FINAL SYNTHESIS REPORT

Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agricultural Sector (LACC II):

2009

Printing supported by:

Comprehensive Disaster Management Programme
Ministry of Disaster Management and Relief

UKaid from the British people

European Union

NORWEGIAN EMBASSY

SWEDEN

Australian AID

UNDP

Empowered lives.
Resilient nations.

FINAL SYNTHESIS REPORT

Results and Findings from BRRI-FAO Collaboration

under Project

Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agricultural Sector (LACC II):

:

J. K. Biswas, M. A. Ali, Abdullah Al Mahbub, T. H. Ansari, A. W. Raghib Hassan and M. S. Islam

BRRI, Joydebpur, Gazipur-1701 & DAE, Khamarbari, Dhaka-1207

submitted by

BANGLADESH RICE RESEARCH INSTITUTE

2009

to the

FOOD AND AGRICULTURE ORGANIZATION &

DEPARTMENT OF AGRICULTURAL EXTENSION

Summary

The contributions of BRRI to the second phase of the LACC project were concentrated in two districts Natore at the north-west and Khulna at the south west part of the country. In Natore, the climate is extreme in terms of temperature, rainfall; very high and low temperature along with low rainfall has threatened the crop production and livelihood of the farmers. While in Khulna district, salinity, natural disaster (sidr, ayla, nargis, resmi), rainfall and water stagnancy are the key environmental constraints where livelihood of hundreds of thousand of farm families are highly vulnerable. In both the locations, soil organic matter and soil fertility is very low. In order to sustain crop production and livelihood, different adaptation options of crop production were demonstrated. Package of technologies developed through Research & Development (R&D) activities by the research institutes (BRRI, BARI, etc.) especially rice based patterns, seeding time & production package, use of available MV varieties and pest management were demonstrated in farmers field. Participatory Crop and Varietal selection were also included in each demonstration so that adjustment of the crop production activities could be made in the specific stress context. System productivity was calculated into Rice Equivalent Yield (REY) with the market price of Rice, Wheat and Lentil. In drought prone environment short duration rice BRRI dhan39 and BRRI dhan49 performed better than either very short (BRRI dhan33) or long duration BR11/Swarna which escaped reproductive stage drought in T. Aman and allowed timely establishment of winter crops. Among the winter crops (wheat, mustard and lentil), wheat was the most adaptable in cloudy and foggy weather condition. Mungbean was successfully grown after wheat harvest in both the demonstrations. Therefore, Natore region, short duration rice (BRRIdhan39 and BRRIdhan49)-Wheat-Mungbean is the most adaptable pattern under drought environment. In saline areas, BR23 (T. Aman) and BRRI dhan47 (Boro) were most adaptable. However, BRRI dhan28 in particular can escape high salinity stress (in May) due to shorter growth duration and allows successful cultivation if mild saline-fresh water is available. Soil flashing with fresh water from the reservoir at the reproductive stage of Boro rice is required to prevent salt injury. Maintenance of continuous standing water prevented capillary rise of salinity. Water stagnancy in T. Aman restricted tillering in BR23 which has successfully corrected by using higher number of rice seedling. Expansion of Boro rice and other winter vegetables seems to be highly prospective if fresh water from Pasur river could be stored in natural reservoirs (ponds, ditches, dead rivers, canals etc) in early December. Boro seeding should be completed within 3rd week of November to prevent high salinity stress in May and to achieve high yield.

Introduction

Climate change poses significant risks for Bangladesh**.** The impacts of higher temperatures, more variable precipitation, extreme weather events, and sea level rise are already felt in Bangladesh and will continue to intensify. The impacts result not only from gradual changes in temperature and sea level but also, in particular, from increased climate variability and extreme events, including more intense floods, droughts, and storms. In Bangladesh, climate change will affect many sectors, including water resources, agriculture and food security, ecosystems and biodiversity, and human health.

