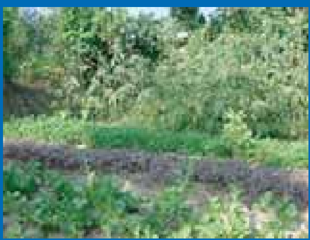
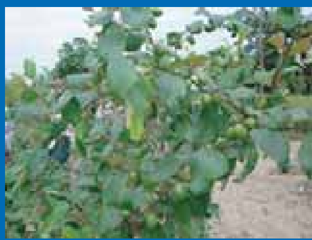
Results and Lessons from Field Testing of Local Adaptation Options for Agriculture in Drought-Prone Areas of North-Western Bangladesh 2005-2007

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LIVELIHOOD ADAPTATION TO CLIMATE CHANGE (LACC) PROJECT

(BGD/01/004/01/99)

Results and Lessons from Field Testing of Local Adaptation Options for Agriculture in Drought-Prone Areas of North-Western Bangladesh 2005-2007

consolidated by

Sanjib Kumar Saha

based on inputs from the LACC field monitoring officers and
the technical backstopping from the Climate Change Unit of FAO

Department of Agricultural Extension (DAE)

Food and Agriculture Organization of the UN (FAO)

August 2008

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ACRONYMS

BARI = Bangladesh Agriculture Research Institute

BDT = Bangladeshi Taka (Currency)

BMDA = Barind Multipurpose Development Authority

BRRI = Bangladesh Rice Research Institute

CDMP = Comprehensive Disaster Management Programme

DAE = Department of Agricultural Extension

DLS = Department of Livestock Services

DMC = Disaster Management Committee

DoF = Department of Fisheries

FAO = Food and Agriculture Organization of the United Nations

FOM = Field Officer (Monitoring)

FYM = Farm Yard Manure

LACC = Livelihood Adaptation to Climate Change

NTIWG = National Technical Implementation Working Group

N-W = North-West

UTIWG = Upazila Technical Implementation Group

SRI = System of Rice Intensification

S-W = South-West

ha = Hectare

kg = Kilogram

kharif I = Pre-monsoon cropping season (February - June)

kharif II = Monsoon cropping season (June - October).

rabi = Winter cropping season (October - February)

1 INTRODUCTION

Impacts of climate change on food production are global concerns, but they represent a particular threat for Bangladesh. Agriculture is already under pressure mainly due to an increase in demand for food, as well as to depletion of land and water resources. The prospect of global climate change makes this problem a priority for Bangladesh. Climate change further threatens food security. Higher temperature and water stress due to heat would result in decline in vegetation and agricultural production. Bangladesh, in particular its northwestern region, is drought-prone. Droughts are associated either with the late arrival or with an early withdrawal of monsoon rains. This phenomenon adversely affects rice crops, which account for more than 80% of the total cultivated land of the country and causes damage to jute, the country's main cash crop.

The Livelihood Adaptation to Climate Change (LACC) Project is a sub-component of the Comprehensive Disaster Management Programme (CDMP). It started its operation in the north-west drought prone region of Bangladesh in 2005 executed by the Ministry of Agriculture, Department of Agricultural Extension (DAE) and technically guided by the Food and Agriculture Organization of the United Nations (FAO). The project implemented activities to promote livelihood adaptation and reduce vulnerability to climate change of poor communities who have the lowest capacity to adapt.

The project has completed its 1st phase in September 2007. Project activities took place in two districts in the North-West (NW) of Bangladesh: Chapai Nawabganj (Nachole and Gomostapur upazila) and Naogaon (Sapahar and Porsha upazila). The project conducted field demonstrations of possible adaptation options aiming at increased resilience to drought in 3 villages per Upazila. The demonstrations of options took place during the rabi season in 2005, the kharif I, kharif II and rabi seasons in 2006 and the kharif I and kharif II seasons in 2007. They were facilitated by Field Monitoring Officers (FMOs) and Upazila Technical Implementation Working Group (TIWG) members. With support from the DAE extension staff farmer-to-farmer learning was organized through several extension approaches including orientation meetings, field days, folk songs and dramas, demonstration rally, and exchange visits. This report summarizes the results, benefits, lessons and feedback received from the farmers for the 1st phase of the project.

2 DESCRIPTION OF THE PROJECT AREA AND CONTEXT OF ANALYSIS

2.1 Agro-Ecological Characteristics of the Project Area

The project area, depicted in the map below, is located in the drought prone areas of NW of Bangladesh. Project sites are located in four major agro-ecological zones (AEZ): High and Level Barind Tract (AEZ 25 and 26, covering 75% of the project area), Lower Punarbhaba Floodplain (AEZ 6, covering 12% of the project area in the western side), High Ganges River Floodplain (AEZ 11, covering 13% of the project area), and Tista Meander Floodplain (AEZ 3, covering a little part of the project area). The AEZ of each the project upazilas is shown in table 1.

Map: Agro-ecological zones in Bangladesh, Project Area

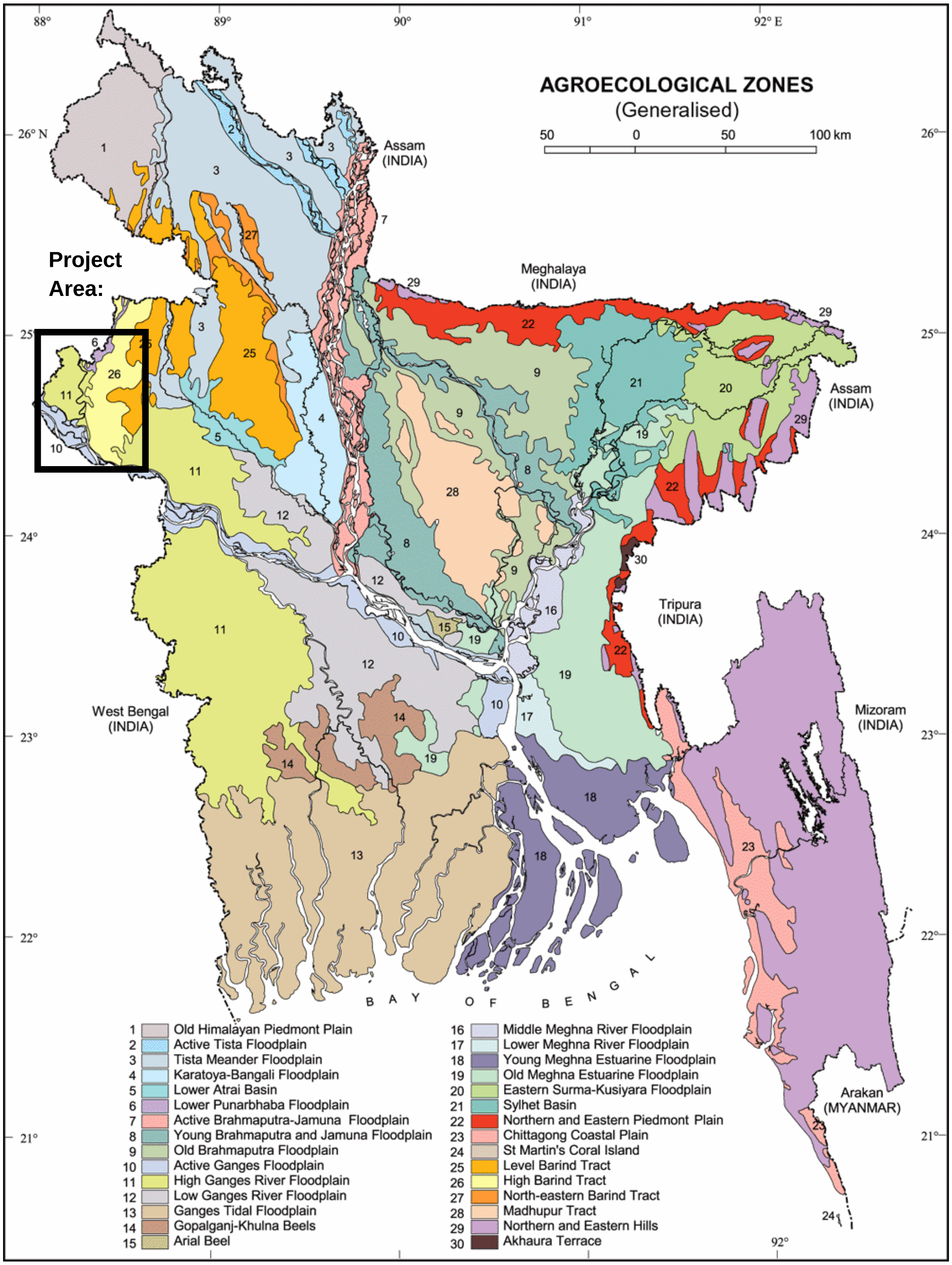


Table 1: Agro-ecological zones of project pilot sites

District	Upazila	Agro-ecological zone
Chapai Nawabganj	Nachole	1. Level and High Barind tract (25, 26) 2. High Ganges River Floodplain (11)
	Gomostapur	1. Level Barind tract (26) 2. High Ganges River Floodplain (11) 3. Tista Meander Floodplain (3)
Naogaon	Sapahar	1. Level and High Barind tract (25, 26) 2. Tista Meander Floodplain (3)
	Porsha	1. Level and High Barind tract (25, 26) 2. Tista Meander Floodplain (3) 3. Lower Punarbhaba Floodplain (6)

The High Barind Tract includes the southwestern part of the Barind Tract where the underlying Madhupur Clay had been uplifted and cut into by deep valleys. The soils include puddled silt loam to silty clay loam in the top soils and porous silt with mottled plastic clay at varying depth. Deep grey terrace soils and grey valley soils are major components of the general soil types of the area. General fertility status is low, having low status of organic matter.

