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Increasing Farmers Income through Demonstration of Climate Resilient Technology

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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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Short Research Article

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ABSTRACT

The project TDC-NICRA (National Innovations on Climate Resilient Agriculture) was initiated in KVK, Dhemaji from 2021-22 in Magurmari village of Simen-Chapori Block under the District Dhemaji. The village was affected by flood every year leaving the villagers in a state of destitute. Majority of the farmers of Magurmari village were marginal farmer. Flood, irrigation, water conservation, diseases infestation on plant and occupational migration were the major problem of the village due to which crop failure occurs which leads low income of the farmers. To establish climate resilient agriculture in Magurmari village Demonstration on submergence tolerant rice variety 'Ranjit sub-1', medium duration rice variety Numoli, Cultivation of megha turmeric through

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organic mulching, cultivation of rabi vegetables using paddy straw as organic mulch and Low cost raised bed vermicompost production interventions were taken up in magurmari village. The study revealed that these climate resililient technology weer provd to be boom in magurmari village which help the farmers to increase the farm production and their income to a great extent.

Keywords: NICRA; flood, climate; agriculture; intervention.

1. INTRODUCTION

Climate and agriculture are inextricably associated. High dissimilarity in environmental factors such as temperature, rainfall and drought distress crop growth tremendously. Thus, change in climatic variables may have positive and negative impact on agricultural productivity and food security situation in the economy (Greg et al. 2011). Agriculture is the main occupation of the people of Dhemaji district as 85% of the population depends on agriculture and allied sector. Paddy is the major crop constituting more than 60 per cent of gross cropped area followed by rapeseed and mustard, black gram, potato and maize. Vegetables and fruits are also cultivated in moderate scale. Piggery, poultry, goat rearing, fishery and sericulture are major agricultural allied activities in the district. The agriculture and allied sector in the district is merely rainfed. The district is blessed with bounty of resources like the water course originating from hillock of Arunachal Pradesh are streaming through the district *viz*, *Dihingia, Jiadhal, Moridhal, Telijan, Kaitongjan, LaipuliaNadi, Kapurdhuwa, Sissi, Gai, Tangani,* and *Guttong.* The same is distressing now a days due to mass deforestation in the hillock. Nearly 27% of the net cropped is affected by flood during rainy season and every years farmers face crop loss specially paddy due to floods.Climate resilient technologies are promising tool to guard a farming system from climate variations and impact study of these technologies are prerequisite for guiding the adaptive research for better customization, for upscaling, and out scaling them [1]. Climate smart Agriculture and Climate smart villages can serve to alleviate the long term effects of climate change in vilages [2]. Looking into the concerns, Indian Council of Agricultural Research (ICAR) initiated the National Innovation for Climate Resilient Agriculture (NICRA) in February, 2011 with a prime objective to boost flexibility of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration [3].The strategic research conducted on adaptation and mitigation which covers crops, livestock, fisheries and natural resource management. In technology demonstration the climate resilient technologies developed under strategic research are demonstrated in climatologically vulnerable locations to help the farmers combat vulnerabilities as well to build up the capacity of the farmers. KrishiVigyan Kendra (KVK) Dhemaji has been implementing Technology Demonstration Component NICRA (TDC-NICRA) since 2021 in Magurmari village of the district. To establish climate resilient agriculture in Magurmari village and mitigate the vagaries of weather along with increasing the farm incomeof the villagers various interventions were taken up under the project . This study is an attempt to analyse the impact of the interventions undertaken and a comparison of the economic condition of the farm families.

2. MATERIALS AND METHODS

2.1 Selection of Village

To implement the TDC-NICRA programme, Magurmari village of Simen Chapori under Jonai MSTD block has selected purposefully observing the climatic vulnerabilities. On the other hand, due to up land situation and sandy soil in one part of the village also affected draught like situation after cessation of rain. A participatory rural appraisal (PRA) exercise was conducted with active participation of village head (*gaonburha*), public representative (ward member of Panchayat) and the villagers to develop a complete village map, to identify climatic vulnerabilities and to analyze the strength, weakness, opportunities and perceived threat. To gather the data on land and land use pattern, existing farm production system, major farm activities including livestock, farm income at individual household a baseline survey was conducted in the year 2021 involving all the farm families of the village by personal interview method with structured schedule. Several awareness programmes and Digital trainings were also conducted in the village to motivate the villagers to adopt the new climate resilient technology.