In the short term, the global warming increases risk of drought, sea level rise which will affect crop production sector severely. Global warming through sea level rise might claim almost 17% land of Bangladesh. The saline water along coastline will extend its periphery towards inner side of the country (Dewan and Nizamuddin, 1998 and SRDI, 1997). In addition, the frequency of severe flood and drought is expected to increase in an alarming rate and with devastating impacts, as was experienced in last two years in Bangladesh, where agriculture and millions of people suffered particularly from the cylones SIDRE, NARGIS, RESHMY and AYLA. The IPCC suggests to device mitigation and adaptation strategies to counteract these afflictions, whereas the developing nations could device their adaptation activities on their own. Accordingly, BRRI has started its part of action through different projects and programs. Also FAO is assisting DAE through the LACC project. In the LACC context BRRI is a collaborating partner working with DAE and FAO for enhanced climate resilience and livelihood security of farmers in two extreme environments viz. drought (Natore) and saline areas of Khulna.

BRRI delivered the following adaptation activities through LACC II:

A. Drought prone ecosystem (Natore):

- Introduction of a set of rice varieties that were relatively shorter growth duration (BRRI dhan33, BRRI dhan39 and BRRI dhan49) than traditional BR11 or Swarna in T. Aman season (Wade et .al. 1999, Karmakar et al. 2003).
- Selection and integration of non rice crops with less water requirements in winter season (Rabi) viz. wheat, lentil, mustard
- Introduction of mungbean which generally deep rooted and drought tolerant.

- Intervention of using benefits of quality seed and proving production packages for each crop (Ahmed et. al. 2006, BRRI, 2007)

B. **Saline ecosystem**:

- Introduction of saline tolerant BRRI dhan40 & BRRI dhan41 (for high to medium land) and BR23 (for medium to low land) in T. Aman (Mondol et al., 2004).
- Introduction of a set of boro varieties viz. BRRI dhan28, BRRI dhan45, BRRI dhan29 and BRRI dhan47 (saline tolerant) depending on the ecosystem and availability of water, level of salinity (BRRI, 2007).
- Seeding time adjustment for boro rice cultivation through analysis of 50 years temperature data of Khulna.
- Intervention of integrated soil salinity management practices viz, soil flashing, application of household ash, incorporation of T. Aman straw, application of gypsum and using shorter growth duration rice varieties (Shah & Mondal, 2004 and BRRI, 1993)
- Modern rice production packages along with quality seed supply (BRRI, 2007)
- Introduction of Sesbania in the T. Aman –Boro crop sequence

All these technological options were implemented in the LACC II demonstration activities in two major rice based cropping patterns such as T. Aman rice – Wheat/Lentil/Mustard – Mungbean and T. Aman rice-Boro-Sesbania in saline eco system respectively. The objective of the interventions was to contribute to the improvement of farmer's livelihoods and to reducing their vulnerable to climate change impacts through adopting appropriate agricultural production techniques or technologies under drought and saline ecosystem.

Materials & Methods:

In the drought prone environments of Natore Lalpur and Bagatipara were selected as pilot upazilas; in the saline environments it were Dacope and Terokhada In these pilot upazilas several demonstrations were conducted on farmer's fields. Technology options were selected based on in depth reviews of the research activities of BRRI, BARI, BINA, SRDI, of weather data analysis of the respective environment, personal experiences, site visit, participatory discussion with the

farmers etc (Hoque and Islam. 1990; Shah & Mondal, 2004 and BRRI, 1993; BRRI, 2007; Wade et al. 1999, Karmakar et al. 2003; Ahmed et al. 2006). In the drought prone environment two different technologies were demonstrated while in saline environment it were four in Dacope and Terokhada and one extrapolated demonstration in Koyra i (Table 1). During implementation several visits were made to the respective upazila and discussions held with collaborative farmers, UAO and FMOs about the overall activities. Inputs and partial operational cost were supplied by the LACC projects. Relevant data was collected during harvest by the scientists of BRRI.

The climatic features recorded during the testing period, as well as the soil conditions in the pilot areas are recorded as part of the overall LACC project, and are documented in other LACC II reports including the situation assessment report for the saline areas. Specific weather phenomena faced during the testing period 2008/09 are discussed in the discussion section of this report

Table 1: Details of the selected farmers, plot size and technologies for demonstration under LACCII in Natore and Khulna