The Level Barind Tract is developed over madhupur clay. The landscape is almost level. The predominant soils have grey, silty, puddled topsoil with plough pan. Shallow grey terrace soil and deep grey terrace soils are the major components of general soil types of the area. The soils are low in available moisture holding capacity and slightly acidic to acidic in reaction. Organic matter status is very low and most of the available nutrients are limiting.

The High Ganges River Floodplain includes the western part of the Ganges river floodplain, which is predominantly highland and medium highland. Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions. The upper parts of high ridges stand above normal flood level. Lower parts of ridges and basin margins are seasonally shallowly flooded. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low.

The Lower Punarbhaba Floodplain occupies basins and beels separated by low floodplain ridges. In this area, dark grey, mottled red, very strongly acid, heavy clays occupy both ridge and basin sites. Organic matter status is medium to high. General fertility level is medium with high K-bearing minerals. The western part of Naogaon and the northern part of Nawabganj districts are included in this AEZ.

Finally, the Tista Meander Floodplain occupies the major part of the Tista floodplain as well as the floodplain of the Atrai, little Jamuna, Karatoya, Dharla and Dudhkumar rivers. Most areas have broad floodplain ridges and almost level basins. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay loam soils on the lower land and parent materials medium in weatherable K minerals. Eight general soil types occur in the region, moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level is low to medium. Soils, in general, have good moisture holding capacity.[1]

[1] FAO/UNDP, Land Resources Appraisal of Bangladesh for Agricultural Development Report 2: Agroecological Regions of Bangladesh, FAO/UNDP, 1988

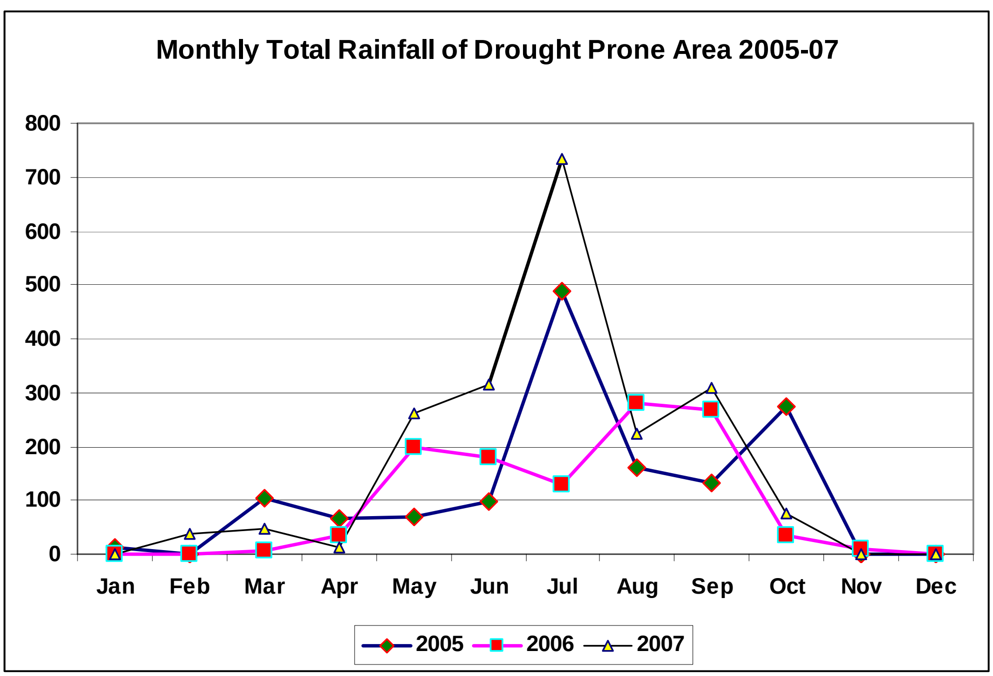
The soil nutrient status of sample villages, which are representatives of the project area, is shown in the table below (Table 2).

Table 2: Soil nutrient status of sample villages of the LACC-I upazilas

Village, Upazila, District	Nutrient Contents						
	Nitrogen	Phosphorus	Potassium	Sulfur	Zinc	Organic Matter	pH
Kaloir, Nachole, Chapai Nawabganj	0.04	4.9	1.09	25.6	2.45	0.81	6.6
Borodadpur, Gomostapur, Chapai Nawabganj	0.04	3.2	0.21	12.6	0.70	0.81	5.4
Basuldanga, Sapahar, Naogaon	0.04	2.3	0.34	9.0	0.44	0.99	5.6
Saor, Porsha, Naogaon	0.06	1.4	0.16	23.0	0.48	1.27	5.4

Annual total rainfall has been relatively stable in the project area over the 15 last years (there has been a slight decrease in total annual rainfall in the upazilas Gomostapur and Nachole and a slight increase in Sapahar and Porsha). However, the amount has been increasing in the rainy season, and decreasing during the dry months of the year. As the figure below, which corresponds with the project life time, illustrates, there has been significant variation in of rainfall particularly during the rainy season between the years 2005, 2006 and 2007. . 2006 has been an exceptionally drought-prone year. The sequence of three years (2005-07) was considered as a representative sample in terms of climate variability .

Figure: Monthly total rainfall in the drought prone area in 2005-07



2.2 Current and Future Risks and Vulnerabilities

Bangladesh has a distinct dry season (November to May) and monsoon season (June to October). According to the AEZ database and land resources inventory maps, drought-prone areas of Bangladesh have been identified and mapped for pre-kharif, kharif and rabi seasons. The drought severity in the project area is very acute, i.e. 45 to 70 percent crop losses, in all seasons. Since a large part of the population depends on single season rice (T. Aman), even a slight negative deviation in production could affect livelihoods very negatively.

Farmers face three different kinds of dry spells in one year: early season, mid season and terminal season. Early season dry spells affect the seedling stage. Although there is some possibility for replanting, if the crop is re-planted late, the terminal season drought coincides with maturity stage, which is more critical in terms of yield reduction. The possibility of introducing other crops during monsoon season is also limited due to the sticky nature of the soil and extended water stagnation.

Local people in the study area perceive that current climate is different from the past. The seasonal cycle has changed, droughts have become more frequent, pest and disease incidences increased, average temperature has increased in the summer while winter has shortened. Local people in the study area also perceive that their boro, aus, winter vegetable and fruit (mango) production are affected by increased rainfall variations, temperature and drought. The observed data also showed higher variability in rainfall patterns and increased temperature trends over the last five decades.

Global Circulation Model projections for Bangladesh indicate an average temperature increase of 1.3ºC and 2.6ºC by 2030 and 2070, respectively. Though monsoon precipitation is likely to increase by 27 percent until 2070, precipitation distribution patterns during the plant growing period, higher temperature and higher rates of evapotranspiration would create further water stress conditions and declines in vegetation and agricultural production in the drought-prone areas. A continued trend towards more frequent and intensive natural hazards is expected as result of increasing climate variability and climate change. Water deficits of around 400-500 mm may occur during the dry months of the year. Groundwater depletion has been increasing since the early 1980s, corresponding with large-scale exploitation for irrigation.

Limited access to deep tube well water in the non-irrigated areas and the occurrence of several anthropogenic factors (e.g. electricity failure, high price of agricultural input) are major factors of underlying vulnerability of farmers. The dominant vulnerable groups are poor and marginal farmers as well as wage laborers. The project aims at increasing the adaptive capacities of the people through the identification and dissemination of effective adaptation measures.

2.3 Livelihoods Portfolio in the Project Area

Households in the drought-prone areas undertake various activities to gain and maintain their livelihoods. About 83 percent of rural households are directly involved in farming. The main rural livelihood groups in the project are: wage laborers (40 percent); small and marginal farmers (30 percent); petty traders and businessmen (7 percent); large farmers (7 percent); and fishers (0.4 percent).

The main produce in the area is rice, followed by vegetables, mustard, pulse and, more recently in some areas, maize. The last decade has seen livelihood (income) diversification into non-farm activities and new activities related to farming, especially cultivation of high value crops such as mango.

The average land holding in some of the pilot upazilas is about 3 bigha (a bigha equals one third of an acre). However, about 20 percent of the households are landless and another 30 percent possess less than 3 bigha. Thus, it is not possible for these households to rely solely on their own production.

People usually cultivate their own land, but there are many sharecroppers cultivating land of rich landowners. In sharecropping, the landowner shares the cost of water and fertilizer with the sharecropper and they divide the produce evenly. However, in many villages the owners do not invest in inputs, but still expect half of the produce. Cultivation in rented out lands also is very common in the area. Almost 60 percent of the farmers in non-irrigated villages are tenants.

