Enhancement of Productivity of Traditional Paddy with Diversified Organic Inputs at Sagar Island, South 24 Parganas, West Bengal, India

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Summary:

*This paper is in continuation our six years' (since 2014) activities on the cultivation of traditional paddy varieties, including **salt tolerant ones** with diversified organic inputs for supplying necessary nutrients and also as pest repellents at Sagar & Patharpratima Block, with the objective of enhancing productivity of salt tolerant paddy varieties; which requires no chemicals, so that the farmers could revert back to cultivating them. The traditional varieties of paddy (nearly 125 in number) were cultivated in our **Biodiversity Conservation Park**, a project of the W.B. Biodiversity Board, of which at least 14 varieties are proved having good results with respect to yield in local saline soil. Local resources (cow dung, cow urine, liquid starches, palm juice/ molasses, paddy straw ash, poultry litter, mustard cake), mixed and named SAGAR SONNA, used for supplying necessary nutrients. In addition, leaf juice mixture of Neem, Karanja, Nishinda, etc., fish tonic, Jeebamrutha, etc are used in combination for getting good results. Climate resilient varieties of paddy were also recorded.*

1. Introduction:

The modern agriculture (High External Input mono-cropping Agriculture), focuses on the practices which are away from **biodiversity conservation.** As a result, the genetic base of traditional paddy seed varieties, inherently more compatible with local climatic & farming conditions, gradually being reduced considerably and several traditional paddy seed varieties are now facing extinction. These varieties were also more resistant to pests, diseases, droughts and floods. *Moreover, the diversified seed varieties are known to allow our nature to facilitate the origin of the future seeds through the process of natural selection*. Moreover, scientists need diversified genetic base for developing improved varieties also.

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Saline water intrusion has become a major problem in the coastal areas of the islands in the Sunderban region of India. The intrusion takes place through breeches in the mud embankments or when the water-level rises above the embankments during storms and cyclones. As a result of sea water intrusion the soil salinity increases, rendering the agricultural lands barren for the next five or six years. Only after five or six good monsoons the salinity of the soil is reduced to its normal level and agriculture may again be resumed. But this period of waiting is too long for marginal and small farmers who practice subsistence farming. To maintain their families they have to either depend on government aids or the male members migrate to Kolkata or other states of India to work as labourers. Moreover land, which is the primary resource of this region, remains idle for five or six years at a stretch.

In the above background the primary objective of the project was to enhance the livelihood security of small and marginal farmers in the climate sensitive zone of Sundarban, West Bengal, through conservation and sustainable utilization of indigenous agro-biodiversity particularly, salt tolerant varieties of paddy and use of organic farming technologies, so as to adopt climate resilient livelihood options.

The IPCC 4th Assessment Report (IPPC, 2007) states that Southeast Asia is expected to be seriously affected by the adverse impacts of climate change. Since most of its economy relies on agriculture and natural resources as primary income, climate change has been and will continue to be a critical factor affecting productivity in the region. The relevance of the objectives of the project and the ensuing interventions can be better appreciated in the lights of the findings in the synthesis report of the **Intergovernmental Report on Climate Change (IPCC 2014). Debnath (2013 & 2014)** examined the agricultural production system is totally hampered after AILA due to high salinity and pH condition of soil. Several authors examined and published similar situations in India and in other countries having coastal saline soils (Danda, A.A. 2007, Danda, A. A, et al, **2011,** Das Sunita, et al. 2018, Debnath, A. 2013, Debnath A., 2014, Gupta S., and Sarkar G., 2015, Haldar and A. Debnath, 2014**,** P.Shrivastava, & Rajesh Kumar, 2014, Sanjida Khandker, et al. 2014,. Seal, A. et al. 2008, Seal, A., 2005, Si Sisir Kumar , 2016, Singh, A.K, et al., 2012}.

The report clearly mentions that climate change is unequivocal, the atmosphere and oceans have warmed, the amount of snow and ice has diminished and the sea level has risen. Driven primarily by population and economic growth, anthropogenic green house gas (GHG) emissions have increased since the pre-industrial era. This has resulted in increasing atmospheric concentration of GHGs. Surface temperature is projected to rise over the 21st century under all assessed emission scenarios, the oceans will continue to warm and acidify and the global mean sea level will rise. These in turn implies frequent storms, storm surges, heat stresses, inland and coastal flooding. So it is imperative to plan and develop climate resilient agriculture to brace ourselves to face future natural calamities like coastal flooding..