Name of the site	Place (Upzilla)	No. of Demo	Farmer's Name and Address	Area (Acre)	Cropping pattern
Natore	Bagatipara	01	Md. Manik Mia S/O, Md. Abdul Kader Village: Paka	1.0	T.Aman (Early Transplanted BR11) – Wheat, Mustard and Lentil - Mungbean
	Lalpur	01	Md. Shahabul Mondol S/O, Late Moes Mondol Village: Walia	0.66	T.Aman (Short duration BRRI dhan39) – Wheat, Mustard and Lentil - Mungbean
Khulna	Terokhada	01	Shaymol Bhattayacaria Village: Rostom Azogora	1.0	Boro -Dhaincha -T. Aman
	Dacope	03	Abdus Salan Bayati Village: Moukhali Union : Dacope sadar	1.0	Boro -Dhaincha -T. Aman (BR23/BRRI dhan46)
			Mrinal kanti Mondol Village : Koilashgonj purbo	0.66	Boro -Dhaincha -T. Aman (BR23/BRRI dhan46)
			Bikash Chandra Mondol Village : Koilashgonj	0.66	Boro -Dhaincha -T. Aman (BR23/BRRI dhan46)
Total		6	Total	5.0	

Results

Drought prone environment (Natore)

In wet season, two demonstrations at Bagatipara and Lalpur upazilla were carried out in Paka and Walia block (Table 1). BRRIdhan39, a short duration variety was grown following optimum time seeding (1st week of July) and transplanting (July) in Walia block of Lalpur. Crop was matured and harvested in 1st week of November. While in Bagatipara, BR11 and BRRIdhan39 were used, BR11 was seeded within 3rd week of June in dry seed bed and BRRIdhan39 (1st week of July) both the varieties were matured within 2nd week of November having yield 4.8 and 4.2 t/ha respectively.

As soon as the crop harvested, upon land preparation wheat, mustard and lentil of cultivar Bijoy, BARI masur-3 and BARIsarisa-7 were seeded on the 23 Nov in optimum soil moisture condition (Bagatipara). In Lalpur, wheat was seeded in 33 dec area while mustard and lentil in 16.5 dec each. Each demo plot was divided into three sub plots half of plot was seeded by wheat and each of mustard and lentil seeded in 1/4th area. Yield of rice, wheat, lentil and Mungbean are presented in Table 2. Individual pattern based productivity are shown in Fig. 1.

Photo 1. Performance of wheat at Bagatipara

Photo 2. Damaged Mustard crop at Bagatipara

Photo 3. Alternaria spot on mustard pod

Photo 4. Performance of wheat at Lalpur

It was found that in both the demonstrations, the highest REY values (14.6 t/ha) was found with BRRIdhan39-wheat-Mungbean pattern, in contrast, the lowest REY (8.8 t/ha) were associated with BRRIdhan39-Mustard-Mungbean pattern. In both the demonstrations in Bagatipara & Lalpur, mustard was totally damaged . Very poor yield of lentil (500 kg/ha) was obtained in Bagatipara while in Lalpur, it was totally damaged. It is necessary to mention that, a prolonged (10-14 days) foggy weather condition prevailed in the month of February across the country which were more severe in Northern and North –West part of the country. In the Natore districts foggy and shaded condition influenced the pest attacks. A total loss of mustard occurred due to a severe attack of aphid (insect); wilt & alternaria leaf and pod spot disease (Photographs 1-4). We could not control the aphid even with spray insecticides honey dew complex was developed throughout inflorescences hence disease complex was developed and the whole plants died.

It may be concluded in Natore districts, that the seeding of wet season aman rice either short or long duration must be done (dry or wet seeding) in such a way that harvest could be done within 15th November. Wheat appears to be a more adaptable and safe crop in rabi season while mustard and lentil were least adaptable.

In saline environment (Khulna):

In T. Aman season one demonstration in Terokhada and 3 demonstrations in Dacope and one extrapolated demonstration in Koyra were implemented. In all the demonstration BR23 was grown. Yield data of T. Aman rice of the selected plots were taken at harvest.

In boro season, seeds (of BRRIdhan47, BRRIdhan45, BRRIdhan28 and BRRIdhan29) fertilizers and pesticides were subscribed to the respective farmers. To each farmer two to three varieties were provided of which BRRIdhan47 was common to all. Instruction materials Adhunik Dhaner Chas, Dhan Chaser Samoshawa and production package of BRRIdhan47 were also provided to demo farmers. Moreover a field note book was given to each demo farmers where instructions are cited & to keep record of different activities of the demo. Details of the results are presented in Table 3 & Fig 2.

