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Krishnendu Chattopadhyay, Sukanta Gayen, Ismail Mondal,
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(Indian Council of Agricultural Research)

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AUTHORS

Foreword

Climate change is becoming a serious issue in all over the world. Indian coastal region particularly eastern region is one of the vulnerable are facing occurrence of more extreme events like drought, flooding and salinity stress at a frequent interval. Rice being the main crop in eastern coastal area, it is affected most by these abiotic stresses. To keep pace with the ever growing population, sustained increase in rice production is necessary, especially in eastern India. Any event which diminishes rice production is a serious threat to food security. In the eastern coastal area, Sundarban is declared as world heritage site by UNESCO. Among the climatic irregularities devastating cyclone called 'Aila' in 2009 changed the socio-economic and livelihood of this area. Cultivation of rice being the main crop and staple food of this region was affected most. Sufficient rice production at small farm holders level is required to secure food as well as livelihood security.

ICAR-NRRI, Cuttack has made significant contribution by developing high yielding climate resilient rice varieties tolerant to abiotic stresses such as drought, submergence, salinity and waterlogging. But spreading of these varieties among farmers in vulnerable areas to climate change has been always been a challenge. Initiative for evaluation of these varieties in Sundarban, one of the most vulnerable areas, is praise worthy. The demonstrations with rice varieties such as Varshadhan, Luna Suvarna, Luna Barial, Swarna-Sub1 and Savitri-Sub1 in five blocks in Sundarban through National Innovation on Climate Resilient Agriculture (NICRA) generated enthusiasm among farmers. This will facilitate quick dissemination of these technologies. Feedbacks from farmers also will help researches for further refining their technologies.

I compliment all the persons involved in such large scale demonstrations in ecologically sensitive region like Sundarban. I wish that in coming years more such initiatives will be taken to improve the productivity of rice in areas likely to be affected most by the climate change.

(A.K. Nayak)

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Executive Summary

"Rice is life". It is the staple food for more than half of the world's population. To keep pace with the ever growing global population, progressive and sustained increase in rice production is necessary, especially in areas with extremely variable climatic conditions. It is a herculean task to improve rice productivity, as climate change is anticipated to lead to a greater variability in hydro-meteorological aberrations resulting in increased frequencies of extreme events like flash floods with fresh or saline water, higher temperatures, salt intrusion, and longer dry spells in some areas. National Rice Research Institute (formerly Central Rice Research Institute), Cuttack is working on the subject so that food security of India is not jeopardized due to any such events. People live in coastal area are now more vulnerable due to such climatic aberrations. Different abiotic stresses such as salinity, waterlogging, drought influence rice productivity in these areas. Extreme events like flood, cyclonic storm are very common now. During May 2009, a severe cyclonic storm occurred in Sundarban area of West Bengal, called 'Aila'. Thousands of people died, destruction of standing crop, salinisation of land and loss of property were too high to survive and to get food twice a day was a dream. Food security especially for poor and marginal farmers was at stake. Rice cultivars such as Varshadhan (CRLC 899)-tolerant to waterlogging, Swarna-Sub1 (CR 2539-1) and Savitri-Sub1- tolerant to submergence, CR Dhan 403 (Luna Suvarna), CR Dhan 402 (Luna Sampad) and CR Dhan 406 (Luna Barial) - long duration salt tolerant type, CR Dhan 405 (Luna Sankhi) - short duration and tolerant to salinity, and CR Dhan 503 (Jayantidhan) - tolerant to waterlogging, were grown in different blocks of Sundarban areas. The name of the blocks are Sandeshkhali-I, Hingalganj, Basanti, Gosaba and Patharpratima. Land use and land cover map based on remote sensing data suggested great variations before and after 'Aila'. There are increments of salinity level and deepwater areas especially after 'Aila' across the different parts of Sundarban. The area under vegetable cultivation drastically decreased after 'Aila'. Fishing activity increased. The demonstrations of varieties were carried out mostly in small and marginal farmers' land. They mainly cultivate rice for home consumption. After meeting the demand if any surplus is left over they sell it in local market. The farmers with irrigation facility cultivate premium rice variety 'Satabdi' (Minikit) mainly in *Rabi* (Dry) season. Survey was conducted and a numbers of problems were known. Farmers put high hope for high yielding rice cultivars, which can tolerant salinity, water stagnation and submergence. Training was imparted to both male and female farmers in disseminating the knowledge of climate resilient rice cultivation. The farmers with surplus rice for sell asked for fine rice whereas farmers who mainly cultivate rice for home consumption greatly preferred "Bold Grain Rice"- the rice with slow digestibility. Varieties with puffing / flattened qualities were preferred by farmers. This is important for breakfast as well as for snacks purpose. Among the tested varieties Varshadhan, Swarna-Sub1, Savitri-Sub1, Luna Suvarna and Luna Barial got greater appreciation by the farmers. They rather selected these varieties for further cultivation. Seeing the performance of the varieties, numbers of farmers purchased the paddy as seed purpose with high price from the farmers who grew NRRI varieties. Seed production was initiated by a group of farmers. Large scale initiative for cultivation of climate resilient varieties by other agencies would improve not only food security but also social security for better education and life at the areas where flood/cyclone/drought are frequent.

1. Introduction

Rice, the most important cereal food crop of India, is occupying about 20% of gross cropped area of the country and contributing 41% of the total food grain production. It plays a vital role in the national food grain supply. Any event which diminishes rice production is a serious threat to food security. In India, rice is mainly cultivated in tiny farms primarily to meet family demand. Marketable surplus to meet the demand of urban populace comes from affluent farmers mainly from northern and southern India, and in limited quantities from eastern Indian farmers. Food security depends on availability of foods. The best example is 'Bengal Famine of 1943'. At least 3 million people perished. Rice crop were damaged due to tidal waves and epidemic of brown spot disease in 1942. The British bought up massive amounts of rice but hoarded it. The famine only ended because Bengal thankfully delivered a strong rice harvest by 1944 (http://www.ibtimes.com/bengal-famine-1943-man-made-holocaust-1100525).With a population of 1.25 billion, India is likely to be the most populous country on this planet by 2030 with 1.6 billion people. The country needs to produce 120 million tons of rice by 2030 to feed its one and a half billion plus population by then (CRRI Vision Document-2030 2011). Sufficient rice production at smallholder farms level is required to secure food as well as livelihood security. Boosting productivity at smallholder farmers level is now more valid as because big farmers are now interested to sell their lands for industry for better income. The Indian Network for Climate Change Assessment (INCCA 2010) projected the climate change scenario for 2030s as compared to 1970s. The magnitude of increase in annual minimum and maximum temperatures along the eastern and western coastal regions was estimated to be 2.0-4.5 °C and 1.0-3.5 °C, respectively. This is lead to erratic rainfall. Consequences of such erratic rainfall were that rice crop in the same season would experience drought, submergence, stagnant flooding, apart from salinity stress in coastal areas. The sea level along the Indian coast has been rising at an average rate of about 1.3 mm/year and the trend is likely to continue in the future. A possible sea-level rise of 15 to 38 cm by the 2050s (Douglas 2009) would cause saline water to penetrate further inland and ultimately displace some 35 million people around the Bay of Bengal, and change the conditions in other deltas and coastal plains on a similar scale (Wassmann *et al.* 2009). India is encircled by sea from three sides, the Arabian Sea on the west, the Bay of Bengal on the east and the Indian Ocean on the south. The east coast accounts for more than 60% of the salt-affected coastal land areas and 75% of this are distributed in West Bengal and Odisha. Most of these areas are rainfed and mono-cropped with rice in the wet season. Therefore, for sustainable rice cultivation the challenges are many. Present and anticipated global food demands further necessitate a significant increase in crop productivity on less favorable farmlands under the adversary of climate change. To tackle such problem rice cultivars tolerant to flood, drought, salinity as well as combination of these or more abiotic stresses would ensure production, food security and livelihood.

Rice is the main crop in Sundarban area of West Bengal. As this delta is largely affected by different climatic constrains, rice is subjected to various abiotic stresses such as salinity, waterlogging, submergence and drought. Present day climatic changes have also great impact on the rice production and livelihood of this region. Many incidence with varying level of intensity such as cyclone, heavy downpour, delay monsoon, etc. have been occurred more frequently in this decade than before. Land situation, the land use pattern, socio-economic condition and preference of crops and varieties have been significantly changed after the mega climatic disaster named 'Aila' in the year 2009. Different government and non-government

agencies are intervening to improve the circumstances to the people live in this fragile ecosystem. Rice is in the heart of the people of Bengal. People mainly get their energy from this tiny cereal. Improving the rice productivity under changing climate ensure food security and livelihood. Our efforts have been oriented towards introducing of climate resilient rice varieties developed by NRRI, Cuttack. The works have been initiated since 2011 and further strengthen by the intervention of the ICAR project entitled "National Initiative on Climate Resilient Agriculture for XII five year plans" since 2012-13. Here in this bulletin, we try to elaborate about the technologies in the light of the socio-economic situation, the preference of farmers and consumers and changes of rice productivity, and food security in coastal Sundarban area of India.

1.1.Location

Indian site of Sundarban has a shore length of 130 km out of the total 180 km coastal length of West Bengal. The location of Western Sundarban (Study Area) of Indian part is between 220 to 22^0-56/ N and 88^0-41/ to 89^0-23/ E. Indian Sundarban is covering the area of south-eastern part of both North-South 24 Parganas (Fig 1). Under Sundarban area, there are 13 blocks in South 24 Parganas and 6 blocks in North 24 Parganas districts.

Fig. 1. Physical position of Sundarban in Indian map
(Source: http://www.sundarbanaffairs.in/block_profile.php)

1.2. Climate

A tropical South-west monsoon type of climate can be experienced during rainy season. The main seasons are spring, summer, rainy / monsoon, autumn and winter. Spring and Autumn seasons are experienced for very short period. The summer season starts in the month of

March and extends till the end of May. Temperatures can reach a maximum of around 41 degrees Celsius during this period in the region. Humidity is also high and this makes it uncomfortable during the day. The low pressure troughs are commonly formed due to the rising temperature, which may brings severe cyclonic storms, thunderstorms and rainfall. This is known as 'Kalbaisakhi' (Nor'westers). The temperature can be expected to drop due to 'Kalbaisakhi'. Mega cyclonic storm 'Aila' occurred in the month of May, 2009. Both materials and life loss were enormous (Table 1).

Table 1. Damages caused by the Aila

Damages Caused by the Aila	
• Number of villages affected: • Size of affected population: • Number of people missing: • Number of deaths:	4249 25,62,442 8000 Official – 70; Unofficial – 300
• Length of embankment breached:	400 kilometers
• Number of cattle lost: • Total area of agricultural land affected: • Estimated financial loss in agriculture:	2,12,8512,12,851 1,25,872 ha Rs.337crore
• Number of houses fully damaged:	1,94,390
• Number of houses partially damaged:	1,94,701
• Total loss:	Rs.1495.63 crore
Source: Unpublished records of the Govt. of West Bengal. Rudra. K., 2010, A South Asian Journal on Forced Migration, MCRG, Kolkata. Pp.86-93 (http://www.mcrg.ac.in/rw%20files/RW35/7.Discussion_Paper1.pdf)	

The monsoons rain start in the month of June and end in the month of September. The average annual rainfall is about 1800-1900 mm and around 75% of rain occurs during this period. During monsoon season low pressure in Bay of Bengal often causes cyclonic storm in coastal regions. Coastal areas may encounter mild to severe and more than one cyclonic storm in each year from March to October. Winters are mild. Winter season starts from December to February and temperatures may range from a minimum of 10 degrees to a maximum of 30 degrees Celsius.

1.3. GIS and Remote sensing study

Eastern part of Indian Sundarban including Sandeshkhali-I and Hingalganj blocks were taken for land use and land cover study using NATMO LULC map, Google Earth map, SOI Toposheet, some ground truth data like photographs, GPS readings, and shore line measurement by tape. Remote sensing techniques were carried out using ERDAS IMAGINE software and TNT MIPS and GIS analysis was carried out using Arc GIS.

1.3.a. Land use

Remote sensing and GIS data indicated that the double cropped area and agricultural fallow

land were significantly decreased while deep water land and settlement with homestead orchard were significantly increased in the period between the years 1990 and 2013 (Fig. 2). Unavailability of sweet water for irrigation and increased area under water logging due to heavy downpour and elevated sea level might be some of the reasons behind these observations (Fig. 3). Resources were diverted for cash crop to aquaculture (mainly fishing).

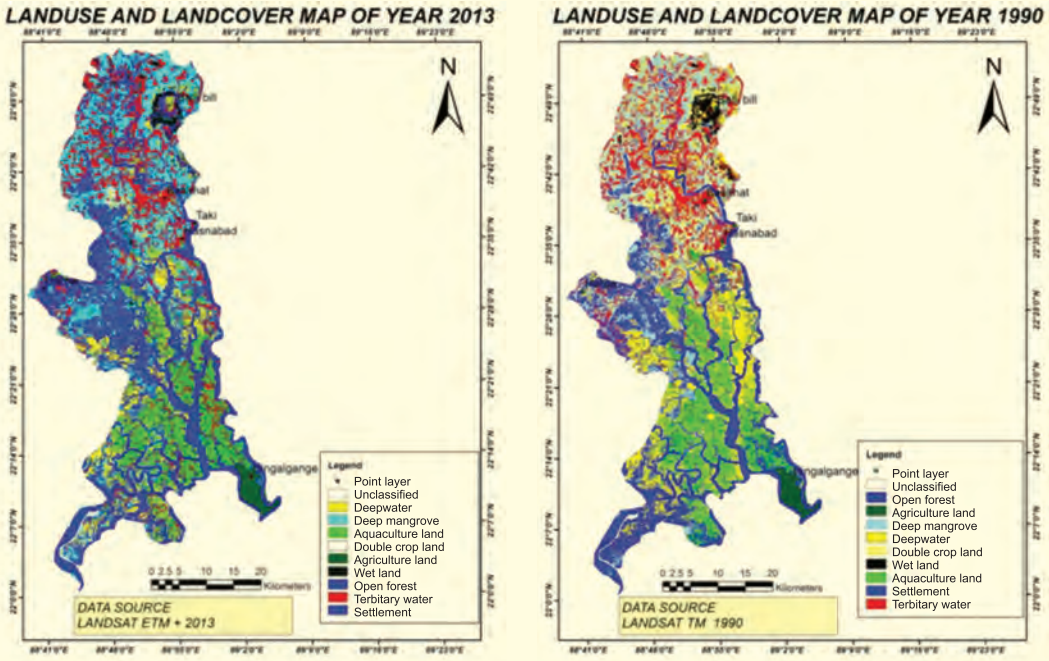

Fig. 2. Land use and land cover map of eastern Sundarban in 1990 and 2013

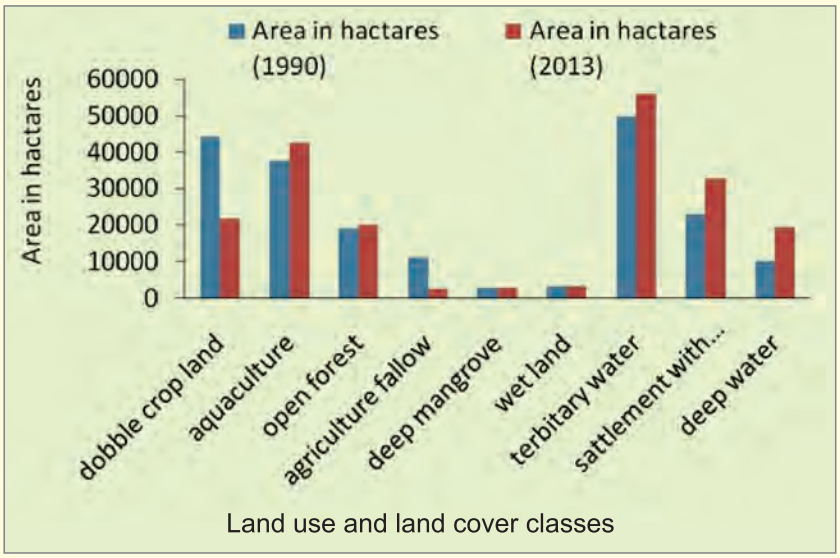

Fig. 3. Comparative graphical representations of land use and land cover pattern of eastern Sundarban in 1990 and 2013

1.3.b. Normalized Difference Vegetation Index (NDVI)

NDVI clearly revealed the high density of green colour in the deep mangrove forest area and also vegetation in domestic area at Hingalgang block. Medium range of colour was representing the plantation area of Canning and Gosaba blocks.

