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Revitalizing the Ganges Coastal Zone: Turning Science into Policy and Practices

CONFERENCE PROCEEDINGS

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Increasing agricultural and aquacultural productivity in the coastal zone of Bangladesh

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Abstract

The coastal zone of the Ganges delta is very susceptible to salinity intrusion and seasonal cyclonic storms. The poverty of farming families in the polders of the coastal zone is extreme. Physical and social factors have prevented many farmers from taking advantage of the technological improvements in rice farming and aquaculture that could increase profitability, productivity and resilience in the polder areas. Coastal zone farmers usually grow a single rice crop using low yielding traditional varieties. Furthermore, cropping intensity is low with the result that productivity of this region is also low. There are great opportunities to increase productivity in the coastal zone through crop intensification and diversification. In light of this, BRAC is scaling out suitable technologies and varieties across a wide range of people throughout the coastal zone. The program described here focused on increasing farming system productivity and profitability to improve livelihoods. A participatory approach was applied to facilitate the scaling out process from varietal selection to technology adoption. Hybrid variety trials and cropping system trials demonstrated better production in the polders than was previously possible. Several promising short duration rice varieties as well as salt-tolerant non-rice (*rabi*) varieties were introduced and were widely accepted by the farmers and are becoming very popular. All the single crop land in the demonstration blocks is now being converted to double or triple crop land. Rice-fish integrated culture with horticulture on dykes is now well established among the participating farmers. Additionally, we piloted community-based brackish water aquaculture to improve productivity. Results of validation activities found double the production both in agriculture and aquaculture, enabling farmers to obtain more profit than in the previous year. The results of the study will be useful for further scaling out of endeavors in another regions. This type of participatory validation work will have a great future impact on agricultural extension work as well as research work in Bangladesh.

Keywords: rice varieties, aquaculture, improved technology, scaling out

1. Introduction

Bangladesh is a small country with an area of about 147,570 km^2 and a large population of about 160 million. The coastal zone covers about 20% of the country and over 30% of the net cultivable area. As an agrarian country, agriculture is the key economic driver in Bangladesh. More than 50% of the people are directly involved and 30% indirectly involved in this sector. It has been estimated that the population of Bangladesh will be 194 million by 2050, when the total rice demand will be 49 million tons per year. As a result it is essential to ensure increasing crop production at a rate that will guarantee food security in the near future.

The coastal zone of Bangladesh largely missed the benefits of the green revolution. Many polders were created in the coastal zone during the early 1960s. The primary functions of the polders were the protection of the land from tidal flooding and salinity intrusion. This enabled the cultivation of traditional *aman* rice crop varieties, which were long duration and low yielding. After harvesting of rice the majority of lands within the polders were left fallow, or sown with a low input, low yielding legume crop in some locations. Production of high yielding or high value *rabi* crops was not possible because of the late harvesting of *aman* rice. Most of the lands in the polders are not suitable for growing the improved high-yielding varieties of rice because the water is too deep for their shorter stature. Shrimp and fish are being farmed in many coastal polders but yields are low and well below potential.

Keeping these challenges in view, BRAC, the largest non-governmental organization of the world, has worked to validate and scale out climate smart agricultural and aquacultural technologies to farmers in the coastal zone of Bangladesh since 2012 with the following objectives:

- To enhancesystem productivity by increasing aqua-cultural and agricultural cropping intensity
- To ensure food security and to improve the livelihood status of the coastal communities through disseminating aquacultural and agricultural technologies
- To develop 'armer's capacity in increasing climate change adaptation and resilience.

In this paper we present the activities and findings of the 2013-14 program.

2. Methodology

BRAC Agriculture and Food Security Program (AFSP) disseminates agricultural technologies through farmers' participatory large scale block demonstrations. It is considered that large scale demonstration of improved technologies in crop fields and *ghers* inspires the neighboring non-participant farmers to adopt the improved and modern technologies in their fields.

The technology dissemination strategy is to convert single crop areas to double or triple cropped areas. This is done by introducing stress toleran: agricultural rice and fish varieties to the cropping systems, and by incorporating high value *rabi* crops in the rice-based cropping systems through the use of shorter maturing rice varieties to enable 'early' (timely) *rabi* crop establishment.

BRAC AFSP organizes groups of 40to 50 marginal farmers farming in a contiguous area (demonstration block) and provides them with partial support to cultivate modern varieties of crops, using improved production technologies and practices. The farmers are provided with training and the latest information for increasing production from their field. It has been estimated that the farmers provide about 55% of the rice production cost, mainly in terms of labor, fertilizer and irrigation, and the program provides about 45% of the production cost in the form of cash to purchase inputs. At present, AFSP is operating its extension activities in 50 sub-districts of 12 districts of Bangladesh. Most of the operational sites are disaster and stress prone areas of the coastal area where the target is to cover around 60,000 direct participants with improved :echnologies by 2015. The target group is mainly poor and marginal farmers in coastal communities.

