate resilient practices as the climate change vulnerability is inversely related to the awareness and adoption of these practices that ensures farmers different dimensions of resilience. In order to compare and find the difference in adoption of climate resilient practices among the farmers of two villages i.e. Kyrdem and Sohriewblei, t-test was conducted. The mean adoption index for farmers in both the villages was calculated. The results revealed that the probability of t-statistic obtained (0.0001) had low significance difference in the adoption of climate resilient practices among the farmers in both the villages (Table 4). The mean adoption index of Kyrdem (78.00) and Sohriewblei (75.27) are not much different, it may be concluded that adoption rate of climate resilient technologies in both the villages are similar. This result may be attributed to the close vicinity of both the villages and there are exchange of knowledge and ideas among the farmers.

Table 4: P value of t-test on adoption of climate resilient practices by the farmers of Kyrdem and Sohriew-blei

District	Mean adoption index	P Value of t - statistic
Kyrdem	78.00	0.0001
Sohriewblei	75.27	

3.7. Relationship between awareness and adoption of climate resilient practices

An attempt was made to analyze the degree of dependency of farmers' level of awareness and adoption regarding climate resilient technologies as adoption influenced by the level of awareness. The correlation obtained showed that the awareness level was significantly influenced to the extent of adoption (Table 5). The similar trend of results was reported by Anseera and Alex (2019) for their studies at Kerala. Acheampong et al. (2018) also reported awareness influenced adoption in a study conducted at Ghana. They opined extension and awareness creation through various means such as demonstrations, field days etc found to be a key aspect of technology adoption. Technology awareness influenced the probability of adoption positively and significantly.

Table 5: Relationship between awareness and adoption of climate resilient practices

Variables		Spearman rank correlation (p)
Awareness on climate resilient practices	Adoption of cli-mate resilient practices	0.730**

**: Significant at (p=0.01) level, 2 tailed

4. Conclusion

Small size of land holdings and fragmented lands were found as the main constraint for adoption of modern horticultural technology. Rigorous awareness programme to orient farming community towards scientific proven methods will definitely be able to minimize the adverse effects of climate change.

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