Among the rice varieties BRRIdhan47 gave the highest yield in all the 4 demonstrations in both Dacope and Terokhada. In Terokhada Upazilla, where salinity was very low 9underground water was used for irrigation, BRRIdhan47 (6.3 t/ha) performed better than BRRIdhan29 (Fig 2). In Dacope upazilla, water preserved in canals/ponds (fresh /very low saline water from rain or river sources) was used for irrigation. Performance of BRRIdhan28 was highly dependant on water salinity. In Kailashgonj union of Dacope, BRRIdhan28 and BRRIdhan45 gave similar yield 5.4 t/ha where surface irrigation was provided from fresh/less saline water. In this block BRRIdhan 47 yielded 6.6 t/ha. In contrast, in Pankhali union Dacope both BRRIdhan47 and BRRIdhan28 suffered from high salinity at the reproductive stage and water scarcity hence yield was poor.

Scope of utilization of underground water is yet to be investigated. Some of the activities of the T. Aman of are given in photographs 5-8. Details of the results of T. Aman 2009 are presented in Table 4. Among the varieties, BR23 was highly suitable in medium stagnant situation with mild salt tolerances. BRRI dhan41 is suitable for only medium high land situation.

It is necessary to mention that, in Dacope Upazilla, there are many big and deep canals (enclosed by WAPDA embankment), which may be used as fresh reservoir for irrigation for boro rice cultivation Farmer awareness about salt tolerant BRRIdhan47 has been developed along with confidence and learning of boro cultivation. Expansion of the boro rice cultivation in saline environment would require preservation of rain water in natural canals/enclosed rivers, seeding should be completed within November (avoiding high salinity at reproductive the stage), wash away rice fields should be done at least twice at the reproductive stage when evaporation rate is *high (March); use of Gypsum and ash (K) will also reduce salinity.*

Photo 5. BR23 crop damaged by prolonged submergence at Terokhada

Photo 6. BRRIdhan 47 seed stored from LACCII demonstration in Dacope for local expansion

Photo 7. Harvested rain water in BR23 demo for next crop boro cultivation, LACCII, Dacope

Photo 8. Performance of BR23 at Kailashgonj, Dacope, LACCII

Table 2: Yield of rice and other crops in Natore

Upzilla	No. of Demo	T. Aman (t/ha)	Kharif-I (t/ha)*	Kharif-II (t/ha)
Bagatipara	01	BR11: 4.8 BRRIdhan39: 4.2	Mustard: TD Lentil: TD Wheat: 3.0 (3.3)	Mungbean: 1.5
Lalpur	01	BRRIdhan39: 4.0	Mustard: TD Lentil: 0.50 Wheat : 3.6	Mungbean: 1.2

TD = Totally damaged

Table 3. Yield performance of different rice varieties in saline ecosystem of Khulna, 2009-10