2.2 Data Collection and Analysis

To unveil the impact of interventions all the parameters attributing yield of crops and economics of the cultivation were taken in to account and data compared with the farmers not included under intervention. The average yield data of respective crops were considered and to calculate the cost of cultivation and profit data was collected from the respondents using personal interview with the help of structured schedule designed for this purpose. Simultaneously, secondary sources like NICRA annual reports, AAU Pop data were used to supplement, and to pay triangulation and crosschecking of primary data. Finally the impact of interventions was tested through t-test using following formula:

$$t = \frac{(\overline{x}_1 - \overline{x}_2) - (\mu_1 - \mu_2)}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where

- x̄1 = Observed Mean of 1st Sample
- x̄2 = Observed Mean of 2nd Sample
- s1 = Standard Deviation of 1st Sample
- s2= Standard Deviation of 2nd Sample
- n1 = Size of 1st Sample
- n2 = Size of 2nd Sample

3. RESULTS AND DISCUSSION

3.1 About the Study Area

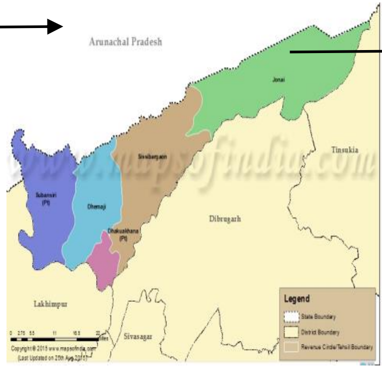
Magurmari is a village located at 27.713159 Latitude and 94.905726 long in Jonai block of Dhemaji District in Assam. In magurmari village TDC-NICRA project was implemented from the year 2021.In the village total cultivated area is 100 ha, among that 90 ha land are under rainfed area and 10 ha are under irrigated land. In the village. The location of the villages with geo coordinates presented in Fig 1.

From Baseline survey following (Table 1) results was obtained about the village.

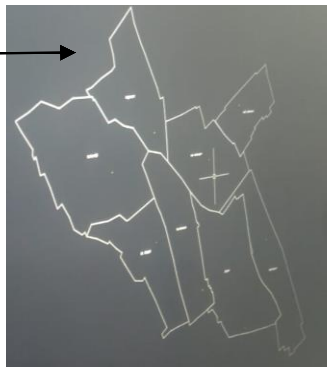
Age of respondents at the time of investigation in complete year was considered for measurement and they were grouped into three categories as - below 35 years, 35-50 years and above 50 years. It is observed from the Table 1 that the majority of the respondents were belonged to middle age category 30-50 years *i.e*. 71.55 percent. While 16.5 % were under young age (below 35 years) category and 11.92 percent were under old age (above 50 years) category. Education constructs the propensity of an individual to revamp knowledge, recognize and utilize the things in a superior way. The data presented in Table 1 shows that the majority of the respondents *i.e*. 38.53 per cent had been educated up to high school level followed by primary level, (26.6%) 14.67% respondents were illiterate and higher secondary level (11.92%) and only 8.25 % respondents were educated up to graduation. None of the respondents belonged to the post graduation category. In case of type of family Table 1 shows that 61.46% of the respondents had joint family and 38.53% had nuclear family and highest percentage of respondents 53.21 had medium sized family with 5-7 members followed by 31.19% per cent of respondents had small sized family with up to 4 members. Only 15.59 per cent of respondents had large sized family where numbers of family members were more than 7. The findings related to operational land holdings of farmers are presented in Table 1 revealed that the maximum number of the respondents i.e. 66.05 % were under the category of marginal farmer (less than 1 ha) followed by small group (1-2 ha) of farmers with 32.11% respondents and only 1.83 % respondents were found under semi medium (2-4ha) category. Annual family income is an indicator of economic stability of the family. Table 1 showed that majority (51.37%) of the respondents belonged to group with annual income up to Rs. 70,000 followed by 32.11 per cent with annual income ranging from Rs. 70001 to 150000, 13.76 % with annual family income 150001 to 300000 and only 2.75 per cent of the respondents were found with annual income level more than Rs.300001 in the study area.

Based on data obtained during baseline survey including climatic vulnerabilitie smagurmari village was divided into four farming system typologies as mentioned in Table 1: Rainfed upland with animal, rainfed medium land with animal, irrigated medium land with animal and rainfed low land and interventions were selected against each typology to enhance their standard of living.The list of interventions along with farmers covered was presented in Table 3.

