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Climate resilient technological interventions to ensure food security in flood affected area – An experience from NICRA village, Dhubri, Assam

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ABSTRACT :

The study was conducted in villages of Dhubri district in Assam under National Innovation on Climate Resilient Agriculture (NICRA) project implemented by Krishi Vigyan Kendra, Dhubri during 2013 to 2015. The villages are situated under Bilasipara sub-division in the district 'Dhubri' of Assam, India on 26° 15. 425´ to 26° 16.570´ N latitude and 90° 14.034´ to 90° 18.040´ E longitude at an elevation of 128 ft from mean sea level. Recurrent floods has been the principal constraints in food production in these villages affecting mainly winter (*Kharif*) rice during the growing season as well as summer rice (*Boro* and *Ahu*) at the time of maturity. The prevailing weather patterns of the area were observed to have a strong bearing on the occurrence, intensity and magnitude of floods. About 71 per cent of total rainfall occurs during monsoon period (June to September), the winter being virtually dry leaving little scope for growing any *Rabi* crop. To ensure rice production to climatic variability leading to flood, site specific climate resilient technologies such as staggered planting rice variety 'Gitesh', flood escaping, short duration HYV rice 'Luit' for post and pre-flood situation, submergence tolerant rice variety 'Swarna Sub 1' and mid duration HYV of rice 'Joymati' during pre-flood situation were tested and demonstrated in the project villages. It was necessary to observe the performance of these varieties to the climatic vulnerability as well as farmer's acceptability. The average yield of the rice variety 'Gitesh' (45 days aged seedlings), 'Luit' (post flood situation), 'Luit' (pre-flood situation), 'Swarna Sub 1' and 'Jomati' were found to be 40 to 42, 26.3 to 36, 23.35 to 31.39, 33 to 45 and 42.37 to 50.76 q per hectare, respectively. As a result of the study and demonstration to endure recurrent flood and climatic variability, the newly introduced winter rice varieties, Gitesh has spread over the highest area in the project villages (90.00%) followed by 'Swarna Sub 1' (75.00 %) and 'Luit' (66.67 %) due to flexibility in seedling age facilitating delayed transplanting, submergence tolerance upto 14 days and allowance for transplanting after recession of flood, respectively.

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Weather variability leading to Climate change has emerged as a major challenge in sustainable production of food grains to feed the teaming millions. Climate change projection upto 2100 for India indicate an overall increase in temperature by 2 - 4^0 C with no substantial change in precipitation. However, different regions are expected to experience differential changes not only in the amount of rainfall but in distribution pattern also in the coming decades (Kavikumar, 2010). Besides, changed rainfall patterns, it is predicted that extreme events are likely to increase in the country resulting in more droughts and floods. Indian Agriculture, with about 58 per cent of its net cultivated area as rainfed, is exposed to frequent stresses arising from climatic variability and climate change (Kavikumar, 2010). It has, therefore, been expected to face severe impacts of climate change on Agriculture and the country's North Eastern region particularly Assam, is highly vulnerable. Enhancing the resilience of agriculture to cope up with weather variability and climate change has become imperative to the livelihood security of millions of small and marginal farmers of this region. The climate vulnerability identified includes drought, flood, cyclone, heat wave, high temperature stress, hail storms etc. Being a basin of the entire hilly NE Region with a single outlet and 65 to 72 per cent of total rainfall intercepted during monsoon period, flood is a recurring phenomenon in Assam, 45 per cent area of the state being flood prone (Dept. of Agriculture, Assam).

Floods, water stagnation, flash floods and resultant sand casting are the most frequently occurred climatic vulnerability in westernmost district 'Dhubri' of Assam due to high intensity rainfall during monsoon coupled with uneven distribution. With flood as the major climatic vulnerability, Krishi Vigyan Kendra, Dhubri under Assam Agricultural University, has been implementing a project on 'National Innovation on Climate Resilient Agriculture' since 2011 at *Udmari* village (part. IV and V) with site specific technology demonstration components for enhancing the adaptive capacity of farmers to flood hazards. In the project village, rice is the staple food for cent percent of the population and winter rice is the major crop cultivated during *Kharif* season. The rice fields of the village were often found to be inundated with flood water during the season resulting not only yield reduction but also loss of rice production. To compensate loss of *Kharif* crop, farmers depended on early *Ahu* or summer rice which was often submerged by flash flood water due to pre-monsoon rains at the time of harvesting leading to yield loss. Agriculture in the district, therefore, has become not only non-remunerative but also has become risky in recent times. Keeping in view of these constraints, a study was conducted to observe the performance of situation specific and climate friendly rice varieties to endure flood hazards and the adoption of these rice varieties by the farmers of the project area during 2013 to 2015.

