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A STUDY ON INDIGENOUS RICE VARIETIES IN SUNDARBAN DELTA AND THEIR ROLE IN ENSURING LOCAL FOOD SECURITY IN THE FACE OF CLIMATE CHANGE THREATS

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PREFACE

The present report entitled *'A Study on Indigenous Rice Varieties in Sundarban Delta and Their Role in Ensuring Local Food Security in the Face of Climate Change Threats'* is the outcome of a study initiated by Agro-Economic Research Centre (Santiniketan) during work plan 2016-17. This study is fully financed and approved by Directorate of Economics and Statistics, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi.

The motivation of the study came from some previous field experience in the remote Sundarban delta region when it was found that many traditional cultivar varieties are in scattered existence in that region which has significant salt tolerance capability. The low lying Sundarban delta is one of the most vulnerable coastal regions in India in the face of Climate Change scenario which predicts future Sea Level Rise and increasing cyclonic activities in the Bay of Bengal. Both of these predictions imply increasing salinity ingress on agricultural lands for this densely populated area, which in turn is a grave threat to local food security. One viable adaptation strategy might be to promote the practice of salt tolerant rice among farmers in the region. It also calls for active research on production and promotion of such varieties. This in turn needs the creation of a knowledge bank on the existing such varieties.

Primary consultation with agricultural experts revealed that there is no systematic documentation about the existing practice among farmers in Sundarban regarding the traditional rice varieties. The local names of such varieties are also sometimes unknown to outside experts. There is no existing study that documents such rice varieties' performance at farmers' fields and farmers' experience and opinion about them. This study was taken up to fill this knowledge gap. This report is a step further towards informed policy making for enhancing local food security against Climate Change threats in Sundarban.

The task of completion of the study was assigned to **Dr. Santadas Ghosh,** Associate Professor,Department of Economics & Politics and **Kali Sankar Chattopadhyay**, Deputy Director of this Centre. Analysis and drafting of the Report was done by **Dr. Santadas Ghosh**. During field survey they were ably assisted by a Research team comprising the staff members of this Centre and **Saptarsi Chakraborty & Sreejit Roy** (*Research Scholar, Department of Economics & Politics, Visva-Bharati*). Typing of the report was done by **Munshi Abdul Khaleque** and **Nityananda Maji**. Secretarial assistance was provided by **D. Mondal, D.Das, P. Mitra and A.R. Patra. Bimal Singh** and **S. Hansda** helped in the office maintenances. The researchers had to take help of some NGO workers some of whom must be mentioned here. We convey our sincere gratitude to Mr. Sudhangshu Dey (*Soceity for Durbachati Social Action*

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Executive Summary

Sundarban is an archipelago of more than hundred islands in Indian side which is the largest mangrove dominated delta region shared with Bangladesh. It is a UNESCO heritage site and 48 islands in India constitute the reserve forest which is the habitat of the famous Royal Bengal Tigers. Another 54 islands surrounding the reserve forest is inhabited by more than five million people. For them agriculture is the primary livelihood and fishing and crab-catching come to the next. The low lying populated islands are surrounded by earthen embankments and a fresh water ecosystem is artificially created amidst surrounding salt waters of deltaic rivers. The region is identified as one of the most vulnerable region in the face of predicted Sea Level Rise due to global Climate Change (CC).

The islands were populated clearing the mangrove forests under the colonial expansion drive to earn more land revenue from new pastures. At that time of settlements (late 19th to early 20th Century), agricultural technology was not advanced and the rice varieties that were cultivated there were local salt tolerant varieties suitable for that particular soil and climatic condition. However, after the Green Revolution and introduction of HYV seeds, many of the modern varieties had replaced local varieties due to higher productivity. This has been detrimental to the of food security for the region. The effect was visible after the infamous cyclone Aila, where the cyclonic storm surges had inundated almost every part of those islands with saline water. The total loss of agriculture forced a huge outmigration of working adults from those islands for outside labour jobs. It is this event that had triggered a new realisation among local people to make a trade off between high productivity and food security. They are now starting to revert back to salt tolerant local varieties to insure against a total loss of crops due to saline water ingress. Such efforts are being undertaken by individual farmers as well as being propagated by some local NGOs.

It has been observed that many of such local varieties of rice, which historically their ancestors used to grow in that agro-climatic conditions, had actually survived in small quantities in some corners of those remote islands. Local people are rediscovering them and bringing them back to their practices. The motivation behind the present study arises from the fact that there is no systematic documentation of such practices among the farmers in Sundarban delta. There has been scientific documentation of salt tolerant rice varieties regarding

their physical characteristics which have been carried out in controlled field experiments and laboratories. But existing studies do not provide a clue to whether or not these varieties are performing well in actual field, and what is the trend in such practices.

Study objectives

This study has been taken up to build a database on such varieties that are being practiced and preserved in isolated pockets in Sundarban through a primary survey. It is aimed at the documentation of such rice varieties and their productivity performance in actual field by untrained farmers. The findings can be helpful for the policy authority to decide the direction of help that can be extended to propagation of such rice varieties as a significant adaptation policy against Climate Change threats. It will cater to the State and National Bio-diversity Board and Agricultural Directorate for providing proper guidance to the farmers in regular manner. With this database, agricultural and soil scientists could enhance their capacity of prescribing suggestions for better production of indigenous rice varieties with modern techniques in coastal regions.

With the above background, the specific objectives of the study are as follows:

(i) To create a database of the existing local rice varieties in Sundarban Delta and their salt tolerance capability as experienced by the cultivators.

(ii) To create a database on time duration and productivity of such rice varieties

(iii) To understand the socio-economic profile of the respective farmers and their motivation to opt for such varieties

(iv) To examine the role of such indigenous varieties in ensuring local food security

(v) To provide policy prescription to promote the practice of growing such indigenous paddy varieties as an adaptation policy against Climate Change threats

Data and Sampling

Field visits for this study had taken place during the monsoon season of 2016 (July-November). The study covers the Sundarban delta islands which are populated by human settlements. They fall under the Gosaba, Kakdwip, Patharprtima and Sagar Blocks in South 24 Parganas district and Hingalgunj and Sandeshkhali Block in North 24 Parganas district.

*The sample selection for this study has been done in a special way, which is formally called '**snowball sampling'**. The six CD blocks that has been covered in this study are very densely populated with farming households and the cultivators of local varieties are thinly dispersed across them. There is no secondary database to identify who*

cultivates what. Also, for productivity, the study needed to identify the farmers who had actually cultivated at least one of these varieties in the monsoon of 2015, for which the complete information regarding yield could be obtained. So, as a starting point, a local organization that has been undertaking activities relating to preservation and propagation of salt tolerant local rice varieties has been approached. From their membership list and other acquaintances, a list of such farmers residing over different Gram Panchayet areas has been prepared. Those farmers constituted the first set of samples. At the end of the interviews, each of the respondents was asked to provide names of families in his neighbourhood who also cultivated some such variety in 2015. A second set of samples could be created this way after eliminating the repeated names. Repeating the selection procedure in this way, after several visits in different parts of Sundarban over five months, the study could complete 157 interviews of such households spread over 15 Gram Panchayet area in six CD blocks as mentioned before.

Findings

The study finds that there are many traditional varieties of rice being cultivated by farmers in Sundarban delta which are known for their salt tolerant property. Though the sample is purposive, yet the number of different varieties is found to be more than what was expected. From 157 farming households that has been interviewed, as many as 32 such varieties has been identified which were cultivated in the monsoon of 2015. The distribution of such farmers is found to be thin across different islands without much communications among themselves. So, except a few commercially successful such varieties, other varieties are found to be locally concentrated in practice. The seeds of such varieties are not commercially available in the market. They are preserved and continued across family lines or neighbourhood.

Many of these varieties are studied and documented by specialized institutions and agencies growing them in small experimental plots under ideal conditions. However, their performance in the field under natural conditions has not been studied.

The study finds that the average productivity of these traditional varieties is significantly less than that of the other High Yielding varieties. This is the major reason why these newly introduced varieties could displace the local varieties and are mostly cultivated by the modern Sundarban farmers.

Still, the survival of traditional varieties was possible because of some special features in them. One dominant reason for survival of the low yielding varieties is their high capability to withstand land salinity. There are pockets in

Sundarban islands which are very susceptible to salinity ingress because of their proximity to saline rivers and the bad condition of the protective embankments. In such locations, farmers hedge their risk of total crop loss during a season by compromising with low productivity.

Another major reason for their survival is farmers' taste and preference for these local varieties. Most of them are having their special taste and flavour which the farmers grew accustomed with from their childhood. Most of the farming households produce their monsoon rice for self-consumption. So, even if their land is location wise not much vulnerable to salinity, many large landholders keep a certain part of their land for production of these varieties for their year-long consumption.

Yet another reason for cultivation of these varieties is their low cost of production. The seed cost is almost nil for such varieties as they preserve the seed from their previous year's production. These varieties require very little fertiliser and pesticide also. So, the total monetary costs for production of these varieties are much less than that of the modern introduced varieties. Poor farmers have a natural tendency to opt for it, specially when they face a continuous threat of crop loss due to salinity ingression.