Problem statement: This project plans to address the problem of poverty & hunger by enhancing the agricultural productivity in Indian Sundarbans, the first two goals of SDG (2016-30). More than 4.6 million people live in 19 Blocks of Sundarbans, land area of 457478 ha of which agricultural land is 1,69,124.6 ha. On an average about 43.51 per cent HHs living below poverty line, about 87 per cent have no food security, and about 21 per cent of the population (more than one person in every five), do not get food even once a day on a regular basis. About 85 per cent of population here depends on agriculture. The productivity (yield) of paddy is very low in saline soils (1.5 to 2 tonne per hectare against a national average of 3. 28 tonne per ha) **[Living with Climate Change, CSE, 2012].** The development of salt tolerant varieties became a awful necessity after thousands of acres of agricultural land become inundated with saltwater after the Cyclone AILA on 25 May, 2009.

The paper at hand is divided into five major sections. The **first section**, Introduction includes a the Problem statement; the **second section** discusses some of the major interventions made during the project period of about five years commencing from February 2014. The **third section** includes the experiment done with Organic Manure (SAGAR SONA); the **fourth section** presents the overall results of such interventions, the **fifth one** with Climate resilient paddy varieties; while the last one deals with Concluding Remarks. The paper ends with relevant references

2. Interventions :

Here we discuss some of the important interventions implemented during the project. The title of the project was *Conservation of Local Agro Biodiversity for Better Livelihoods through use of Local Resources in Response to poor Areas of Sundarban,* and funded by the Ministry of Environment and Forests (Government of India) under the UNDP/GEF small grants programme (SGP). The Principal Investigator was Dr. Santanu Mitra (Prisident, Paribesh Unnayan Parishad) and there were four other NGO/CBO partners who helped in implementing and monitoring the project at different parts of the project area, that is, Sagar Island and Patharpratima blocks of South 24 Parganas, West Bengal, India.

2.1 Salt Tolerant Paddy Varieties :

Identification of salt-tolerant paddy varieties corresponding to salinity of soil & Traditional paddy conservation. The intrusion of saline sea water during the devastating cyclone (AILA) in 2009 not only destroyed the standing crops but degraded the soil to such an extent that the lands were left barren for nearly five years. The project introduced indigenous salt-tolerant paddy varieties (like Hamilton, Talmugur, Kerala Sundari, Gheus, Malaboti, etc.) on an experimental basis in the farmers fields. The outcome was positive but productivity varied depending on salinity of the soil. It was positive in the sense that substantial output was obtained in fields that had little or no yields with the common HYVs. But to get the best result the paddy varieties need to be matched with the soil salinity. Fifteen varieties salt-tolerant paddy were cultivated in the ten demo-plots **(Table 1)** . The varieties were Hangra Hamilton, Malabati, Talmugur, Dhudheswar, Kalobakra, KeralaSundari**,** Ranjit, Chamarmani, Lal Ghetu, Nona-sampad, Nona-Swarna, Patnai, Sada kalobakra, and Sadamota. These varieties were cultivated using organic (locally available) inputs along with land-shaping.

2.2 Organic Manure:

Organic manure preparation [Compost (FYM), **Sagar Sona (**Magic Manure: innovative manure by mixing eight locally available ingredients, developed by PUPA), vermicompost, Jeebamrutha (concentrated as well as diluted), Fish tonic, use of Tricoderma viridae, pseudomonas sp., Azotobactor with PSB, Bacilus, etc.] continued by the farmers and used as

organic manure & organic bio-pesticides for soil biodiversity conservation. Several training programmes were arranged at the farmers' fields to give them hands-on training in the preparation and use of these manures. Dhaincha (Sesbania baculeate), Bokful (Sesbania grandiflora), Sunhemp (Crotalaria juncea), Atasi (crotalaria sp.), Cowpea (Vigna sp.),black gram (Vigna mungo), Moringa oleifera etc. were introduced in the locality for the first time.