Map of Assam



Map of Dhemaji District



Map of Magurmari Village

Fig. 1. Study area

Table 1. Profile characteristics of the farmers of magurmari village

Sl. no	Profile characteristics		Frequency and percentage
1	age	Below 35 years	18(16.5%)
		35-50 years	78(71.55 %)
		Above 50 years	13(11.92%)
2	Education	Illiterate	16(14.67%)
		Upto primary level	29(26.60 %)
		Upto high school level	42(38.53%)
		Upto higher secondary level	13(11.92%)
		Upto graduation level	9(8.25%)
		Up to Post graduation	0(00.00%)
3	Type of family	Nuclear	67(61.46%)
		Joint	42(38.53
4	Size of family	Small (up to 4)	34(31.19 %)
		Medium (5 to 7)	58(53.21%)
		Large (more than 7)	17(15.59)
5	Operational land holdings	Marginal farmer (Less than 1 ha)	72(66.05%)
		Small farmer (1-2 ha)	35(32.11%)
		Semi medium farmer (2-4 ha)	02(1.83%)
6	Annual family income	Up to Rs 70000	56(51.37%)
		Rs70001-150000	35(32.11%)
		Rs 150001-300000	15(13.76%)
		Above Rs 300000	3(2.75%)

Demonstration on Sali paddy using the submergence tolerant variety *Ranjit sub 1* was conducted in the village in 10 ha of area which covered 48 farmers in the village. Their traditional paddy variety Ranjana was used as check. The demonstration variety was cultivated by following scientific cultivation practices as per PoP, 2021 developed by AAU, 2021. From the study, it was found that average plant height was148 cm, tiller per hill was15, panicle length was 24 cm, grains per panicle was 236 and grains yield was 48(q/ha) of Ranjit sub-1 for the season 2022-23 whereas average plant height was 122cm , tiller per hill was 9, panicle length was 19 cm, grains per panicle was 160 and grains yield was 39(kg/ha) of check (Var.Ranjana) and it is quite clear from the data presented in Table 3 that Ranjit sub-1 showed better yield performance than farmer's variety in all attributes. The variety performed well in stressful flooded situation and it out-yielded the traditional variety *Ranjana* due to non-submergence to flooded situation. On average, there was a 9 % increase in crop yield. It was also found from the demonstration that the Benefit Cost Ratio (BCR) of the demonstration unit was 2.45 which was more than normal cultivation practice (BCR 1.73). Goswami*et. al.* [4] stated that the benefit cost ratio (B: C) in demonstrated variety (1.58) was more than the

Table 2. Rainfall characteristics during kharif and rabi in Dhemaji district of Assam

Rainfall		Year Normal RF	2022-23
Annual rainfall (mm)		2999.2	2482.1
June		618	773.17
July		548	324.55
August		469	365.67
September		444	191.77
Total *Kharif* rainfall		2079	1848.00
No. of rainy days (*Kharif*)		80	98 days
No. of dry spells during *kharif* season 2022	>10days		
	>15days	No	
	>20days	No	
No. of intensive rain spells (2022)	>60 mm per day	4 days	
Flood situations experienced in NICRA villages (Timing, Duration and Crop stage)	Flood occurs during the month of June for 4 days and in July for 8 days which affected the Sali paddy during seedling and tillering stages		

Table 3. The list of interventions along with area and farmers covered, season, duration conducted during 2021-23

Sl. No.	Interventions	Farming situation	Season	Duration	Area	No. of farmers covered
1	Demonstration on submergence tolerant rice variety 'Ranjit sub-1'	Rainfed Low land	Kharif	150 days	10 ha	50
2	Demonstration on medium duration rice variety Numoli	Rainfed medium land with animal	Kharif	135 days	5 ha	20
3	Cultivation of megha turmeric through organic mulching	Irrigated medium land with animal and rainfed upland with animal	Kharif and Rabi	315 days	0.65 ha	30
4	Cultivation of rabi vegetables –Cabbage, Broccoli, Cauliflower and Tomato (variety ArkaAbhed) using paddy straw as organic mulch	Rainfed medium land and irrigated medium land with animal	Rabi	90-120 days	0.13 ha	30
5	Low cost raised bed vermicompost production	Rainfed medium land with animal	Kharif-rabi	3-4 months	16 nos	16 nos

farmers' variety (1.31) for the year 2018-19 and During 2019-20, the B: C ratio (1.54) was also found to be more in case of demonstrated variety then the farmer's variety (1.35) which concluded that farmer's income was more in demonstrated technology than their own practice.90 farmers have come forward to adopt the technology and have exchanged 2.65q of submergence tolerant variety Ranjit sub1 seeds in their village leading to a horizontal spread of the technology. An additional area of 7 hectare has been covered by cultivation of Ranijit Sub 1.