1.3.c. Normalized Difference Water Index (NDWI)

NDWI indicated that there was an increase in water table especially in Sandeshkhali-I block at the rate of 0.35% in 2013 as compared to 1990. This increase was corroborated with the increase of the fishery area in this region. (Fig. 4)

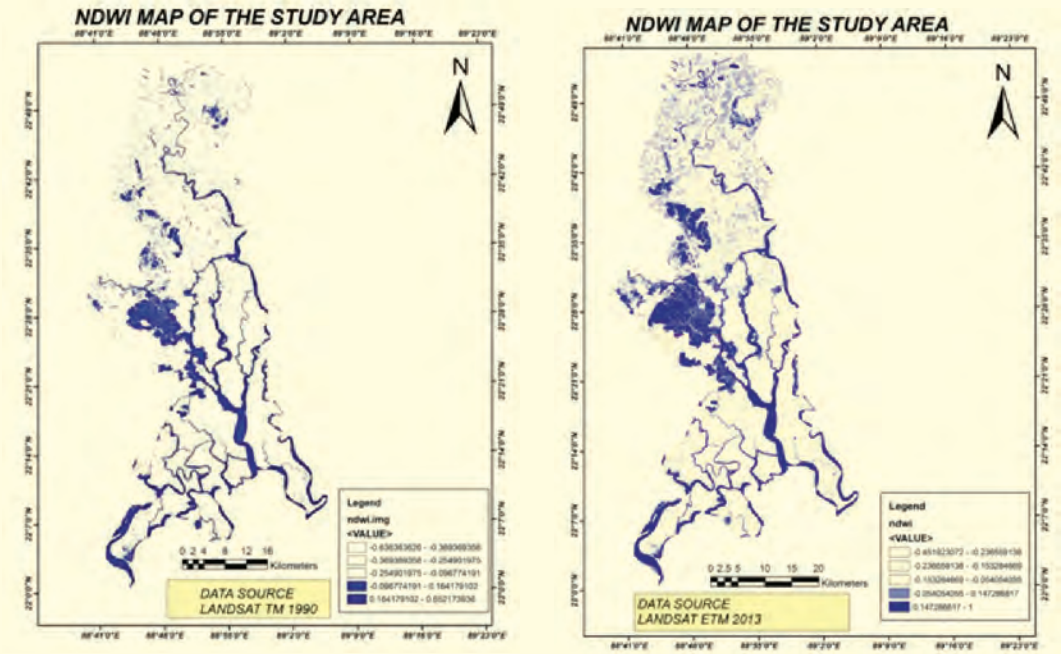

Fig. 4. NDWI map of eastern part of Sundarban in 1990 and 2013

1.3.d. Salinity level

Salinity in the Sundarban is highly dependent on the volume of freshwater coming from the upstream. The variation is subject to the nature of tide in the area. Annual pattern of salinity changes inside the Sundarban is also related with the changes of freshwater flow from upstream rivers. The peak salinity was found to be about 11 ppt (22 dS / m) in 2013 and the minimum salinity during post monsoon was found nearly zero. Salinity in eastern boundary areas is influenced by the Bidhadhari River; salinity in this part is almost zero throughout the monsoon. Salinity in the southern part of the Bay remains less than 1.5 ppt (3.0 dS / m) during monsoon and starts to increase. Salinity in the western part is not reduced to low salinity range even during monsoon periods; salinity increases at a steady rate during dry periods.

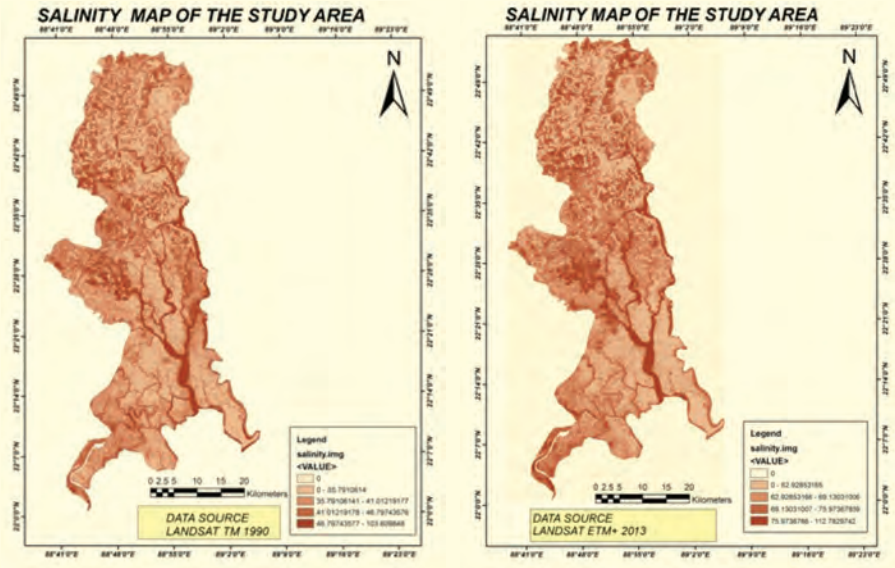

Fig. 5. Salinity map of eastern part of Sundarban in 1990 and 2013

Table 2. Salinity values as per remote sensing data in 1990 and 2013. Scale difference is described in remarks

Salinity 1990 (Value)	Salinity 2013 (Value)	Average increment (%) of salinity value	Remarks
0- 35.791	0-62.928	75.5	Very Low Salinity zone
35.791- 41.012	62.928-69.130	72.1	Low Salinity zone
41.012 - 46.797	69.130-75.973	66.7	Moderate Salinity zone
46.797-103.609	75.973-112.782	25.5	High Salinity zone

There are increments of salinity level especially after 'Aila' across the different salinity zones in Sundarban (Fig 5). The adverse effects of increased salinity on the ecosystem of the Sundarbans are manifested in the dying of tops of Sundari trees, retrogression of forest types, slow forest growth, and reduced productivity of rice and other crops. The increment of high salinity zone was 25.5% (Table 2). Increment of very low salinity zone was greater (75.5%), followed by low salinity zone (72.1%) and moderate salinity zone (66.7%). Many areas under low and medium salinity zones are unsuitable for raising high yielding varieties.

2. Climate resilient rice varieties tested

The varieties tested are as follows:

2. A. Varshadhan (CRLC 899)

It is photosensitive, late maturing (160 days), tall (150 cm) but non-lodging variety which can tolerate prolonged water logging up to a depth of 75 cm. This variety was released and notified

for cultivation in low line areas of Odisha, West Bengal and Assam. It has long bold grain with average productivity of 4.0 t/ha. It can tolerate to neck blast, bacterial leaf blight, sheath rot and white backed plant hopper.

2.B. Swarna-Sub1 (CR 2539-1)

It is a late maturing (143 days), semi-dwarf (100 cm) variety developed through introgression of SUB1 (submergence tolerant gene) in the genetic background of popular variety 'Swarna (MTU 7029)'. Therefore, it is tolerant to complete submergence due to flash flooding in coastal areas. It was released and notified (2009) for cultivation in Odisha. It has medium slender grains with an average productivity of 5.0- 5.5 t / ha.

2.C. CR Dhna 403 (Luna Suvarna)

It is tall (135 cm), late maturing (150 cm) variety with salt tolerance (5.0-8.0 dS/ m). It was released and notified in 2010 for cultivation in coastal saline areas of Odisha. It has medium slender grains with an average productivity of 3.5-4.0 t / ha. It can also withstand water stagnation up to 45 cm.

2.D. CR Dhan 402 (Luna Sampad)

It is a medium late maturing (140 days), tall (130 cm) and saline tolerant (5.0- 8.0 dS/ m) variety released and notified for cultivation in coastal saline areas in wet season of Odisha. It has medium bold grains with an average productivity of 3.6-4.2 t / ha. It is resistant to blast.

2.E. CR Dhan 406 (Luna Barial)

It is a late duration (150-155 days), medium tall (120 cm), saline tolerant (5.0-8.0 dS/m) variety released and notified in 2012 for cultivation of coastal saline areas of Odisha. It has short bold grains with an average productivity of 3.9 t / ha. It is tolerant to yellow stem borer.

2.F. CR Dhan 405 (Luna Sankhi)

It is early duration (110 days) variety suitable for cultivation in coastal saline areas for dry season. It is moderately tolerant to salinity (5.0-8.0 dS/ m) and blast. It was released and notified in 2012 for cultivation in irrigated situation of coastal saline areas of Odisha. It has medium slender grains with average productivity of 4.6 t / ha.

2.G. CR Dhan 503 (Jayantidhan)

It is late maturing (160 days) variety released for cultivation in deep water situation of Odisha in 2012. It has medium slender grains with average productivity of 4.6 t / ha. It can tolerate water stagnation up to one m.

2.H. Savitri-Sub1

Long duration (150-155 days) variety developed through introgression of submergence tolerant quantitative trait loci (QTL) SUB1 in Savitri background. Savitri (IET5897) is a derivative of cross Pankaj x Jagannath. This is recommended for rainfed shallow lowland (0-30 cm water depth). This is a semi-dwarf (110-120 cm) with short bold grain type. Milling recovery is fantastic, is tolerant to blast and sheet blight. This variety is tolerant to flash flood as compared to Savitri. The yield potentiality is 5.5 t / ha.

3. Blocks taken for demonstration of varieties

Demonstrations of climate resilient rice varieties were done in five blocks of Sundarban region, namely, Sandeshkhali-1, Hingalganj (Fig. 6), Gosaba, Basanti and Patharpratima (Fig. 7).

Fig. 6. Sandeshkhali-I and Hingalganj Blocks under North 24 Parganas highlighted in picture are taken for study

Fig. 7. Gosaba, Basanti and Patharpratima Blocks under South 24 Parganas highlighted in picture are taken for study

3.A. Sandeshkhali-I block

A detail survey was done at Chhoto Sehara village at Sandeshkhali-I block, North 24 Parganas, West Bengal, India on type of land (Fig. 8), land holding pattern, purpose of production, preference and yielding abilities of rice varieties and changing of cropping system after 'Aila' (Fig. 9), etc. The following points have been evolved from this survey which was conducted between 2013 and 2015.

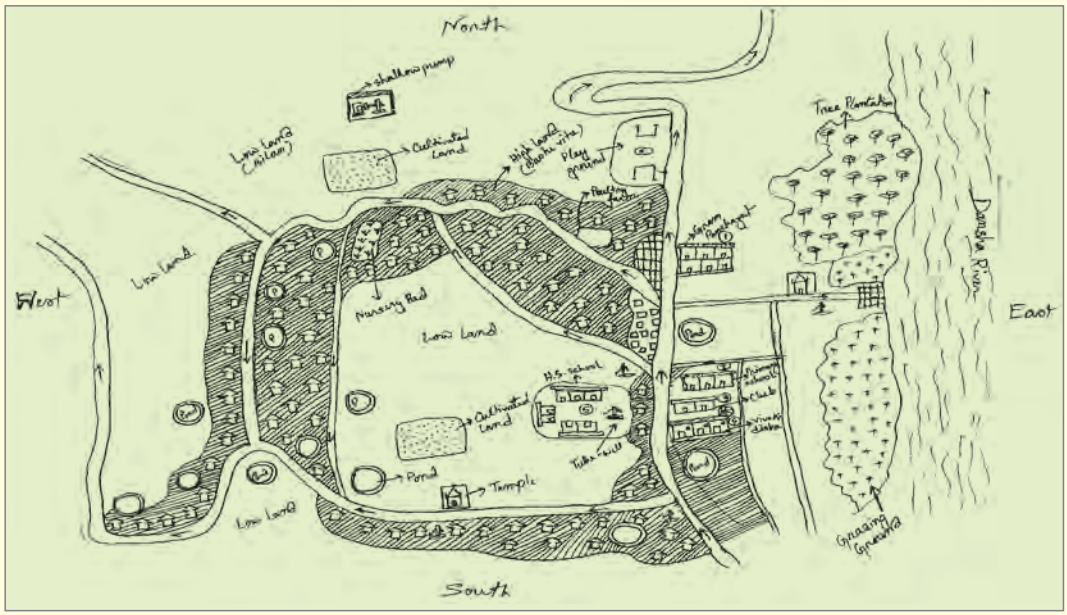

Fig. 8. A village map of Chhoto Sehara drawn by consultation with farmers (Not to scale)