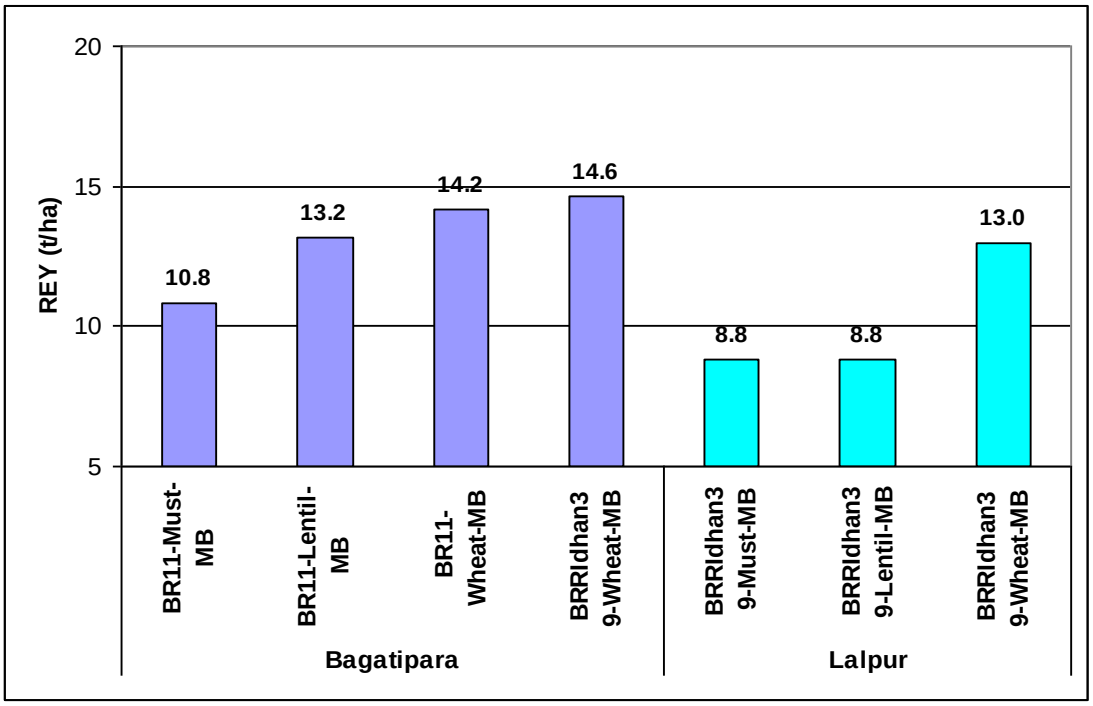
Upazilla	No. of Demo	Kharif-I (Boro) (t/ha)	Kharif-II (t/ha)	T. Aman 09
Terokhada	01	BRRIdhan47: 6.3 BRRIdhan29:6.0 BRRIdhan45: 5.4	Fallow	BR23:
Dacope	3	BRRIdhan28: 5.4 BRRIdhan47: 6.6	Dhaincha ***	BR23
		BRRIdhan45: 4.8 BRRIdhan47: 6.0	Fallow	BR23
		BRRIdhan47: 3.0** BRRIdhan28: 1.2**	Fallow	BR23 BRRIdhan40 & 41

- = Data taken from farmers plot (selected for demo) during harvest

** = Crops severely suffered from water stress and salinity

*** = Damaged by open grazing cattle

Fig. 1. Productivity of different cropping patterns based on REY in Natore, 2009-10



(Lentil = Tk. 60/Kg, Mungbean = Tk. 50/Kg, Wheat = Tk 14.5 /kg and Rice = Tk 12.50 /kg).

Fig. 2. Yield performance of different BRRI released boro varieties in demonstration plots established under LACCII, Saline environment, Khulna, 2009-10