3 IDENTIFICATION AND VALIDATION PROCESS OF THE ADAPTATION PRACTICES

In a first step, adaptation practices that had already been applied locally and/or had been previously introduced by national development, research and extension organizations were collected and documented by the project (Table-3-1). The adaptation practices identified from the project area can be categorized as: a) agronomic management, b) water harvesting c) water resources exploitation, d) water use efficiency, e) crop intensification, f) alternative enterprise, g) alternative energy source etc.

From this preliminary list, those adaptation options to be further promoted and/or replicated were selected through a sequence of evaluation processes at different levels starting from upazila-level DMC members, Upazila level Technical Implementation Groups (UTIWG) and National level Technical Implementation Working Groups (NTIWG). First consultative meetings and brief feed back workshops were also organized with the national research institutions (BARI and BRRI) and developmental organizations. The adaptation options were evaluated with the UTIWG and NTIWG for their technical suitability in drought-prone areas.

The outcome of the stakeholder evaluation was integrated into the multi-criteria analysis that included (a) drought mitigation potential, (b) suitability for future climate scenarios, (c) environmental friendliness, (d) economic viability, (e) increased productivity, (f) sustainability (f) social acceptability, (g) gender integration, (h) household income, (i) employment opportunity, (j) relevance to vulnerable community, (k) applicability to multiple sectors, (l) seasonal relevance, (m) immediate need, (n) institutional support and (o) expert acceptance. The criteria based evaluation was followed by a selection and prioritization based on (i) effectiveness in reducing key risks, (ii) potential technical as well as costs, social acceptance and manageability, and (iii) current state of implementation and additional requirements.

Selected adaptation practices suitable for different seasons (*kharif I, kharif II* and *rabi*) were recommended for field demonstrations in the farmers fields. Local farmer groups together with extension staff finally choose suitable adaptation options for their localities.

Table 3: adaptation options considered in the validation process

Sl. No.	Categories	Adaptation Practice	Source	Tested (Yes/No)
1	Agronomic management	Seedbed method for T. Aman rice	Farmers and experts	Yes
2		Manures and composting	Farmers	Yes
3		Depth of transplanting for T. Aman	Farmers	Yes
4		Weed control-reduce water seepage	Farmers	No
5		Manual closing of soil cracks	Farmers	No
6		Strengthening field bunds (Ail lifting)	Farmers	No
7	Water harvesting	Re-excavation of traditional ponds	Farmers	No
8		Re-excavation of khari canals	BMDA	No
9		Canals	Farmers	No
10		Water control structures	BMDA	No
11		Mini-ponds	BMDA	Yes
12		Supplemental irrigation	Farmers/DAE	Yes
13	Water resources exploitation	Shallow and deep tube wells	BMDA	No
14	Water use efficiency	System of rice Intensification	Experts	Yes
15		Direct sown rice (Drum Seeder)	Experts	No
16		Drought resistant rice varieties	Multiple sources	No
17. a)	Crop intensification	Green manure-T. Aman system	Farmers	No
b)		T. Aus-Chini Atap system	Farmers	No
c)		T. Aman-Mustard/Linseed system	BARI/BRRI	Yes
d)		T. Aman-Chickpea	BARI/BRRI	Yes
e)		T. Aman-Mung Bean	DAE	Yes
f)		Famine reserve crops	Experts	No
18	Alternative enterprise	Mango cultivation	Farmers	Yes
19		Homestead gardens	BARI	Yes
20		Mulberry intercropping in rice	BRRI	No
21		Fodder cultivation	DLS	Yes
22		Fish cultivation in mini ponds	DoF	Yes
23		Cottage industries	Community	No
24		Manufacturing industries	Community	No
25	Alternative energy source	Community based bio-gas and tree planting	Experts	No
26	Post harvest practices	Seed storage for higher viability	Farmers	No

4 RESULT DOCUMENTATION PROCESS

In order to validate the field tested options the results and benefits of the adaptation technologies have been assessed through a regular monitoring of the demonstration activities. A participatory approach was taken up in monitoring the demonstration activities involving project staff, DAE officers, farmers and community people. In order to capture the qualitative aspects of the adaptation options and their impact on the livelihood of the farming families, semi-structured meetings and discussions were organized with the farming families and the community people.

In the regular monitoring activities a monitoring sheet was used to collect data from the individual demonstration. Results, benefits, farmers' feedback and lessons are analyzed in quantitative and qualitative manner. The monitoring sheet/formats included some major areas to be recorded like the inputs used, out puts especially the yield gained, economics of the yield and other parameters. The field staff recorded the data and information during the field visit in the farmers' households and the demonstration sites.

Climatic data and information were collected from the local meteorological station, upazila DAE offices and other reliable sources during the implementation of the adaptation demonstrations at the farmers' fields. Semi-structured discussions in the farmers group meeting were organized during and after the demonstrations, as feasible and as required, in order to assess the farmers' perception about the impact of climate variability and changes in their farming practices. Data and information were also collected during the participatory discussion with the community in general, local institutions and secondary sources.

The data and information gathered were documented at the upazila level by the project officers. The primary monitoring report was then prepared and sent to the Project Management Unit and the final analysis was done. The analysis was done following both quantitative and qualitative aspects of the demonstrations.

5 SUMMARY TABLE OF THE TESTED OPTIONS

Details of the demonstrated options are given in the table below (Table 4). More than 292 demonstrations of 15 adaptation technologies were implemented in 5 seasons (Rabi 2005 to Kharif II 2007) in 96.57 ha of land area in 4 project upazilas. Among the 292 demonstrations established, 76 were established in irrigated villages, where there are govt. supported irrigation facilities and 216 demonstrations were established in non-irrigated villages. The results obtained from the monitoring information and data shows that 372 farming families have benefited directly from implementation of the technologies in their field. A huge number (4170) of community farmers, other than the project farmers, participated in the demonstration of the technologies and among them 212 farmers have replicated the technologies in their field on their own expense.

Table 4: Implemented LACC adaptation technologies and beneficiaries

Sl. No	Name of the technology	Number of demonstrations established			Total area of land brought under the demo (ha)	Total no. of benefiting farming families	Total no. of community farmers participated in demonstrations	Total no. of community farmers replicating the technologies
		In irrigated villages	In non-irrigated villages	Total				
Agronomic management								
1	Dry seed bed method for raising rice seedlings	0	24	24	1.16	24	200	0
2	Preparation of Farm yard manure	6	18	24	0.0	24	65	0
3	Management of Mango orchard	6	12	18	0.0	18	65	0
Water harvesting								
4	Excavation of Mini pond (5mX5mX2m)	0	20	20	2.68	20	190	0
5	Excavation of Mini pond (10mX10mX2m)	0	16	16	8.56	16	235	11
Water use efficiency								
6	Impact of water saturated soil condition on rice cultivation	8	0	8	2.7	8	420	0
7	Cultivation of Linseed	0	7	7	3.82	7	400	25
Crop intensification								
8	Cultivation of short duration T. Aman as an alternative technology	0	8	8	42.76	64	1370	46
9	Cultivation of Chick pea after T. Aman	0	4	4	21.38	28	350	22
Alternative crop/livelihood enterprise								
10	Homestead vegetable gardening	18	26	44	0.18	44	112	57
11	Establishment of Jujube garden (66 plants)	5	10	15	0.52	15	125	8
12	Establishment of Jujube garden (25 plants)	6	10	16	0.52	16	90	0
13	Cultivation of Papaya	6	16	22	2.85	22	49	0
14	Cultivation of Maize	2	4	6	2.56	6	270	25
15	Establishment of Mini nursery	8	16	24	5.84	24	9	3
16	Mango gardening	2	6	8	1.04	8	55	0
Household energy efficiency								
17	Improved stove	9	19	28	0.0	28	165	15
	Total	**76**	**216**	**292**	**96.57**	**372**	**4170**	**212**

6 DISCUSSION OF RESULTS AND BENEFITS OF VARIOUS ADAPTATION OPTIONS

In the following chapter, the adaptation options demonstrations are discussed in detail including their background rationale, implementation process, results and benefits and the feedback and recommendations and an evaluation of adaptation option for suitability.

6.1 Dry Seed Bed Method for Raising Rice Seedlings

Background

Transplanted Aman, a major rice crop in *barind* tracts is frequently affected by drought at different stages of the growth with varied intensities. In north-western part of Bangladesh summer monsoon rain sets in mid June and ends in last week of September. The length of rainy season is about three and half to four months, which is sufficient to grow a rice crop under normal conditions in the Kharif-I season. However, due to inter-annual and inter-seasonal variability of monsoon rainfall, rice crop suffers from water scarcity at critical stages. Further delayed on-set of rains shortens the length of growing period, sometimes by a month. Generally, farmers start preparing seed beds during early June upon receipt of first rain and transplant during early July. When the rainfall is delayed, subsequently transplanting also delays by up to a month and the crop suffers from late season drought. In this situation farmers require an alternative technology to cope with the condition. The dry seed bed method for raising rice seedlings is a local adaptation practice which was taken up and demonstrated in the farmers' field of the project villages which is suitable in the monsoon season.