A couple of these varieties are in fact increasing the area under them due to market signals. Dudhersar and Gobindobhog are two such varieties which are being propagated throughout the region in recent years as they could fetch a premium over other varieties in selling price. This was possible due to their fine grain quality and a tilt of urban consumers' taste in their favour. So, in spite of their low productivity, they are successfully competing with other HYV seeds in expanding their market share through better realised price. Among these two, Dudhersar is of medum salt tolerance and Gobindobhog is of low salt tolerance as reported by the farmers. This finding helps us to understand that the preservation and propagation of more salt tolerant rice varieties can be easily achieved if a differential procurement price system can be put in place in favour of more salt tolerant rice varieties.

The traditional varieties are found to be more organic in nature as they require very little chemical fertilisers or pesticides compared to their HYV counterparts. They require mostly organic manures like cow dung and hence such households practicing traditional varieties almost invariably has some livestock holding with them.

Cyclone Aila in May 2009, which devastated all of these islands with salt water overflowing from surrounding rivers to the agricultural fields, has ushered in a new realisation among island dwellers regarding their food

security. They realised, after that painful experience, that preserving and practicing local salt tolerant varieties is a viable coping strategy against such threats in future. The realisation translated into, even without any outside support or counselling, renewed interest among farmers to organize themselves to create local seed banks for such rice varieties.

However, remoteness of these islands prevented the percolation of many institutional benefits that are being delivered to other well-connected parts of India. For example, crop insurance and soil testing are almost absent on these islands due to absence of institutions and official visits in this remote area. Very few of the farmers are in fact aware of the benefits and services that they are entitled to get freely or at a negligible cost.

This study by AERC (Santiniketan) has tried to cover the information gap and bring to light certain aspects of paddy cultivation in Sundarban islands that cannot be generated through laboratory experiments. Household level data from 157 farming households spread over 15 Gram Panchayet area, highlights the following points:

- *The inaccessibility and remoteness of the area hindered the penetration of formal institutions to render some crucial services to Sundarban farmers. Whatever services they receive comes mostly from local NGOs and some outside agencies who can earn profit from particular types of services.*
- *Only about 10% of owners of these plots has reported that they had conducted, through the help of NGOs, some soil testing on their plots within last 10 years. It seems that there is very little penetration of the idea of having an up-to-date soil health card in this region.*
- *There are a large number of salt tolerant varieties of rice that are being preserved and being cultivated in nooks and corners of Sundarban island, the performance details of which are not yet known and there is knowledge gap in this regard.*
- *The cost of cultivation of these varieties is significantly less and farmers don't need to depend on outside agencies or government departments for obtaining the seeds.*
- *The cultivation practice for these varieties is mostly organic in nature and requires little or no chemical fertilizers or pesticides.*
- *These varieties are mostly of low productivity, but are important for the local food security and hence needs to be propagated among local farmers through policy measures.*
- *Farmers are mostly aware of the vulnerability of the HYV seeds which are of higher productivity but of low salt tolerance. The experience of cyclone Aila has made*

them aware of the positive side of local rice varieties.

- *Getting enough good quality seeds of local salt tolerant varieties is a problem these days as they are confined in pockets of Sundarban. There are demands for such seeds which the local farmers are failing to meet.*
- *Varieties like "Dudhersar", due to its special quality, fetches a premium in the market over other varieties. So, in spite of low productivity, farmers get over-compensated through realized price. That is why this variety is found throughout the delta.*
- *Dudhersar is of medium salt tolerance quality. There other highly salt tolerant rice varieties (like Darsal, Nona Bokra, Talmugur), as was identified by scientific community and is in practice in Sundarban, that cannot fetch the price premium in the market. These varieties are existing in pockets of Sundarban but are confined within farming households that are in close neighbourhood of each other.*

Policy Implications

In the backdrop of these findings, the main points that this study throws up for informed policy making are as follows:

- *The inaccessibility and remoteness of the area forbids formal institutions and their officials to come and visit Sundarban farmers and provide institutional support. Whatever services they receive comes mostly from local NGOs and some outside agencies who can earn profit from particular types of services. So, there should be a differential treatment for locally operational NGOs and agencies, in terms of increased financial incentive, to provide services like Crop Insurance.*
- *Similar situation exists for development of a comprehensive knowledge in the farmers about their soil condition. There is very little penetration of the idea of having an up-to-date soil health card in this region. It calls for an intensive campaign among farmers making them aware of the benefits of soil testing and calls for organizing special camps with mobile soil testing units in this remote rural area.*
- *The cultivation and propagation of these varieties needs government's active help. In terms of motivating the farmers, cyclone Aila paved the groundwork already. Getting enough good quality seeds of local salt tolerant varieties is a problem these days. There are demands for such seeds which the local farmers are failing to meet. There should be seed banks specialized for such salt tolerant varieties and more seed*

distribution centres in this remote area.

- *Varieties like "Dudhersar", due to its special quality, fetches a premium in the market over other varieties. So, in spite of low productivity, farmers get over-compensated through realized price. One efficient policy measure can be to devise differential (favourable to salt tolerant varieties) procurement price for these varieties, as farmers have a selling objective over and above their own consumption. If procurement prices are enhanced for more salt tolerant rice varieties in Sundarban, locals will invariably be inclined to propagate their cultivation*

Way Forward

This study was undertaken with limited resources and manpower in a difficult and remote location. In absence of plant specialists in the study team, the findings could not shed much light on the bio-physical characteristics of the reported rice varieties. The exact soil characteristics of the plots could not be matched with the productivity as almost no farmer had a recent soil test report of their plots.

Such local varieties are to be unearthed in greater numbers that would enrich the plant genetic base for future cross-breeding of new species. For this, more large scale surveys in such remote locations are needed, coupled with sufficient funding for recruiting plant biologists and soil scientists. Sundarban is one of the most vulnerable regions in the face of Climate Change and Sea Level Rise predictions. A widespread survey in this line will enhance the knowledge base for effective adaptation policy for this region's future food security. It remains an open research agenda for future - both for AERC (Santiniketan) and for any other interested agency.

Chapter – I
Introduction

1.1 Back ground

Sundarban is an archipelago of more than hundred islands in Indian side which is the largest mangrove dominated delta region shared with Bangladesh. It is a UNESCO heritage site and 48 islands in India constitute the reserve forest which is the habitat of the famous Royal Bengal Tigers. Another 54 islands surrounding the reserve forest is inhabited by more than five million people. For them agriculture is the primary livelihood and fishing and crab-catching come to the next. The low lying populated islands are surrounded by earthen embankments and a fresh water ecosystem is artificially created amidst surrounding salt waters of deltaic rivers. The region is identified as one of the most vulnerable region in the face of predicted Sea Level Rise due to global Climate Change (CC).

The islands were populated clearing the mangrove forests under the colonial expansion drive to earn more land revenue from new pastures. At that time of settlements (late 19^{th} to early 20^{th} Century), agricultural technology was not advanced and the rice varieties that were cultivated there were local salt tolerant varieties suitable for that particular soil and climatic condition. However, after the Green Revolution and introduction of HYV seeds, many of the modern varieties had replaced local varieties due to higher productivity. This has been detrimental to the of food security for the region. The effect was visible after the infamous cyclone Aila, where the cyclonic storm surges had inundated almost every part of those islands with saline water. The total loss of agriculture forced a huge outmigration of working adults from those islands for outside labour jobs. It is this event that had triggered a new realisation among local people to make a trade off between high productivity and food security. They are now starting to revert back to salt tolerant local varieties to insure against a total loss of crops due to saline water ingress. Such efforts are being undertaken by individual farmers as well as being propagated by some local NGOs.

It has been observed that many of such local varieties of rice, which historically their ancestors used to grow in that agro-climatic conditions, had actually survived in small quantities in some corners of those remote islands. Local people are rediscovering them and bringing them back to their practices. This study was prompted by some field information from one of the Sundarban islands where it was seen that after the infamous cyclone Aila, some villagers realized the necessity for practice and propagation of local salt tolerant rice varieties and they organized themselves to form a

Society[1] for this purpose. The society, without any significant outside help, has started collecting the seed samples of all such varieties that has been preserved and practiced in different farming households all over Sundarban delta. They have started their initiative from 2013 and through their friends and relatives scattered over different islands, have already gathered more than 40 of such varieties. They are cultivating these varieties under natural conditions in small demonstration plots (without any scientific/technology inputs) and multiplying their 'seed bank'. The interest in local farmers about these varieties is apparent by the increasing number of their membership and increasing demand for the seeds they produce every year.

It needs to be mentioned that these rice varieties are not always 'local' in their true sense. The people on these islands are not 'local' either, as the human settlement history is only a little over hundred years. But people mostly came here from other coastal areas and they introduced and experimented with salt tolerant non-HYV rice seeds. Many such varieties were found suitable and continued for long, before giving way to the HYV seeds few decades ago. The so called 'local' varieties are often called in the names from where they were originally obtained. For example, we find a variety locally called 'Patnai' which implies it has its relation with Patna (Bihar) when it was introduced.

The motivation behind the present study arises from the fact that there is no systematic documentation of such practices among the farmers in Sundarban delta. There has been scientific documentation of salt tolerant rice varieties regarding their physical characteristics which have been carried out in controlled field experiments and laboratories[2]. But existing studies do not provide a clue to whether or not these varieties are performing well in actual field, and what is the trend in such practices.