PUPA has been undertaking cultivation in the demo farm for a long time by using organic manure. In 2019, **'Sagar Sona'** was also used on an experimental basis. The manure was used first during preparation of the bed and then again one month after transplanting. It was observed that the colour of the leaf was very good and the number of tillers (Pashkathi) were comparatively more in number. Lal Dudheshwar, Aman Dudheshwar, Ghoramara Dudheswar**--** these varieties produced 40 to 50 tillers on an average. Kokila Patnai, CARI-5, Jagannath silet, Tangra, Kamal, Churnakathi-- yielded 30 to 35 tillers on an average. But productivity could not be recorded properly due to Cyclone Bulbul in the last week of November,19.

2.3 Integrated Farming *(using local resources)***:**

At present there is single cropping as agriculture is monsoon dependent. The river & canal waters are saline. To increase cropping intensity either a pond is excavated or the depth of the existing pond is increased to store rain water. This gives an additional winter crop /vegetables. Fruit trees or other plants can be grown along the bank of the pond and during summer when the water level falls, the slopes of the banks can be used for growing leafy vegetables. In addition there is scope of fishery and ducks. One can also have poultry. For marginal farmers these are sources of additional income. There income can be further enhanced by reducing cost of fertilisers by using home-made fertilisers and manures like vermicompost, fish tonic, jeevamurtha. These also help in retaining the fertility of the soil. Fish and poultry feed can also be prepared at home at low cost. It may also provide income security through diversification of activities.

2.4 Cost-Benefit Sharing Mechanism *(with interest free project support)*:

This particular economic design is followed in supporting any income generation activity of the project. The cost of the activity (calculated jointly by the beneficiaries & the skilled project staff) is equally shared in most of cases between the beneficiary and the project fund. The project fund is given at zero percent interest but the principal amount has to be returned to another member of the group or community). Thus timely payment benefits another member of the group or community. Moreover, repayment is assured by peer monitoring. By providing interest free loan on half the activity cost, the interest cost on the full amount is halved, thereby increasing profitability of livelihood activities as well as making repayment easier. This revolving fund should make the project economically sustainable even after the completion of the project, with the help of village level institutional development (Village Committee including SHG members).

Table: 1– Production of salt tolerant paddy varieties in one of the ten Demo plots

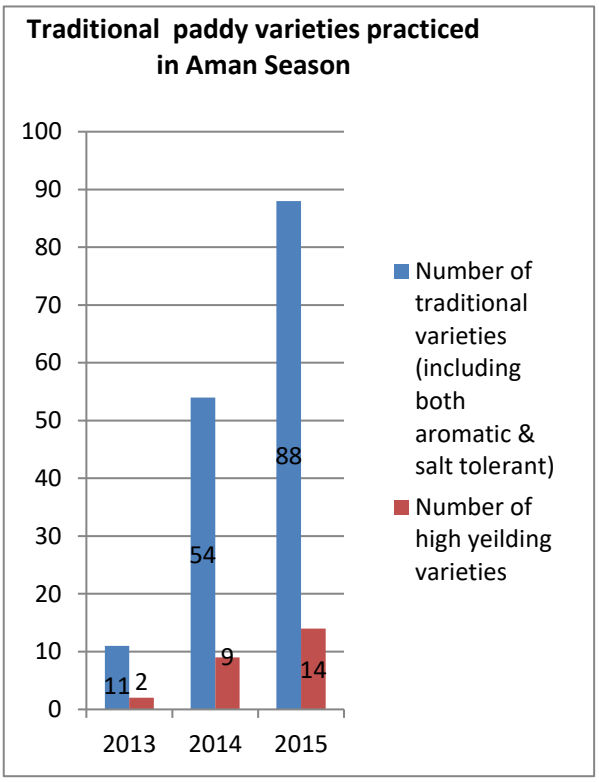
Sl. No.	Paddy varieties	Plot No. *	Salt tolerant *(opinion of Farmers)*	Maximum tillers noticed	**Production** (recorded for 10 varieties only) **Kg/ha**
1.	Hangra	**P-4, P-10**	**+++**	**23**	**3828.5**
2.	Hamilton	**P-10**	**+++**	**24**	**2595.5**
3.	Malabati	**P-1, P-3, P-5,P-6,P-9, P-10**	**+++**	**21**	**2595.5**
4.	Talmugur	**P-10**	**+++**	**23**	**2595.5**
5.	Dudheswar	**P-1,P-3, P-4, P-5, P-6, P-7, P-8,P-9,P-10**	**+ +**	**29**	**2964**
6.	Kalo bakra	**P-5**	**++**	**13**	**NC****
7.	**Kerala Sundari**	**P-10**	**++**	**23**	**5557.5**
8.	Ranjit	**P-1,P-2**	**++**	**27**	**3828.5**
9.	Chamarmani	**P-9**	**+**	**26**	**3087.5**
10.	Lal Ghetu	**P-10**	**+**	**14**	**NC****
11.	Nona sampad	**P-1**	**+**	**NC**	**NC****
12.	Nona swarna	**P-1**	**+**	**NC**	**NC****
13.	Patnai	**P-2**	**+**	**15**	**NC****
14.	Sada kalobakra	**P-3, P-7,P-8**	**+**	**NC**	**2223**
15.	Sadamota	**P-1, P-3,P-5, P-8**	**+**	**21**	**3211**