MATERIAL AND METHODS

The study was conducted in the Udmari villages (part. IV and V) under Udmari Gram Panchayat of Raniganj block under Bilasipara sub-division of Dhubri district, Assam. The villages are situated in Lower Brahmaputra Valley Agro-climatic Zone of Assam at 26° 15. 425´ to 26° 16.570´ N latitude and 90° 14.034´ to 90° 18.040´E longitude at an elevation of 128 ft from mean sea level. At the beginning of the project implementation, a base line survey was conducted in the selected villages. Total cultivable area under the project area was 204 ha out of which 146 ha was rainfed with cropping intensity 150 per cent. Rice was found to be the major crop of the project village. For the study, a total of 100 farmers were personally interviewed with the help of a structured schedule.

The major contingencies were identified as per group discussion with villagers. The areas of the villages were grouped according to flood water depth and duration of water stagnation during flood. According to different agro-ecological situations, three rice varieties *viz*., Gitesh, Luit and Swarna Sub 1 during *Kharif* season and another rice variety 'Joymati' during *Rabi* season were demonstrated in the farmer's field. The performances of these varieties and farmers adoption were observed. Weather parameters were studied based on secondary data collected from District Agricultural Office, Dhubri and analysed as per standard procedures.

RESULTS AND DISCUSSION

The Dhubri district including the project village was found to experience a warm humid climate with an average normal annual rainfall of 2990.28 mm with 133 rainy days (based on data 1971 to 2010). It was observed that the monsoon in the district used to start from the first week of June and continues upto September. About

71 per cent rainfall with normal average rainfall of 2138.71 mm is received in the district during monsoon (*Kharif)* season. The district has also experienced substantial amount of pre-monsoon rain starting from April leaving winter (*Rabi*) virtually dry. The prevailing weather patterns were observed to have a strong bearing on the occurrence and intensity of floods (Table 1). The flood, in the project village, was found to occur two to seven times in a year during mid May to mid September. For example, floods occurred during 2015 were June 5 to 11, July 4 to 6, August 18 to 20 and August 22 to 24. The main reasons for floods were observed to be high intensity and incessant rainfall in the locality and overflowing of the main drainage system, river Gaurang due to heavy rains in 'Bhutan'. It was observed that the duration of inundation of the rice field varied from site to site in the project area. Out of the total project area, the *Kharif* rice fields were found to be inundated with flood water for 2 to 8 days in 130 ha area with water depth varying from 0.6 to 1.5 m, 7 to 12 days in 40 ha area with water depth of 1.5 to 1.8 m and 15 -20 days in another 30 ha with water depth of 2.14 to 2.4 m.

As discussed above, flood and inundation was observed to be the major weather led climate vulnerability in the project villages affecting *Kharif* rice during its vegetative growth period as well as summer rice at the time of maturity. However, it was also observed that sporadic occurrence of drought like situations due to erratic behaviour of rainfall affects the growth of *Kharif* rice at various stages and affected mostly the *Rabi* crops. Hailstorms were also found to occur during pre monsoon and monsoon period affecting mostly summer rice and horticultural crops (Table 2).

After studying weather vulnerability in relation to weather parameters and discussion with various farmers' groups, situation specific technological interventions were carefully selected and demonstrated in the project village both for testing and horizontal spread. High yielding rice varieties like 'Gitesh', 'Swarna Sub 1' and 'Luit' during *Kharif* and 'Joymati' as early *Ahu* were introduced as per suitability of different agro-ecological situations.

Performance of staggered planting rice variety 'Gitesh':

It was evident from the baseline survey that farmers incurred loss as they were unable to transplant HYV of

Table 1 : Rainfall characteristics during *Kharif* in Dhubri district of Assam

Historical trends in rainfall	Normal	Year (s)				
	Rainfall (mm)	2011	2012	2013	2014	2015
Annual rainfall (mm)	2990.28	1756.70	2797.60	1073.30	2170.20	2333.20
June	603.31	375.80	1430.30	377.30	615.90	472.00
July	681.19	260.00	422.50	85.20	160.60	211.00
August	464.08	444.60	221.50	276.60	382.00	800.40
September	390.14	251.10	434.04	0	492.40	204.00
Total *Kharif* rainfall (mm)	2138.71	1331.50	2508.34	739.10	1650.90	1687.40
No. of rainy days (*Kharif*)	52	36	26	55	71	64
No. of intensive rain spells (*Kharif*) > 60 mm per day	-	6	17	4	9	6