1.2 STUDY OBJECTIVES

In the background stated above, this study has been taken up to build a database on such varieties that are being practiced and preserved in isolated pockets in Sundarban through a primary survey. It is aimed at the documentation of such rice varieties and their productivity performance in actual field by untrained farmers. The findings can be helpful for the policy authority to decide the direction of help that can be extended to propagation of such rice varieties as a significant adaptation policy against Climate Change threats. It will cater to the State and National Bio-diversity Board and

[1] Soceity for Durbachati Social Action and Transformation (GP: Durbachati; Block: Patharpratima; District: South 24 Parganas)

[2] Pani D. R., S.K. Sarangi, R.C. Misra, S. K. Pradhan, H.N. Subudhi and T.K. Mondal (2013): "Performance of Rice Germplasm (Oryza sativa L.) under Coastal Saline Conditions", *Journal of Indian Society for Coastal Agricultural Resources*; Vol 31, No.-1; pp 11-20.

Agricultural Directorate for providing proper guidance to the farmers in regular manner. With this database, agricultural and soil scientists could enhance their capacity of prescribing suggestions for better production of indigenous rice varieties with modern techniques in coastal regions.

With the above background, the specific objectives of the study are as follows:

(i) To create a database of the existing local rice varieties in Sundarban Delta and their salt tolerance capability as experienced by the cultivators.

(ii) To create a database on time duration and productivity of such rice varieties

(iii) To understand the socio-economic profile of the respective farmers and their motivation to opt for such varieties

(iv) To examine the role of such indigenous varieties in ensuring local food security

(v) To provide policy prescription to promote the practice of growing such indigenous paddy varieties as an adaptation policy against Climate Change threats

1.3 SAMPLING AND SPATIAL COVERAGE OF THE STUDY

Field visits for this study had taken place during the monsoon season of 2016 (July-November). The study covers the Sundarban delta islands which are populated by human settlements. They fall under the *Gosaba*, *Kakdwip, Patharprtima* and *Sagar* Blocks in *South 24 Parganas district* and *Hingalgunj* and *Sandeshkhali* Block in *North 24 Parganas district*.

The sample selection for this study has been done in a special way, which is formally called '**snowball sampling'**. The six CD blocks that has been covered in this study are very densely populated with farming households and the cultivators of local varieties are thinly dispersed across them. There is no secondary database to identify who cultivates what. Also, for productivity, the study needed to identify the farmers who had actually cultivated at least one of these varieties in the monsoon of 2015, for which the complete information regarding yield could be obtained. So, as a starting point, a local organization that has been undertaking activities relating to preservation and propagation of salt tolerant local rice varieties has been approached[3]. From their membership list and other acquaintances, a list of such farmers residing over different Gram Panchayet areas has been prepared. Those farmers constituted the first set of samples. At the end of the interviews, each of the respondents was asked to provide names of families in his neighbourhood who also cultivated some such variety in 2015.

[3] *Soceity for Durbachati Social Action and Transformation* (GP: Durbachati; Block: Patharpratima; District: South 24 Parganas)

A second set of samples could be created this way after eliminating the repeated names. Repeating the selection procedure in this way, after several visits in different parts of Sundarban over five months, the study could complete 157 interviews of such households spread over 15 Gram Panchayet area in six CD blocks as already mentioned.

1.4 TYPES OF INFORMATION AND ANALYTICAL METHODOLOGY

In the survey region, ground water is also saline in most parts and there is no canal irrigation. On these islands, the year-long source of fresh water is available only through rain-water harvesting. There are innumerable small ponds dotting the islands but the capacity of pond water to irrigate agricultural land is very limited. Pond waters are mostly used for household chores, maintaining livestock and small irrigation activities in summer and winter to produce some vegetables for self-consumption. Rice requires a lot of water and is mainly produced by monsoon waters. There are small pockets where summer cultivation of rice is recently taking place using deep submersible pumps. But the varieties produced in times other than monsoon are invariably of HYV nature. The traditional varieties that are found in Sundarban are all adapted to the monsoon season.

Since this study was specifically aimed to gather knowledge about traditional varieties, it focused on monsoon rice only. Further, the study was conducted during monsoon of 2015. So, the most recent data on productivities could be obtained for monsoon of 2015 only. In the sampling process also (snowballing), the names of the possible respondent farmers were obtained using the information of the cultivated varieties in monsoon of 2015. All the production and input-use related data used for analysis in this study relates to monsoon of 2015.

The primary survey was carried out by a structured questionnaire most part of which was pre-coded. The types of information collected through it can be categorized as follows:

- *Basic profile of the household (religion, caste, family size, asset holding etc.)*
- *Age, sex, education and years of farming experience of the household head*
- *Names of the traditional rice varieties that the household has cultivated after Aila (2009)*
- *Farmer's motivation for cultivating such varieties (pre-coded options)*
- *Farmer's level of satisfaction with these varieties*
- *Names of traditional as well as HYV varieties that the farmer cultivated in monsoon 2015*
- *Area, input use and realized productivity of all the varieties cultivated in monsoon 2015*

The study objective is to build a baseline and hence it required little more than descriptive analysis of the collected information. For the most part, the study used appropriate tables and charts in its analytical section. However, one innovation is needed to process the information on farmer's perception and experience regarding 'salt tolerance' property of different traditional varieties and their level of satisfaction with these varieties. Against the same rice variety, different farmers have indicated different level of salt tolerance capacity. The options were provided in qualitative manner[4]. The aggregate information, thus collected, needed to be converted into an index for each of the varieties. This was done by using some weights. For example, against 'salt tolerance' there were three options (*high, medium, low*). This has been responded by different farmers differently against the same variety. So, a weighted average has been calculated by multiplying the number of 'high' responses with 3, number of 'medium' responses with 2 and number of 'low' responses with 1. Adding these scores, the 'average score for salt tolerance' has been calculated by dividing the total score of each variety with the corresponding number of responses. In this case, the highest possible value of this average score could be 3 (all responded *high*) and the lowest possible value could be 1 (all responded *low*). This average score was made a continuous variable within the specified range (here 1-3) and all the varieties could be ranked in terms of their salt tolerance capacity as perceived by the farmers. For their overall performance and farmers' satisfaction with them, the same methodology has been used and the traditional varieties had been ranked accordingly.

[4] For e.g. : Experience on salt tolerance were elicited as (put tick): highly tolerant, medium tolerance, low tolerance

Chapter - II
Findings of the Study

2.1 Profile of Sample Households

As discussed, the sample selection was done in a way which ensured farmers on Sundarban islands who are endowed with land and cultivated some local rice varieties in the monsoon of 2015. As such this cannot be treated as a random sample and hence the profile of the sample households that emerges does not represent that of an average household on Sundarban islands. The objective of this study was not to find out that average either. Still, it is important to have an idea of the average sample household profile that has been used to draw the primary information of this study. The average family size of these households and their respective landholding and livestock holding (cows) information is summarized in the following Table-2.1.

Table 2.1: Size and asset holding of sample households

	Observations	Mean	Std. Dev	Minimum	Maximum
Family Size	157	4.78	1.80	1	13
Landholding(Acre)	157	1.41	1.38	0	10.33
Livestock (Cow)	123	2.91	1.45	1	11

Source: Primary survey

There was one household in the sample who has one permanent member at the time of the interview. The average family size is otherwise compatible with the State average. It might be noted that 'zero' landholding also occurred to few sample households in spite of the fact that they cultivated some rice in 2015 monsoon. This table actually represents the landholding which the household 'owns'. It was found that a few households actually cultivated rice without any 'owned' land but did it on leased-in land. Interestingly, 78 percentage of respondent households have cows which is used for ploughing as well as getting organic manure.

The average landholding on these islands is usually small compared to state average. However, the distribution of landholding will be clearer from Table-2.2.

Table 2.2: Landholding distribution of sample households

Landholding status	Percentage of sample households
Landless	6.4
Between 0.0 to 0.5 acre	14.6
Between 0.5 to 1.0 acre	29.3
Between 1.0 to 2.0 acre	32.5
Between 2.0 to 3.0 acre	10.2
Above 3.0 acre	7.0
Total	**100.0**

Source: Primary survey

The households were found to be predominantly Hindu by religion and are headed by a male member. The following figure tells us about the religion and sex distribution of the head of the household.

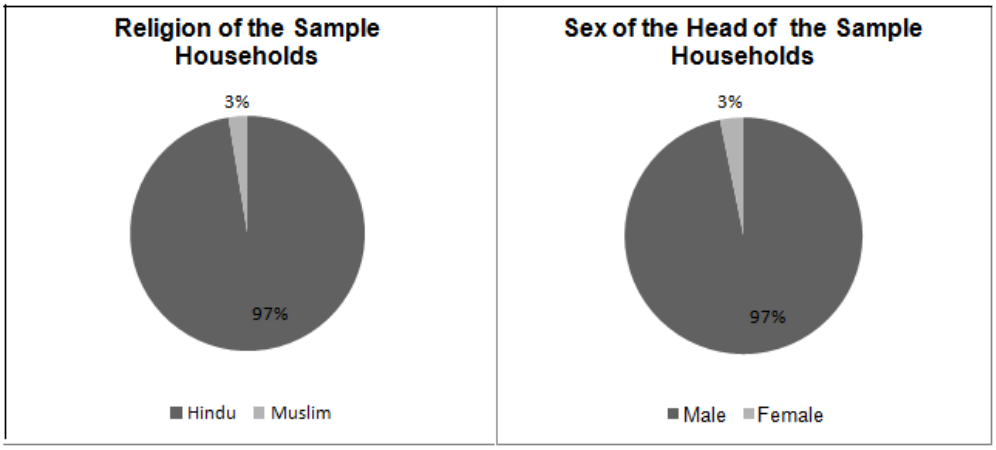

Figure 1: Religion and sex of the household head

Though there is a significant presence of ST population on Sundarban islands, it turned out that none of the farming households included in the sample belongs to that caste category. This is plausible as the sample is not a representative random sample of Sundarban population. The caste distribution of the sample households is shown in the Table-2.3.