**** Plot No. & Farmer's Name : P-1: Saroj Panda*** *(Kachuberia, Sagar);* ***P-2 : Bhaskar Pramanik*** *(Kachuberia, Sagar);* ***P-3: Pradip Mandal*** *(Pakhirala, Sagar);* ***P-4: Achinta Khanra*** *(Pakhirala, Sagar);* ***P5 : Madan Pal*** *(HendalKetki, Sagar);* ***P-6: Anusuya Maity*** *(Boatkhali, Sagar);* ***P-7 : Tapasi Kalsa (Boatkhali, Sagar);*** ***P-8: Arati Bhuniya (****Boatkhali, Sagar);* ***P-9: Sudhanshu De (****Durbachati, Patharpratima);* ***P-10: Ashoke Pradhan (****Rakshashkhali, Patharpratima)*

*NC** = not recorded*

+ = minimum tolerance; ++ = moderate tolerance ; +++ = more tolerance [ECe (dSm^{-1})]

3. Results at a Glance *(See- Table 2)* **:**



i) Sadakalo bokra, Talmugur, Hamilton, Lal Gheus, Tangra are well known salt tolerant varieties. However, paddies like, nona-Dhudheswar, Malabati, Hangra, Chamarmoni, collected from Farmers of Sundarban area and Kerala Sundari (Horticulture Farm, Calcutta University, Agriculture Dept., Baruipur) etc. were found to be also salt tolerant.

ii) Highest productivity recorded was 2500 kg/acre (6425 kg/ha) for Keralasundari which is a traditional variety and can withstand salinity to moderate extent. Next to Keralasundari, the higher productivities were recorded for Hangra, Dhudheswar & Ranjit (HYV), all these are moderately salt tolerant. In all there were total 16 varieties of salt-tolerant paddy and the production enhanced (average 360 Kg/ 0.33 acres or 2694.5 kg/ha**)** in saline affected areas.

iii) The increase in productivity in the saline lands ensured enough food for the subsistence farmers.

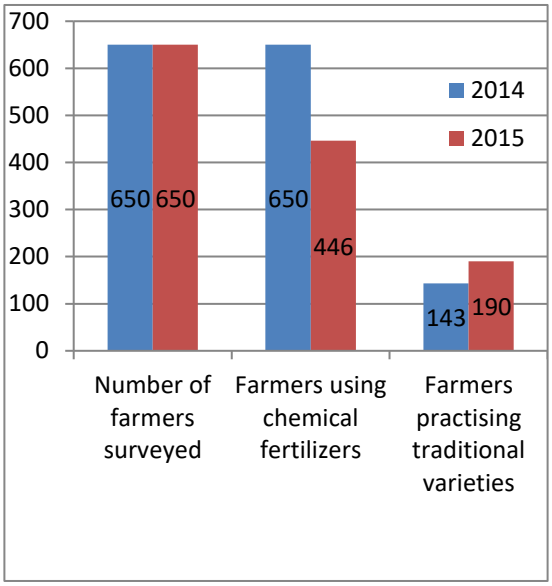
iv) As a result of counselling for promotion of salt tolerant and traditional paddy varieties a total of 3732 bighas of land (534 hectares / 1244 acres) of land was brought under paddy cultivation by more than 650 farmers. These included lands which were not cultivable due to saline water intrusion.