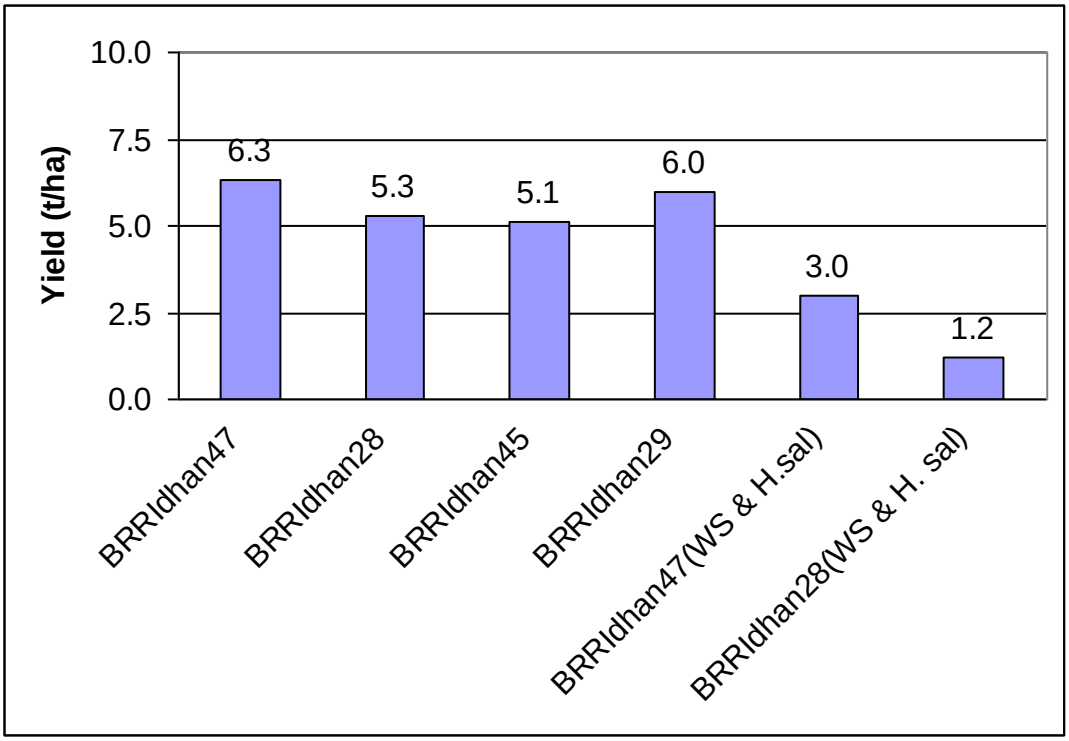


Table 4; Performance of on going T. Aman (2009) in drought and saline environment of Natore and Khulna,

Upazilla	No. of Demo	T. Aman	Yield (t/ha)
Natore			
Lalpur	01	BRRIdhan39	3.8
		BRRIdhan33	3.2
Bagatipara	01	BR11	2.8
		BRRIdhan49	4.8
Khulna			
Terokhada	01	BR23	1.8
Dacope	3	BR23	5.2
		BR23	6.0
		BR23	4.8
Koyra*	01	BR23	5.4
		BRRIdhan41	4.8

- = Based on last year data, one extrapolation demonstration was set up in Koyra, saline environment.

Discussion:

Water is the scarce resource in both drought prone areas of Natore and Khulna (fresh water). During the reported period (2008-09) various elements of climate unusually affected the on going crop production activities under LACCII which perhaps the impact of global climate change. Notable changes were; interim drought during wet season; sudden heavy rainfall (caused stagnancy and submergence of rice crop), prolonging cloudy & foggy (10-14 days) weather in winter (in the month of February) in Northern and North –West part of the country affected seriously the pulses and mustards.

Drought prone area (Natore)

Wheat was the least affected crop in the demos from above anomalies and was identified as the most adaptable crop species in climate change situation in winter in Natore. The highest economic profitability was found with the Rice-wheat-mungbean cropping pattern and BRRIdhan39 and BRRIdhan49 was better either than too short duration (BRRIdhan33) or long duration BR11 and Swarna. In Kharif-1, mungbean identified the most adaptable crops under drought environment; which gave quite high pod yield with little rain in March-April. Mungbean is drought tolerant, deep rooted high valued pulse crop in the country. Incorporation of mungbean plant after pod harvest has further contributed to improved soil health & water holding capacity and added benefit to successive T. Aman crop.

Saline ecosystem (Dacobe, Khulna)

The introduction of Boro rice cultivation is a very recent matter with BRRIdhan28 using surface water (rain water). Intervention of BRRIdhan47 under LACCII activities further accelerated the expansion of Boro areas in Dacope. Among the three rice varieties in Boro in Dacope, BRRIdhan47 and BRRIdhan28 performed better than BRRIdhan45. Salt tolerant BRRIdhan47 and earliness of BRRIdhan28 successfully escaped high salinity stress in May. Seeding must be completed within 3rd week of November for good harvest of Boro rice. Accumulation of salt on the upper surface of Boro rice field occurs due to evapo-transpiration by rice plants or capillary rise had successfully reduced by soil flashing with fresh water at the reproductive stage had reduced the risk of salt injury.

In Aman, these areas found to be dominated by local varieties like Sadamota, Kachaomota, Morichsail etc. because of poor drainage and water stagnancy. Tall heighted rice varieties particularly taller seedlings having stagnancy tolerant characters are required for transplanting as found with local cultivar. Careful selection of BR23 and BRRIdhan41 were included in the LACCII activities and found that BR23 was the most adaptable in Dacope under medium stagnant situation and found highly prospective however, poor drainage developed earlier by the shrimp gher owner, yet to be removed to expand HYV in larger extent. Higher number of seedlings (7-8) per hill with closer spacing (20 cm x 15 cm) performed the best in Pankhali demonstration. Opportunity of utilization of Pasur river water (fresh to very low saline) up to December is a unique scope for successful cultivation of Aman without drought stress. Fresh water from Pasur river can be kept reserved in natural reservoir (canals, dead rivers, ponds) for boro or other winter crops cultivation.