Table- 2. 3: Caste composition in the sample

Caste	Percentage of sample households
SC	32
ST	0
OBC	11
GEN	57
Total	**100**

Source: Primary survey

The decision maker of the respondent households regarding their agricultural practices is considered as the 'head of the household'. The distribution of age, farming experience and education of the household head is an integral part of the households' profile. The age of the household head ranges from 31 to 95 years. The distribution of age is shown in Table-2.4.

Table – 2.4: Distribution of age of the household head

Age of Household Head	Percentage of sample households
Below 40 years	17.65
Between 40 to 50 years	30.06
Between 50 to 60 years	30.07
Between 60 to 70 years	15.03
Between 70 to 80 years	4.58
Above 80 years	2.61
Total	**100**

Source: Primary survey

The farming experience of the household head is also interesting to know for the sample households. It turns out that barring a very few of them, most of the households are headed by people with more than 10 years of farming experience. The average years of experience is found to be 30 years which can be considered as high. The range of such experiences was found to be 4 years to 80 years. The Table-2.5 shows the detailed distribution in this respect.

Table – 2.5: Farming experience of the household head

Farming experience of the household head	**Percentage of sample households**
Below 10 years	2.01
Between 10 to 20 years	15.44
Between 20 to 30 years	31.54
Between 30 to 40 years	22.82
Between 40 to 50 years	18.79
Above 50 years	9.4
Total	**100**

Source: Primary survey

Turning to education of the household head, it was found that 4 percent of such households are headed by illiterate people. More than 75% of the households are, however, headed by people who have not studies beyond Secondary examination.

Table – 2. 6: Education of the household head

Highest educational Qualification of the household head	**Percentage of sample households**
Illiterate	4
Less than primary	10
Class VIII	47
Secondary	24
Higher Secondary	8
Graduate & above	7
Total	100

Source: Primary survey

Traditionally, agriculture on Sundarban islands meant only one single monsoon crop pf paddy. Ground water lifting is very costly as the ground water near the surface is also saline and unfit for agriculture. It is only in few pockets of Sundarban, where a

shallow pump is viable for lifting groundwater for irrigation. In times other than monsoon, the main source of irrigation for agriculture is lifting of pond-water, collected and stored during monsoon months, through motor pumps.

It was found that these 157 households together own 309 different agricultural plots which amount to an average of approximately two plots per household. Out of these 309 plots, 47.2% plots do not have any winter irrigation facility. Another 45.3% of plots can get irrigation water outside monsoon months through their own pond or village ponds. Only 4.2 % of them had reported to have access to shallow pumps for ground water lifting in dry time.

It is to be noted that only about 10% of these plots (30 out of 309) has reported that they had conducted, through the help of NGOs, some soil testing on their plots within last 10 years. It seems that there is very little penetration of the idea of having an up-to-date soil health card in this region. It calls for an intensive campaign among farmers regarding the benefits of soil testing and calls for organizing special camps with mobile soil testing units in this remote rural area.

2.2 Distribution of survey sample and rice varieties

One of the objectives of this study was to create a database on the availability of different traditional rice varieties in different parts of Sundarban delta. As already discussed, due to inaccessibility and lack of regular communication between residents across different islands, and also due to the absence of a vibrant market for such seeds, the traditional rice varieties are found to be surviving in isolated pockets. Few of these varieties, like HYVs, are commercially profitable and their seeds are available in local markets as well. They are found in almost every part of the delta. For the remaining, one finds them concentrated in specific locations and in the hands of few households who had continued with them for a long time.

Though reliable production data was obtained only for the latest completed agricultural season (monsoon, 2015), the survey questionnaire asked the respondent about all the rice varieties that they had produced during all the monsoon seasons after cyclone Aila (2009). In this way, a total of 401 different responses could be obtained from 157 sample households. These are spread over two districts, six CD blocks and 15 Gram Panchayets. The spatial distribution of all the recorded traditional varieties as well as HYV rice is tabulated in two different tables (Table-2.7 and Table-2.8) as follows. It is to be noted that these are varieties cultivated by the respondent farmers. The respondents were purposively chosen after identifying them as traditional rice growers. For HYV rice, some ‘zero’ responses were found which means in those area, none of the sample respondents has produced any HYV variety. It does not imply, however, that HYV rice is totally absent in those locations.

Table– 2.7:Spatial distribution of sample households and traditional rice varieties

District	Block	GP Name	Total No. of response	Total No. of traditional varieties cultivated after 2009	Names of the traditional varieties
North 24 Parganas	Hingalgunj	Hingalgunj	16	16	Asfal, Chamarmani, Darsal, Dudhersar, Rupsal, Talmugur
		Sandelbeel	2	2	Gheus, Hamai
	Sandeshkhali	Sandesh Khali	4	4	Darsal, Hamai
South 24 Parganas	Gosaba	Bali-1	3	1	Rupshal
		Bali-2	3	3	Boyerbat, Rupsal
		Choto Mollakhali	84	62	Chinekamini, Dudhersar, Gheus, Gobindabhog, Gopalbhog, Kalomota, Khejurchori, Lilabati, Niko, (alternatively 'Narasinghajatta')
		Satjelia	64	11	Chamarmani, Dudhersar, Gobindabhog, Malabati, Olisent (alternatively 'Narasinghajatta')
	Kakdwip	Rishi Bankim Chandra	62	35	Dudhersar, Lal Dhan, Paloi, Patnai, Sabita Patnai
	Patharpratima	Brajaballavpur	48	33	Bahurupi, Balam, Chamarmani, Dudhersar, Malabati, Marichsal, Sabita Patnai
	Patharpratima	Durbachati	65	52	Basmati, Dudhersar, Hiramati, Khejurchori, Marichsal, Patnai, Rupsal, Kabirajasal, Kalabhat
		G-plot	8	7	Dudhersar, Gobindabhog, Malabati, Patnai
		Gopalnagar	11	5	Dudhersar
		Ramganga	2	1	Sabita Patnai
		Shridharnagar	9	8	Balam , Dudhersar
	Sagar	Sumatinagar Daspara	20	19	Bahurupi, Balam, Dudhersar , Rupsal, Valuki, Patnai
		Total	**401**	**259**	

Source: Primary survey

Table – 2. 8: Spatial distribution of sample households and HYV rice

District	Block	GP Name	Total No. of response	Total No. of HYVs cultivated after 2009	Names of the HYVs
North 24 Parganas	Hingalgunj	Hingalgunj	16	0	-
		Sandelbeel	2	0	-
	Sandeshkhali	Sandeshkhali	4	0	-
South 24 Parganas	Gosaba	Bali-1	3	2	Masuri
		Bali-2	3	0	-
		Choto Mollakhali	84	22	CR1017, Ganga-Kaberi, N-Sankar, Pankaj, Ranjit
		Satjelia	64	53	BN20, Bangabandhu, Barsha, CR1017, Jamuna, Masuri, Niranjan, Pankaj, ratikha, Ranjit, Santoshi, Super-shyamali, Swarna- masuri
	Kakdwip	Rishi Bankim Chandra	62	27	Anushree, Barsha, JP72, Maharaj, Pankaj, Pratikha, Ranjit, Sabita, Shyamali
	Patharpratima	Brajaballavpur	48	15	Maharaj, Niranjan, Pankaj, Pratikha, Ranjit, Swarnasaon, Swarno, Sabita
		Durbachati	65	13	Dharitri, JP72, Pankaj, Pratikha, Ranjit, Super-Shyamali
		G-plot	8	1	Pratikha
		Gopalnagar	11	6	Keralasundari, Pankaj, Pratikha, Super-Shyamali
		Ramganga	2	1	Pratikha
		Shridharnagar	9	1	Sabita
	Sagar (South 24 Parganas)	Sumatinagar Daspara	20	1	Keralasundari
		Total	**401**	**142**	

Source: Primary survey

A direct comparison of popularity of traditional varieties compared to HYV among the respondent farmers can be made if we put the numbers in a single table avoiding the variety names. This has been done in Table-2.9. It is to be noted that farmers often

have more than one plot. They often chose for a combination of local varieties as well as HYV. The information in Table-2.9 is compiled from the same set of farmers who are already known to be inclined towards traditional varieties. So, it cannot be interpreted as a reflection of general choice in Sundarban delta. Also, the number of respondents across different GP area is different. A direct comparison of the entries in rows of Table-9 only highlights the fact that traditional varieties are more frequently cultivated by this set of sample respondents.