v) 100 traditional varieties of Paddy **(Fig.)** including 16 varieties of salt tolerant ones, were conserved and the following varieties were cultivated for seed production: Dhudheswar, Malabati, Sadamota, Nonasampad, Nonaswarna, Radhatilak, CR2314, CR2328, Ranjit, Radhatilak, Patnai, Sadakalobakra, Radhuni-pagal, Hangra, Tulaipanji,

Talmugur, Hamilton, Lalghetu, Bhuri, Keralasundari, Gobindabhog, Charmani, Jugal, Kamalabhog.

vi) A survey among the project beneficiaries in 2014 revealed that, all the 650 farmers used chemical fertilizers, where as in 2015 it was observed that 446 farmers have either fully or partly have shifted from use of chemical fertilisers and started using organic products.

Traditional Paddy cultivation (more than 100 varieties), being grown with harvested rain water (during one month rainless days) and organic manures only



No. of farmers using Traditional paddy & Organic manures (2014 & 2015)

vii) The same survey revealed that in 2014 only 143 of the 650 farmers used to cultivate traditional varieties like Malaboti, Hangra, Dudheswar, Chapakusi but in 2015 it was found that 190 farmers were producing traditional varieties of rice. Some new traditional varieties like Kerala Sundari, Darokasal, Tangra, Jhingasal, Harinakhuri, Binni have been introduced in the area to increase seed diversity.

viii) Promotion of integrated farming resulted in rain water harvesting, kitchen gardens, paddy cum fish, poultry and horticulture. This has resulted in an additional winter crop (where rain water harvesting took place) and diversification of income from poultry, fishery, kitchen gardens, horticulture and reduction in expenditure on external farm inputs, especially organic manures.

ix) Emission reduction of carbon dioxide has not yet been fully estimated. However, paddy cultivation in saline low-production and barren fields certainly keeps vast areas of land green, absorbing carbon-dioxide for a period of 5-6 months in a year.

x) In 2017, that is, one year after official completion of the project, about 100 new farmers (in Sagar Island) have been provided with indigenous paddy varieties and salt tolerant paddy seeds. This is the result of cost benefit sharing model developed and pursued by us during the project. The farmers are provided with the seeds when demand for the seeds is very high and so are prices. They have to return 1.5 to 2 times the quantity of seeds given just after harvesting when the price of seeds is low. Thus in the following year we can reach out to 1.5 or 2 times the number of new farmers of this year. Similarly, about 2.5 lakh rupees is rolling among SHG members (in Sagar Island) as loan this year for poultry, betel vine, fisheries, house repairing and small business.

Table: 2 – Details of Paddy cultivation report (Village wise):

Sl. No.	Name of the Village	Name of the Block	Name of the varieties Cultivated	No. Of farmers Adopting	Area of land Cultivated in (in acre)	Productivity of Paddy/ Hectare (Kg)
1	Durbachati	Patharpratima	Malabati, Dhudheswar, Charmani, Jugal, Anticancer, Tulsimukul, Joha,Tulaipanji, Gobindabhog, Kamalabhog	28	30	2000 to 2240
2	Rakshaskhali		Dhuseswar,bhuri,hamilton, Hangra, lalghetu, talmugur, keralasundari, gobindabhog, malabati	122	150	2000 to 2250
3	Gobindapurabad		keralasundari,	39	4	4250
4	Indrapur		keralasundari,	37	92	4250
5.	Dakshin Sitarampur		keralasundari, malabati	47	14	2250
6	U.Sitarampur		keralasundari	21	21	2260
7.	Buraburirtat		keralasundari	28	84	3200
8.	Gobardhanpur		keralasundari	29	87	3200
9	Kachubera	Sagar Block	Dhudheswar, Malabati,sada mota,nona sampad, nona swarna, radhatilak, CR2314, CR2328, **Ranjit (HYV)**	25		1500 to 2000
10	Pakhirala		Radhatilak, Patnai, Ranjit Dhusesar, malabati, sadamota, sadakalobakra, radhatilak, radhuni pagal, Hangra	20		1400 to 1550
11	Patharpratima		Dhudheswar	26		2520