Unavailability of medium duration Kharif paddy variety is a major setback for the farmers of Magurmari due to which the paddy fields remain fallow after Kharif paddy cultivation**.** With an objective to increase the farm income of the villagers and also boost double cropping, a demonstration on Medium duration Kharif paddy variety Numoli was undertaken in Magurmari village covering 15 farmers in an area of 5 hectare. They were provided with necessary inputs and technical guidance throughout the demonstration in order to encourage efficient utilization of land through double and triple cropping. The local cultivar Nilanjana was used as check.From the study it was found that average plant height was 132 cm, tiller per hill 14, panicle length was 22 cm, grains per panicle was 228 and grains yield was 46q/ha of Numoli for the season 2022-23 whereas average plant height was 115, tiller per hill 8, panicle length was 17 cm, grains per panicle was 168 and grains yield was 35 of local cultivar Nilanjana. From the data presented in the Table 4 it is evident that Numoli showed better yield performance than farmer's variety in all attributes.

Apart from providing necessary nutrients, vegetable cultivation renders a plethora of benefits such as their short growing cycles, and efficient use of irrigation and aids to reduce farmers' vulnerability to climate change. Lack of knowledge among farmers regarding scientific cultivation practices of vegetables caused low yield. With the objective to increase farm income and minimize the risk, an initiative was taken to the cultivate of rabi vegetables after Kharif Paddy under the project. After the harvest of paddy, they opted for seasonal vegetables. Owing to the interest of the villagers' a demonstration on Rabi vegetables viz. cabbage, cauliflower, broccoli, and tomato was conducted among the villagers using paddy straw as organic mulch. The results indicated that Rabi vegetables fetched them a good profit with an average BC ratio of 3.60. This inspired their fellow farmers towards double cropping and enhancement of income.

Cultivation of Megha turmeric-1 was demonstrated in the NICRA adopted village through organic mulch method to enhance their income which is a new variety developed by the Indian Council of Agricultural Research (ICAR) Complex for NEH Region, Meghalaya has high curcumin content and also has high tolerance towards leaf spot and leaf blotch diseases [5]. The indigenous turmeric varieties are susceptible to various fungal diseases like leaf spot which limits the yield. Mulching was done immediately after planting and repeated 40 days after planting with suitable mulching material like paddy husk and sawdust, straw, green leaves, etc. The first weeding was done at 40 days after planting (before the second mulching) and repeated depending upon the intensity of weed growth at fortnightly intervals. The crop was ready for harvesting after 8-9 months of planting (Dec-Jan). Turmeric yield (q) and productivity (q/ha) were recorded at farmers' field locations and provided in table 5. Cultivation of megha turmeric leads to productivity enhancement from 235-247 q /ha with B: C ratio of 5.5. The results have motivated several farmers from nearby villages are coming forward with the adoption of turmeric cultivation in a scientific method.

Demonstration on low cost vermicompost production on raised bed for proper utilization of cow dung, rural farm waste, kitchen wastes, other locally available organic waste materials and organic residues was conducted in magurmai village among 16 framers. Vermicomposting is a technology in which earthworms are used for converting organic waste into nutritious composts for crop production [6-8] Yadavet al.,2010). Cow dung manure was the only organic manure used by the farmers of the village but the quality of the manure was very poor due to unscientific management and the villages were not at all aware about the recycling of rural farm waste, kitchen waste and other organic residues for preparation of organic manure. The average time needed for completion of the process of Vermicomposting was found to be 86.53 days and the average production of vermicompost per harvest per tank was found to be 4.9q. From the results as mentioned in Table 4, it was seen that vermicomposting is a profitable business with a B:C ratio of 4.75:1. Pertaining to the benefits rendered by vermicompost, 38 farmers of NICRA village have shown keen interest to produce vermicompost from different organic wastes and residues [9-11].