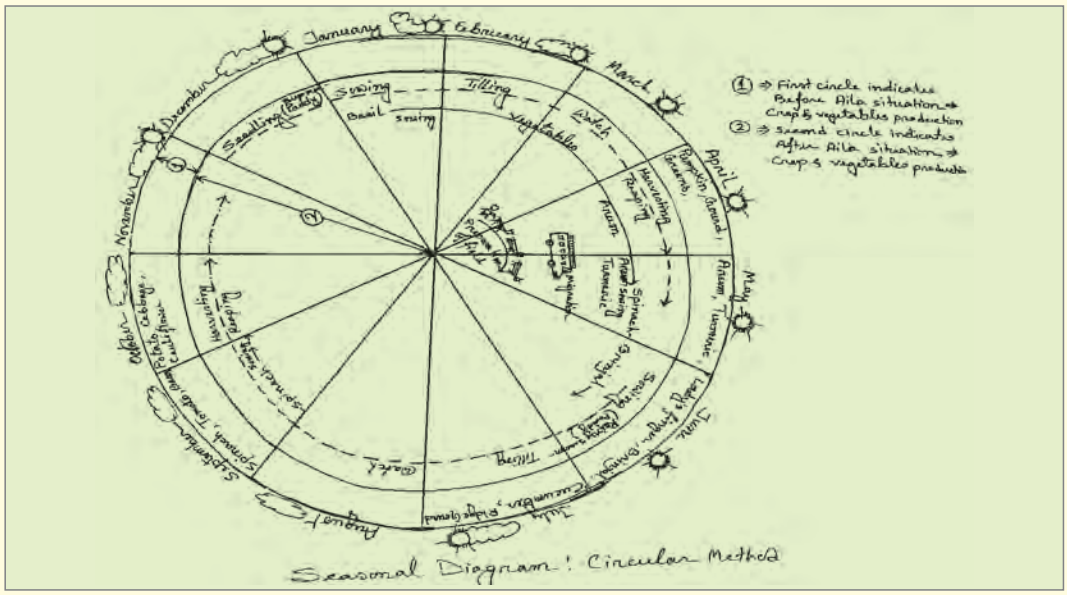

Fig. 9. Seasonal diagram (Circular Method) of Chhoto Sehara village drawn by consultation with the farmers

3.A.1.a. Purpose of rice cultivation

Sixty three % respondents expressed that they used to produce only for subsistence purpose to feed their family first whereas 37 % farmers sold their surplus after subsistence. (Fig. 10)

3.A.1.b. Land holding pattern

Out of 49 farmers, 42 were marginal (land-holding capacity < 1 ha) and 7 were small farmers (land-holding capacity 1 to < 2 ha). (Fig. 11)

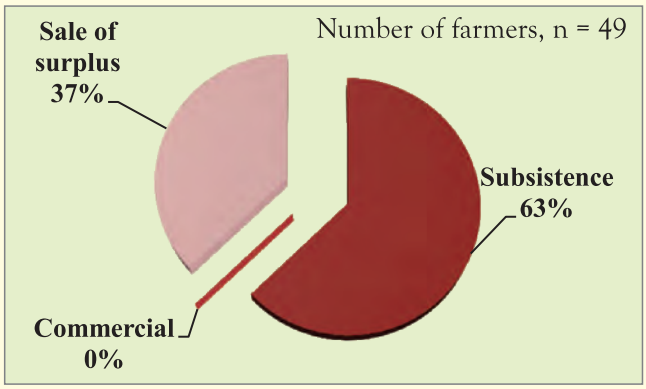

Fig. 10. Purpose of rice cultivation at Chhoto Sehara village

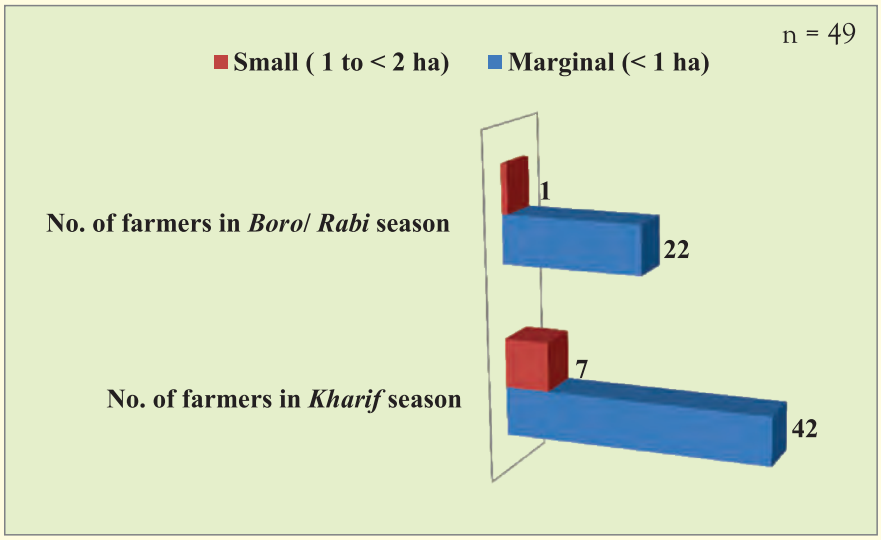

Fig. 11. Land holding pattern at Chhoto Sehara village

3. A.1.c. Power source for land preparation

Ninety six % respondents used tractor for ploughing the agricultural land, whereas very less (i.e. 4 %) respondents utilized animal for ploughing as most of the farmers lost their cattle at the time of 'Aila'. (Fig. 12)

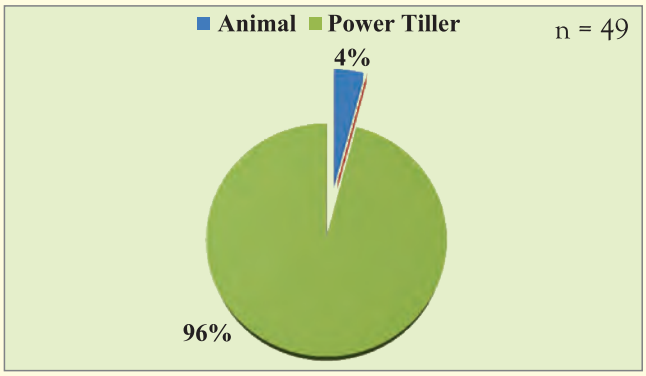

Fig. 12. Power source for land preparation at Chhoto Sehara village

3. A.1.d. Area under vegetable cultivation before and after 'Aila'

Land occupied for vegetable cultivation before 'Aila' was 4.39 ha. But after 'Aila' the vegetable cultivation was reduced to half due to increased level of salinity, scarcity of fresh water etc. (Fig. 13)

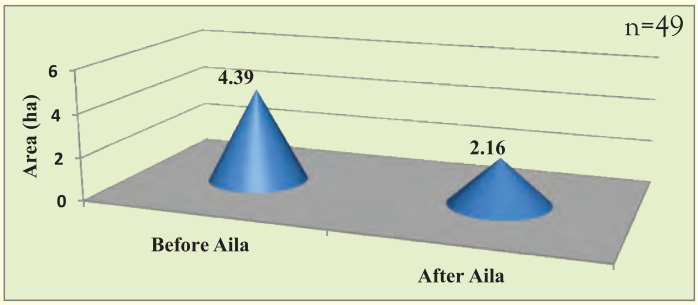

Fig. 13. Area under vegetable cultivation before and after 'Aila' at Chhoto Sehara village

3. A.1.e. Classification of land based on water stagnation probability under rice cultivation during rainy season

Out of total land (31.4 ha), medium depth lowland (30-50 cm water level) occupied 14.4 ha, deepwater lowland (50-90 cm) occupied 13.4 ha and shallow lowland (0-30 cm) occupied 3.6 ha. (Fig. 14)

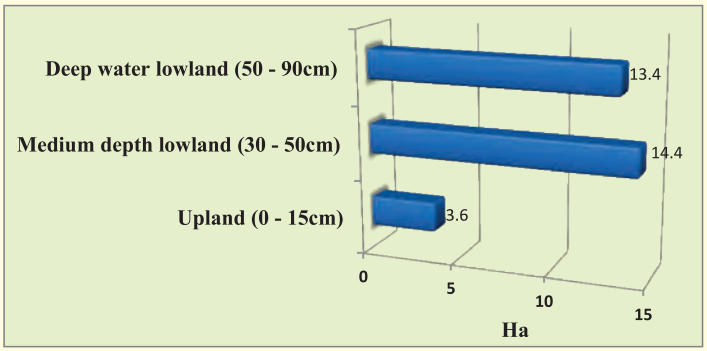

Fig. 14. Classification of land based on water stagnation probability under rice cultivation during rainy season at Chhoto Sehara village

3. A.1.f. Classification of land based on prevalent abiotic stress

Salinity-prone land occupied the major area (9.8 ha), followed by submergence and water logging in combination (7.91 ha), and only submergence-prone (7.22 ha). Upland and medium land (6.33 ha) with occasional drought also exist at Chhoto Sehara village. In a year when rainfall is less drought prone increases whereas when rainfall is more than normal deep water increases. (Fig.15)

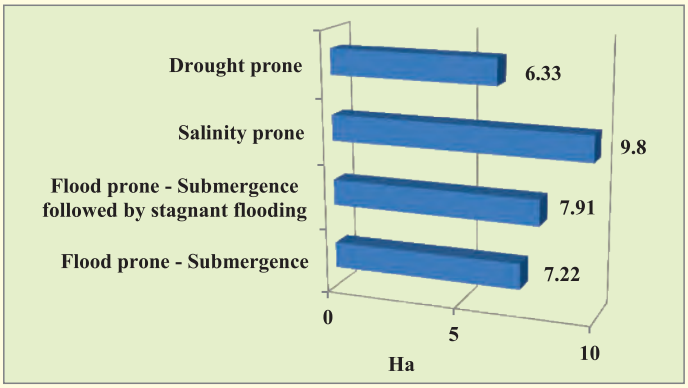

Fig. 15. Classification of land based on prevalent abiotic stress at Chhoto Sehara village

3. A.1.g. Farmer's preference in selection of rice variety

To know the preference in selection of rice varieties, fifteen criteria were selected and the responses of farmers were collected in a 3-point continuum scale and scoring was made based on their importance, namely, Very important – 3 score, Moderately important – 2 score and Less important – 1 score. Then, ranking was made based on their weighted cumulative score (WCS) as given in Table-3.

Table 3. Farmer's preference in selection of rice variety at Chhoto Sehara village (n = 49)

Sl. No.	Preference Criteria in Selection of Rrice Variety	Weighted Cumulative Score	Rank
1.	High yield (productivity)	144	I
2.	Resistance to flood and submergence	134	II
3.	Resistance to disease and pests	134	II
4.	Easily marketable	122	III
5.	Resistance to salinity	120	IV
6.	Bold grain quality	117	V
7.	Resistance to occasional drought or water shortage	112	VI
8.	Fine grain quality for better sale price	107	VII
9.	Early duration of maturity	107	VII
10.	Easy to prepare value added products (Raw rice/ Parboiled rice/ Watered rice/ Expanded rice/ flattened rice / Puffed rice)	96	VIII

11.	Response to low dose of fertilizer/ organic manure	86	IX
12.	Good cooking quality	80	X
13.	Good milling quality of paddy	75	XI
14.	White coloured grain	74	XII
15.	Good quality paddy straw	72	XIII

'High yield or productivity' was found to be the most preferred criterion with weighted cumulative score (WCS) of 144 to select a variety. Out of 49 respondents, 46 farmers responded that 'high yield or productivity' was the main force for selection of rice variety for cultivation. Thirty six respondents (with WCS of 134) emphasized for selection of rice varieties either 'resistance to diseases and pests' (biotic stresses) and/or 'resistance to flood and submergence' (abiotic stresses). These were followed by other important criteria like, 'easy marketability of rice' (WCS–122), 'resistance to salinity' (WCS–120) and 'bold grain quality' with slow digestibility for their daily consumption (WCS–117) respectively.

Twenty eight respondents expressed that salinity damaged their rice and they needed salt tolerant rice varieties. Twenty seven respondents gave importance of whereas 26 respondents preferred for cultivation of bold grain with slow digestibility for their daily consumption. Thirty-two respondents were in favour of resistance to occasional drought or water shortage (WCS–112), whereas fine grain quality for better market price (WCS–107), early maturity variety (WCS–107) and easy to prepare value added products from rice (WCS-96) were separately preferred by 27 respondents for selection of rice variety. Twenty three respondents opined that they needed varieties suitable under low dose of fertilizer (WCS-86). Criteria like good quality straw (WCS-72) and white colour of grain (WCS-74) were found not much important in selecting a variety.

3. A.1.h. Production performance status of different local/traditional rice cultivars

Effort was made to collect responses on production performance status of different practicing local / traditional rice cultivars in the village in a 5-point continuum scale and scoring was made based on their performance, namely, Very good–5 score, Good–4 score, Average–3 score, Bad–2 score and Very bad–1 score. Then, ranking was made based on their weighted cumulative score (Table-4)

Traditional / local rice varieties grown in kharif season: In 1970s and eighties some varieties were given to farmers of Sundarban from NRRI, Cuttack. They are CR 1017 (local CR) (with WCS of 103), Pankaj (WCS–95), Satabdi (popularly known as 'Minikit' in Sundarban area) (WCS–66) etc. Farmers still cultivate such varieties. Besides, some landraces e.g. Patnai (WCS – 88), Kalomota (WCS–53), etc. are also been cultivated mainly for home consumption. Satabdi (Minikit) is cultivated by them for its fine grain quality and high market price (Rs. 900-1000/60kg). For puffed rice they cultivate local cultivars like 'Hogla', 'Gotra' etc.