Coastal ecosystem (Terokhada, Khulna)

The situation of Terokhada is quite different from Dacope. Only a little area is affected by salinity in Boro. The main constraint of rice or other crop production is poor drainage. Chitra river, a branch of Modhumoti has been silted up due manmade embankment to prevent inclusion of saline water especially to Bhutiar bil. However, this embankment has created another threat of stagnation within five years of the project. In consequence, many farmers have shifted crop cultivation (HYV in wet season) to deep water rice which has reduced their rice yield in many folds. Now-a-days, many farmers along the periphery Bhutiar bil have started DWR and fish cultivation by making embankment/levee alongside their field and in wet season followed by boro. Introduction of BRRIdhan29, BRRIdhan47 and BRRIdhan45 in LACCII demos BRRIdhan47 performed better either than BRRIdhan29 or BRRIdhan45.

Recommendations:

1. Short duration rice (BRRIdhan39 and BRRIdhan49) – Wheat –Mungbean is the most promising and adaptable cropping pattern in drought prone environment.

2. Medium height deep water rice variety appears to be quite prospective in Terokhada Upazila in Aman along with fresh water fish (King prawn, White fishes etc) culture.

3. BRRIdhan47, BRRIdhan28 and BRRIdhan29 could be cultivated provided improved water management with respect to salinity and stagnation.

4. Fresh water storage in canals and dead rivers (rain water and river water) could expand Boro culture.

5. BR23 is performing quite well under the water stagnant and mild saline condition prevailing in Dacope upazila.

6. A little thicker plant population compared to the BRRI practice appears to perform better and might be suggested for future practice in Dacope.

7. BRRI's intervention should be strengthened in those fragile environments.

References

Ahmed, K U, N A Mondal and J A Mahmud. 2006. Integrated Nutrient Management for Wheat-Mungbean-T. Aman Rice cropping pattern under AEZ 11. OFRD, BARI, Joydebpur, gazipur.

Karmakar, B, M A Mazid & M A Ali. Cultivation of Mungbean in Rice-Wheat cropping pattern to increase soil fertility. Krishi Biplob, A fortnightly Agricultural National Newspaper, Dhaka, Bangladesh. 29 April-14 May, 2003. 4(15): p10-11

BRRI 2007. Adhunik Dhaner Chas. 13th edn. Bangladesh Rice Research Institute. Gazipur-1701

BRRI. 1993. Proceedings of the Workshop on Coastal Salinity and Crop Production in Bangladesh. Bangladesh Rice Research Institute, Gazipur-1701.

Dewan A. M. and K. Nizamuddin. 1998. A geographical Analysis of Salinity Intrusion in the South-West Region of Bangladesh. In ভূগোল পত্রিকা. সংখ্যা-১৭.

Haque, M. Z. and M.S. Islam. 1990. Low temperature damage in rice crops of Bangladesh. Paper No. 14. International Rice Conference, 27-31 August, Seoul, Korea, Papers, IRRI, Los Banos, Philippines (SB 206, AZ22, 1990).

Mondal, M. K., S. P. Ritu, M. H. K. Choudhury, A. M. Chasi, P. K. Majumdar, M. M. Islam and S. K. Adhikari. 2004. Performance of high yielding varieties of transplanted Aman rie in southwest coastal region of Bangladesh. 19-27. Proc. worksho: coastal water management and uptake technologies. IRRI and PETRA.

Shah, M A L and M. R. Mondal . 2004. Proceedings of the Workshop on Integrated Nutrient Management and Water Resources Utilization for Crop Production in the Coastal saline Zon of Bangladesh. Bangladesh Rice Research Institute, Gazipur-1701.

SRDI. 1997. বাংলাদেশের উপকূলীয় কৃষি পরিবেশ ও লবণাক্তা । ঢাকা: মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট, ঢাকা ।

Wade, L.J., S. Fukai, B.K. Samson, A. Ali, M.A. Mazid. (1999). Rainfed lowland rice : physical environment and cultivar requirements. Field Crops Research 64 (1-2) 1999, 3-12