Table 2 : Major contingencies of the project villages

Contingencies	Season			Regular			Sporadic			Crops affected most
	May - September	October - January	February - April	Severe	Moderate	Mild	Severe	Moderate	Mild	
Flood	√			√						Sali rice, summer rice
Drought like situation		√						√		Sali rice, *Rabi* crops
Hail storm	√		√	√						Summer rice, jute, Banana, areca nut

rice at appropriate time with proper seedling age due to water stagnation. It also revealed that flood damages *Kharif* rice during July to August even if transplanting could be done. Double transplanting with traditional or improved varieties, transplanting over aged seedlings of photosensitive traditional *Sali* varieties like Panisali, Goyaswari, Malchira etc. after recession of flood water are common cropping strategies adopted by farmers to adverse situations. Adoption of traditional photosensitive rice varieties with higher seedling age resulted in poor yield (15 q/ha). In this situation, technological intervention with high yielding rice variety 'Gitesh' having the flexibility in respect of seedling age from 30-60 days (Sarma and Saikia, 2009), was demonstrated in the farmers' field of the project area. The average yield of the rice variety 'Gitesh' (45 days old seedlings) were 40 to 42 q/ha (Table 3) with 42.02 to 62.16 per cent increase in yield with higher net return over the existing varieties and practices.

Performance of short duration HYV rice 'Luit' for post and pre flood situation :

After recession of the flood water, farmers of the project area either cultivated some traditional photosensitive low yielding varieties upto last part of August or left the field fallow during *Kharif* season. On the other hand, it was found that farmers used to cultivate some intruded rice varieties as early *Ahu* (summer) under irrigated conditions to compensate the loss during *Kharif* season. This crop was often affected by flash flood water at the time of harvesting because of the longer duration. A short duration photo-insensitive new rice variety 'Luit' (100-105 days) was introduced as demonstration in the project area to escape flood both during pre and post flood period. The base line survey revealed no such short duration rice varieties (100 days) was cultivated in the project area before introduction of this rice variety.

The average yield of the rice variety 'Luit' in a hectare were found to be 30.0, 26.3, 36 q in post flood situation (*Kharif*) and 23.35, 28.93, 31.39 q in pre flood situation (*Rabi*) during 2013, 2014 and 2015, respectively (Table 3). This rice variety performed very well with higher net return (Table 3) and could escape flood.

Performance of submergence tolerant rice varieties :

Since flood was the major constraints of crop production during *Kharif* season in the project villages, were unable to cultivate winter rice (*Sali*) in time because of flood water and mainly adopted some traditional local late *Sali* varieties for cultivation. In most of the area (about 130 ha), flood water receded within 2 to 12 days. In this semi deep rainfed lowland situation with flash flood, technological intervention through introduction of

Table 3 : Performance of situation specific rice varieties under aberrant weather condition

Technology demonstrated	Year	Average yield (q/ha)		% Increase in	Net return		B : C	
		Demo	Local	Yield	Demo	Local	Demo	Local
High yielding delayed	2013-2014	42.00	25.90	62.16	23,448	8058	1.87	1.35
planting rice variety	2014-2015	40.50	27.00	50.00	21,400	9350	2.10	1.52
'Gitesh'	2015-2016	40.05	28.20	42.02	17319	9382	1.76	1.50
Short duration HYV	2013-2014	36.00	-	-	17937	-	1.71	-
rice variety under post	2014-2015	26.30	-	-	9,050	-	1.52	-
flood situation – 'Luit'	2015-2016	30.00	-	-	13500	-	1.78	-
Short duration HYV	2013-2014	31.39	-	-	13577.86	-	1.83	-
rice variety under pre-	2014-2015	28.93	-	-	13821	-	1.61	-
flood situation – 'Luit'	2015-2016	23.35	-	-	6270	-	1.42	-
Submerge tolerant rice	2013-2014	45.00	24.00	87.50	26,307	8229	1.95	1.40
variety- Swarna sub-1	2014-2015	33.00	27.00	22.22	14,700	9,350	1.80	1.52
	2015-2016	38.60	26.54	45.44	18071.92	8196.15	1.90	1.44
HYV of rice under pre	2013-2014	42.37	27.30	55.20	20767	9167.95	1.96	1.50
flood situation –	2014-2015	50.76	44.40	14.32	26374	21640	2.08	1.95
'Joymati'	2015-2016	47.75	42.90	11.30	24258	13,849	1.94	1.58

Demo indicates Demonstrated plots; Local indicates farmers' practices

submergence tolerant rice variety (Sarkar *et al.*, 2009) was the need of situation. The study was taken up with introduction of 'Swarna Sub 1' to cope up with such weather hazard.