Table 4: Production performance status of different practicing local / traditional rice cultivars at Chhoto Sehara village (n=49)

Sl. No.	Practicing Local /Traditional Rice Cultivars	Weighted Cumulative Score	Rank
1.	Local (CR 1017)	103	I
2.	Pankaj	95	II
3.	Patnai	88	III
4.	Minikit (Satabdi)	66	IV
5.	Kalomota	53	V
6.	Ranjit	17	VI
7.	Masuri	14	VII
8.	Gotra	13	VIII
9.	Pratiksha	11	IX
10.	Swarna-Pankaj	4	X
11.	Gogla	4	X
12.	Lalmota	4	X
13.	NC	4	X
14.	Kolma	4	X
15.	Odisha Patnai	3	XI
16.	Local (1444)	3	XI
17.	Maharaj	3	XI

3. A.1.i. Problems of rice cultivation:

Responses of farmers with regard to problems in rice cultivation were collected in a 5-point continuum scale and scoring was made based on their severity, namely, Very severe – 5 score, Severe – 4 score, Moderately severe – 3 score, Mild – 2 score and Very mild – 1 score. Then, ranking was made based on their weighted cumulative score (Table-5)

Table 5. Problems in rice cultivation at Chhoto Sehara village (n=49)

Sl. No.	Problems in Rice Cultivation	Weighted Cumulative Score	Rank
1.	Sale of paddy below minimum support price (MSP) fixed by govt.	211	I
2.	Flood and submergence after heavy rain	209	II
3.	Erratic rainfall in rainfed areas	195	III
4.	Unavailability of quality seeds in time	194	IV

5.	Infestation of insects and pests	189	V
6.	Infestation of diseases	182	VI
7.	Lack of proper technical knowledge and skill in rice farming	181	VII
8.	Unavailability of labour during rice cropping season	176	VIII
9.	Unavailability of sufficient pesticides and fertilizers	175	IX
10.	High cost of farm inputs (like seeds, fertilizers, pesticides and labour)	173	X
11.	Crop damage due to drought or water scarcity	172	XI
12.	Poor economic condition of self/ farmers	163	XII
13.	Lack of irrigation facility	161	XIII
14.	Illegal practices and bribes by govt. officials for providing services, loans and subsidy etc	118	XIV
15.	Poor farmers-extension officers linkage	108	XV
16.	Unavailability of sufficient nos. of farm implements/ machineries	94	XVI
17.	Unavailability of references materials for farmers	85	XVII
18.	Lack of knowledge in handling of farm machineries	83	XVIII
19.	Incompatibility of farm machineries in our farming situation	81	XIX

Many problems have been faced by rice growers at Chhoto Sehara village. Most of the respondents (WCS – 211) emphasized that the farmers did not get minimum support price (MSP) and they sold it to middle man who collected the paddy from their door steps with very low price. This was closely followed by the problem of flood and submergence after heavy rain with WCS of 209. Other important problems perceived by the farmers were related to erratic rainfall starting from moisture deficit (WCS–195), unavailability of quality seeds in time (WCS–194), infestation of insects (WCS–189) and diseases (WCS –182) damaged the rice crop in greater extent, lack of proper technical knowledge and skill in rice farming (WCS–181). Farmers do not adapt the modern technology due to unavailability of labour during rice cropping season (WCS–176), high cost of farm inputs (WCS–173), poor economic condition as responded by farmers (WCS–163) etc hampered the adoption of modern technologies. Some farmers expressed the lacking of water bodies adjacent to the agricultural land which could be utilized for fishing, vegetable and rice cultivation in boro/ rabi season.

3. A.2. Evaluation of varieties at target sites (Sandeshkhali-I block) in *Kharif* 2013

Luna Suvarna, Luna Sampad and Luna Barial (Photo 1) for salt affected plots (EC= 2-6 dS/m) , Varshadhan and Jayantidhan (CR Dhan 503) for waterlogged areas (>30cm) and Swarna-Sub1 for submergence prone plots were evaluated in *Kharif* 2013 at Sandeshkhali-1 block. Local variety is salt and waterlogged sensitive (Photo 2). Based on the performance under different situations, a large section of farmers of this area desired to grow Varshadhan under waterlogged lowland area and Luna Suvarna (CR Dhan 403) (Photo 3) under slight to medium salinity stress (2-6 dS/m) in the next *Kharif* season. Grain yield of Varshadhan varied from 9.2 kg to15.5 kg in 25 sq m plot (Photo 4). On the other hand grain yield of Luna Suvarna varied from 10.15 kg to 14.0 kg in 25 sq m plot. Average yield (kg/ha) of Varshadhan (4860kg/ha), CR

Dhan 403 (4680kg/ha), CR Dhan 406 (4360kg/ha) and Swana-Sub1 (4300kg/ha) were found superior than local check, CR 1017 (3400kg/ha) (Table 6).

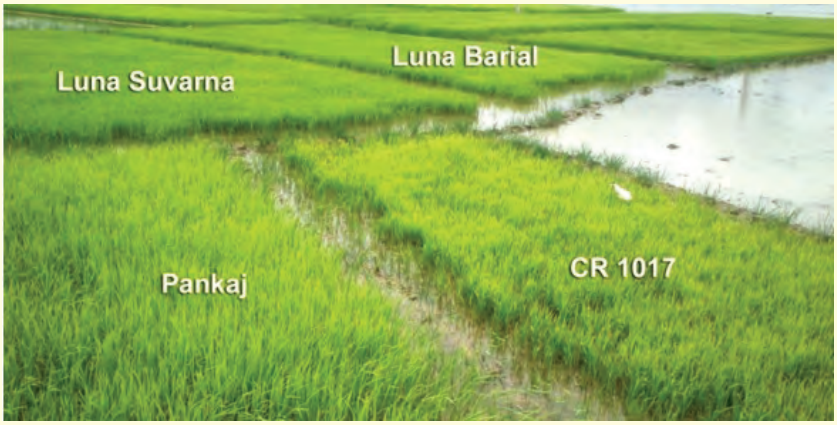

Photo 1. Seed bed of salt tolerant (Luna Suvarna and Luna Barial) and salt susceptible (CR 1017 and Pankaj) at Sandeshkhali-I block in *Kharif* 2013

Photo 2. Seedlings of CR 1017 affected by salinity stress in *Kharif* 2013 at Ssandeshkhali-I block

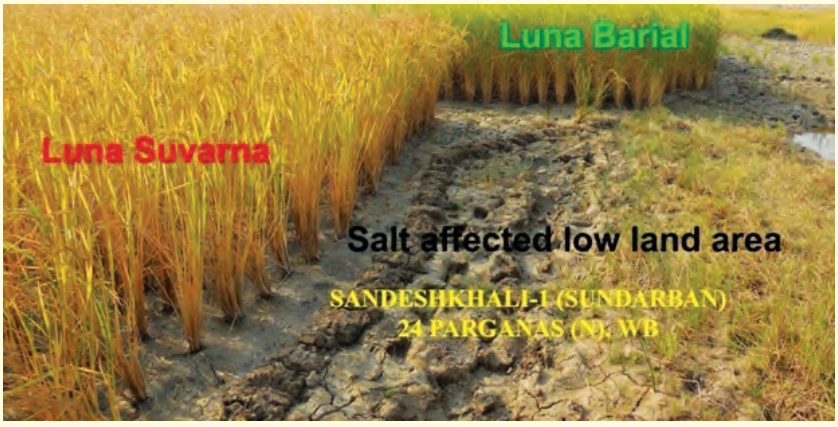

Photo 3. Luna Suvarna and Luna Barial grown at salt affected fields at Sandeshkhali-I block in *Kharif* 2013

Photo 4. Varshadhan under waterlogged lowland area showing high productivity at Sundarban

Table 6. Mean performance of climate resilient rice varieties under coastal area at Sandeshkhali-I block (Sundarban) of West Bengal

Parameter	Swarna-Sub1	CR Dhan 402	CR Dhan 403	CR Dhan 406	CR Dhan 503	Varshadhan	Local (CR 1017)
Average yield (kg)	4300	3180	4680	4360	2560	4864	3400
Yield Range (Kg)	3760-5040	1880-3920	4040-5600	3920-5120	2000-3360	3680-6200	2800-4600
Duration (days)	144-146	137-149	147-155	147-153	155-167	154-164	145-150
Mean yield (kg)	3992 ± 364						
CD (5%) (yield)	760.00						

3.A.2.1. Conducting training programmes for general awareness among farmers and distribution of seeds of climate resilient rice varieties at Sundarban region

- On 27th June 2014, a farmers Training programme on 'General Awareness of Climate Resilient Rice varieties' was organized under NICRA Project, NRRI at Chhoto Sehera village, Sandeshkhali-I block (Sundarban), 24 Parganas (N), West Bengal on 27th June 2014. Around 100 farmers attended the meeting. In this meeting, 300 Kg truthfully leveled seeds of four NRRI varieties, Luna Suvarna, Luna Barial, Varshadhan and Swarna-Sub1 were distributed (Photo 5) for cultivation among 80 farmers. Depending on land situation of these farmers, seeds were provided with technical support for cultivation practices.
- On 2nd December, 2014 another training was conducted on "General awareness of proper selection of rice varieties under changing climatic scenario" at Chhoto Sehera village (Sandeshkhali-I block). Adaptation of the distributed varieties by the farmers was discussed (Photo 6). All experts interacted with the farmers to understand the probable yield gain of farmers for cultivating NRRI varieties as compared to their own varieties and also about the problems faced by them, especially due to biotic stresses. Seeds (30 Kg) of dry season variety, Luna Sankhi have been distributed among ten farmers for cultivation in saline affected irrigated lands.

Photo 5. Distribution of seeds of climate resilient rice varieties in a training programme at Chhoto Sehara village, Sandeshkhali-I block

Photo 6. A farmers' training programme at Sandeshkhali-I block (Sundarban)

3.A.3. Performance of some recently developed NRRI varieties during *Kharif* 2014 and 2015 in Sundarban region

3. A.3.a. Rainfall pattern (ACT=Actual & NOR=Normal)

There was a deficit in rainfall especially in the month of September and onwards in 2014. Therefore, salinity stress at late vegetative and reproductive stages was observed frequently in some medium lands at Sandeshkhali-I block, Patharpratima block and some others parts of Sundarban (Fig. 16A). In 2015 there was an excess rainfall in the month of July and August. Therefore, most of the area in Sundarban was inundated with water and damage of seedlings in seed bed as well as after transplanting was noticed all over Sundarban (Fig. 16B).

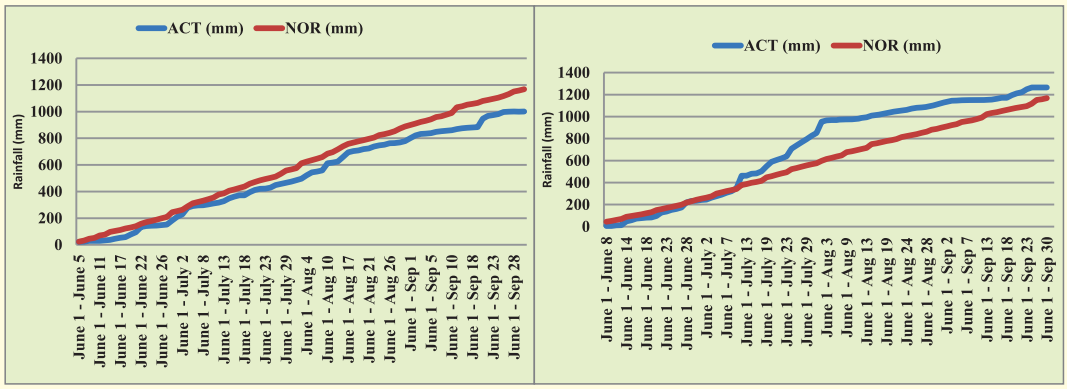

Fig. 16. Rainfall pattern in rainy season of A. 2014 and B. 2015 in Gangetic West Bengal

3. A.3.b. Demonstration of NRRI varieties at Sandeshkhali-I block of West Bengal in *Kharif* 2014

Four climate resilient varieties , Varshadhan, Luna Suvarna (CR Dhan 403), Luna Barial (CR Dhan 406) and Swarna-Sub1 have been taken for 32 demonstrations at farmers fields at Sandeshkhali-I block (Sundarban), West Bengal in *Kharif* season 2014. It shows that the average estimated yield kg/ha of NRRI varieties like Varshadhan, CR Dhan 403, CR Dhan 406, Swarna-Sub1 and overall were better/ more than local rice varieties like CR 1017, Patnai, Pankaj, Kalomota, Mahsuri, etc. (Fig. 17). Overall 12.63% yield advantage (Table 7.) has been registered for using NRRI climate resilient rice varieties as compared to varieties grown in the last *Kharif* season from the lands affected by one or more than one abiotic stresses such as water logging (10-45 cm water depth), salinity (EC = 2-5.7 dS/m) and submergence. Submergence occurred in the seed bed for 5-7 days (Photo 7) as well as just after transplanting. Farmers could protect seedlings by making bunds beside seed bed (Photo 8). Waterlogging was a common phenomenon in this area (Photo 9). Water stagnation (10-60 cm) for more than 2 months was occurred regularly. Farmers were suggested to take aged seedlings (40-50 days) for transplanting (Photo 10) in waterlogged situation (Photo 11-12). Varshadhan performed well (Photo 13) under water logging situation and registered 14.59% mean yield advantage over varieties (Patnai, Pankaj, CR 1017) grown in kharif season under 14 demonstrations (Photo 14). Farmers observed that it has good cooking and eating qualities, and good for puffed rice. CR Dhan 406 performed well under medium salinity and water logging situation under 5 demonstrations and registered 16.51% yield advantage over varieties (Pankaj, CR 1017) grown in the last year in the same fields. Swarna-Sub1 (Photo 15) also registered 15.49% mean yield advantage over check (Mahsuri, CR 1017). It is preferred for eating and has good market demand. On the other hand although CR Dhan 403 (Photo 16) has registered 3.93% yield advantage over checks but it is preferred very well by farmers for its good cooking qualities and market demand.

Table 7. Production status of NRRI rice varieties and Check (local) rice varieties in different stress situation at Chhoto Sehara village, *Kharif* 2014

Types of Stress	Rice Variety	Average Estimated Yield (kg/ha)	Average Yield Advantage (%)	No. of Demonstration
Flood Prone	Varshadhan	5145.56	14.59	14
	Check (local varieties)	4389.07		
Salinity Prone	CR Dhan 403	3967.17	3.93	6
	Check (local varieties)	3813.13		
	CR Dhan 406	5245.45	16.51	5
	Check (local varieties)	4372.73		
Submergence	Swarna-Sub1	5418.83	15.49	7
	Check (local varieties)	4573.59		
Overall	NRRI varieties	4944.25	12.63	32
	Check (local varieties)	4287.13		

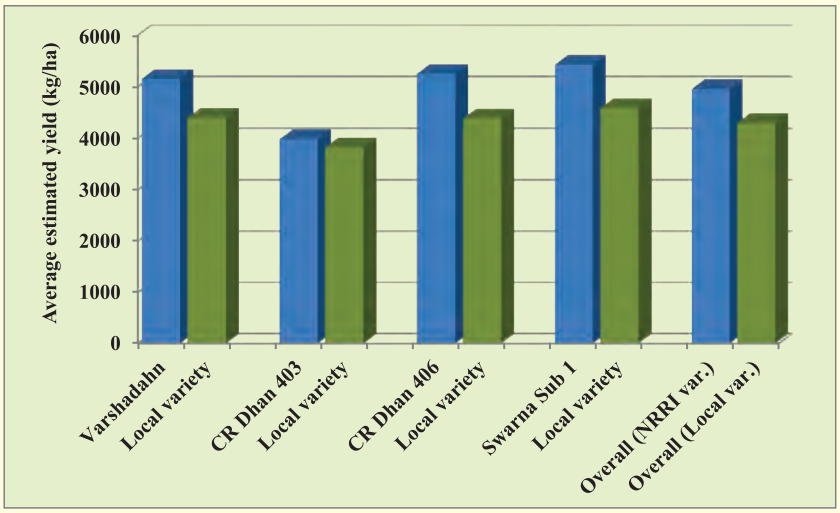

Fig. 17. Average estimated yield (kg/ha) of NRRI and Check (local) rice varieties in *Kharif* 2014

Photo 7. Seed bed of Swarna-Sub1 and other varieties was submerged in *Kharif* 2014 at Sandeshkhali-I block

Photo 8. Seed bed was protected by bunding

Photo 9. Large area at Sandeshkhali-I block was affected by water logging in *Kharif* 2014

Photo 10. More than 40 days old seedling of Varshadhan uprooted for planting

Photo 11. Planting has been done in 28 cm standing water with the seedlings of Varshadhan at Sandeshkhali-I block in *Kharif* 2014

Photo 12. Crop stand at active tillering stage of variety Varshadhan at Sandeshkhali-I block in *Kharif* 2014

Photo 13. Varshadhan variety performed well under water logging situation at Sundarban in *Kharif* 2014

Photo 14. Close view of Varshadhan crop in a farmer's field at Sandeshkhali-I block in *Kharif* 2014.