12	Hendalketki		Sadamota, malbati, dhuseswar, tulaipanji, kalobakra	35		1800 to 2500
13	Silpara		Dhudheswar, patnai	20		1600 to 2500
14	Moorigan ga		Dhudheswar,patnai	20		1600 to 2500
15	Phulbari		Dhudheswar,malabati,patnai	15		1500 to 2500
16	Sibpur		Dhudheswar	12		2000 to 2500
17	Mrityunjayn agar		Dhudheswar	15		2000 to 2500
18	Boatkhali Sibpur		Malabati, dhudheswar Kalobakra, sadmota	10		1800 to 2500

4. Experiment carried out with Sagar Sona *(balanced Organic Manure)* **:**

Application of Sagar Sona & Chemical manures and comparing the result with two varieties of paddy (Ananda & Ganga), [**Table 4 & 5] .**

4.1 Production Method :

Cow dung (70 kg), Cow urine (3 litre), Mustard cake (3 kg), Poultry litter (3 kg), Boiled Paddy dust (3 kg) , Paddy husk Ash (1 bag,10 kg, Molasses (3 kg). Soil (moist garden soil, 5 kg). These eight ingredients are mixed together and kept for 10 to 15 days for fermentation. This manure is used during land preparation at the rate of 100 kg per bigha (0.33 acre). The pH of the soil is better to be adjusted (neutralised) by adding lime, if required. Another dose of 100 kg per bigha is applied after 25 to 30 days and the final dose just during flowering time. The production in both the cases (organic & chemical) appeared to be almost equal.

4.2 Field Action:

In order to popularise the use of "Sagar Sona" and wean away the farmers from chemical fertilizers, PUPA carried out a comparative experiment applying "Sagar Sona" (PUPA's demo plot) and commonly used chemical fertilizer (farmer's field) on two varieties of paddy, Ananda & Ganga. The production in both the cases (organic & chemical) appeared to be almost equal. Two plots (15 feet X 10 feet) were selected for 2 HYVs (Annada & Ganga). Cultivation methods were planned starting from seed selection, sterilisation, use of manures (Sagar Sona), spraying of liquid manures & bio-repellents, etc. Regular visits to the fields were done to record the number of tillers (date-wise) and also to see the need to spray of bio-repellents. The flowering

time was also recorded and harvesting was done in time. The number of tillers are recorded to be better in the organic fields. The average numbers of tillers recorded for Annada is 65 & 58 in the experimental & farmer's field respectively. Whereas for Ganga it is 25 & 30. The productivity recorded in the experimental field for Annada is 816kg/0.33 acre, for Ganga it is 720 kg/0.33 acre; whereas, Annada is 806 kg/0.33 acre Ganga is 749 kg/0.33 acre

4.3 Conclusion :

From our study it could be stated that if organic inputs are rationally used, paddy production will not be hampered. In addition, the natural soil fertility will be rejuvenated and maintained. However, to conclude we need more experimentation.

Table 4: Details of Paddy cultivation Report With SAGAR SONA (Magic Manure)

Paddy	Seed Bed	Transplan-tation		Counting of Tillers						Flowering	Harvesting	Production	Production
	Exp	Exp	Farmer	Exp	Farmer	Exp	Farmer	Exp	Farmer	Both the fields	both the fields	Exp	Farmers
Annada (115 day)	16.06.18	12.07.18	30.06.18	24.07.18 (5)	21.07.18 (9)	12.08.18 (30)	05.08.18 (20)	20.09.18 (65)	20.09.18 (58)	31.08.18	10.10.18	8.5 Kg (150 Sq.ft)	8.4 kg (150 Sq.ft)
Ganga (115 day)	16.06.18	12.07.18	10.07.18	24.07.18 (2)	21.07.18 (9)	12.08.18 (18)	05.08.18 (20)	20.09.18 (25)	20.09.18 (30)	31.08.18	10.10.18	7.5 Kg (150 Sq.ft)	7.8 Kg (150 Sq.ft)

N.B.- Number within brackets are number of tillers

Table 5: Production/Bigha (0.33 acre)

Paddy variety	Exp.	Exp.	Farmer	Farmer
Annada (115-120 day)	8.5Kg (150 Sq.ft)	816kg/0.33 acre	8.4Kg (150 Sq.ft)	806 kg/0.33 acre
Ganga (115-120 day)	7.5 Kg (150 Sq.ft)	720 kg/0.33 acre	7.8 Kg (150 Sq.ft	749 kg/0.33 acre