Implementation process

The dry seed bed was established in the farmers' plot of the project villages. In the dry seed bed method, seeds were sown after thorough ploughing of the soil and the seeds were covered with soil unlike the wet seedbed method, where seeds are kept exposed. The soil was mixed with dry red soil, compost and farm yard manure.

The option was demonstrated in the Kharif-I season in 2006.

A total of 24 farmers undertook 24 demonstrations and about 1.16 ha of land were brought under cultivation for the option demonstrations (Table 5).

Table 5: Implementation of the dry seed bed

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of demonstration established	6	6	6	6	24
2	Total no. of farmers benefited (directly)	6	6	6	6	24
3	Total area of land brought under the option (ha)	0.29	0.29	0.29	0.29	1.16
4	No. of other farming households participated in the demonstration of the technology	65	50	45	40	200
5	No. of other farming households replicated the technology with own cost	0	0	0	0	0

Results, benefits and lessons

a) Socio-economic benefits

Table 6: Economic benefits of the dry seed bed

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of dry seed bed preparation (BDT)	1225	1225	1225	1225	4224.13
2	Additional yield received from the option demonstrations (kg)	86	80	88	85	292.24
3	Economic benefit received from the option plot (BDT)	860	800	880	850	2922.41

b) Climatic and environmental benefits

- It was perceived that the seedlings from dry seed bed can withstand dry spells from 9 to 12 rainless days against 7 days of seedlings produced from wet seedbed. This confirms the general knowledge that seedlings produced from dry seedbeds are more resilient to drought conditions.
- The option enables farmers to start producing seedlings in drought condition even under delayed onset of monsoon rain so that they can transplant seedlings in the main field without loosing time.
- Field observations showed that the seedlings of the dry seed bed method were healthier and were able to produce more tillers in comparison to the wet seed bed seedlings. The root system of seedlings of dry seedbed is comparatively longer, which can penetrate deeper into the soil.
- Rice seedlings grown in the dry seed bed can tolerate water stress that means it saves water and also saves energy for irrigation.

Farmers' feedback

Pulling out of the seedlings was difficult under dry conditions and required twice as much labour than for conventional wet seedling bed method. The rice root system was also damaged while pulling out from the dry seedling beds.

According to the farmers, the above problems can be minimized by loosening the soil through addition of more fine soil, farmyard manure or compost and sand and thus reducing damage of seedlings while pulling out from the bed.

Conclusion and recommended action for follow-up in LACC II and III

The dry seed bed method has been followed by the farmers in some drought prone villages of the project. Farmers only apply the method when 20-25 rainless days occur.

As per the feedback from the farmers little changes in the technique of bed preparation are suggested and an awareness programme may be taken up for promotion and adoption of the technology as the situation of certain year demands.

Farmers who do not have access to irrigation water and who can not afford cost of the irrigation water find the option suitable in their land.

The yield and other parameters like general seedling health, root system, number of tillers produced, number of labour required for uprooting the seedlings may also be monitored and evaluated in order to provide more realistic recommendations on the advantages of the option over the wet seed bed method.

Further field trials in the farmers' fields should be established to get more consistent results in the non-irrigated land of high barind area which would allow for a conclusion on whether the option should be recommended for replication or not.

Table 7: Replication suitability and recommendation: dry seed bed method for raising rice seedling

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat / Pulse-Mango	25, 26	Drought spells; loss of crops	Rain fed	High barind tract	Poor/ medium farmers	15 US $	High	High	Yes	no increase	Recommended for further trial with little changes in technology

6.2 Farm Yard Manure

Background

The organic matter content of soil in the *barind* tract is exceptionally low at 0.8-1.2%, which is not enough to support agricultural production. Enhancing the organic matter level in soils improves soil structure, moisture retention, erosion stability and water infiltration and hence strengthens the resilience of farming systems to drought, climate variability and increasing temperatures. This can be achieved by the preservation and increased application of Farm Yard Manure (FYM), which is organic matter prepared from various kinds of animal excreta mixed with other organic materials. It can be done round the year in the homestead premise and can enhance the fertility and productivity of soils that have been negatively affected by recurrent exposure to droughts.

The use of cow dung and household sweeps as manure is problematic, because these are often used as fuel due to lack of firewood and other fueling material in the area. However, improved stoves (see section 6.15) can reduce the need of fueling inputs, including dung.

Implementation process

In 4 upazilas, 24 FYMs were prepared in 24 farming households where farmers have taken the responsibilities of regular piling of the cow dung, other organic matters, house sweeps, debris and other management activities like applying water, mixing of the FYM after a certain period of time (Table 8).

Farmers who had access to cow dung and other household organic matters/debris were selected for the demonstrations of the option. A two chamber pit was dug close to the organic matter sources and where enough sun light is available. The pit was covered by a tin/thatched roof for protection from excessive sunlight, rainfall and other external problems.

Through social mobilization initiative like farmers' field day, result demonstrations were presented to the farming communities in the surrounding while 65 households were exposed to the technologies of the demonstrations.

Table 8: Implementation of FYM preparation

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of FYM demonstrations established	6	6	6	6	24
2	Total no. of farmers benefited (directly)	6	6	6	6	24
3	No. of other farming households participated in the demonstration of the technology	50	0	15	0	65
4	No. of other farming households replicated the technology with own cost	0	0	0	0	0

Results and benefits

a) Socio-economic benefits

Farmers were able to use the farm yard manure (FYM) in their crop field and saved some money from buying chemical fertilizers.

b) Climatic and environmental benefits

- FYM can save chemical fertilizers for crop production and thus save energy for manufacturing the fertilizers.
- The FYM is believed to have increased the water holding capacity of the soil, improved soil texture and structure and increased total nutrient contents of the soil which is extremely required for the soil and crops of the *barind* area.

- Soil mixed with FYM can retain moisture, thus require less irrigation. It means it saves water and saves energy used for irrigation purposes.

Farmers' feedback

Families having enough cattle and draft animals are appropriate as participants of the demonstration. The shade/roof of the FYM pit should be prepared by strong materials like tin and so as other parts of the shade to make it more robust and reduce the need for frequent maintenance by the farmers. Members of the farming family especially who look after the cattle should be trained as how to use the dung and other debris for the FYM preparation and how to sprinkle water and take other management activities.

Conclusion and recommended action for follow-up in LACC II and III

Accumulation of organic matters in the pit and other necessary management could not be ensured as a regular practice and thus the quality of manure produced was still not up to the standard. A social mobilization programme is critically needed for awareness raising on the benefits and technical aspects that would encourage a higher adoption of the option among the farming families.

The amount of cow dung used for the farm yard manure and later use in the cropping field, its ultimate benefit in increasing the soil nutrient content, and emission reductions from saving of chemical fertilizers could be studied for better understanding, lessons and making further recommendations. The contribution in the over all livelihoods development and thus improvement of the family resilience to the climate change shock may also be considered for further assessment/study.

The option should be released to the farmers for continuation in all agro-ecological settings. The manure should be further applied in the crop field, and the yield benefit and amount of money and energy saved assessed systematically. Retesting the option in combination with the improved stove is suggested in the next phase of the project to ascertain combined socio-economic and climatic benefits. Awareness raising programme especially on the win-win adaptation and emission reduction benefits is felt highly important.

Table 9: Replication suitability and recommendation: FYM preparation

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat / Pulse-Mango	25, 26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers	30 US $	High	High	Yes	no increase	Ideal as single option or combined with improved stove

6.3 Management of Mango Orchard

Background

Mango, the single most predominant species is planted spontaneously and unsystematically, in garden or in the rice field, mostly to fetch the economic benefit. As a common practice of the area, mango trees are fed with manure and fertilizers before and after the harvest of the fruits in each season/year. The need for appropriate dose and appropriate method of application articulated, mostly by the farmers and field staff, led to the demonstration of the mango orchard management. The orchard management activity was undertaken with a view to understand the yield performance between the treatment plant and the control plants which are traditionally managed by the farming community in the monsoon season.

Implementation process

Farmers who own land and have a 1-2 years old mango garden with around 15 plants were selected for the demonstration in the Kharif-II season 2007. For control farmers the same criteria were applied so that two gardens, one treatment and one control in the same area, could be monitored closely. For the treatment garden the recommended standard procedures for dose and management were followed and control framers were allowed to follow whatever they usually do.

Results and benefits

Till the end of Kharif-II 2007, 18 mango garden demonstrations were established in 18 farmers' fields in 12 pilot villages of project (Table 10).

Table 10: Implementation of Management of Mango Orchard

SL. No.	Parameters	Upazilas			Total
		Gomostapur	Sapahar	Porsha	
1	Total no. of mango orchard management demonstrations established	6	6	6	18
2	Total no. of farmers benefited (directly)	6	6	6	18
3	No. of other farming households participated in the demonstration of the technology	0	25	40	65
4	No. of other farming households replicated the technology with own cost	0	0	0	0

No yield and economic benefits were accumulated because the mango plants did not produce fruits while the project collected data and information. Therefore no comparison and other analysis whatsoever could be done in this regard. Through the process of demonstration activities, 55 neighbouring farmers and community people were invited in the field and exposed to the technology. So far, none of them replicated the technology in their own field.