Photo 15. Swarna-Sub1 at flood affected plot at Sandeshkhali-I block in *Kharif* 2014

Photo 16. Luna Suvarna (CR Dhan 403) grown in a farmer's field at Sandeshkhali-I block (Sundarban) in *Kharif* 2014

3.A.3.c. Demonstration of NRRI varieties at Sandeshkhali-I block of West Bengal in *Kharif* 2015

Five climate resilient varieties , Varshadhan, Luna Suvarna (CR Dhan 403), Luna Barial (CR Dhan 406), Swarna-Sub1 and Savitri Sub 1 have been taken for 19 demonstration at farmers fields at Sandeshkhali-I block (Sundarban), West Bengal in *Kharif* season 2015. It shows that average estimated yield (kg/ha) of single variety to overall rice varieties of NRRI were more than single local rice varieties to overall local rice varieties. The average estimated yield (kg/ha) of Savitri-Sub1 was more than other NRRI varieties along with local rice varieties like Kalomota, CR 1017, Pankaj (Fig. 18). Overall 26.04% yield advantage (Table 8) has been registered for using NRRI climate resilient rice varieties as compared to varieties grown in the last kharif season from the lands affected by one or more than one abiotic stresses such as water logging (15-65 cm water depth), salinity (EC= 1.9-5.1 dS/m) and submergence (>7 days). Varshadhan performed well under water logging situation and registered 21.11% mean yield advantage over check varieties (Patnai, Pankaj, and CR 1017) grown in the last kharif season in 4 demonstrations. Farmers observed that it has good cooking and eating qualities, good for puffed rice and has demand in the rice market. CR Dhan 406 performed well under medium salinity and water logging situation under three demonstrations and registered 25.06% yield advantage over check varieties (Pankaj, CR 1017) grown in the last year in the same fields. Although it was not preferred for eating by farmers but it has demand for selling to traders. Swarna-Sub1 (Photo 17) also registered 29.52% mean yield advantage over check (Pankaj, CR 1017). It is preferred for eating and has good market demand. On the other hand although CR Dhan 403 has 18.73% yield advantage over checks but it is preferred very well by farmers for its good cooking qualities and market demand. Another rice variety, Savitri-Sub1 also registered 35.77% mean yield advantage over check (CR 1017) and it is demanding to the farmers.

Table 8. Production status of NRRI rice varieties and Check (local) rice varieties in different stress situation at Chhoto Sehara village in *Kharif* 2015

Types of Stress	Rice Variety	Average Estimated Yield (kg/ha)	Average Yield Advantage (%)	No. of Demonstration
Flood Prone	Varshadhan	5287.82	21.11	4
	Check (local varieties)	4169.30		
Salinity Prone	CR Dhan 403	4515.15	18.73	6
	Check (local varieties)	3656.51		
	CR Dhan 406	5233.13	25.06	3
	Check (local varieties)	3923.19		
Submergence Prone	Swarna-Sub1	5370.97	29.52	5
	Check (local varieties)	3774.54		
	Savitri-Sub1	5998.53	35.77	1
	Check (local varieties)	3852.87		
Overall	NRRI/improved varieties	4400.93	26.04	19
	Check (local varieties)	3229.40		

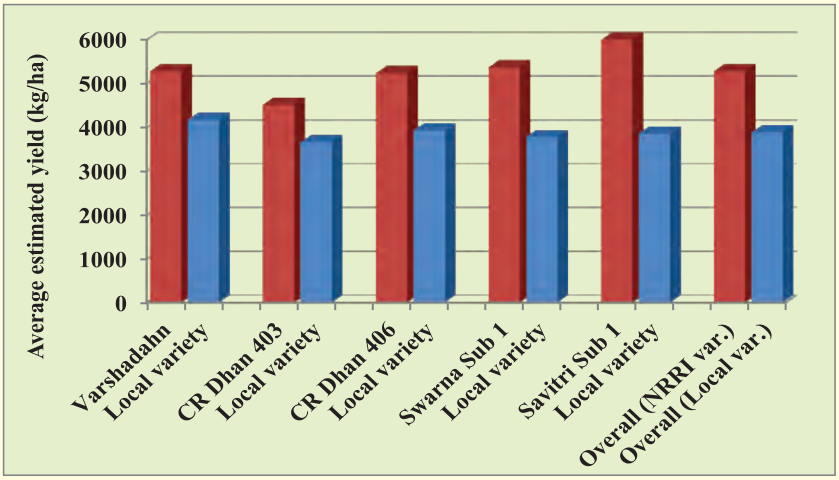

Fig. 18. Average estimated yield (kg/ha) of NRRI and Check (local) rice varieties in *Kharif* 2015

Photo 17. Swarna-Sub1 in the field of Sanjay Das in *Kharif* 2015

3. A.3.d. Demonstration of NRRI variety, Luna Sankhi (CR Dhan 405) at Sandeshkhali-I block of West Bengal in *Boro/Rabi* 2015

Luna Sankhi was found more productive under salinity stress (4-7.5 dS/m) than existing varieties at Sandeshkhali-I block. Luna Sankhi performed well under salinity situation under 5 demonstrations and registered 9.63% yield advantage over varieties {Satabdi (Minikit), M-Shankar} grown last *Boro/Rabi* season 2014-15 (Table 9).

Table 9. Varietal demonstration of Luna Sankhi in dry season in coastal saline area of Sundarban, *Boro/Rabi* 2014-15

No. of Demonstration	Farmers Name	NRRI Variety	Yield (kg/ha)	Local Rice Variety	Yield (kg/ha)	Average Yield Advantage (%)
1	Sarat Bindu	Luna Sankhi	4152	Satabdi (Minikit)	3750	9.68
		Luna Sankhi	4152	M-Shankar	4020	3.18
2	Saifuddin Fokir	Luna Sankhi	4050	Satabdi	3850	4.94
3	Janmenjay Das	Luna Sankhi	4750	Satabdi	4150	12.63
4	Sanjay Das	Luna Sankhi	4750	Satabdi	4150	12.63
5	Niranjan Khatua	Luna Sankhi	4750	Satabdi	4050	14.74
Overall			**4434**		**3995**	**9.63**

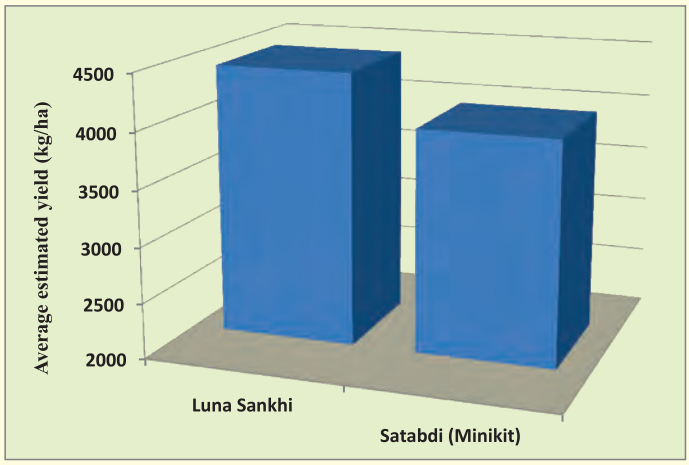

Fig. 19. Average estimated yield (kg/ha) of Luna Sankhi and Satabdi (Minikit)

Graphical presentation (Fig. 19) shows that the average estimated yield (kg/ha) was more than Satabdi (Minikit) cultivated in *rabi/boro* season 2014. In boro season farmer cultivated rice variety for commercial purpose not for home consumption. Their first preference was fine and good grain quality which have high market price. Though production status of Luna Sankhi was more, still they cultivated Satabdi (Minikit) rice variety for more profitable in *Boro/Rabi* season.

3.B. Hingalganj block

A detail survey was done at Kumirmari village, Hingalganj block, North 24 Parganas, West Bengal, India on type of land (Fig. 20), land holding pattern, purpose of production, preference and yielding abilities of rice varieties, etc. Changing cropping system was presented as seasonal diagram in this village before (Fig. 21) and after Aila (Fig. 22). The following points have been evolved from this survey which was conducted in 2015-16.

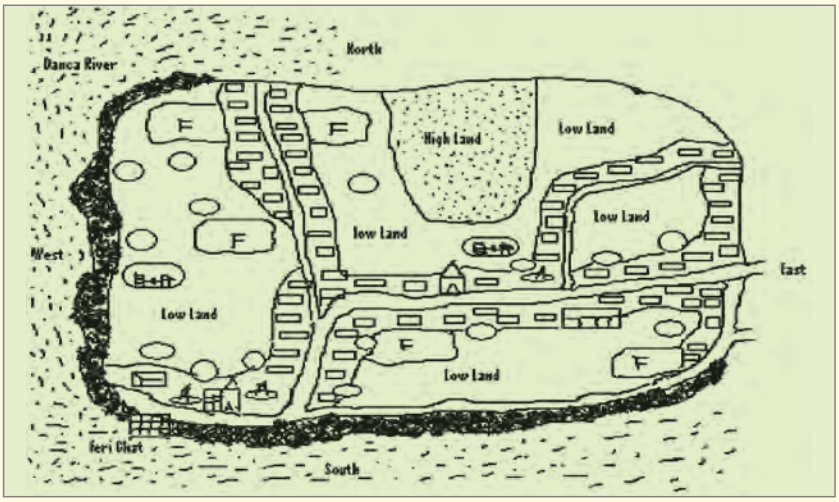

Fig. 20. A village map of Kumirmari drawn by consultation with the villagers (Not to scale)

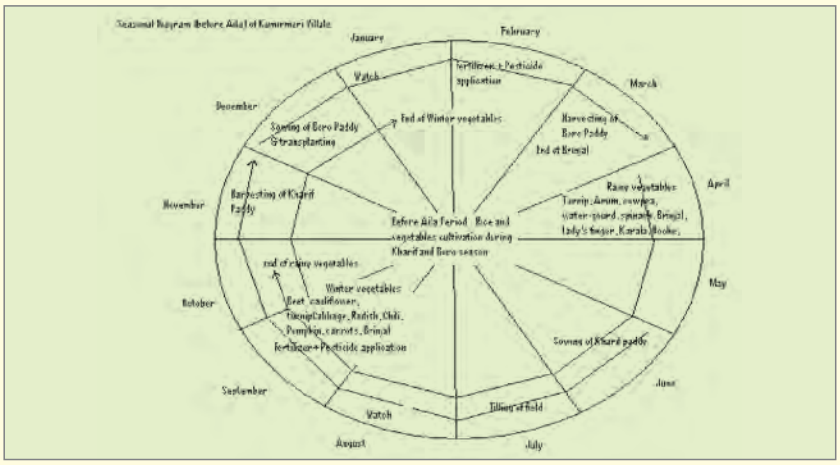

Fig. 21. Seasonal diagram (Circular Method) of Kumirmari village before Aila

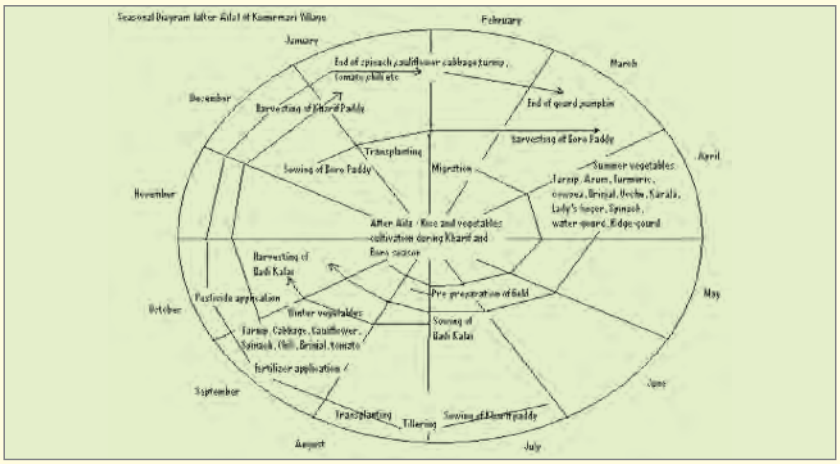

Fig. 22. Seasonal diagram (Circular Method) of Kumirmari village after Aila

3.B.1.a. Land holding pattern

Out of 50 respondents, 49 respondents were marginal farmers and one was small farmer (Fig. 23)

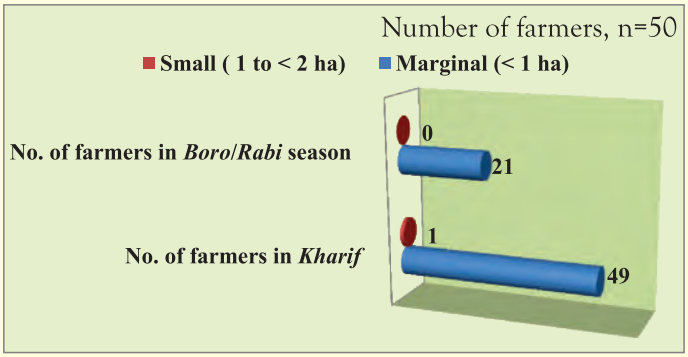

Fig. 23. Land holding pattern at Kumirmari village

3.B.1.b. Classification of land based on water stagnation probability under rice cultivation during rainy season