Table- 2.9: Distribution of traditional and HYV rice across different Gram Panchayets

GP Name	Total number of varieties cultivated after Aila (2009)	Number of Traditional varieties cultivated after Aila	Number of HYVs cultivated after Aila
Bali-1	3	1	2
Bali-2	3	3	0
Brajaballavpur	48	33	15
Choto Mollakhali	84	62	22
Sumatinagar Daspara	20	19	1
Durbachati	65	52	13
G-plot	8	7	1
Gopalnagar	11	5	6
Hingalgunj	16	16	0
Ramganga	2	1	1
Rishi Bankimchandra	62	35	27
Sandelbeel	2	2	0
Sandeshkhali	4	4	0
Satjelia	64	11	53
Shridharnagar	9	8	1
Total	**401**	**259**	**142**

Source: Primary survey

2.3 Traditional versus modern varieties: trend after cyclone Aila

After obtaining the names of the rice varieties cultivated after cyclone Aila, it was interesting to rank them according to their frequency (a proxy for popularity). From the 401 responses, the frequency ranking of different traditional and modern varieties has been done and is shown in Table-2.10.

Table – 2. 10: Traditional and HYV rice: choice of sample farmers

Traditional Rice Varieties			**HYV Rice Varieties**	
Variety Name	**Frequency of response**		**Variety Name**	**Frequency of Response**
Dudhersar	92		CR1017	28
Gobindabhog	22		Pratikha	21
Patnai	12		Pankaj	11
Rupshal	12		Ranjit	11
Khejurchori	11		Barsha	9
Malabati	10		BN20	7
Olisent/ Narasinghajatta	9		Niranjan	7
Marichsal	9		Super-Shyamali	7
Balam	8		Santoshi	6
Niko	7		Swarna masuri	5
Chamarmani	7		Swarnasaon	5
Gheus	6		Maharaj	3
Basmati	5		Masuri	3
Lilabati	5		Bangabandhu	2
Valuki	5		Dharitri	2
Darsal	4		JP72	2
Sabita Patnai	4		Jamuna	2
Asfal	3		Keralasundari	2
Bahurupi	3		Sabita	2
Chinekamini	3		Swarno	2
Hiramati	3		Anushree	1
Kalabhat	3		Ganga kaberi	1
master patnai	3		N-Sankar	1
Boyerbat	2		Shyamali	1
Hamai	2		Sabita	1
Kalomota	2			
Lal Dhan	2			
Paloi	2			
Gopalbhog	1			
Talmugur	1			
Kabirajashal	1			
Total	**259**		**Total**	**142**

Source: Primary survey

It is found that six of the traditional varieties had been cultivated by at least ten respondents after Aila compared to four types of HYV rice. It also reveals that

Dudhersar is the most popular traditional variety among the respondents while ***CR1017*** tops the list among the HYV .

Table – 2. 11: New adaptations after Aila experience: Traditional versus HYV

Traditional Varieties		**HYVs**	
Variety Name	**Number of responses**	**Variety Name**	**Number of responses**
Asfal	1	Anushree	1
Babui	1	BR20	1
Bahurupi	2	Barsha	6
Balam	1	Bidiomota	1
Basmati	3	CR1017	2
Chamarmani	3	JP72	1
Darsal	2	Masuri	1
Dudhersar	8	Pankaj	2
Ganti	1	Pratikha	9
Gheus	1	Ranjit	2
Gobindabhog	9	Rani51	1
Hiramati	1	Santoshi	3
Kabirajsal	1	Shymali	1
Kalabhat	3	Super-shyamali	1
Kanakchur	1	Swarna masuri	1
Karpur kanti	1	Swarnasaon	4
Khara	1	**Total**	**37**
Khejurchori	1		
Lal Dhan	2		
Lilabati	1		
Malabati	2		
Marichsal	6		
Niko	4		
Nona Khorcha	2		
Nona Khetchori	1		
Nonasal	1		
Olisent/Narasinghajatta	2		
Paloi	1		
Patnai	2		
Rabansal	1		
Sabita Patnai	1		
Sarma nona	1		
Talmugur	2		
Tulsi Bhog	1		
Tulsi Mukul	1		
Total	**72**		

Source: Primary survey

However, Table-2.10 fails to indicate about the trend in acceptance of traditional varieties. In the questionnaire, against each reported variety that had been cultivated by the respondent after 2009, it was asked whether the same variety had been cultivated by the respondent even before Aila. The responses were elicited in 'YES/NO' format. Eliminating the 'YES" responses, we could identify which of these varieties has been 'newly adopted' by the respondent after the cyclone experience. This has been shown in Table-2.11.

It was found that as many as 72 respondents tried new traditional varieties involving 35 such varieties after their experience of cyclone Aila. Against this, as is evident from Table-2.11, only 37 new trails were carried out involving 16 HYV rice. It strongly indicates that there is a renewed interest among Sundarban farmers to go for traditional rice varieties due to their salt tolerant property.

2.4 Comparison in input use

One of the key advantages of traditional rice varieties is that their comparatively lower productivity is partly compensated by their less dependence on inputs like chemical fertilizers and pesticides. Also, seeds for such varieties are often preserved by the farming households from their last year's production and hence seed costs are very less if not nil. Together it means a substantially less monetary cost of cultivation. When farmers are poor, family labour is mostly used and the primary objective of rice cultivation is self-consumption, these aspects play a crucial role in farmers' choice of varieties.

That so many traditional rice varieties are surviving in Sundarban delta can be partly explained by these characteristics of them. To have a concrete comparison of monetary costs of crucial inputs that are bought from the market, we made some costs estimates across two broad varieties of rice from our primary data. Table-2.12 clearly indicates that the costs across three such major components are significantly lower for traditional varieties as compared to their HYV counterpart.

Table – 2. 12: Comparison in cost components: traditional versus HYV

Variety	Seed (Rs./Acre)	Pesticide (Rs./Acre)	Fertilizer (Rs./Acre)
Traditional	19.0	26.0	29.3
HYV	67.0	34.0	131.0

Source: Primary survey

The comparison has been made on the basis of cost incurred by the respondents in their monsoon cultivation of 2015. These costs also vary across different traditional varieties. Separate estimates for each of them needs information from sufficient number of farmers cultivating each of these varieties for statistical reliability. Unfortunately, within this limited sample, not all the varieties had been cultivated by significant number of farmers. So, we selected only those varieties which were cultivated by at least ten farmers (as is described in Table-2.10) in our sample. The component wise average cost, estimated for each of the 'popular' varieties of traditional and HYV rice, is given in the following table.

Table – 2. 13: Variety wise comparison in cost components (monsoon 2015)

	Seed (Rs/Acre)	**Pesticide (Rs/Acre)**	**Fertilizer (Rs/Acre)**	**Total (Rs/Acre)**
Traditional Varieties				
Dudhersar	23.46	7.89	22.89	54.25
Gobindobhog	37.22	64.55	72.75	174.52
Patnai	12.62	1.31	10.46	24.39
Rupsal	0.00	0.00	0.97	0.97
Khejurchori	21.48	101.82	31.07	154.37
Malabati	0.00	8.02	17.37	25.39
HYVs				
CR1017	100.00	40.00	50.00	190.00
Pratikha	92.67	23.08	95.61	211.36
Pankaj	128.22	37.33	140.11	305.67
Ranjit	75.05	28.21	64.12	167.38

Source: Primary survey

Table-2.13 clearly shows that for some of the traditional varieties like *Patnai, Rupsal, Malabati,* monetary cost of cultivation is negligible compared to other HYV rice. The case of *Gobindobhog* seems a bit different which compares almost equally with HYV varieties. It has to be noted that this variety fetches a huge premium in the market for its natural scent and quality. So, in spite of its high cost of production, it was found to have been taken up by quite a few respondents. The case of *Khejurchori* is not very

clearly explained by this logic. This might be a limitation of a small sample. However, the cost estimate is lesser than that of other HYV counterparts. The case of *Dudhersar* is very clear. It has a price premium by its quality and it is also having a much lesser cost of production. It is no wonder that this variety is by far the most popular among Sundarban farmers. All the cost estimates has been done taking the land unit as Bigha[5], as this is the most commonly used local unit for land in the survey region.

2.5 Comparison in maturity period

In choosing between different varieties of same crop, one important aspect remains that of the duration required for crop maturity. A quick-yielding variety will generally get preference over late-yielding varieties if other aspects remain similar. It was interesting to see whether the traditional varieties are at a disadvantage to HYV rice in this respect. The controlled field studies might provide information on the maturity period of different rice varieties. But this study wanted to get it from the farmers own experience and see whether there is any significant systematic difference between two broad types of rice. For each of the respondents, against each type of rice that had been cultivated in monsoon of 2015, the questionnaire asked the sowing as well as the harvesting month and week[6]. After processing the data, the duration (in terms of weeks required for maturity from sowing time) for each of the responses were calculated. The 'average maturity duration' for each of the separate varieties, both traditional and HYV, were then calculated. The result is given in Table-2.14, where variety names were reported against increasing order of maturity duration.

It might be noted here that the reliability of this estimate is questionable. As described earlier, only some of these varieties were cultivated by many farmers in the sample. For them (which can be identified from Table-2.10) the estimated duration might be taken as reliable. For the rest of the varieties, estimates were done on the basis of a handful of farmers' responses. To get a reliable estimate for all these varieties, a large scale survey is required to be undertaken further. Table-2.14 shows that there is enough variability in the maturity duration across two subgroups – traditional and modern HYV. The ranges of duration (lowest and highest) are also very close across these two subgroups. It can be concluded that the traditional varieties are not in any disadvantageous position in this regard compared to their HYV counterparts.

[5] The conversion factor is **One Acre = Three Bigha**

[6] A month is divided into four weeks in this regard. Option for 'week' was provided as 1, 2, 3 and 4.