Farmers found the option easy and quickly understood the appropriate dose and methods of application of the manure and fertilizers and other activities.

Farmers' feedback

Farmers were quite happy to apply the technology in their field, however, expressed concern about the low number of plants in the garden. If allowed they would take bigger garden with more trees.

Conclusion and recommended action for follow-up in LACC II and III

The demonstrations of the technology were stopped after one season based on the analysis and conclusion that project intervention was not required in this case for two reasons: 1) farmers of the area know the technology and 2) encouraging mango cultivation and management is dangerous for the area since it is already dominated by mango. More mango gardens would reduce the rice fields and with that employment opportunities for the landless, making rich farmers richer and the poor even poorer. Furthermore, a higher mango production might lead to a price fall in the season.

Therefore, the technology should not be promoted further.

Table 11: Replication suitability and recommendation: Management of Mango Orchard

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat/ Pulse-Mango	25, 26	Drought spells; loss of crops	Irri-gated	High barind tract	Medium/ wealthier farmers	50 US $	Me-dium	Me-dium	No	no increase	Not recommended

6.4 <u>Excavation of Mini Pond</u>

Background

To reduce impacts of intermittent dry spells in the drought-prone areas of north-western Bangladesh, surface water stored from the previous rainfall needs to be used before rice maturity stage. Yet often high intensity rainfall is wasted, due to non-availability of proper water storage structures. Therefore adaptation options on rainwater harvesting, recycling and conservation are key to managing seasonal droughts through supplemental irrigation. The excavation and re-excavation of mini ponds is one of the feasible climate change adaptation options in the *barind area*. In farmlands with no irrigation source, rainwater harvesting was done through the excavation of mini-ponds for supplemental irrigation for T. Aman rice during drought spells in the early monsoon season.

Implementation process

Mini ponds were excavated in areas where irrigation facility is limited or non-existent in the project villages. Farmers who had minimum of 0.13 ha rice field and who could afford space for pond were selected for the mini pond excavation demonstration. Ponds were excavated in a corner of the field for facilitating easy irrigation to the field as desired by the farmers.

Farmers excavated the ponds in the Kharif-I (March-June) season of the year while the monsoon rain usually begins and they can easily harvest the rain water and store in the pond for subsequent use in the T. Aman rice in the Kharif-II (July-October) season or as desired.

At the beginning, as per the *barind* Multipurpose Development Authority (BMDA) model, mini-ponds of 5m x 5m x 2m (length x breadth x depth) size were preferred on small farms. However, based on the feedback from the farmers, larger ponds (10m x 10m x 2m) were excavated in the following seasons.

Till the end of Kharif-II 2007, 36 mini ponds were excavated in 36 farmers' fields in 12 pilot villages of the project (Table 6-4-1 and 6-4-2).

About 12 ha of rice field were irrigated by water from the 36 ponds. In most cases, irrigation was done twice in the rice field. Few farmers could irrigate the rice field more than twice as per their need and based on the amount of water they harvested. Irrigation was done mostly for the T. Aman rice field, for which the ponds were excavated. In some cases, farmers could provide additional irrigation to their vegetables on the pond bank and homestead and trees planted close to the pond.

Table 12: Implementation of (5mX5mX2m) Mini pond

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of pond excavated	5	5	5	5	20
2	Total no. of farmers benefited (directly)	5	5	5	5	20
3	Total area of land irrigated in one season (ha)	0.67	0.67	0.67	0.67	2.68
4	No. of times of irrigation to the field from one pond	2	2	1	1	6
5	No. of other farming households participating in the demonstration of the technology	80	30	30	50	190
6	No. of other farming households replicating the technology on own expense	0	0	0	0	0

Table 13: Implementation of (10mX10mX2m) Mini pond

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of pond excavated	4	4	4	4	16
2	Total no. of farmers benefited (directly)	4	4	4	4	16
3	Total area of land irrigated (ha)	2.14	2.14	2.14	2.14	8.56
4	No. of times of irrigation to the field from one pond	3	2	2	2	9
5	No. of other farming households participated in the demonstration of the technology	120	30	35	50	235
6	No. of other farming households replicated the technology on own expense	2	3	2	4	11

Results and benefits

a) Socio-economic benefits

The cost of excavation of a mini pond varies as per the size; the bigger one (10mX10mX2m) takes about BDT 6500 (less than 100 US$), the smaller one (5mX5mX2m) less than BDT 4000. The costs also include the cost of family labour.

Table 14: Economic benefits of Mini pond (5mX5mX2m)

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of excavation of pond (BDT) (5 ponds)	20000	20000	20000	20000	29850.75
2	Additional yield received in one season (kg)	1200	1150	1100	1100	1697.76
3	Additional economic benefit received (BDT)	12000	11500	11000	11000	16977.61

Table 15: Economic benefits of Mini pond (10mX10mX2m)

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of excavation of pond (BDT) (4 ponds)	26000	26000	26000	26000	12149.53
2	Additional yield received in one season (kg)	3840	3680	3760	3800	1761.68
3	Additional economic benefit received from one pond (BDT)	38400	36800	37600	38000	17616.82

The amount of harvested water depends on the intensity and amount of rainfall in the particular year, and the need of supplemental irrigation depends on the intensity of drought. The rainfall in the monsoon season 2006 was below normal and many farmers used the water from mini-ponds for supplemental irrigation.

Usually farmers can harvest 2488 kg of rice from 1 ha of land without supplemental irrigation. If they are able to provide the supplemental irrigation at the critical stage (milking/grain filing) of T. Aman rice they can harvest 4250 kg of rice from 1 ha. Farmers were able to harvest 1762 kg of additional T. Aman rice from 1 ha of land by providing supplemental irrigation from one 5mX5mX2m pond. In total, 4550 kg (1697.76 Kg/ha) of additional rice was harvested from 20 mini ponds of 5mX5mX2m size and 15080 kg (1761.68 Kg/ha) from 16 ponds of 10mX10mX2m size. Therefore an increment of almost 71-74% in the rice yield was found.

A total of additional BDT 45,500 (16977.61 BDT/ha) was earned by 20 farmers from 20 ponds of 5mX5mX2m size and BDT 150800 (17616.82 BDT/ha) by 16 farmers from 16 mini ponds of 10mX10mX2m size.

About 425 farming households from the surrounding villages participated and exposed to the implementation of the adaptation technology through social mobilization and farmers' field days and among them 11 farmers have excavated mini ponds in their rice fields. The size of the ponds is also 10mX10mX2m and few cases it is bigger as per the size of the rice field and requirement of the farmers.

The bank of the mini pond also served as good space for vegetable cultivation and fruit tree raising. Along ponds where the water retained for longer periods, farmers cultivated deep rooted gourd vegetables and short duration fruits. Some farmers have started rearing short duration fish in their mini pond, like common carp and nilotika varieties of fish which they used for home consumption and sometimes distributed to relatives and neighbours. Additional vegetables, fruits and fishes produced brought some extra food and income for the poor farming families.

b) Climatic and environmental benefits

Rain water harvest in the mini pond and application in the T. Aman rice field reduce risk of exposure to late season drought spells.

Supplemental irrigation to rice field with harvested rain water saves lots of energy required for uplifting underground water.

Harvesting rain water in the mini pond and thus using the water as supplemental irrigation also reduces dependency and saves the ground water resources.

Farmers' feedback

In the wake of increased climate variability and high intensity of drought condition in the *barind* tract, farmers have been searching for alternatives for providing irrigation to their T. Aman rice fields. Mini pond has been found suitable alternative option for the farmers of the area. The pond is particularly useful for the seasonal drought that may occur during the cultivation of T. Aman rice in the *barind* area. In any year, if the harvested water is not required for supplemental irrigation due to the availability of the rain water, it may be used for other crops or other farming activities.

Farmers felt that supplemental irrigation to rice field with harvested rain water saves lots of energy required for uplifting underground water. Due to the increase in intensity and severity of droughts and decreased availability of groundwater, farmers wish to increase the number of mini ponds to reduce the dependence on groundwater.

Although the small holder farmers have been satisfied with the current pond size i.e. 10mX10mX2m, farmers who could afford space in the rice field, proposed to have even larger ponds.

Conclusion and recommended action for follow-up in LACC II and III

Farmers have accepted the mini pond and rated very high as per a performance assessment done by the project with the farmers.

The practice was introduced in the Kharif-I season in 2006 to better manage drought spells. However, it is not widespread due to lack of investment capital and organization among poor farmers. Adequate awareness of the utility of these structures should continually be raised at community level.

While in some years supplemental irrigation is not required, a diversification in mini pond water use may be meaningfully done with the farmers so that the pond water is used for other crops or other faming activities.

From the farmers' perspective, the size of the mini pond was enlarged and more diversification with vegetables on the pond bank and quick growing fish in the pond water are recommended for future.