Out of total land (16.93 ha), medium depth lowland (30-50 cm water level) occupied 14.33 ha, deepwater lowland (50-90 cm) occupied 2.4 ha and upland (0-15 cm) occupied 0.2 ha. (Fig. 24)

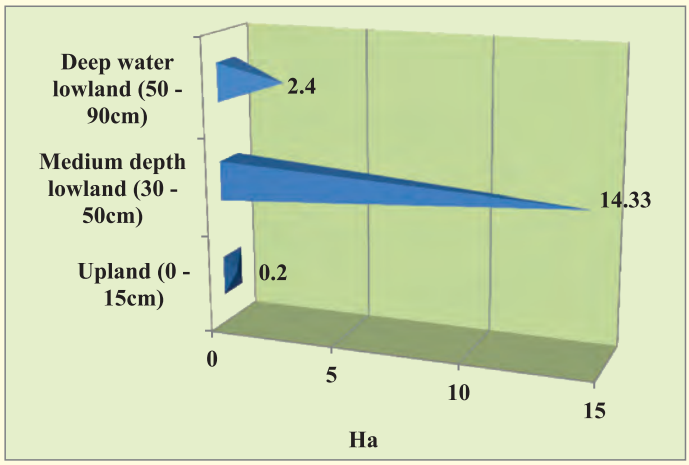

Fig. 24. Classification of land based on water stagnation probability under rice cultivation during rainy season at Kumirmari village

3.B.1.c. Classification of land based on prevalent abiotic stress

All abiotic stresses such as submergence, waterlogging and salinity prevailed at this village. Flood prone-submergence followed by stagnant flooding land occupied 3.2 ha and flood prone-submergence land occupied 5.13 ha. On the other hand, salinity prone land occupied 14.22 ha and drought prone upland and medium land occupied 2.07 ha (Fig. 25)

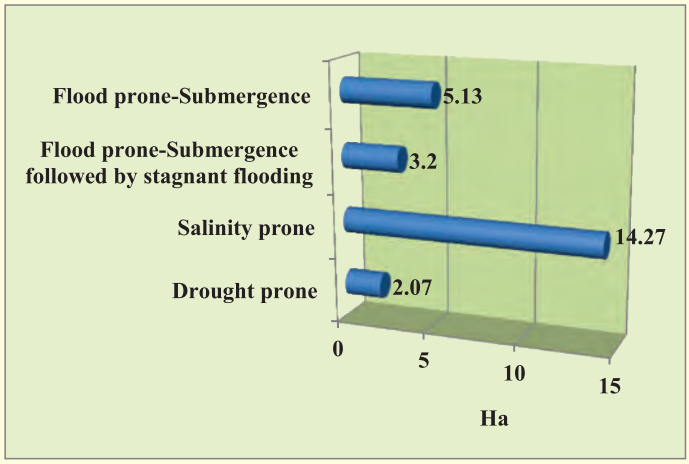

Fig. 25. Classification of land based on prevalent abiotic stress at Kumirmari village

3.B.1.d. Purpose of rice cultivation

Seventy two per cent respondent cultivated rice for subsistence only and 28 % farmers those who had surplus of production, they sold in the market (Fig. 26)

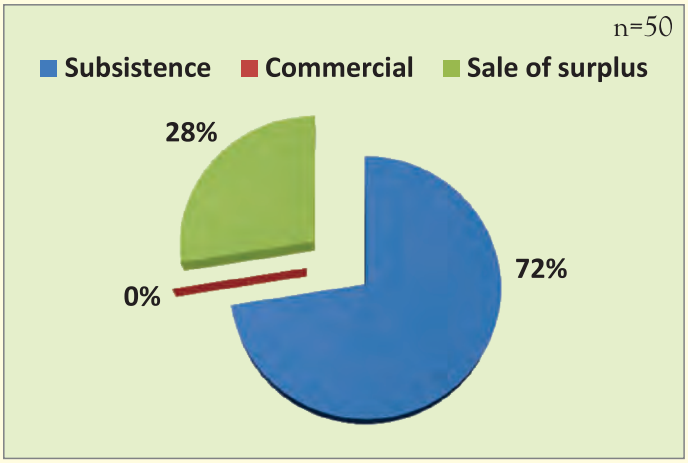

Fig. 26. Purpose of rice cultivation at Kumirmari village

3.B.1.e. Power source for land preparation

Still 86 % respondent utilized animal for ploughing in their land whereas 14 % respondent utilized power tiller for ploughing (Fig. 27)

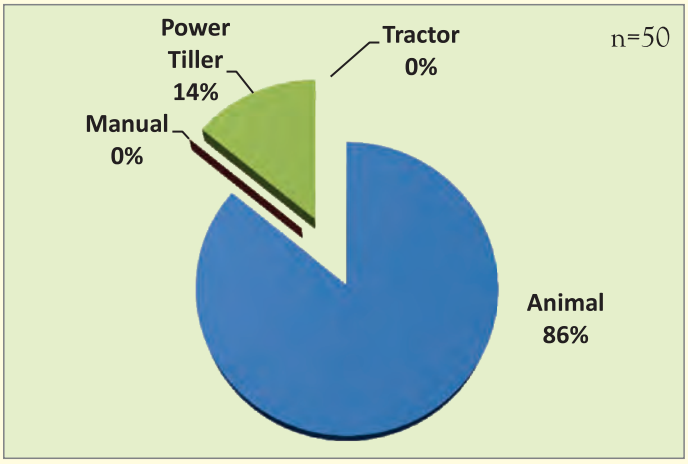

Fig. 27. Power source for land preparation at Kumirmari village

3. B.1.f. Area under vegetable cultivation before and after 'Aila'

Occupying land for vegetable cultivation before Aila was 2.32 ha, whereas land for vegetable cultivation reduced to 1.79 ha and productivity also reduced due to soil salinity, water scarcity etc. after Aila. Mainly they consumed vegetables in home and surplus sold in market/ village (Fig. 28).

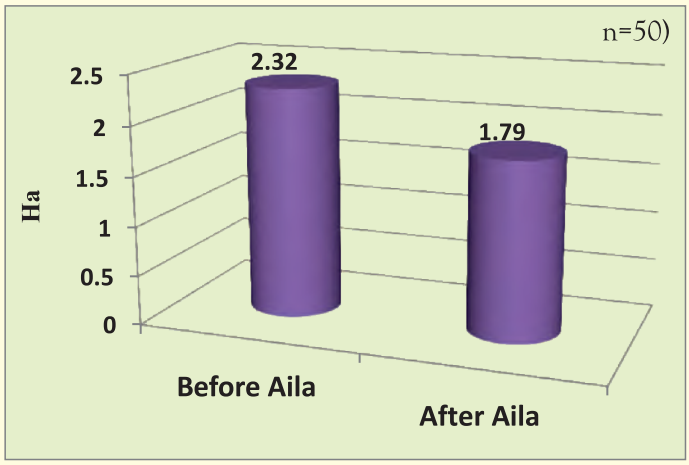

Fig. 28. Area under vegetable cultivation before and after 'Aila' at Kumirmari village

3.B.1.g. Production status of different local/ traditional rice cultivars

In Kumirmari village, 4 rice varieties i.e. Varshadhan, CR Dhan 403, CR Dhan 406 and Swarna Sub1 developed by NRRI, Cuttack were demonstrated in *Kharif* season. The productivity of those rice varieties was very good. In kharif season, the performance of CR 1017 and Pankaj (with WCS of 120 of each) were average as realized from the positive response from 40 respondents which was followed by Patnai (with WCS of 93) from 31 respondents and Satabdi (with WCS of 61) by 18 respondents.

Table 10. Production performance status of different practicing local/traditional rice cultivars at Kumirmari village (n=50)

Sl. No.	Practicing Local/Traditional Rice Cultivars	Weighted Cumulative Score	Rank
1.	Local (CR 1017)	120	I
2.	Pankaj	120	I
3.	Patnai	93	II
4.	Minikit (Satabdi)	61	III
5.	Kalomota	6	IV
6.	NC	6	IV
7.	Masuri	3	V
8.	Gotra	3	V
9.	Hogla	3	V
10.	Local (1016)	3	V
11.	Local (1181)	2	VI

3.B.1.h. Farmer's preference in selection of rice variety

Responses with regard to preferences of farmers in selection of rice varieties were collected in a 3-point continuum scale with fifteen selected criteria as given in (Table 11) and scoring was made based on their importance, namely, Very important–3 score, Moderately important–2 score and Less important–1 score. Then, ranking was made based on their weighted cumulative score

Table 11. Farmer's preference in selection of rice variety at Kumirmari village (n=50)

Sl. No.	Preference Criteria in Selection of Rice Variety	Weighted Cumulative Score	Rank
1.	High yield (productivity)	149	I
2.	Resistance to disease and pests	144	II
3.	Resistance to flood and submergence	144	II
4.	Resistance to occasional drought or water shortage	140	III
5.	Easily marketable	123	IV
6.	Good milling quality of paddy	120	V
7.	Bold grain quality	117	VI
8.	Resistance to salinity	115	VII
9.	Early duration of maturity	114	VIII
10.	Fine grain quality	113	IX
11.	Good cooking quality	102	X
12.	Easy to prepare value added products (Raw rice/ Parboiled rice/ Watered rice/ Expanded rice/ Flaked rice/ Puffed rice)	100	XI
13.	Response to low dose of fertilizer/ organic manure	91	XII
14.	Good quality paddy straw	88	XIII
15.	White coloured grain	73	XIV

In general, preference criteria for selection of a rice variety were very important in respect of high yield potentiality (with WCS of 149), resistance to diseases and pests (WCS-144) and resistance to flood and submergence (WCS-144), resistance to occasional drought or water (WCS-140), easy to marketable (WCS -123). More than half respondents with WCS of 117 said that bold grain quality was very much important for home consumption because they did laborious work in field and it minimized the hunger due to slow digestibility. About fifty percent respondents opined that those have large area of land, so they prefer fine grains for home consumption as well as marketable. Moderately important criteria for selection of rice variety were early duration for maturity (WCS–114), fodder etc, good cooking quality (WCS–102), and good quality paddy straw (WCS–88) for fuel).

3. B.1.i. Problems in rice cultivation

Responses of farmers of Kumirmari village with respect to problems in rice cultivation were collected in a 5-point continuum scale and scoring was made based on their severity, namely, Very

severe–5 score, Severe–4 score, Moderately severe – 3 score, Mild – 2 score and Very mild–1 score. Then, ranking of problems was made based on their weighted cumulative score (Table-12)

Table 12. Problems in rice cultivation at Kumirmari village (n=50)

Sl. No.	Problems in Rice Cultivation	Weighted Cumulative Score	Rank
1.	Unavailability of quality seeds in time	239	I
2.	Flood and submergence after heavy rain	239	I
3.	Unavailability of sufficient pesticides and fertilizers	238	II
4.	Erratic rainfall in rainfed areas	234	III
5.	Crop damage due to drought or water scarcity	233	IV
6.	Poor economic condition of self/ farmers,	233	IV
7.	Lack of proper technical knowledge and skill in rice farming	229	V
8.	Lack of irrigation facilities	228	VI
9.	Unavailability of labour during rice cropping season	225	VII
10.	High costs of farm inputs (like seeds, fertilizers, pesticides and labour)	224	VIII
11.	Lack of knowledge in handling of farm machineries	202	IX
12.	Infestation of insects and pests	196	X
13.	Unavailability of sufficient nos. of farm implements/ machineries	187	XI
14.	Incompatibility of farm machineries in our farming situation	185	XII
15.	Infestation of diseases	182	XIII
16.	Sale of paddy below minimum support price (MSP) fixed by the govt.	179	XIV
17.	Unavailability of references materials for farmers	174	XV
18.	Poor farmers-extension officers linkage	155	XVI
19.	Illegal practices and bribes by govt. officials for providing services, loans and subsidy etc.	120	XVII

(Note: Farmers wanted pond in the agricultural land, which can be utilized for fishing, vegetable and rice cultivation in *Boro/Rabi* season)

Most of the respondent faced unavailability of quality seeds in time (WCS–239) and flood and submergence after heavy rainfall (WCS–239). This was a very severe problem in rice cultivation. This was closely followed by unavailability of sufficient pesticides and fertilizers (WCS–238), erratic rainfall in rainfed areas (WCS–234), crops damage due to drought or water scarcity (WCS–233) and poor economic condition of farmers (WCS–233). Whereas 80 percent respondents with WCS of 255 responded separately that unavailability of labour during rice cropping season, lack of proper knowledge and skill in rice farming (WCS–229)

and lack of irrigation facilities (WCS–228) in *boro/rabi* season were very severe in rice cultivation. Other problems related to high cost of farm inputs (seeds, fertilizers, pesticides and labour) with WCS of 224, not getting minimum support price (WCS–179) and also effected due to lack of storage facilities, high cost of transportation and the middle man.

3. B.2. Demonstration of NRRI varieties at Hingalganj block of West Bengal in *Kharif* 2015

Four climate resilient varieties, Varshadhan, Luna Suvarna (CR Dhan 403), Luna Barial (CR Dhan 406) and Swarna-Sub1 have been taken for 6 demonstrations at farmer's fields at Kumirmari village, Hingalganj block (Sundarban), West Bengal in kharif season 2015. It shows that the average estimated yield (kg/ha) of NRRI rive varieties like Varshadhan, CR Dhan 403, CR Dhan 406 and Swarna-Sub1 were better than local rice varieties like CR 1017, Sabita and Masuri (Fig. 29). Overall 11.77% yield advantage (Table 13) has been registered for using NRRI climate resilient rice varieties as compared to varieties grown in the last *Kharif* season from the lands affected by one or more than one abiotic stresses such as water logging (16-57cm water depth), salinity (EC= 1.7-5.5 dS/m) and submergence. Varshadhan (Photo 18) performed well under water logging situation and registered 14.54% mean yield advantage over varieties (Masuri and CR 1017) grown in the last *Kharif* season in two demonstrations. Farmers observed that it has good cooking and eating qualities, good paddy straw and seeds have demand for in the village. CR Dhan 406 performed well under medium salinity and water logging situation under one demonstration and registered 15.00% yield advantage over check varieties (CR 1017) grown in the last year in the same fields. It was not preferred for eating by farmers. Swarna-Sub1 (Photo 19) also registered 3.75% mean yield advantage over check (Sabita). It is preferred for eating and has good demand in the village. On the other hand although CR Dhan 403 (Photo 20) has registered 13.79% mean yield advantage over check (CR 1017 and Sabita) but it is preferred very well by farmers for its good cooking qualities and paddy straw.