Results from the 2013-14 seasons are reported inthis paper. Yield data were taken from an area of 20 m^2 in five randomly selected farmers' fields in each demonstration block. Grain moisture content was determined using a grain moisture meter and yield is presented at 14% moisture content for cereal crops and at 10% for oil seed crops.

3. Activities and results of the 2013-14 program

3.1 Extending improved rice varieties

High yielding rice varieties, both hybrid and inbred, were demonstrated during the *aus*, *aman* and *boro* cropping seasons. Hybrid rice as well as salt tolerant *boro* inbred rice were demonstrated in the *aus* and *boro* seasons, while high yielding varieties of inbred rice were demonstrated during the *aman* season.

3.1.1 Aus

Hands-on training for rice cultivation was given to the participants in the 2013 *aus* season and they were advised to cultivatehybrid rice. The farmers cultivated hybrid rice (Alloran, Shakti-2 and Sathi) from April to August 2013 in Barisal and Khulna regions. They applied irrigation at the beginning of the cropping season, usually up to May. Later on the fields were inundated with tidal water that came naturally, and which was sufficient to meet crop water requirements in most cases.

Eighty-eight farmers cultivated hybrid dhan Shakti-2, 80 cultivated hybrid dhan Sathi and 179 cultivated hybrid dhan Alloran. With identical growth duration, all varieties had similar average yield (7.1-7.6t/ha). The average hybrid *Aus* production was 7.32 t/ha (Table 1). Average net return was 63,000 to 90,000Tk/ha (Fig. 1).

Table 1. Block number, farmer number, seedling age, growth duration, yield and yield components of hybrid rice in *aus* season 2013

Variety	No. of blocks	No. of farmers	Seedling age (d)	Growth duration (d)	Effective tillers/ hill	1000 grain weight (g)	% filled grains	Yield at 14% (t/ha)
Hybrid Shakti-2	20	88	20	119	9	25	86	7.29
Hybrid Sathi	16	80	23	118	11	26	93	7.58
Hybrid Alloran	37	179	22	120	10	28	87	7.08
Average yield: 7.32 t/ha								

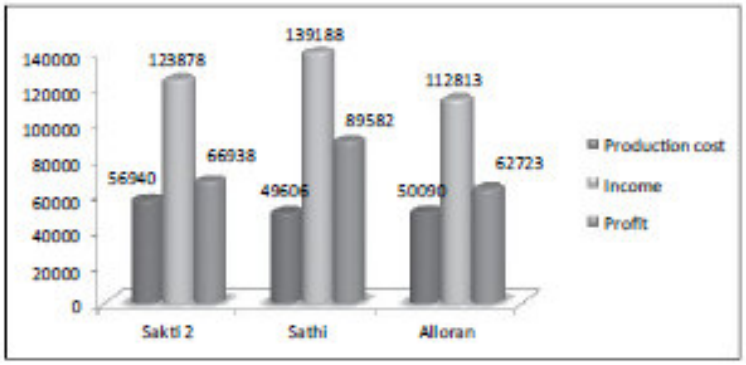

Fig. 1. Average production cost, income and profit of three hybrids during *aus* season 2013 (Tk/ha).

3.1.2 Aman

Nine *aman* varieties were cultivated in 430 blocks of 12 districts by over 2,000 participants. Five crop cuts (1 m^2) were taken in four locations in five fields in each block for yield determination. Average variety yields in the main block ranged from 5.2 t/ha (BRRI dhan39) to 7.1 t/ha (BRRI dhan64) (Table 2). The national average *aman* yield for 2011-2012 has been estimated at 2.29 t/ha, less than half the average production in the demonstration blocks (5.84 t/ha). Average cost of production was 43,000 Tk/ha, which brought an average net profit of 66,000 Tk/ha (Table 3).

In main blocks farmers followed the improved cultivation technology where the yield of the *aman* varieties was 0.5 to 1.6 t/ha higher than yield of the same varieties grown by farmers outside the demonstration blocks ("non-block farmers"), who usually follow traditional cultural practices. Yield of BRRI dhan64 in the non-blocks (6.2 t/ha) was much higher than yield of all the other improved varieties (4.2-5.0 t/ha) and of the local varieties (2.1-5.4 t/ha).