The size of the pond should be dependent on the farmers land size and other socio-economic factors. The 10mX10mX2m or even bigger size pond is suggested for richer farmers while the earlier size, i.e. 5mX5mX2m, may be promoted further for the poorer ones. The pond production should be intensified with quick growing vegetables and fruit trees on the pond bank and with short duration fish cultivation in the pond water. More social mobilization programmes for greater dissemination of the technology should be undertaken.

Table 16: Replication suitability and recommendation: Mini Pond (5mX5mX2m and 10mX10mX2m)

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat /Pulse	25, 26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	60 - 100 US $	High	High	Yes	no increase (Use of surface water)	Highly recommended as adaptation option

6.5 Impact of Water Saturated Soil Condition on Rice Cultivation

Background

Farmers of *barind* tract struggle for irrigation water especially in the months of Rabi season, for cultivating irrigated rice crops. As a general practice, farmers irrigate the rice field by flooding method, i.e. they keep the rice field in almost stagnant water. Sometimes redundant water is lost which is costly and causes negative environmental impacts like soil erosion, leaching loss of soil nutrients etc. The water saturated soil condition on rice production, a similar technology as the System of Rice Intensification (SRI), was introduced in the winter season to increase water use efficiency by ensuring use of judicious amount of water in irrigation and save the precious water from being lost though evaporation, seepage and run-off during the production cycle.

Implementation process

The option was demonstrated in the villages of the project where the farmer had access to irrigation water. In order to compare various production and yield parameters two demonstrations were established; one being the option demonstration and the other one farmers' practice.

In the Rabi 2005, 8 demonstrations were implemented in 8 farmers' fields in the pilot villages of project covering about 2.7 ha of land. The number of farmers and demonstrations remained low considering the option is new one in the project pilot villages.

Table 17: Implementation of saturated soil condition on rice

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of demonstration established	2	2	2	2	8
2	Total no. of farmers benefited (directly)	2	2	2	2	8
3	Total area of land brought under the option (ha)	0.27	0.81	0.81	0.81	2.7

Results and benefits

a) Socio-economic benefits

Since the irrigation is provided from a power driven deep tube well, the availability of irrigation water is dependent on the power supply situation which is often disrupted during the cropping season in the area concerned. Hence the cultivation practice and the ultimate growth of the rice crop were impacted and the yield varied from demonstration to demonstration.

Comparing the yield of the option plot to farmers practice, it was found that on average additional 189.62 kg of rice were harvested from 1 ha of land and an amount of BDT 2161 was received from 1 ha of land.

Table 18: Economic benefits of saturated soil condition on rice

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of cultivation (BDT)	3995	11950	11985	11970	14777.78
2	Additional yield received from the option demonstrations (kg)	45	150	162	155	189.62
3	Economic benefit received from the option plot (BDT)	500	1725	1820	1790	2161.11
4	Economic benefit from the water savings (BDT)	90	290	308	300	365.93

The savings from the irrigation water was about BDT 365.93 per 1 ha. The saved amount was not very high compared to the overall economic benefit of the crop production. However, climate change scenarios for the drought prone *barind* area and the future risks associated with rice production call for an efficient water use in crop production, in particular for boro rice.

b) Climatic and environmental benefits

Require less amount of irrigation water and thus save irrigation water and thus save environment from depletion of ground water.

Less water loss in the form of evaporation from the rice field that is very crucial for environment conservation point of view.

The practice saves energy required in the machine for uplifting irrigation water from the ground and thus reduces the emission of the green house gas.

Farmers' feedback

Farmers' acceptance (35%) of the option was not very promising resulting from the local power supply situation during the boro season which continues to be a precondition for ensuring irrigation water in the crop field. Another reason for low acceptance was the labour requirement for the demonstration which is a little higher than for the usual practice for boro rice cultivation.

Conclusion and recommended action for follow-up in LACC II and III

The option was introduced with the aim of increasing the water use efficiency in the rice field. Due to the less secure access of irrigation water a low acceptance by the local farmers was observed. However, in respect of the climatic and environmental benefits, the option is suggested to be offered to the project farmers under more secure irrigation conditions and/or water availability or in combination with options that increase water availability (e.g. a mini pond).

Table 19: Replication suitability and recommendation: saturated soil condition on rice cultivation

Suitable for replication under the following conditions					Primary target group	Investment costs for replication	Environ-mental benefits	Justification for replication			Recommendation (remarks)
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				Increase of CC resilience	Economic and social feasibility	No/ marginal increase of GHG emission	
Rice-Rice/ Wheat	25, 26	Drought spells; loss of crops	Irri-gated	High and low barind tract	Poor/ medium farmers with land ownership	60 US $	High	Me-dium	Yes	marginal increase (use of energy for irrigation)	Recommended as adaptation option with secured irrigation (from mini pond)

6.6 <u>Cultivation of Linseed</u>

Background

In the rain fed dry areas of the *barind* tract farmers are unable to cultivate rabi (winter season) crops like pulse and oil. Due to the high temperature and early withdrawal of rain in some years, field soil is left with no or little amount of moisture which does not allow crops to grow and sustain. As a result most of the *barind* tract lands remain fallow for the whole rabi season after the harvest of T. Aman rice and farmers have almost no choice to grow crop. In this context, research institutes, as BARI, promoted crop diversification and introduced T. Aman-Chick pea/oil cropping pattern in recent years. After T. Aman transplantation in the early onset of rain in the month of July and rice harvesting, the seeds of the oil crop are sown to tap the residual moisture in the field for easy germination. The linseed cultivation demonstration was introduced in the winter season to increase the cropping intensity of the high *barind* areas by using the residual moisture after T. Aman harvesting.

Implementation process

Crop fields cultivated with T. Aman and retained with high moisture retention were selected for the linseed demonstration. Seeds of linseed were sown just after harvesting of the T. Aman. The demonstrations were established in two of the four project upazilas of the *barind* area.

As a starting point to test the suitability of the technology and to raise the confidence level, 7 demonstrations were established in 2 upazilas of the project.

400 farmers participated in the demonstration activities of the option through farmers' field day at method and result demonstrations. Among them a few tried the option in their own field.

Table 20: Implementation of linseed cultivation

Sl. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Total
1	Total no. of demonstrations established	3	4	7
2	Total no. of farmers benefited (directly)	3	4	7
3	Total area of land brought under the option (ha)	1.2	2.62	3.82
4	No. of other farming households participated in the demonstration of the technology	200	200	400
5	No. of other farming households replicated the technology on own cost	20	5	25

Results and benefits

a) Socio-economic benefits

Table 21: Economic benefits of linseed cultivation

Sl. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Average/ha
1	Cost of cultivation (BDT)	1198	2610	996.86
2	Yield from the demonstration (kg)	378	584	251.83
3	Economic benefit received from the demonstration (BDT)	13281	19008	8452.61

The yield (251.83 kg/ha) from the linseed demonstration was lower than the normal yield in other parts of the country but the selected farmers in the high *barind* lands were satisfied. An economic benefit of BDT 8452.61/ha was achieved compared to no income from fallow land in the rabi season.

The crop was infested by the pod borer insect that reduced the expected yield. Farmers were not aware of the infestation and could not manage it well.

b) Climatic and environmental benefits

Require less amount of irrigation during its growth stage. Therefore, the option reduces the risks of drought for crop production in the barind area. It also increases the resilience of the farming households in drought condition.

Farmers' feedback

Although the yield and economic benefit was not very high, farmers were pretty satisfied and convinced to take up the same practice in the following year because they considered the benefit entirely additional for them. They requested appropriate pest management solutions to avoid yield reductions.

Conclusion and recommended action for follow-up in LACC II and III

The demonstration was taken up responding to farmers' needs and recommendations by the local agriculture department officers and farmers were found satisfied. The option is particularly suitable for poor farmers and sharecroppers. Demonstrations, in combination with social mobilization through communication programmes, need to continue in the following 2-3 seasons/years for gathering further lessons that would allow for a comprehensive recommendation. Incorporation of IPM practices for the management of the pod borer and other insect or disease problems may also be considered for better yield performance.

Table 22: Replication suitability and recommendation: cultivation of linseed

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat/ Pulse/ Oils	25, 26	Drought spells; loss of crops	Rain fed	High barind tract	Poor (share-cropper) farmers	20 US $	High	Me-dium	Yes	no increase	Highly recommended as adaptation option combined with mini pond

6.7 <u>Cultivation of Short Duration T. Aman as an Alternative Technology</u>

Background

In recent years, increasing climate variability has caused serious and frequent drought spells in drought prone north-western Bangladesh, which influence agricultural systems in all stages of growth and consequently the crop yields. Diversification and adjustment of cropping patterns are a way to reduce losses, thus mitigating the impact of droughts on the rural poor. In the rain fed high *barind* tracts farmers usually grow only one rice crop i.e. transplanted Aman during Kharif-II (July-October) season and leave the land as fallow in the other two seasons, Rabi (October-March) and Kharif-I (March-July). BARI introduced T. Aman-Chick pea/pulse cropping pattern in recent years. The pattern includes T. Aman transplantation in the early onset of rain in the month of July and after rice harvesting sowing the seeds of the pulse crop capturing the residual moisture in the field to facilitate easy germination. The demonstration was established in order to introduce a new cropping pattern that exploits the current climatic condition of the high *barind* area and provides farmers with options to incorporate crops in the fallow period.