Table 13. Production status of NRRI rice varieties and Check (local) rice varieties in different stress situation at Kumirmari village, Kharif 2015

Types of Stress	Rice Variety	Average Estimated Yield (kg/ha)	Average Yield Advantage (%)	No. of Demonstration
Flood Prone	Varshadhan	4367.29	14.54	2
	Check (local varieties)	3733.91		
Salinity Prone	CR Dhan 403	4554.39	13.79	2
	Check (local varieties)	3926.04		
	CR Dhan 406	4281.38	15.00	1
	Check (local varieties)	3639.27		
Submergence	Swarna-Sub 1	3759.15	3.75	1
	Check (local varieties)	3618.28		
Overall	NRRI varieties	4240.55	11.77	6
	Check (local varieties)	3729.38		

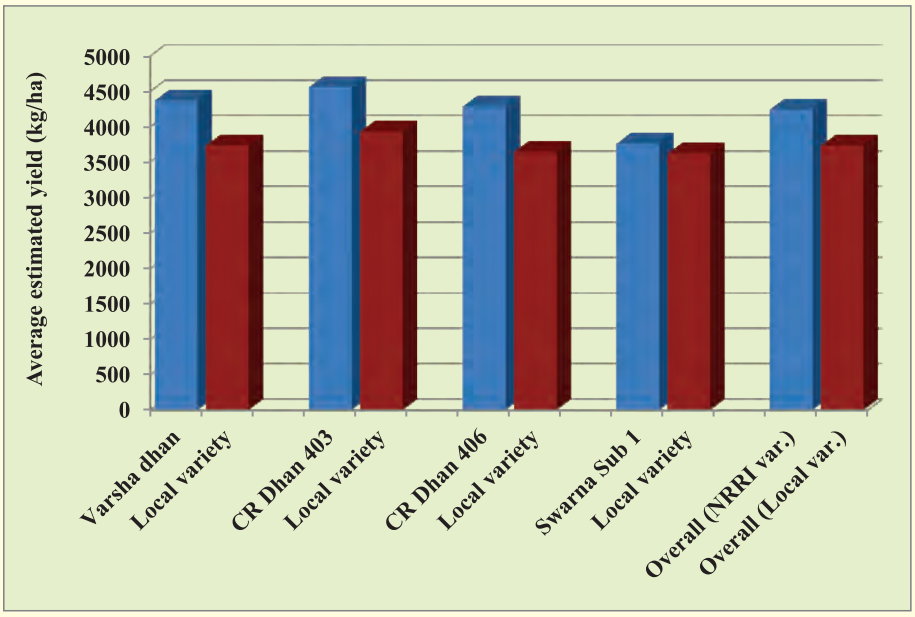

Fig. 29. Average estimated yield (kg/ha) of NRRI and Check (local) rice varieties

Photo 18. Varshadhan in the field of Krishnapada Das at Kumirmari village in *Kharif* 2015

Photo 19. Swarna-Sub1 in the field of Dulal Krishna Das at Kumirmari village in *Kharif* 2015

Photo 20. CR Dhan 403 in the farmer field of Parimal Mondal at Kumirmari village in *Kharif* 2015

3. C. Gosaba block

3.C.1. Evaluation cum demonstration at farmers' field with varieties for coastal saline areas in *Kharif* season

Performance of three recently-released high-yielding varieties namely Luna Suvarna, Luna Sampad and Luna Barial was evaluated at three locations at Gosaba block under the coastal saline situation in Sundarbans, South 24 Parganas, West Bengal during the wet season 2012 (Table 14). Luna Suvarna produced significantly higher grain yield than SR 26B at one location (Photo 21) while at the remaining two locations it was comparable to SR 26B. It performed well under medium salinity (field water EC 2.4-6.7 dS/m), slightly alkaline pH (7.6-8.2) with varying water depth of 6-47.3 cm. Average grain yield of Luna Suvarna (Photo 22) and SR 26B over the three locations was 4212 and 3988 kg/ ha, respectively.

Table 14. Varietal evaluation for grain yield under coastal saline situation at Gosaba block, Sundarbans, West Bengal during the wet season 2012

Variety/ Environmental Parameters	Plot Yield (kg) (Plot Size = 25 sq. m.)				
	Farmer-1 (Asim Mondol, Rajapur)	Farmer-2 (Prasanta Mondol, Rajapur)	Farmer-3 (Shibani Raut, Bagbagan)	Over locations	Grain Yield (kg/ha)
Luna Suvarna	11.7	10.91	9.00	10.53	4212
Luna Sampad	6.90	6.98	6.63	6.84	2736
Luna Barial	12.7	6.79	8.30	9.26	3704
SR 26B	12.1	8.93	8.88	9.97	3988
Mean	10.8	8.40	8.20	9.13	3652
LSD (5%)	2.17	1.55	0.85	0.94	376
Water depth (cm)	8-56	5-48	4-38	6-47.3	
pH	8-8.3	7.7-8.0	7.3-8.4	7.6-8.23	
Water EC (dS/m)	2-6.6	1.8-5.7	3.4-7.8	2.4-6.7	

Varietal Evaluation and Demonstration Conducted at Sundarban

Photo 21. Varital evaluation and demonstration conducted at Gosaba block, Sundarban in 2012

Photo 22. Picture of Luna Suvarna and Luna Sampad at Gosaba block

3. C.2. Participatory varietal selection for salinity tolerance in *Boro* rice at 'Sundarbans'

Participatory varietal selection was conducted by National Rice Research Institute (NRRI) with the help of IFFCO at flowering stage on 18th May 2012. The site of the present experiment was Bagbagan village under Gosaba block of South 24 Parganas in West Bengal. This area belongs to coastal saline ecology of rice cultivation. *Boro* rice area in Sundarban is marginal due to soil salinity throughout the growth period and unavailability of non-saline irrigation water. Due to increasing cost of land preparation and transplanting farmers are getting inclined towards direct seeding of rice. Eleven cultures including check high yielding variety, WGL20471, were sown (Photo 23) with three replications in the month of February 2012. The plot size was 50 sq m. Uniform plant population was maintained. Soil salinity was measured in 15 days interval throughout the growing period. EC was found varied from 7-10 dS/m. The crop establishment and growth of the check variety was found highly affected by salinity. The objective of this experiment was to understand the farmers' preference and correlate it with researchers' observation and interpretation in the course of selection of rice varieties under abiotic stress like salinity.

Photo 23. Direct seeding of 11 rice varieties from NRRI at Bagbagan, Gosaba block in dry season

Fifteen male and thirteen female farmers participated (Photo 24) in the participatory varietal selection. Their average holding size varied from 1-4 acre. They put their acceptance and rejection through marked papers. All of them were found highly enthusiastic in participation in that event. Counting of positive (√) and negative (x) votes revealed that CR2815-4-26-2-1-1-1 ranked first followed by CR2815-4-26-1-S-5-2-1 and Luna Sankhi (Photo 25). Farmers told their preference and the basis of their selection. They mainly gave weight-age to better crop establishment, higher grain density, more number of seeds per panicle and number of panicles per plant under this stress environment in *boro* season. Breeder's choice in this regard was found quite similar. Moreover, CR2815-4-26-2-1-1-1 was also found most preferred line under the present set of experiment.

Photo 24. Participatory varietal selection with the help of farmers at Gosaba block in *Boro* season

Photo 25. Farmers active participation in agricultural field at Gosaba block during participatory varietal selection in *boro* 2012

3. C.3. Meeting with women farmers

A meeting was conducted on 3rd December 2012 with the active collaboration between NRRI and IFFCO for women farmers (Photo 26). Participation of women in rice cultivation in Sundarban area is throughout the cropping season and they take active role in selection of varieties based on quality and post harvest uses. They actively participated in varietal evaluation and demonstration of rice varieties from NRRI in salt affected area at Bagbagan at Gosaba block. Dr. Sukanta Dasgupta, ADA, Seed certification, Govt. of West Bengal detailed about the requirements of new high yielding varieties salt tolerant varieties such as Luna Suvarna, Luna Barial, etc. for the replacement of old non-salt tolerant varieties in salt infected areas in post cyclone 'Aila' period. Mr. Partha Bhattacharyya, Regional Manager, IFFCO and Dr. K Chattopadhyay and Mr. B.C. Marndi, Scientist, NRRI also interacted with the participants on the performance of NRRI varieties and future need of new technologies.

Photo 26. Dr. Sukanta Dasgupta, ADA, Seed certification, Govt. of West Bengal delivered his lecture

3. C.4. Activity: Evaluation of breeding lines at target site

Eighteen lines derived from various crosses involving salt tolerant donors SR 26B, FL 496, Pateni and FL 478 were evaluated along with Luna Suvarna, a released variety for coastal saline area and CR 1017, a salt susceptible cultivar. They were planted on 7th August in replicated plots at Gosaba (Sundarban) under coastal saline area. Throughout the cropping season salinity varied from 0.5-7 dS m^{-1}. Water depth in that field varied from 5 cm to 54 cm. Due to heavy rain crops were submerged totally with muddy water for 2-3 days. Four lines exceeded Luna Suvarna for average plot yield. Among them two lines (CR 2839-1*-1-S-1-2B-35-B, CR2859-S-B-3-1-2B-1) were chosen by farmers. Another line CR 2218-41-2-1-1-S-B2-B was also identified by the growers through participatory selection. They have given estimated yield of around 3-3.5 t/ha in 145-155 days.

3.D. Basanti Block

3. D.1. Demonstration of salt tolerant varieties at Basanti block

Demonstrations of salt tolerant rice varieties, Luna Suvarna, Luna Barial and Luna Sampad were taken at Basanti block with the help of a NGO, Citizen Forum and Govt. of West Bengal in *Kharif* 2013. The salinity level was very high in two plots (>8 dS/m) planted with Luna Barial and Luna Suvarna. The average yield was Luna Barial and Luna Suvarna were 3.3 t/ha. The high yielding varieties were found unsuitable for those plots.

In another demonstration, one farmer with 1 ha land with EC of 5.8 dS/m raised Luna Suvarna (Photo 27). He received 4.7 t/ha paddy yields in *Kharif* 2013. He has distributed 50 kg seeds for rising in the next *Kharif* season.

Photo 27. A farmer who got 4.7 ton in his 1 ha area cultivated with Luna Suvarna at Basanti block

3.E. Patharpratima block

3. E.1. Demonstration of salt tolerant varieties at Patharpratima block

Twelve demonstrations had taken with Luna Suvarna, Luna Sampad and Luna Barial in *Kharif* season. The salinity level was low to medium (0.8-5.9 dS/m) with no water logging. Due to low salinity level the check variety Pratiksha performed better than these varieties. However, due to

high yielding ability (4.5 t/ha) and preferred grain type with higher market demand farmers selected Luna Suvarna for the next year.

3. E.2. Production of foundation seeds

Four farmers from Rakhaskhali village under the society Pathar Pratima Dakshin Shibganj Lokosiksha and Rural Development Society (Photo 28) took 20 kg breeder seeds of Swarna-Sub1 from NRRI, Cuttack. They have produced 200 kg foundation seeds under the guidance of NRRI, Cuttack in *Kharif* 2015. These seeds will be used for production of certified seeds in the coming *Kharif* season for cultivation in flood prone ecology in this block.

Photo 28. NRRI Scientist with the Secretary of Pathar Pratima Dakshin Shibganj Lokosiksha and Rural Development Society at Patharpratima block

4. Impact on NRRI climate resilient rice varieties in coastal area of Sundarban, West Bengal:

- After 'Aila' incidence, water logging and salinity have been increased significantly at Chhoto Sehera village of Sandeshkhali-I block. Due to unavailability of seeds of high yielding climate resilient varieties people of this area was continuing their cultivation with local /old rice varieties such as CR 1017, Pankaj, Patnai, Kalomota, etc. NRRI climate resilient rice varieties were first introduced at Sandeshkhali-I block in *Kharif* 2013. Farmer's preference for cultivation of Varshadhan for water logging condition, CR Dhan 403 and CR Dhan 406 for salinity condition, Swarna-Sub1 and Savitri-Sub1 for submergence prone conditions were recorded in three *Kharif* season (year 2013-2015). Productivity of these varieties was recorded much higher than the existing varieties in low land areas with abiotic stresses.
- Among thirty two farmers those who cultivated four NRRI rice varieties (Varshadhan, CR Dhan 403, CR Dhan 406 and Swarna-Sub1) in *Kharif* season 2014, 31 of them again cultivated those varieties in *Kharif* season 2015. The adaptability of improved NRRI climate resilient rice varieties in 2015 was found around 98% at Chhoto Sehera village.
- People of this area and nearby areas at Sandeshkhali-I block and Hingalganj block are gradually realizing the value of these newly introduced varieties for their high yielding ability under different stresses condition which became more prominent in post-Aila

period. They are purchasing seeds from those who cultivated these varieties at the rate of Rs 20/- per Kg (Fig. 30). The increasing areas under high yielding climate resilient varieties will definitely improve the overall productivity and profitability of this area.

- People awareness has been increased through meeting and demonstrations for choosing right kind of varieties for their land with the intervention of Scientists from NRRI, Cuttack. Swarna-Sub1 and Savitri-Sub1 are taken by farmers only in submergence prone areas, whereas Luna Suvarna only for salt affected areas.
- More than 200 Kg seeds of Luna Suvarna and Luna Sampad were generated from the farmers' fields at Gosaba in 2013 and these seeds were distributed among farmers at Gosaba and Basanti blocks in 2014. Grain quality of Luna Suvarna was accepted by farmers and consumers at Gosaba and Basanti areas.
- Seed production was taken by a few farmers at Patharpratima block under the guidance of NRRI. Around 200 kg foundation seeds of Swarna-Sub1 were generated in *Kharif* 2015 for cultivation in flood prone areas of Patharpratima.
- Meeting was conducted for increasing awareness among lady farmers at Gosaba. Three women farmers at Gosaba, four women farmers at Sandeshkhali-I block and one women farmer at Hingalganj block demonstrated climate resilient varieties from NRRI during this period.