Table – 2. 14: Comparison in duration of maturity

Traditional Varieties		HYVs	
Variety Name	**No. Of Weeks**	**Variety Name**	**No. Of Weeks**
Basmati	12.0	Swarna masuri	12.0
Bahurupi	14.7	Bangabandhu	14.0
Malabati	15.6	JP72	14.0
Asfal	16.0	Swarno	14.0
Balam	16.0	Anushree	16.0
Boyerbat	16.0	Barsha	16.0
Chamarmani	16.0	Dharitri	16.0
Chinekamini	16.0	Jamuna	16.0
Darsal	16.0	Maharaj	16.0
Gheus	16.0	Masuri	16.0
Gopalbhog	16.0	Niranjan	16.0
Hamai	16.0	Santashi	16.0
Hiramati	16.0	Santoshi	16.0
kabirajashal	16.0	Shemali	16.0
kalabhat	16.0	Swarnasaon	16.0
Kalomota	16.0	Sabita	16.0
Lal Dhan	16.0	CR	16.3
Lilabati	16.0	Ranjit	16.4
master patnai	16.0	Pratikha	16.4
Paloi	16.0	BN20	16.5
Patnai	16.0	Pankaj	17.2
Rupshal	16.0	CR-17	17.3
Talmugur	16.0	Keralasundari	18.0
Valuki	16.0	CR-1017	19.3
Gobindabhog	16.2	CR-Pankaj	20.0
Olisent/Narasing	16.6	Super Shamali	20.0
Dudhersar	16.6	Super shamali	20.0
Marichsal	16.9	CR1017	22.0
Sabita Patnai	17.0		
Sabita	18.0		
Khejurchori	19.3		
Niko	21.0		

Source: Primary survey

2.6 Comparison in productivity

The important information that such a baseline survey needs to bring out, is to estimate the productivity performance of different such rice varieties in the actual farmers' land, instead of a controlled experiments carried out in government farms. The production quantities and corresponding plot size data were collected for each variety – traditional or HYV- that the respondents cultivated in monsoon of 2015. A total of 309 such clean responses were obtained. The productivities, calculated in the standard unit of 'quintal per acre' were estimated and averaged over two broad sub-groups – traditional and HYV. The resulting Figure-2 confirms that HYV rice is overwhelmingly more productive than traditional varieties. This is in conformity with usual expectation and the main reason why such HYv rice was successful in driving out many traditional varieties from the Sundarban region.

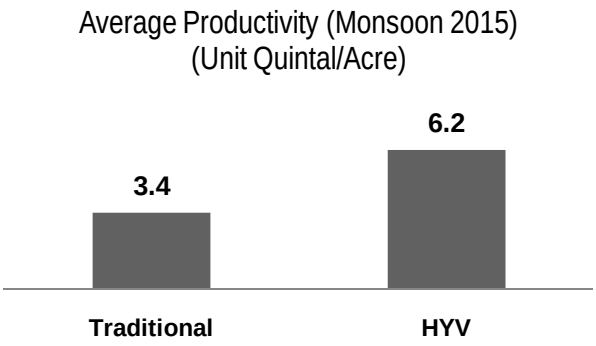

Figure 2: Traditional versus HYV: average productivity

However, as the data were collected in a disaggregated form, much insight can be gained if we look at the productivity estimates of different varieties separately. This has been done in Table-2.15 where average productivity of each of these cultivated varieties is reported for two broad sub-groups. Moreover, the varieties, under each subgroup of traditional and HYV, have been arranged in decreasing order of productivity for a more meaningful comparison.

As is already indicated, not all of these estimates are based on information from many respondents. Following Table-2.10, only few of these estimates can be considered as reliable since the data is an average of at least ten farmers. These are highlighted by bold fonts in Table-2.15. It is interesting to note that some of the traditional varieties were cultivated by many farmers (like Gobindobhog, Khejurchori and Basmati) in spite of their significantly lower productivity. This is because of the price premium that they fetch in the market for their special quality and scent. As indicated earlier. A more reliable estimate of individual productivities can be obtained through a much larger scale study, which remains an open research agenda.

Table -2. 15: Variety wise productivity and ranking

Traditional Varieties	Productivity (Quintal/Acre)		HYVs	Productivity (Quintal/Acre)
Hiramati	8.96		Santoshi	11.20
Talmugur	7.20		Niranjan	10.56
Darsal	6.40		**CR1017**	9.11
Bahurupi	5.60		Swarnasaon	8.00
Chamarmani	5.46		**Pankaj**	6.79
Master patnai	5.07		Ganga kaberi	6.72
Chinekamini	4.80		Swarna masuri	6.16
Valuki	4.80		Jamuna	5.81
Patnai	4.58		Keralasundari	5.40
Marichsal	4.45		BN20	5.31
Olisent/Narasinghajatta	4.43		**Barsha**	5.20
Rupsal	3.93		Swarno	4.90
Malabati	3.35		Dharitri	4.80
Lilabati	3.29		Shemali	4.80
Paloi	3.20		**Ranjit**	4.61
Kabirajashal	3.20		Super shamali	4.44
Niko	3.10		**Pratikha**	4.36
Dudhersar	3.02		JP72	4.17
Balam	2.89		Sabita	4.00
Asfal	2.73		Santashi	3.60
Hamai	2.70		Super Shamali	3.47
Boyerbat	2.69		Maharaj	2.67
Khejurchori	2.63		Masuri	2.43
Gheus	2.49		Bangabandhu	2.17
Gobindabhog	2.44		Anushree	2.00
Kalabhat	2.40		N-Sankar	1.12
Sabita Patnai	2.03			
Kalomota	1.96			
Lal Dhan	1.80			
Sabita	1.40			
Basmati	1.20			
Gopalbhog	0.75			

Source: Primary survey

2.7 Farmers' motivation for traditional rice varieties

One important study objective was to find out the motivations of the Sudnarban farmers behind continuing with traditional varieties in spite of the known fact that they are of lesser productivity. Some of the reasons like their salt tolerance capability were already known. Before the conduct of this survey, a reasonable number of Focus Group Discussions were carried out with farmers and related NGOs to understand the possible reasons. The set of reasons that was identified before the survey are as follows:

1. Provides security against salt water damage

2. Provides security against irregular rainfall

3. Used for own consumption and favoured for less use of chemical fertilizers

4. Used for own consumption and it is of better taste

5. Historical (emotional) attachment with this rice variety as is used to from childhood

6. Better Profitability

7. Requirement of less labour

In the actual survey, these options were provided and farmers were asked to respond their relevant motivations by ticking appropriate options. At most four of them could be ticked by a famer against a particular traditional variety that he/she had cultivated after Aila. The elicited responses were processed and later tabulated. The result is described in Tables-2.16(a) and 2.16(b).

The total number of responses that were elicited against each variety is obviously larger for the varieties that were cultivated by more number of farmers. Variety *Dudhersar* obviously stands first in this regard as it was cultivated by an overwhelming number of sample respondents. However, what is more interesting is to look at the relative importance of the frequencies against each row of the tables. For both *Dudhersar* and *Gobindobhog*, the largest entry in corresponding rows has been against the option 'better profitability'. This is perfectly in conformity with the knowledge that these varieties have price premium for their special quality, as has been discussed earlier. Following the same logic, *Malabati, Khejurchori* and *Chamarmani* are reported to be reliable more for their salt tolerance.

Table -2. 16 (a): Reported advantages of traditional varieties over HYV

Variety Name / Reason	No. of favourable responses from sample responses for reasons							Total
	1. Security against salt water damage	2. Security against irregular rainfall	3. Own consumption and less chemical use	4. Own consumption and better taste	5. Emotional attachment with this variety (historical)	6. Better Profitability	7. Requirement of less labour	
Asfal	1		2	3		3	2	11
Babui	1			1				2
Bagara	1		1	1				3
Bahurupi	1		2	1		1	1	7
Balam	4		4	1	1	2	1	13
Banshkathi						1		1
Basmati	2		3	4	2	2		13
Boyerbat	1	1						3
Chamarmani	5	1	3	5	1	2	2	19
Chinekamini	1		1	2	1	3		8
Darsal	3			3		3	3	12
Degba Patnai	1		1	1				3
Dudhersar	**47**	**6**	**42**	**59**	**10**	**73**	**41**	**278**
Dudhkamal	1	1						2
Dyagra Patnai	1		1	1				3
Ganti	1							2
Gheus	3		3	3		5	2	16
Gobindabhog	**11**	**1**	**12**	**11**	**4**	**16**		**57**
Halda patali	1	1						2
Hamai	1		1	2		2	2	8
Hiramati	3		1	2	3			9
Jamainaru	1		1	1		1		4
Kabirajsal	1		1	1	1			4
Kalabhat	2		2	3	1	2	2	12
Kalomota	1	1						3
Kaminibhog	1			1		1		3
Karpurkanti	1		1					2
Kerala sundari	1		1	1		2	2	7
Khara				1		1	1	3
Khejurchori	8		3	5	6	7	1	30
Kanakchur	1			1	1			3
Kokil bhas	1			1				2

Source: Primary survey

Table – 2.16 (b): Reported advantages of traditional varieties over HYV

Variety Name / Reason	No. of favourable responses from sample responses for reasons							Total
	1. Security against salt water damage	2. Security against irregular rainfall	3. Own consumption and less chemical use	4. Own consumption and better taste	Emotional attachment with this variety (historical)	6. Better Profitability	7. Requirement of less labour	
Labansura	1		1					
Lal Dhan	1		1					
Lilabati	5		4		1			5
Malabati	10	1	6		3			0
Marichsal	5	1	3					3
Master Patnai			3					
Niko	4		3					6
Nona Bokra	1							
Nona Khetchori	1	1						
Nona Khorcha	3							
Nonasal	1							
Olisent (Narasinghajatta)	6		5		2			8
Paloi	2		1					
Patnai	4	2	5					8
Rabansal			3					0
Raniakand			1					
Rupsal	1		6		1			8
Sabita Patnai	4		4		2			5
Sadamota	1							
Sarma non	1		1					
Talmugur	1		1					
Tulsi Bhog			1					
Tulsi Mukul			1					
Valuki	1		6					8

Source: Primary survey

2.8 Salt tolerance capability of traditional rice varieties: farmer's experience

One important feature of traditional varieties in Sundarban delta is that many of them are known to have salt tolerant capability. This is a special advantage in this particular geographical context as that can help in addressing the local food security issue in the face of predicted increase in salinity ingress due to Climate Change. The salt tolerant capability of different such varieties had been estimated and classified under controlled field trials. However, actual farmers' experience in this regard is an interesting outcome that has been brought forward by this study.