Experimentation with SAGAR SONA (magic manure) on ANNADA & GANGA paddy varieties at Biodiversity Conservation Park, PUPA, Sagar Island

5. Climate Resilient Paddy Varieties *(Table 3 and pictures shown in end of the Article)* **:**

A fiery cyclonic storm named 'Bulbul' hit the coasts of South Bengal and Bangladesh and lashed out at Sagar island on November 08, 2019. Irreparable loss was there in terms of damage of crops, trees, plants, etc. The main crop of paddy bore the biggest brunt of loss. However, there was no loss of life as the local government agencies moved people from vulnerable locations to a sizeable number of cyclone shelters built in recent times. PUPA has been cultivating various types of indigenous paddy for the last seven years in Sagar island. In its demo plot, 130 types of indigenous paddy were cultivated in 2019. Due to incessant rain and wind brought by 'Bulbul' for a continuous period of 5 days, water level in the paddy fields rose to more than 2 feet. The plants were left helter skelter by the 'Bulbul', although a few tillers stood straight. The best among these were the indigenous paddy varieties of Tangra **or Tangrashal**. Besides, the tillers of other varieties like CARI-5, Hogla, Narasingha saru, Khara, Dhanraj, Sadamota, Patnai, Dokra Patnai could get straight quite fast even though they fell in the initial aftermath of Bulbul. Other plant varieties viz. HMTD, Mugai, Nona Pankaj, Hogla, Nilanjana, Hangra were affected most as these plants are very small-sized (2'-3' in height) and were under water for a longer period.

6. Concluding Remarks :

If the prediction of environmentalists holds true, that is, global warming will increase the water level throughout the world, then coastal agriculture in many developed and developing countries are under serious threat of intrusion of saline water. Thus identification of salt tolerant paddy seeds is a big step forward. However, two things are to be noted. First, it is not enough to identify the salt tolerant paddy seeds but availability of those seeds among the

farming communities of the coastal regions is also necessary. The current project could only make those seeds available among the farmers in the project area. But to make them available among a larger population of coastal farmers, suitable scaling up of the project is necessary. The second important point is to establish the salt tolerant capacities of the paddy seeds. This is possible only through a number of rounds of replication under varying soil-salinity conditions.

According to synthesis report of the IPCC (2014) some of the approaches for managing the risks of climate change through adaptation are human development through better education, nutrition, health care facilities and so on. Poverty alleviation has to be made through improved access and control of local resources. Disaster risk reduction may be made through income, asset and livelihood diversification. Ecosystem management through maintaining wetlands, urban green spaces, coastal afforestation, maintenance of genetic diversity and community based natural resource management.

The project has tried to address some of these management issues like poverty alleviation through profitable utilization of saline coastal land using salt tolerant paddy seeds and use of local resources to produce organic manures. The increase in productivity in the saline plots has significantly helped the marginal and subsistence farmers to move out of starvation. It has also increased seed diversity by encouraging cultivation of different varieties of traditional paddies (including salt-tolerant varieties). Nearly 100 traditional varieties of Paddy including 16 varieties of salt-tolerant ones were cultivated in 3732 bighas (504 hectares or 1244 acres) of land . In fact many new varieties were introduced which were earlier not cultivated in the project area (like Kerala Sundari, Tulaipanji, Darokasal, Tangrasal, Jhingasal, Harinakhuri, Binni and so on). At present the organisation has over 125 varieties of traditional and salt-tolerant varieties of seeds in its seed bank. Livelihood diversification was attempted through integrated farming and by providing vocational training on organic farming, house wiring, food- processing and poultry farming. Soil conservation was promoted through use of organic manure and pesticides. These interventions also indirectly influence the problems of nutrition and health of farmers and consumers. Two things have come out very clearly from **Table- 1 and Table-2**. First, the salt-tolerance capacity varies with paddy varieties (as shown by their

productivities in the same plots) and second that the salt-tolerant varieties also grow better under normal soil conditions. Some other facts, which may be interesting, were are that there is large scale migration of men-folks from these affected areas to South Indian States of Tamil Nadu, Andhra Pradesh and Kerala to work as unskilled labourers in construction sites. Another important observation is that no HYV seed were found to be salt-tolerant except Ranjit (which can grow under low or moderate soil-salinity). Among the traditional varieties Sadakalo bokra, Talmugur, Hamilton, Talmugur, Lal Gheus are well known as salt tolerant varieties. However, paddy varieties like, nona Dhudheswar, Malabati, Hangra, Chamarmoni, collected from Farmers of Sundarban area and Kerala Sundari (Horticulture Farm, Calcutta University, Agriculture Dept., Baruipur) were also found to be salt tolerant. However, we end the paper with a note of caution. As we have seen that the productivities of salt-tolerant paddy varieties are not independent of soil salinity, as well as other factors like soil fertility, timely monsoon and seed quality, replication in experimental fields over a few years are necessary before conclusive results can be inferred.