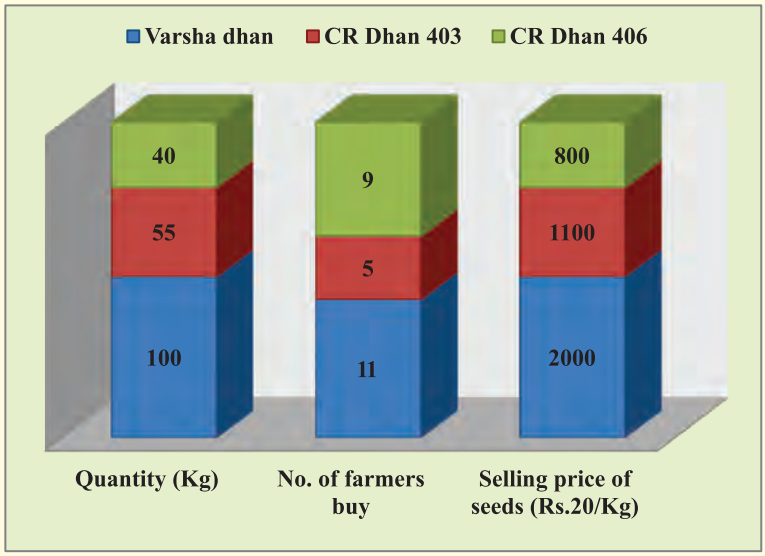

Fig. 30. Purchase of stress tolerance rice variety as seeds at Sandeshkhali-I block

Annexure-I

Among all the salt tolerant varieties tested in different locations in Sundarban area like Basanti, Gosaba and Prathaprotima in West Bengal during last few years, Luna Sampad and Luna Suvarna performed better and accepted by the farmers. Average seed productivity is 4 Mt/Ha. But farmers now prefer fine rice varieties even in problematic soil. Salt tolerant, mid duration, fine rice and non lodging high yielding varieties will be more acceptable by the farmers of this production zone of West Bengal.

Dr. Sukanta Dasgupta
ADA (Administration),
Seed Certification,
Govt. of W.B.

Annexure-II

After Aila I cultivated salt tolerant rice varieties CR Dhan 403 and CR Dhan 406 and waterlogging tolerant variety Varshadhan and also submergence tolerance varieties Swarna-Sub1 and Savitri-Sub1 taken from NRRI, Cuttack along with local rice varieties, Pankaj, Patnai and CR 1017. The production status of NRRI climate resilient rice varieties were better than local rice varieties. I utilized Varshadhan for puffed rice. I adopted these rice varieties and sold 200 Kg of CR Dhan 406 and Varshadhan. I told farmers to cultivate NRRI varieties for better yield.

Jaykrishna Mondal
Village : Chhoto Sehara,
Sandeshkhali-I Block

Annexure-III

I cultivated Varshadhan in my water logging field and CR Dhan 403 in high salinity field along with CR 1017 and Swarna-Pankaj. The productivity of NRRI climate resilient rice varieties were more than local rice varieties grown years after years. I am thankful to NRRI Scientists for providing climate resilient rice varieties at Chhoto Sehara and training for increased awareness about the proper selection of rice variety in Aila affected area of Sundarban.

Sekh Rojob Ali
Village : Sehara-Radhanagar
Sandeshkhali-I Block

Annexure-IV

Demonstration of climate resilient rice varieties from NRRI at Sandeshkhali-I block (Sundarban) West Bengal, Kharif 2014

No of Demonstration	Name of the Farmer	Village	Male/ Female	NRRI Variety	Estimated Yield (kg/ha)	Water Logging / Salinity Tolerance	Farmers' Preference	Check (Last year variety)	Estimated yield (kg/ha)	Average yield advantage (%)
1	Jaykrishna Mondal	Chhoto Sehara	M	Varshadahn	5151.52	Water logging	Good for eating and puffed rice	Swarna Pankaj	4583.33	11.03
2	Ranjan Das	Chhoto Sehara	M	Varshadahn	5606.06	Water logging	Good for eating and puffed rice, selling price high	Patnai	4590.91	18.11
3	Subrata Konra	Chhoto Sehara	M	Varshadahn	5227.27	Water logging	Good for eating and selling price high	Patnai	4628.79	11.45
4	Chayet Ali Shek	Chhoto Sehara	M	Varshadahn	5000.00	Water logging	Good for eating and high market demand	Local	4227.27	15.45
5	Sarat Bindu	Radhanagar	M	Varshadahn	4848.48	Water logging	Good for eating and high selling price	CR 1017	4515.15	6.87
6	Basanti Aari	Majher para	F	Varshadahn	4924.24	Water logging	Good for eating and high selling price	Pankaj	4136.36	16.00
7	Amalendu Sena	Chhoto Sehara	M	Varshadahn	4878.79	Water logging	Good for eating and high selling price	Patnai/ Sabita	4333.33	11.18

8	Niranjan Khatua	Chhoto Sehara	M	Varshadahn	5265.15	Water logging	Good for eating and puffed rice, high selling price	CR 1017	4651.52	11.65
9	Khudo Gazi	Chhoto Sehara	M	Varshadahn	5303.03	Water logging	Good for eating, high selling demand	Kalo mota	3954.55	25.43
10	Hajo Khatua	Chhoto Sehara	M	Varshadahn	5113.64	Water logging	High selling demand, good for eating	Local	4196.97	17.93
11	Maidul Gazi	Nityaberia	M	Varshadahn	5189.39	Water logging	High selling demand, good for eating	CR 1017	4568.18	11.97
12	Anil Nath	Chhoto Sehara	M	Varshadahn	5681.82	Water logging	Easy to sell, good for roof top covering	CR 1017	4606.06	18.93
13	Angur Bala Mandol	Chhoto Sehara	F	Varshadahn	4924.24	Water logging	High selling demand, good for eating	CR 1017	4196.97	14.77
14	Gurupada Singh	Chhoto Sehara	M	Varshadahn	4924.24	Water logging	Good for eating and puffed rice, selling price high	CR 1017	4257.58	13.54
Average				**Varshadahn**	**5145.56**				**4389.07**	**14.59**
15	Debabrata Konra	Chhoto Sehara	M	CR Dhan 403	4962.12	Salinity	Very good eating quality, good for selling	Pankaj	4204.55	15.27
16	Krishna Pada Konra	Chhoto Sehara	M	CR Dhan 403	3939.39	Salinity	Very good eating quality	Pankaj	3803.03	3.46
17	Sunil Dhapor	Chhoto Sehara	M	CR Dhan 403	3863.64	Salinity	Very good eating quality	CR 1017	3863.64	0

18	Boturam Das	Chhoto Sehara	M	CR Dhan 403	3712.12	Salinity	Very good eating quality	Patnai	3651.52	1.63
19	Romjan Ali Gazi	Chhoto Sehara	M	CR Dhan 403	3674.24	Salinity	Very good eating quality	Patnai	3674.24	0
20	Necher Ali Sekh	Chhoto Sehara	M	CR Dhan 403	3651.52	Salinity	Very good eating quality	CR 1017	3651.52	0
Average				**CR Dhan 403**	**3967.17**				**3813.13**	**3.93**
21	Asu Pradhan	Chhoto Sehara	M	CR Dhan 406	4886.36	Salinity	Not very good for eating quality, good for selling	Pankaj	4189.39	14.26
22	Sanjay Das	Chhoto Sehara	M	CR Dhan 406	4962.12	Salinity	Not very good for eating quality	Pankaj	4181.82	15.73
23	Nripen Mondal	Chhoto Sehara	M	CR Dhan 406	5628.79	Salinity	Not very good for eating quality	Pankaj	4568.18	18.84
24	Amal Nath	Chhoto Sehara	M	CR Dhan 406	5704.55	Salinity	Weak straw, not good for eating	CR 1017	4636.36	18.73
25	Mujibar Gazi	Chhoto Sehara	M	CR Dhan 406	5045.45	Salinity	Good for selling, not good for eating	Pankaj	4287.88	15.01
Average				**CR Dhan 406**	**5245.45**				**4372.73**	**16.51**
26	Baburam Nath	Chhoto Sehara	M	Swarna-Sub1	5681.82	Submergence	Good for eating and selling	Masuri	4598.48	19.07
27	Bishnu Pada Konra	Chhoto Sehara	M	Swarna-Sub1	5378.79	Submergence	Good for eating and selling]	Gotra	4575.76	14.93
28	Sachin Das	Chhoto Sehara	M	Swarna-Sub1	5401.52	Submergence	Good for eating and selling	Masuri	4628.79	14.31

29	Banamali Das	Nityaberia	M	Swarna-Sub1	5712.12	Submergence	Good for eating	Masuri	4469.70	21.75
30	Nirapada Mondal	Chhoto Sehara	M	Swarna-Sub1	5265.15	Submergence	Good for eating and selling	Masuri	4575.76	13.09
31	Chitta Ghorami	Chhoto Sehara	M	Swarna-Sub1	5250.00	Submergence	Good for eating and selling	CR 1017	4545.45	13.42
32	Ashok Nath	Chhoto Sehara	M	Swarna-Sub1	5242.42	Submergence	Good for eating and selling	Masuri	4621.21	11.85
Average				**Swarna-Sub**	**5418.83**				**4573.59**	**15.49**
				Overall	**4944.25**				**4287.13**	**12.63**

Annexure-V

Demonstration of climate resilient rice varieties from NRRI at Sandeshkhali-I block in Kharif 2015

No. of Demonst-ration	Name of the Farmers	Village	Male/ Female	NRRI variety	Estimated yield (kg/ha)	Water logging/ salinity tolerance	Farmers' Preference	Check (Last year variety)	Estimate d yield (kg/ha)	Average yield advantage (%)
1	Anil Bhunya	Raipur	M	CR Dhan 403	4630.10	Salinity tolerance	Very good for eating and selling	Kalo Mota	3679.31	20.53
2	Sachinandan Majhi	Chhoto Sehara	M	CR Dhan 403	4409.87	Salinity tolerance	Very good for eating and selling	Kalo Mota	3150.80	28.55
3	Baturam Das		M	CR Dhan 403	4513.06	Salinity tolerance	Very good for eating and selling	Pankaj	3651.02	19.10

4	Sunil Dhapor	Chhoto Sehara	M	CR Dhan 403	4330.08	Salinity tolerance	Very good for eating and selling	CR 1017 (local)	3679.70	15.02
5	Debabrata Konra	Chhoto Sehara	M	CR Dhan 403	4250.60	Salinity tolerance	Very good for eating and selling	CR 1017 (local)	4156.45	2.21
6	Romjan Ali Gazi	Chhoto Sehara	M	CR Dhan 403	4957.21	Salinity tolerance	Very good for eating and selling	Patnai/Kalo Mota	3621.80	26.94
Average				**CR Dhan 403**	**4515.15**				**3656.51**	**18.73**
7	Jaykrishna Mondal	Chhoto Sehara	M	CR Dhan 406	5401.05	Salinity tolerance	Not very good for eating and selling	Local CR	3956.23	26.75
8	Bimal Konra	Chhoto Sehara	M	CR Dhan 406	4988.65	Salinity tolerance	Not very good for eating and selling	Pankaj	3643.18	26.97
9	Nripen Mondal	Chhoto Sehara	M	CR Dhan 406	5309.70	Salinity tolerance	Not good for eating and selling	CR 1017 (local)	4170.15	21.46
Average				**CR Dhan 406**	**5233.13**				**3923.19**	**25.06**
10	Ashthami Mondal	Chhoto Sehara	F	Swarna-Sub1	4786.50	Submergence tolerance	Good for eating and selling	Pankaj	3641.34	23.92
11	Nirapada Mondal	Chhoto Sehara	M	Swarna-Sub1	5430.10	Submergence tolerance	Good for eating and selling	CR 1017 /Pankaj	3825.62	29.55
12	Baburam Nath	Chhoto Sehara	M	Swarna-Sub1	5050.25	Submergence tolerance	Good for eating and selling	CR 1017 /Pankaj/ Kalo Mota	3455.48	31.58

13	Banamali Das	Chhoto Sehara	M	Swarna-Sub1	6075.50	Submergence tolerance	Good for eating and selling	CR 1017 (local)	4012.50	33.96
14	Sanjoy Das	Chhoto Sehara	M	Swarna-Sub1	5512.50	Submergence tolerance	Good for eating and selling	CR 1017 (local)	3937.75	28.57
Average				Swarna-Sub1	**5370.97**				**3774.54**	**29.52**
15	Anil Nath	Chhoto Sehara	M	Varshadhan	5625.48	Water logging tolerance more	Good for eating, puffed rice and selling	Pankaj	4725.27	16.00
16	Dayal Das	Chhoto Sehara	M	Varshadhan	5512.56	Water logging tolerance more	Good for eating, puffed rice and selling	Local CR/Kalo mota	4117.45	25.31
17	Jaykrishna Mondal	Chhoto Sehara	M	Varshadhan	5310.69	Water logging tolerance more	Good for eating, puffed rice and selling	Patnai	3996.68	24.74
18	Bimal Konra	Chhoto Sehara	M	Varshadhan	4702.55	Water logging tolerance more	Good for eating, puffed rice and selling	CR 1017 (local)	3837.79	18.39
Average				**Varshadhan**	**5287.82**				**4169.30**	**21.11**
19	Jaykrishna Mondal	Chhoto Sehara	M	Savitri-Sub1	5998.53	Submergence	Good for eating, puffed rice and selling		3852.87	**35.77**
Overall					**5281.12**				**3875.28**	**26.04**

Annexure-VI

Demonstration of climate resilient rice varieties from NRRI at Hingalganj block (Sundarban) West Bengal, Kharif 2015

No. of Demonstration	Name of the Farmers	Village	Male/ Female	NRRI Variety	Estimated Yield (kg/ha)	Water logging/ salinity tolerance	Farmers' Preference	Check (Last year variety)	Estimated yield (kg/ha)	Average yield advantage (%)
1	Dulal Krishna Das	Kumirmari	M	Swarna-Sub1	**3759.15**	Submergence	Good for eating, farmers demand	Sabita	**3618.28**	**3.75**
2	Parimal Mondal	Kumirmari	M	CR Dhan 403	4590.75	Salinity	Good for eating, paddy straw and demand in the village	Local (CR 1017)/ Sabita	3895.40	15.15
3	Dr. Ajit Mondal	Kumirmari	M	CR Dhan 403	4518.02	Salinity	Good for eating, paddy straw and demand in the village	Local (CR 1017)/ Sabita	3956.67	12.42
Average				**CR Dhan 403**	**4554.39**				**3926.04**	**13.79**
4	Bidesh Nath	Kumirmari	M	**CR-406**	**4281.38**	Salinity	Not good for eating	Local (CR 1017)	**3639.27**	**15.00**
5	Goshtha Das	Kumirmari	M	Varshadhan	4321.16	Water logging	Good for eating, paddy straw and demand in the village	Local (CR 1017)/ Masuri	3545.31	17.95
6	Krishna Das	Kumirmari	M	Varshadhan	4413.42	Water logging	Good for eating, paddy straw and demand in the village	Local (CR 1017)/ Masuri	3922.50	11.12
Average				**Varshadhan**	**4367.29**				**3733.91**	**14.54**
Overall					**4240.55**				**3729.38**	**11.77**

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