As was explained in Section-4 (analytical methodology), a salt tolerance score has been constructed for each of the traditional rice varieties on the basis of farmers' qualitative responses based on their post-Aila farming experience. The different varieties have been ranked accordingly and are described in Tables 2.17(a) and 2.17(b).

Table -2.177 (a): Farmers' ranking of traditional varieties according to salinity tolerance

Variety Name	Number of responses			Tolerance Score
	High	Medium	Low	
Bagara	1	0	0	3.00
Dyagra Patnai	2	0	0	3.00
Halda patali	1	0	0	3.00
Kabirajsal	1	0	0	3.00
Kokil bhas	1	0	0	3.00
Labansura	1	0	0	3.00
Nona Bokra	1	0	0	3.00
Nona Khetchori	1	0	0	3.00
Sarma nona	1	0	0	3.00
Malabati	8	2	0	2.80
Sabita Patnai	4	1	0	2.80
Nona Khorcha	2	1	0	2.67
Boyerbat	1	1	0	2.50
Kalomota	1	1	0	2.50
Talmugur	1	1	0	2.50
Balam	2	3	0	2.40
Asfal	1	2	0	2.33
Chamarmani	2	4	0	2.33
Kalabhat	1	2	0	2.33
Master Patnai	1	2	0	2.33
Rabansal	1	2	0	2.33
Valuki	2	4	0	2.33
Darsal	1	3	0	2.25
Khejurchori	2	7	0	2.22
Niko	1	5	0	2.17
Patnai	2	9	1	2.08
Dudhersar	13	63	8	2.06

* Tolerance Score: 3=highest salt tolerance; 1=Lowest salt tolerance

Source: Primary survey

Table – 2. 17(b): Farmers' ranking of traditional varieties according to salinity tolerance

Variety Name	Number of responses			Tolerance Score
	High	Medium	Low	
Babui	0	1	0	2.00
Bahurupi	1	1	1	2.00
Chinekamini	0	3	0	2.00
Dudhkamal	0	1	0	2.00
Gheus	0	6	0	2.00
Hamai	0	2	0	2.00
Jamainaru	0	1	0	2.00
Kaminibhog	0	1	0	2.00
Karpurkanti	0	1	0	2.00
Kanakchur	0	1	0	2.00
Lal Dhan	0	2	0	2.00
Lilabati	0	5	0	2.00
Marichsal	1	7	1	2.00
Nonasal	0	1	0	2.00
Olisent/Narasinghajatta	1	8	1	2.00
Paloi	0	2	0	2.00
Rupsal	0	8	0	2.00
Sadamota	1	0	1	2.00
Gobindabhog	0	13	9	1.59
Ganti	0	1	1	1.50
Kerala sundari	0	1	1	1.50
Basmati	0	2	3	1.40
Hiramati	0	1	2	1.33
Banshkathi	0	0	1	1.00
Khara	0	0	1	1.00
Raniakand	0	0	1	1.00
Tulsi Bhog	0	0	1	1.00
Tulsi Mukul	0	0	1	1.00

* Tolerance Score: 3=highest salt tolerance; 1=Lowest salt tolerance
Source: Primary survey

It turns out that the most popular traditional variety among local farmers, namely *Dudhersar*, has a medium salt tolerance score. It is most popular because of its

profitability derived from price premium, as described in earlier tables. Another variety that is popular for similar reason, *Gobindobhog*, is found to have a low rank in terms of salt tolerance. In contrast, the top few salt tolerant varieties are not that popular. It implies that salt tolerance, though a required feature for choice of rice in ensuring food security, is a secondary criteria after realized price or profit. This finding puts up a policy guidance of promoting salt tolerant rice varieties in this region. Apparently, a price premium holds the key and government has an important policy handle here.

2.9 Overall performance of traditional rice varieties: farmer's ranking

Salt tolerance might be one criterion for which local farmers continued with many such traditional rice varieties. There are other criteria like low cost, less chemical use, better taste and so forth that also went in their favour. In the end, the questionnaire had asked the respondents about their overall level of satisfaction, elicited on a three point qualitative scale, with each of these varieties that they had cultivated since Aila (2009). The responses has been weighted and a 'overall satisfaction score' has been derived between the range (1,3) exactly in the same manner in which 'salt tolerance score' has been constructed. The varieties' ranking in terms of this satisfaction score is described in Tables 2.18(a) and 2.18(b).

Table -2.18(a): Overall evaluation of traditional varieties by farmers

Variety Name	Number of responses			Satisfaction Score
	Highly satisfied	Satisfied	Not satisfied	
Chinekamini	1	0	0	3.00
Dyagra Patnai	1	0	0	3.00
Kabirajsal	1	0	0	3.00
Kanakchur	1	0	0	3.00
Bahurupi	2	1	0	2.67
Kalabhat	2	1	0	2.67
Malabati	5	4	0	2.56
Lal Dhan	1	1	0	2.50
Sabita Patnai	3	1	1	2.40
Marichsal	3	5	0	2.38
Asfal	1	2	0	2.33
Chamarmani	1	5	0	2.17
Dudhersar	17	51	6	2.15
Rupsal	1	7	0	2.13
Olisent/Narasinghajatta	2	7	1	2.10
Babui	0	1	0	2.00
Bagara	0	1	0	2.00
Balam	0	5	0	2.00
Banshkathi	0	1	0	2.00
Basmati	1	3	1	2.00

* Satisfaction Score: 3=highest satisfaction; 1=Lowest Satisfaction
Source: Primary survey

Table – 2.18(b): Overall evaluation of traditional varieties by farmers

Variety Name	Number of responses			Satisfaction Score
	Highly satisfied	Satisfied	Not satisfied	
Darsal	1	2	1	2.00
Degba Patnai	0	1	0	2.00
Ganti	0	2	0	2.00
Gheus	1	4	1	2.00
Hamai	0	2	0	2.00
Kaminibhog	0	1	0	2.00
Khara	0	1	0	2.00
Khejurchori	3	3	3	2.00
Kokil bhas	0	1	0	2.00
Labansura	0	1	0	2.00
Lilabati	0	5	0	2.00
Master Patnai	0	3	0	2.00
Nona Khetchori	0	1	0	2.00
Nonasal	0	1	0	2.00
Paloi	0	1	0	2.00
Patnai	2	7	2	2.00
Rabansal	0	2	0	2.00
Sabita	0	1	0	2.00
Sarma nona	0	1	0	2.00
Talmugur	0	2	0	2.00
Tulsi Mukul	0	1	0	2.00
Gobindabhog	1	17	4	1.86
Valuki	0	5	1	1.83
Hiramati	0	2	1	1.67
Niko	0	3	2	1.60
Boyerbat	0	1	1	1.50
Kerala sundari	0	1	1	1.50
Sadamota	0	1	1	1.50
Dudhkamal	0	0	1	1.00
Halda patali	0	0	1	1.00
Kalomota	0	0	2	1.00
Nona Bokra	0	0	1	1.00
Nona Khorcha	0	0	3	1.00
Raniakand	0	0	1	1.00

* Satisfaction Score: 3=highest satisfaction; 1=Lowest Satisfaction

Source: Primary survey

It turns out that the most popular rice varieties do not figure among the top 10 satisfactory performers among the local farmers. *Dudhersar* comes at 12th position whereas *Gobindobhog* is placed much below and towards the 'not satisfied' range. This interesting revelation indicates that there is ample scope for small policy inducements that can promote the local traditional varieties of salt tolerant rice, the acceptability and satisfactory performance of which is already there.

Chapter – III

Summary, Conclusions and Policy Prescriptions

3.1 SUMMARY AND CONCLUSION

The study finds that there are many traditional varieties of rice being cultivated by farmers in Sundarban delta which are known for their salt tolerant property. Though the sample is purposive, yet the number of different varieties is found to be more than what was expected. From 157 farming households that has been interviewed, as many as 32 such varieties has been identified which were cultivated in the monsoon of 2015. The distribution of such farmers is found to be thin across different islands without much communications among themselves. So, except a few commercially successful such varieties, other varieties are found to be locally concentrated in practice. The seeds of such varieties are not commercially available in the market. They are preserved and continued across family lines or neighbourhood.