Table 3. Total production cost, gross income, profit and BCR of HYV rice in *aman* season 2013

Variety	Total production cost (Tk./ha x 1000)	Gross income (Tk/ha x 1000)	Profit (Tk/ha x 1000)	BCR
BINA dhan7	45.6	118	73.2	2.70
BRRI dhan33	43.2	106	62.9	2.49
BRRI dhan39	44.2	103	59.3	2.41
BRRI dhan41	42.3	106	63.5	2.55
BRRI dhan49	43.4	111	67.7	2.60
BRRI dhan51	42.3	106	63.9	2.52
BRRI dhan54	42.8	111	68.4	2.62
BR22	44.8	113	67.7	2.51
BR11	42.3	113	70.4	2.66
Average	**43.3**	**110**	**66.3**	**2.56**

3.1.3 Boro

In the 2013-2014 *boro* season around 1200 farmers cultivarted a range of hybrids and inbreds in 262 blocks. The highest average yield of ~9.5 t/ha was observed with the hybrids Sakti-2 and Sathi.. Average non-block yields of respective hybrids were 1.2 to 1.9 t/ha lower than yields in the demonstration blocks. In non-block fields, the average yield of hybrid Shakti-2 was about 3 t/ha higher yield than yield of the local variety Vojon (Table 4).

Table 4. Number of demonstration blocks and farmers, yield and yield components of rice in the 2013-14 *boro* season.

Variety	No. of blocks	No. of farmers	Yield and yield components			
			Effective tillers/ hill	% filled grains	1000 grain weight (g)	Yield at 14% (t/ha)
1.0 Main Block						
Hybrid Shakti-2	42	210	13	83	27	9.45
Hybrid Alloran	27	135	10	92	28	7.71
Hybrid Sathi	93	430	13	93	30	9.54
BRRI dhan28	100	420	12	85	24	6.70
Total	**262**	**1195**				
2.0 Non-block						
Hybrid Shakti-2		34	13	87	27	7.93
Hybrid Alloran		10	6	88	25	5.78
Hybrid Sathi		54	11	87	28	8.32
BRRI dhan28		332	10	82	24	5.51
ACI		10	11	86	27	8.60
HERA		34	14	66	27	7.30
Vojon (local)		24	9	85	26	4.83

3.2 Extension of non-rice crops

3.2.1 Maize

During the 2013-14 *rabi* season, more than ten thousand (10,147) farmers cultivated maize hybrids (Pacific 984, and Pacific 999 super) on 2,572 ha. Yield and yield component data were taken from 742 farmers across 188 main and satellite blocks (areas where a technology is only demonstrated for one season). Crop cuts were taken from the fields of five participants per main block and from two farmers' fields per satellite block. Average yield of maize was 8.5 t/ha and varied from 6.3 t/ha in Jhalokathi District to 11.2 t/ha in Bogra District (Table 5). Average yields in excess of 10 t/ha were also achieved in Rangpur, Lalmanirhat and Kurigram Districts. Yield in the medium salinity coastal districts (Khulna, Bagerhat and Sathkhira) were lower at 8 to 9 t/ha.

Table 5. Yield and yield components of maize in different locations including the coastal region of Bangladesh during *rabi* season 2013-14

District	Plants per m^2	Yield and plant characters			
		Grains per cob	% of filled grains	1000 grain weight (gm)	Yield at 14% (t/ha)a
1. Main Block					
Barguna	4.69	463	98	307	8.25
Jhalokathi	5.26	508	96	288	6.26
Pirojpur	4.82	665	99	312	8.21
Bagerhat	4.81	561	99	346	8.11
Khulna	5.75	352	97	320	8.33
Satkhira	5.70	640	99	369	9.09
Bogra	7.02	129	99	351	11.23
Rangpur	6.76	119	99	344	10.79
Lalmonirhat	6.94	125	99	363	10.75
Kurigram	7.45	107	99	451	10.67
Average	5.92	367	98	345	9.17
2. Satellite Block					
Barguna	4.73	663	90	300	7.73
Patuakhali	4.76	546	95	325	8.04
Jhalokathi	5.03	575	93	310	6.92
Pirojpur	4.66	642	98	309	7.55
Bagerhat	4.76	521	98	329	7.25
Khulna	5.36	531	98	343	8.28
Satkhira	5.98	573	97	351	6.55
Rangpur	6.04	105	97	322	8.34
Lalmonirhat	7.24	122	99	320	9.03
Average	5.39	475	96	323	7.74
Overall average	5.66	421	97	334	8.46

Fig. 2 Maize cultivation in the 2013-14 *rabi* season in Pirojpur district.

3.2.2 Sunflower

In the 2013-14 *rabi* season, critical inputs were provided to 11,299 farmers for hybrid sunflower (Hi-sun33) cultivation on 2,844 ha in both coastal and northern regions of Bangladesh. Yield and yield component data were collected from 961 farmers' fields across 260 blocks (both main and satellite). Five crop cuts were taken from each main block and two from each satellite block. Average yield of sunflower was 2.79 t/ha and average district yield varied from 2.01 to 3.26 t/ha. Highest grain yield (3.26 t/ha) of sunflower was observed in Barguna District (Table 6).