7. Acknowledgement :

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Table- 3 : Salt Tolerant Paddy Cultivation Report

Name of the farmer	Village (Pathar Block)	Soil testing Report [ECe (dSm^{-1})]	Cultivation (2014) & productivity/hectre	Cultivation (2013) productivity
Shyamal Kinkar Das	Krishnadaspur	9.0	Hamilton & Talmugur (1120 kg)	Dhudheswar (560 kg)
Bharat Hasda	Satyadaspur	1.5	Dhudheswar & Malabati (1960kg)	1010 & 1017 (1120 kg)
Bimal Kr. Bhunia	Dakshin Sitarampur	1.9	Dhudheswar & Malabati (1960kg)	Barsa pankaj (840 kg)
Ananta Bera (Lang shaping)	Dakshin Sitarampur	8.5	Malabati & Sadakalobokra (1120 kg	Uncultivated due to salinity
Ramchandra Das	Krishnadaspur	6.5	Dhudheswar & Charmani (1400 kg)	Sada mota champakusi (840 kg)
Bimal Dinda	Gobordhanpur	8.7	Dhudheswar & Malabati (1680 Kg)	Champakhusi (1120 kg)

Courtesy: Das Sunita, et. al. (2018)

• Blue marked varieties can withstand climatic hazards			
Altapati	Dhanaraj	Kerala Sundari	Nona Ketki
Amonmona	Dokra Patni	Khanda Giri	Nona Ranjit
Annada	Dudheswar	Khejur chari	Nona Sarna
Andaman Cari- V	Durga	Khara	Nona Pankaj
Asam Lal	Etanagar	Kokila Patni	Nonasal
Badsha Bhog	Gamra	Kopur dhuli	Orda Sal
Baburupi	Ganga	Kumra Gor	Pankaj
Balam Musur	Gitanjoli	Ladu	Pasakanthi
Banga Bandhu	Gobinda Bhog	Lal Joyari	P. R. – 4919
Baskanta	Gopal Bhog	Lal Minikit	PNR 546
Baskanthi	Gosaba – 5	Lal Patni	Pratikha
Basmoti	Gosaba – 92	Lal Sarna	Rabansal
Barsha	Deradun Gandheswary	Lal Gheus	Radha Tilak
Begun Bichi	Dhanaraj	Lal Sankar	Radhunipagal
Bhog	Dokra Patni	Lathisal	Raj Laxmi
Bhuri	Dudheswar	Leni MO	Rani Kajal
Biran T.R.	Durga	Lilaboti	Rupsal
Bina 10	Itanagar	Luna Sarna	Sabita Patni
Binni	Gamra	Mahadi	Sada Kalo Bakra
Bombai Mugi	Ganga	Mahan bhog	Sada Kamini
Basmoti	Gitanjoli	Malaboti	Sada Mota
Barsha	Gobinda Bhog	Masuri	Sada Sankar
Begun Bichi	Gopal Bhog	Meghna Dumur	Sarna Sab- 1
C.R – 2314	Kalo Bhat	Morichsal	Sarna Masuri
C.R. 28-14	Kalo Jira	Moul	Shak Bhat
Chamar Moni	Kalo nuniya	Moyurakhhi	Sitasal
Chapa Kusi	Kamal	Nagalmura	SR – 26- B
China Kamini	Kamini Bhog	Nagra	Sundari
Dadsal	Kanak Chur	Niko	Talmugur
Darakasal	Kankure	Nilanjana	Tangra
Deradun	Kata Rangi	Nikunja	Tulai Panji

Traditional Paddy varieties cultivated in the Biodiversity Conservation Park, PUPA, Sagar Island (2019)

Salt tolerant paddy varieties cultivated at Sagar Island (2015)