The Table 5 depicted an increase in average yield for rice both in low land and medium land, turmeric, cabbage, cauliflower, broccoli, tomato and vermicompost in comparison to previous yield. The differences were found to be significant in all the cases. A multitude of factors including Flood resistant, submergence, high yielding, timely sowing, planting and transplanting, high moisture content in soil, increased frequency of irrigations, improved soil and water management practices would have merged in recognition of better yields.

Table 4. Economics of interventions conducted on the village

Intervention	Crop/ enterprise	Variety	Production	GR	GC	NR	BC
Demonstration on submergence tolerant rice variety 'Ranjit sub-1'	Sali-paddy	Before NICRA Variety: Ranjana	39	54,660.00	31,500.00	23,160.00	1.73
		After NICRA variety : Ranjit sub 1	48	93,120.00	38,000.00	55,120.00	2.45
Demonstration on medium duration rice variety Numoli	Sali-paddy	Before NICRA Variety: Nilanjana	31	60,140.00	36,684.00	23,456.00	1.63
		After NICRA variety : Numoli	46	89,240.00	38,000.00	51,240.00	2.34
Cultivation of Rabi vegetables using organic mulching	Rabi vegetables	Before NICRA Cabbage	170	50,750.00	1,42,800.00	92,000.00	2.81
		After NICRA cabbage	220	52,000.00	1,85,000.00	1,33,000.00	3.55
		Before NICRA Cauliflower	145	52,500.00	1,66,750.00	1,14,250.00	3.17
		After NICRA Cauliflower	180	57,000.00	2,15,000.00	1,58,000.00	3.77
		Before NICRA Broccoli	45	57,000.00	1,31,760.00	74,760.00	2.31`
		After NICRA Broccoli	70	65,000.00	2,05,000.00	1,40,000.00	3.15
		Before NICRA Tomato	175	48,000.00	1,75,000.00	1,27,000.00	3.64
		After NICRA Tomato	210	52,000.00	2,10,000.00	1,58,000.00	4.03
Cultivation of megha turmeric through straw mulching	Tuber crop	Before NICRA Variety : Local	198	89,000.00	3,95,000.00	3,06,000.00	4.48
		After MICRA variety : Megha turmeric	247	4,95,000.00	90,000.00	4,05,000.00	5.5

Intervention	Crop/ enterprise	Variety	Production	GR	GC	NR	BC
Low cost vermicompost production	Organic manure	Before NICRA Vermicompost	3	6,630.00	2,250.00	4,380.00	2.94
		After NICRA vermicompost	6 q	13,260.00	2,8000.00	10,450.00	4.75

Table 5. Before-after comparison of yield of crops

Crop/Vegetables		Yield Mean	Standard Deviation	T-value
Sali Paddy (Low land)	Before NICRA	34.425	5.26	1.22*
	After NICRA	**47.35**	1	
Sali Paddy (Medium land)	Before NICRA	31.82	1.82	2.35**
	After NICRA	**45.425**	0.78	
Turmeric	Before NICRA	198.17	8.2	3.54*
	After NICRA	**245.35**	3.58	
Cabbage	Before NICRA	167.6	4.63	1.05**
	After NICRA	**216.07**	2.63	
Cauliflower	Before NICRA	132.25	3.05	1.27*
	After NICRA	**185.6**	2.87	
Broccoli	Before NICRA	52.35	1.89	2.33*
	After NICRA	**69.85**	1.23	
Tomato	Before NICRA	154.35	4.87	4.13**
	After NICRA	**215.2**	4.02	
Vermicompost	Before NICRA	3.65	1.5	2.18*
	After NICRA	**5.66**	0.23	

4. CONCLUSION

It can be concluded from the above study that NICRA project was a successful project in Dhemaji district and has been able to accomplish the prime objective of the project which was the adoption of new technology with changing of agro-climatic condition to establish resilient agriculture system. The horizontal spread of the demonstrations under the project is one of the key factors that prove its success. The project extended its impacts through different farmers 'clubs, SHGs, and district line departments. KVK scientists perceived that the motivation and interest level of farmers of NICRA adopted Village (Dhemaji) on agriculture were high compared to other villages. This type of task was challenging both for scientists and farmers but it was the only project which can sustain the Indian agricultural system with changing of global agricultural climate. This project will help the farmers' with the adoption of site-specific technology and enhance the decision-making powers among the scientist and policymakers on climate resilience agriculture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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