Fig. 3. Sunflower in the 2013-14 *Rabi* season in Bagerhat

Table 6. Yield and plant characters of sunflower in *rabi* season 2013-14 (average of five crop cuts per main block and two per satellite block)

District	Yield and plant characters					
	Population (plants/m²)	Flower diameter (cm)	Seed per flower	% of filled seeds	1000 seed weight (g)	Yield a 10% (t/ha)
1. Main Block						
Barguna	2.80	68	708	93	76	3.26
Patuakhali	2.78	75	1,220	87	86	3.15
Jhalokathi	2.99	15	635	85	94	2.78
Pirojpur	2.98	21	581	96	108	2.84
Bagerhat	2.94	18	985	88	99	2.85
Khulna	2.87	21	1,341	86	92	3.04
Satkhira	3.60	19	1,152	92	76	2.88
Bogra	2.41	20	179	84	53	1.88
Rangpur	3.05	26	249	80	71	2.18
Lalmanirhat	3.09	21	235	86	67	2.23
Kurigram	2.825	23	243	72	79	2.01
Average	2.94	30	685	86	82	2.64
2. Satellite Block						
Barguna	2.81	23	781	93	75	3.14
Patuakhali	2.82	22	945	90	82	2.98
Jhalokathi	3.09	20	569	79	107	2.72
Pirojpur	2.60	23	636	89	213	2.89
Bagerhat	2.89	18	1,191	89	94	2.70
Khulna	2.75	14	1,082	87	91	3.03
Satkhira	3.60	19	1,152	92	76	2.88
Gopalgonj	2.75	10	1,544	92	75	3.17
Average	2.91	19	987	89	102	2.94
Overall average	2.93	24	836	88	92	2.79

3.3 Aquaculture in ghers

Gher aquaculture is a year-round activity and profitable business for the farmers of southern Bangladesh. The participants were given experience in a range of improved management practices including feed formulation and fish-rice-vegetable integration. Fish production data were collected from 266 farmers who were engaged in fish cultivation in a total of 37 ha of *ghers* across 15 *upazilas*. Production cost was highest in Tala sub-district of Satkhira (319 thousand Tk/ha) compared with the average cost of 244 thousand Tk/ha (Table 7). Morrelgonj sub-district of Bagerhat District showed very good performance in both total income (over 1 million Tk/ha) and net profit (almost 800 thousand Tk/ha). Average total income and net profit were 417 and 173 thousand Tk/ha, respectively. Average fish production of the 15 *upazilas* was 1,325 kg/ha, while the highest production of 3,873 kg/ha was obtained at Morrelgonj. Production was lower in areas affected by salinity.

Table 7. Productivity and profitability of fish in *ghers* during 2013

Sl. no	Name of upazila/ sub-district	No. of farmers	Total water body (bigha)[1]	Production cost (tk/ha x 1000)	Fish production (kg/ha)	Income (tk/ha x 1000)	Net profit (tk/ha x 1000)	BCR
1	Morrelgonj	25	26	288	3,873	1,087	799	3.78
2	Fakirhat	12	11	316	1,318	786	470	2.49
3	Mollahat	14	38	291	3,207	975	684	3.35
4	Mongla	26	17	191	372	279	88	1.46
5	Rampal	14	13	261	2,620	713	452	2.74
6	Satkhira Sadar	17	17	209	788	240	31	1.15
7	Tala	25	23	319	707	214	(105)	0.67
8	Kaligonj	14	12	226	908	264	38	1.17
9	Assasuni	12	12	196	1,072	356	160	1.82
10	Shyamnagar	12	11	209	2,090	803	594	3.84
11	Kalaroa	19	18	216	2,271	294	78	1.36
12	Debhata	14	13	287	230	24	(263)	0.08
13	Dacope	27	32	208	143	48	(160)	0.23
14	Koyra	16	14	249	280	170	(79)	0.68
15	Paikgacha	19	15	200	-	-	(200)	-
Total		266	273					
Average				244	1,325	417	173	1.71

[1] 1 ha = 7.47 bigha

Fig. 4. Successful *gher* activity in (a) Bagerhat and (b) Satkhira Districts during 2013.

4. Conclusions

Increasing production, productivity and income from farm holdings is possible through increased cropping intensity, shifting from local crop varieties to improved varieties and diversification. By scaling out the results obtained from validation activities, production of both agriculture and aquaculture can be doubled. The results of the study will be useful for further research and extension work. An integrated approach focusing on training, block level demonstrations, farm level advisory support, financial support and field days ensured successful demonstration and promotion of new knowledge among farmers.

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