Implementation process

The block demonstration method was followed in the demonstration of the T. Aman cultivation and a short duration variety of rice was used. For each demonstration more or less 6.6 acre of crop land was selected where in each case more than 5 farmers participated. The land for demonstrations was selected in locations highly visible to other farmers and the community in general. Transplantation of T. Aman was done in July with the early onset of monsoon rain. Farmers' field days were organized to demonstrate the technology to the farming community in the surrounding area.

A total of 64 farmers in 8 groups undertook 8 demonstrations and about 42.76 ha of land were brought under the option demonstration.

As per the purpose of the demonstration, for generating interest among the farming community farmers' field days were organized at the demonstration sites where a total of 1370 farmers participated and were exposed to the technology and the process of implementation.

Among the farmers participated in the demonstration of the technology 46 farmers are reported to have taken up the option for implementation in their respective fields.

Table 23: Implementation of Short Duration T. Aman cultivation

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of demonstrations established	2	2	2	2	8
2	Total no. of farmers benefited (directly)	14	14	16	20	64
3	Total area of land brought under the option (ha)	10.69	10.69	10.69	10.69	42.76
4	No. of other farming households participated in the demonstration of the technology	220	400	500	250	1370
5	No. of other farming households replicated the technology on own cost	15	10	12	9	46

Results and benefits

a) Socio-economic benefits

Table 24: Economic benefits of Short Duration T. Aman cultivation

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of cultivation (BDT)	7714	7714	7714	7714	721.61
2	Additional yield from T. Aman demonstration (kg)	4200	4032	4224	4100	387.18
3	Economic benefit received from the demonstration (BDT)	42000	40320	42240	41000	3871.84

Farmers could receive an additional yield of 387 kg/ha. The economic benefit BDT 3871/ha from the T. Aman block demonstration does not differ much from the other season. However, if the production practice is treated as part of the cropping pattern and the benefits from the entire cropping cycle are compared it can be a profitable option in drought-prone areas.

b) Climatic and environmental benefits

Diversification, i.e. an additional crop, increases farmers' resilience to climate variability.

Farmers' feedback

Farmers of the area are concerned about the duration of the rice variety and the content of soil moisture retained after T. Aman harvesting. From the farmers' point of view short duration rice variety should be used, transplanted in the first onset rain of the season and harvested a little earlier than usual varieties. This will facilitates early seed sowing of the pulse seeds as soon as possible to use the residual moisture for easy germination.

Conclusion and recommended action for follow-up in LACC II and III

The option was applied in one season i.e. Kharif-II 2006 and the results justify further demonstration for wider audience in the community. Further demonstrations combined with an awareness and communication programme would be essential for the option to be taken up by the farming community of the drought prone area. The option can be promoted in high barind area where farmers have less or no access to irrigation water. The option can also be combined with the mini pond where if irrigation is needed that can be supplemented from the pond. As the option requires early seedlings, inclusion of the dry seed bed method for seedlings availability should also be taken up as part of the total pattern.

The technology should be promoted further in the community and the adjacent villages in the following seasons for the poor and medium farmers, including sharecroppers, and for the community as a whole, particularly where they can bring more land together (as a block) under the demonstration.

Table 25: Replication suitability and recommendation: Cultivation of T. Aman as part of the T. Aman-Chick Pea Cropping Pattern

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat /Pulse	25, 26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	90 US $	High	High	Yes	no increase	Highly recommended as adaptation option

6.8 Cultivation of Chick Pea after T. Aman

Background

In the rain fed dry areas of the *barind* tract farmers are unable to cultivate rabi (winter season) crops like pulses and oils with their traditional practice that starts late while the crop land gets dry. Due to the high temperature and early withdrawal of rain in some years, field soil is left with no or little amount of moisture which does not allow crops to grow and sustain. As a result most of the high lands remain fallow for the whole rabi season after the harvest of T. Aman rice. In this context, research institute like BARI suggest crop diversification and introduced T. Aman-Chick pea/pulse cropping pattern in recent years. After T. Aman transplantation in the early onset of rain in the month of July and rice harvesting, the seeds of the pulse crop are sown tapping the residual moisture in the field to facilitate easy germination. As a part of the T. Aman-Chick pea cropping pattern the chickpea block demonstration was established to introduce a new cropping pattern that exploits the current climatic condition of the drought prone area and provides farmers an option to incorporate crops in the fallow period.

Implementation process

The block demonstration method was followed in the demonstration of the chickpea cultivation and BARI variety of chickpea was used. T. Aman block demonstration field was used for the chickpea demonstration as per the purpose to use the moisture of the same field. Seed of chickpea was sown just after harvesting of the T. Aman to ensure germination of the seed exploiting the residual moisture left in the field. The demonstrations were established in two of the four project upazilas of the *barind* area. To enable farmers to farmers learning, farmers' field days were organized to demonstrate the technology to the farming community in the surrounding area.

In 2 upazilas 4 demonstrations were established on 21.38 ha of land where 28 farmers were involved (Table-5-8-1).

Awareness programmes through result demonstrations and field day were also arranged with 350 farmers participating. A few (22) of the community farmers tried the pattern in their field in the following year.

Table 26: Implementation of Chick Pea Cultivation after T. Aman

SL. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Total
1	Total no. of demonstrations established	2	2	4
2	Total no. of farmers benefited (directly)	14	14	28
3	Total area of land brought under the option (ha)	10.69	10.69	21.38
4	No. of other farming households participated in the demonstration of the technology	150	200	350
5	No. of other farming households replicated the technology on own cost	12	10	22

Results and benefits

a) Socio-economic benefits

Table 27: Economic benefits of Chick Pea Cultivation after T. Aman

SL. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Average/ha
1	Cost of cultivation (BDT)	5100	5100	477.08
2	Yield from Chick pea demonstration (kg)	626	550	55.00
3	Economic benefit received from the demonstration (BDT)	14780	16902	1481.85

The residual moisture left in the T. Aman field facilitated the germination of chickpea and a satisfactory growth was observed. A single supplemental irrigation during vegetative growth of the crop in few plots of Gomostapur upazila produced a slightly better yield than in Nachole where irrigation could not be ensured.

The yield (55 kg/ha) from the chickpea demonstration was lower than the normal yield from chickpea in the country (1500 kg/ha). Ultimately, the economic benefit (BDT 1481) was also lower in comparison with the normal benefit farmers might get from other parts of the country where the climatic condition and the irrigation water are no limiting factors. However, if the yield and economic benefit are compared with zero production in the fallow period when farmers hardly could produce anything, the benefit is additional for the farmers (given also the high nutritional value of chick peas).

b) Climatic and environmental benefits

An excellent example of adaptation option that exploits the drought condition and produce crops in high temperature.

Farmers' feedback

Farmers were satisfied with the result they received from minimum investment where, according to them, no crop can be successfully grown in the *rabi* season. They felt that timely transplantation of T. Aman and subsequent chickpea seed sowing are key to get satisfying yields in the fallow period of the year.

They also felt that the incorporation of pulse crops in their rice field could improve their soil fertility and they appreciated the pulse crop as cheap source of protein for their nutrition.

Conclusion and recommended action for follow-up in LACC II and III

Cultivation of chickpea allows on the one hand an exploitation of the current climatic condition of the drought prone *barind* area and on the other hand provides a risk reduction strategy that ensures yield and income during the lean period of the year and thus improves the resilience of the farming community.

The results show a potential of the technology in the area which needs to be demonstrated as a routine activity. However, in order to fetch more yield and thus economic benefits, the demonstrations may be diversified with other crops like linseed, barley. In addition, more social mobilization programmes are needed for more awareness generation and a higher adoption by the farmers.

The option can be promoted in high barind area where farmers have less or no access to irrigation water. The option can also be combined with the small mini pond where some irrigation is needed. As the option requires early seedlings, inclusion of the dry seed bed method for seedlings availability may also be taken up as part of the total pattern.

The technology should be promoted further in the community and the adjacent villages in the following seasons for the poor and small farmers, including sharecroppers, and for the community as a whole, particularly where they can bring more land together (as a block) under the demonstration.

Table 28: Replication suitability and recommendation: Cultivation of Chick pea as part of the T. Aman-Chick Pea Cropping Pattern

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat/ Pulse	25, 26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	60 US $	High	High	Yes	no increase	Highly recommended as adaptation option combined with mini pond

6.9 <u>Homestead Vegetables Gardening with More Drought Tolerant Vegetables</u>

Background

Homestead gardening is an old production practice in the rural areas of Bangladesh, creating opportunity for employment and year-round income even when other sources fail due to drought. The practice was already suggested by the Bangladesh Agricultural Research Institute in the early 1980s. However at that stage it was not successful due to non-availability of drought resistant vegetables. Current efforts helped to identify drought resistant vegetable crops involving farmers themselves.

This practice ensures year round income, nutritional security and gender involvement. Producing vegetables in the homestead can also ensure use of fallow and unexploited land and is a way of using homestead wastes, sweepings and debris as organic matter, as well as irrigation water from the homestead source.