Many of these varieties are studied and documented by specialized institutions and agencies growing them in small experimental plots under ideal conditions. However, their performance in the field under natural conditions has not been studied.

The study finds that the average productivity of these traditional varieties are significantly less than that of the other High Yielding varieties. This is the major reason why these newly introduced varieties could displace the local varieties and are mostly cultivated by the modern Sundarban farmers.

Still, the survival of traditional varieties was possible because of some special features in them. One dominant reason for survival of the low yielding varieties is their high capability to withstand land salinity. There are pockets in Sundarban islands which are very susceptible to salinity ingress because of their proximity to saline rivers and the bad condition of the protective embankments. In such locations, farmers hedge their risk of total crop loss during a season by compromising with low productivity.

Another major reason for their survival is farmers' taste and preference for these local varieties. Most of them are having their special taste and flavour which the farmers grew accustomed with from their childhood. Most of the farming households produce their monsoon rice for self-consumption. So, even if their land is not much vulnerable to salinity location wise, many large landholders keep a certain part of their land for production of these varieties for their year-long consumption.

Yet another reason for cultivation of these varieties is their low cost of production. The seed cost is almost nil for such varieties as they preserve the seed from their previous year's production. These varieties require very little fertiliser and pesticide also. So,

the total monetary costs for production of these varieties are much less than that of the modern introduced varieties. Poor farmers have a natural tendency to opt for it, specially when they face a continuous threat of crop loss due to salinity ingression.

A couple of these varieties are in fact increasing the area under them due to market signals. Dudhersar and Gobindobhog are two such varieties which are being propagated throughout the region in recent years as they could fetch a premium over other varieties in selling price. This was possible due to their fine grain quality and a tilt of urban consumers' taste in their favour. So, in spite of their low productivity, they are successfully competing with other HYV seeds in expanding their market share through better realised price. Among these two, Dudhersar is of medum salt tolerance and Gobindobhog is of low salt tolerance. This finding helps us to understand that the preservation and propagation of more salt tolerant rice varieties can be easily achieved if a differential procurement price system can be put in place in favour of more salt tolerant rice varieties.

The traditional varieties are found to be more organic in nature as they require very little chemical fertilisers or pesticides compared to their HYV counterparts. They require mostly organic manures like cow dung and hence such households practicing traditional varieties almost invariably has some livestock holding with them.

Cyclone Aila in May 2009, which devastated all of these islands with salt water overflowing from surrounding rivers to the agricultural fields, has ushered in a new realisation among island dwellers regarding their food security. They realised, after that painful experience, that preserving and practicing local salt tolerant varieties is a viable coping strategy against such threats in future. The realisation translated into, even without any outside support or counselling, renewed interest among farmers to organize themselves to create local seed banks for such rice varieties.

However, remoteness of these islands prevented the percolation of many institutional benefits that are being delivered to other well-connected parts of India. For example, crop insurance and soil testing are almost absent on these islands due to absence of institutions and official visits in this remote area. Very few of the farmers are in fact aware of the benefits and services that they are entitled to get freely or at a negligible cost.

This study by AERC (Santiniketan) has tried to cover the information gap and bring to light certain aspects of paddy cultivation in Sundarban islands that cannot be generated through laboratory experiments. Household level data from 157 farming households spread over 15 Gram Panchayet area, highlights the following points:

- The inaccessibility and remoteness of the area hindered the penetration of formal institutions to render some crucial services to Sundarban farmers. Whatever services they receive comes mostly from local NGOs and some outside agencies who can earn profit from particular types of services.

- Only about 10% of owners of these plots has reported that they had conducted, through the help of NGOs, some soil testing on their plots within last 10 years. It seems that there is very little penetration of the idea of having an up-to-date soil health card in this region.

- There are a large number of salt tolerant varieties of rice that are being preserved and being cultivated in nooks and corners of Sundarban island, the performance details of which are not yet known and there is knowledge gap in this regard.

- The cost of cultivation of these varieties is significantly less and farmers don't need to depend on outside agencies or government departments for obtaining the seeds.

- The cultivation practice for these varieties is mostly organic in nature and requires little or no chemical fertilizers or pesticides.

- These varieties are mostly of low productivity, but are important for the local food security and hence needs to be propagated among local farmers through policy measures.

- Farmers are mostly aware of the vulnerability of the HYV seeds which are of higher productivity but of low salt tolerance. The experience of cyclone Aila has made them aware of the positive side of local rice varieties.

- Getting enough good quality seeds of local salt tolerant varieties is a problem these days as they are confined in pockets of Sundarban. There are demands for such seeds which the local farmers are failing to meet.

- Varieties like "Dudhersar", due to its special quality, fetches a premium in the market over other varieties. So, in spite of low productivity, farmers get over-compensated through realized price. That is why this variety is found throughout the delta.

- Dudhersar is of medium salt tolerance quality. There other highly salt tolerant rice varieties (like Darsal, Nona Bokra, Talmugur), as was identified by scientific community and is in practice in Sundarban, that cannot fetch the price premium in the market. These varieties are existing in pockets of Sundarban but are confined within farming households that are in close neighbourhood of each other.

3.2 POLICY IMPLICATIONS

In the backdrop of these findings, the main points that this study throws up for informed policy making are as follows:

- The inaccessibility and remoteness of the area forbids formal institutions and their officials to come and visit Sundarban farmers and provide institutional support. Whatever services they receive comes mostly from local NGOs and some outside agencies who can earn profit from particular types of services. So, there should be a differential treatment for locally operational NGOs and agencies, in terms of increased financial incentive, to provide services like Crop Insurance.
- Similar situation exists for development of a comprehensive knowledge in the farmers about their soil condition. There is very little penetration of the idea of having an up-to-date soil health card in this region. It calls for an intensive campaign among farmers making them aware of the benefits of soil testing and calls for organizing special camps with mobile soil testing units in this remote rural area.
- The cultivation and propagation of these varieties needs government's active help. In terms of motivating the farmers, cyclone Aila paved the groundwork already. Getting enough good quality seeds of local salt tolerant varieties is a problem these days. There are demands for such seeds which the local farmers are failing to meet. There should be seed banks specialized for such salt tolerant varieties and more seed distribution centres in this remote area.
- Varieties like "Dudhersar", due to its special quality, fetches a premium in the market over other varieties. So, in spite of low productivity, farmers get over-compensated through realized price. One efficient policy measure can be to devise differential (favourable to salt tolerant varieties) procurement price for these varieties, as farmers have a selling objective over and above their own consumption. If procurement prices are enhanced for more salt tolerant rice varieties in Sundarban, locals will invariably be inclined to propagate their cultivation

3.3 NEED FOR FURTHER STUDY

This study was undertaken with limited resources and manpower in a difficult and remote location. In absence of plant specialists in the study team, the findings could not shed much light on the bio-physical characteristics of the reported rice varieties.

The exact soil characteristics of the plots could not be matched with the productivity as almost no farmer had a recent soil test report of their plots.

Such local varieties are to be unearthed in greater numbers that would enrich the plant genetic base for future cross-breeding of new species. For this, more large scale surveys in such remote locations are needed, coupled with sufficient funding for recruiting plant biologists and soil scientists. Sundarban is one of the most vulnerable regions in the face of Climate Change and Sea Level Rise predictions. A widespread survey in this line will enhance the knowledge base for effective adaptation policy for this region's future food security. It remains an open research agenda for future - both for AERC (Santiniketan) and for any other interested agency.

ANNEXURE-1

Comments Received on the Draft Report Submitted in February, 2017

1. Title of the Study :**A Study on Indigenous Rice Varieties in Sunderban Delta and their Role in Ensuring Local Food Security in the Face of Climate Change Threats.**

2. Date of receipt of the Draft Report : 16/02/2017

3. Comments on Objectives : It is well designed in respect of the problems of the study.

4. Comments on Methodology : It has been followed to pursue the set objectives of the study.

5. Comments on the Study :

   i. Preface page should be next to contents page.
   ii. Numbering of tables from page No. 24 to 27 needs to be corrected and put the number accordingly in list of tables.
   iii. Don't keep the column blank, as it is in table 2.1. It may be filled with particulars.'
   iv. In tables 2.4 to 2.6 re-check the percentage as per the number of sample Hhs.
   v. Convert the figures in acre of table 2.12
   vi. Comparative cost components given in table 2.13 are either in Rs. per acre or Rs. per bigha. It is not clear though it should be in Rs./acre.

6. Overall view: The report may be accepted after necessary corrections as suggested above.

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Annexure-II

Actions Taken on the Above Comments

Comment 5.(i), Putting 'preface' before or after the 'content' depends on the style adopted for the report. Though the suggestion is welcome, we preferred to continue with the style that has been followed in earlier reports of AERC (Santiniketan).

Comment 5(ii): The mismatch in page numbers of few tables with the numbers mentioned in 'List of Tables' was an inadvertent mistake and has been corrected.

Comment 5(iii) & 5(iv): The contents of the tables have been rechecked and corrected.

Comment 5(v): The unit of measurement has been changed and the figures are recalculated in Table-2.12.

Comment 5(v): The unit of measurement has been mentioned and the figures are recalculated in Table-2.13.

Authors