It was observed from the Table 3 that the submergence tolerant rice variety 'Swarna Sub 1' was found to tolerate submergence condition upto 14 days with an average yield of 33 to 45 q per ha which was up to 87.5 per cent higher over that of local variety.

Performance of HYV of rice 'Joymati' during pre-flood situation :

Cultivation of rice as *Boro* or as early *Ahu* (summer rice) was found to be the common practice to compensate losses in *Kharif* crops due to flood. It was observed that farmers used to transplant early *Ahu* rice in the month of February with some intruded non-descript varieties. However, this crop were often submerged by flood water at the time of maturity by early flood leading to crop loss because of longer duration and dwarfness in stature. With this background, an intervention through introduction of a new HYV of *Boro* rice variety 'Joymati' was made to cope up with the problem. The rice variety 'Joymati' was known to have non-lodging behaviour and higher plant height with yield potentiality of 5.1 t/ha.

It was observed that farmers could harvest this rice variety as it escaped flood due to relative earliness in maturity and was not completely submerged by flood water at the time of harvest and yielded 42.37 to 50.76 q/ha with 11.30 to 55.2 per cent higher crop yield as compared to existing varieties (Table 3).

Farmers' acceptability to demonstrated site specific technologies :

From the survey and group discussion conducted during *Kharif* 2016, it was observed that the farmers of the project villages adopted all the three rice varieties during *Kharif* as per their situation according to climatic vulnerability. Results from the Table 4 revealed horizontal spread and adoption was the highest in the variety 'Gitesh' (90.00%). The submergence tolerant rice variety 'Swarna Sub 1' introduced in the area also has considerably adopted and spread over the area (75.00 %). The short duration variety 'Luit' was also adopted by farmers and attained a spread level of 66.67 per cent. Among the three introduced verities in the project villages, farmers were found to prefer staggered planting rice variety 'Gitesh' due to relaxation of seedling ages (30 to 60 days) which could be cultivated either after recession of flood or intermittent drought like situation at the time of transplanting. From the group discussion with farmers, it was revealed that the farmers' preference was due to higher yield over local varieties and flexibility in seedling age and transplanting time.

In flash flood affected areas, farmers adopted 'Swarna Sub 1' variety which could withstand total submergence upto 14 days in farmer's field with higher grain yield. Farmers also revealed that the grain weight of this variety (1000 grain weight 19.30 g) was found to be comparatively higher to local varieties (1000 grain weight 19.08 g). However, the availability of quality seeds was found to be the major problems in increasing the area under this variety.

Results from Table 4 revealed 66.67 per cent increase in area during *Kharif* 2016 under short duration rice variety 'Luit' in project and nearby villages. Farmer's preference to this variety was due to its shorter duration which could be cultivated during post flood situation up to early September. It was found that many farmers preferred to cultivate contingent crop like Black gram during post flood situation to catch the season rather than late transplanting of rice which resulted into lower adoption of this variety in comparison to other two varieties. In case of all these three varieties, farmers opined that the availability of quality seeds was found to be the most important problem in increasing the area under these varieties.

Table 4 : Farmer's acceptability to site specific technologies demonstrated in project villages during *Kharif* 2016

Technology demonstrated	2013-14		2016-17		% increase in area due to farmers' adoption
	Area (in hectare)	No. of Farmers	Area (in hectare)	No. of farmers	
High yielding delayed planting rice variety 'Gitesh'	1	4	10	19	90.00
Short duration HYV rice variety under post flood situation – 'Luit'	2	2	6	6	66.67
Submerge tolerant rice variety- Swarna Sub-1	2	7	8	25	75.00

Conclusion:

With changing climate, extreme events are likely to increase in the country in general and in the north eastern region in particular resulting into more drought and floods. Rainfall patterns of the region and Assam shows that 65 to 72 per cent of the total rainfall is received during the monsoon period from June to September resulting in frequent floods. Floods during the entire *Kharif* season hinders in achieving achievable yield and production threatening food security of majority of small and marginal farmers of the state (85%). In such situations prevailing in one-third of rice land in Assam and elsewhere in the country may have specific technological interventions as has been demonstrated and proven in the present project villages of Dhubri district of Assam. To enhance the resilience to agriculture in flood affected and submergence prone area, high yielding rice varieties with certain specialities like 'Gitesh', 'Swarna Sub 1' and 'Luit' during *Kharif* and 'Joymati' as early *Ahu* could be introduced which will certainly be adopted by farmers as per their agro-ecological situations as proved in the present study.

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