The practice was considered as a good adaptation option for improving family food and nutrition and managing seasonal famine called 'Monga' in north western Bangladesh.

Implementation process

Homestead vegetables gardens were established in all 3 seasons (Kharif-I, Kharif-II and Rabi) of the year with the aim that the farming family can harvest vegetables through out the year, use them for home consumption and sale the surplus to the market to support other livelihoods aspects of the family. The project follows the BARI model for establishing homestead vegetables gardens in farmers' homesteads. Land was selected within or close to the homestead so that the women members of the family could look after and work in the garden. Less chemical intensive methods and techniques were followed and household resources like cow dung, debris, water were used and family labour was employed in the gardening activities.

Vegetables grown in the homestead garden were mostly year-round and were selected such that less water is required in the cultivation. The vegetables were kangkong, egg plant, okra, stem amaranth, red amaranth, Indian spinach, beans and other local varieties which are suitable to the drought condition.

In the project period i.e. from Rabi 2006 till Kharif-II 2007, 44 homestead vegetable gardens were established in 44 farmers' homesteads in 12 pilot villages of project.

112 farming families took part in the demonstration activities and 57 of them also started applying the technology who found it better than their traditional one because the project promoted gardens are well structured with more varieties of vegetables those require less amount irrigation water which is very crucial in drought prone environment.

Table 29: Implementation of Homestead Vegetable Garden

Sl. No.	Parameters	Upazilas				Total in one season
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of garden established	14	6	12	12	44
2	Total no. of farmers benefited (directly)	14	6	12	12	44
3	Total area of land brought under the option (ha)	0.06	0.02	0.05	0.05	0.18
4	No. of vegetables varieties grown in the garden	13	5	5	5	28
5	No. of other farming households participated in the demonstration of the technology	50	20	20	22	112
6	No. of other farming households replicated the technology on own cost	26	10	10	11	57

Results and benefits

a) Socio-economic benefits

Table 30: Economic benefits of Homestead Vegetable Garden

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of cultivation (BDT)	17080	7320	14640	14640	298222.22
2	Total yield of vegetables in one season (kg)	2520	1044	2328	2280	45400.00
3	Economic benefit received in one season (BDT)	11200	5100	12360	11760	224555.56

A farming family spent only about BDT 1220 (less than 20 US$) for the establishment of a homestead vegetables garden including the cost of seeds, fertilizers, other inputs and family labour. It is BDT 298222.22 (4260 US$) in one hectare.

A farming family could harvest on average 186 kg. of vegetables per garden (45400 Kg/ha) in one season. Therefore, in 3 seasons estimated 558 kg of vegetables could be produced per garden and accordingly 24516 kg i.e. 25 tons (approx.) of vegetables could be produced from 44 vegetables gardens in a year.

In terms of economic benefits, a farming family could earn on average BDT 918 per garden in each season. Thus from one hectare of vegetable garden, a farming family could earn BDT 224555 which is 23% higher than in earnings from traditional homestead gardens.

In certain months of the year, in particular in drought periods, when farming families have less access to employment opportunities and income, homestead vegetables gardens serve as a food, nutrition and income source.

Farmers could use their fallow land in and around homestead which otherwise would be left fallow. Vegetables grown in the homestead gardens require less chemical fertilizers and pesticides, which saves money and energy thus also contribution to climate change mitigation.

Homestead is the women domain and they manage the enterprise, in planning, selection of varieties, sell and use of the produce. The involvement of women in the gardening activities ensured their participation in decision making and empowerment in the family and society.

b) Climatic and environmental benefits

Vegetable species and varieties grown require less irrigation water. In other words it saves water which is extremely critical in a drought prone environment.

Homestead vegetables are grown mostly with more homestead organic matter and less chemical fertilizers and pesticides. Therefore, by using fewer chemicals, the option is contributing to the less GHG emission from the factory for producing the chemicals.

Farmers' feedback

In general, vegetables require lots of water and irrigation needs to be ensured almost through out the life cycle, which is a challenge in drought prone *barind* area. More drought-resistant varieties should be explored and made available for the farmers. Farmers are struggling with quality seeds and most of the time they are cheated by seed traders and others. They ask for year-round availability and access to quality seeds and seedlings.

Strong fence is extremely needed for ensuring year round production of various vegetables and securing the produce from cattle and other animals.

Conclusion and recommended action for follow-up in LACC II and III

Considering the scarcity of the quality seeds and objective of the demonstrations, homestead vegetable gardens need to be provided with quality seed and seedlings. Direct communication with the reliable seed dealer and seed sources needs to be established for accessing good quality seed and other planting materials.

Recognizing the trend of increasing temperature and more droughts, the promoted vegetable varieties should be tolerant to such conditions. Therefore demonstrations should be carried out in a way that suitable varieties and species are raised, which are adapted to changing climate conditions.

More in-depth assessment and analysis is needed to find out the amount of water, energy and other resources required and saved in the LACC promoted homestead vegetable garden in comparison with the traditional one.

The promotion of the technology should be continued as a routine activity with more drought tolerant varieties in the homesteads of landless and marginal farmers. Regular monitoring and seasonal assessment should be included to find out the water, inputs and energy requirement.

Table 31: Replication suitability and recommendation: of Homestead Vegetable Garden with more drought tolerant vegetables

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Vege-tables/ fruit, tree/ timber, tree/ livestock/ poultry	25, 26	Drought spells; loss of crops	Irri-gated/ rain fed	High and low barind tract	Poor/ medium farmers with land ownership	20 US $	High	High	Yes	no increase	Highly recommended as adaptation option

6.10 <u>Jujube Gardening</u>

Background

In the *barind* tract of Bangladesh, fruit trees are cultivated as a viable drought impact reduction strategy. Fruit trees such as jujube thrive well in drought prone environments and were recommended in the uplands of the *barind* tract as a potential adaptation option to the existing spontaneous mango cultivation. Mango plantation is an autonomous adaptation spreading rapidly. However, the project anticipated that under changing climatic conditions, high temperature induced synchronized maturity may lead to price drop. Further, it threatens to replace rice completely causing food insecurity and aggravate *monga* (seasonal famine conditions). Rice is the only crop grown during monsoon season and is crucial for food security of the *barind* tract. Introduction of Jujube offers scope for diversification, risk reduction due to its tolerance of high temperatures and a reduced shade effect on the rice and other crops beneath, as and wherever cultivated. Hence rice may not be completely replaced by jujube cultivation in an area predominantly cultivated by rice. The option is suitable to initiate at the beginning of monsoon where it can take the advantage of natural rainfall just to get established.

Implementation process

The gardens were established in relatively marginal land and land where farmers can provide regular care. Farmers establish the gardens in the Kharif-I (March-June) season of the year while the monsoon rain usually begins and the trees can easily establish in the soil. Jujube garden was established in 0.13 ha of land of a farmer.

At the beginning according to the local practice, assessed from the farmers and the community people, 66 number of jujube plants were planted in 0.13 ha of land. In the following seasons, according to the suggestion of Bangladesh Agriculture Research Institute (BARI), 25 plants were established in 0.13 ha of land. *Apple Kul,* a locally selected variety, which is highly drought and temperature tolerant, was promoted at the beginning. Later, a new variety named *BAU Kul* was incorporated in few farmers' lands.

The land used for the gardening purpose is mainly marginal and had generally been used by farmers for rice or vegetables cultivation. Farmers selected garden closer to the home so that they could look after regularly.

During the project period a total of 31 jujube gardens were established in 31 farmers' field of 4 upazilas. Among them, 15 gardens were established with 66 plants and 16 gardens with 25 plants.

Table 32: Implementation of 66 Plants Jujube Garden

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
	Total no. of garden established	5	3	3	4	15
	Total no. of farmers benefited (directly)	5	3	3	4	15
	Total area of land brought under the option (ha)	0.13	0.13	0.13	0.13	1.95
	No. of other farming households participated in the demonstration of the technology	50	20	30	25	125
	No. of other farming households replicated the technology on own cost	0	4	2	2	8

Table 33: Implementation of 25 Plants Jujube Garden

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of garden established	6	3	3	4	16
2	Total no. of farmers benefited (directly)	6	3	3	4	16
3	Total area of land brought under the option (ha)	0.13	0.13	0.13	0.13	2.08
7	No. of other farming households participated in the demonstration of the technology	20	15	30	25	90
8	No. of other farming households replicated the technology on own cost	The plants did not start producing fruits yet. Farmers are waiting to see first results before they consider replicating the option.				

Results and benefits

Cost of establishment of a jujube garden of 66 plants is BDT 4000 (less than 60 US$) and BDT 1800 (about 25 US$) for 25 plants. In total, more than 4 ha of land were brought under jujube gardening with 31 gardens established.

Farmers were able to harvest fruits from the 66 plants garden. Since the 25 plants gardens were established in later part of the LACC-I project, plants did not start production and hence no data could be recorded. From 0.13 ha of land of 66 plants garden farmers harvested 126 to 132 kgs of jujube in the following year (1^{st} year) of plantation. Minimum price of 1 kg of jujube at the period of harvesting was 30 taka and the total economic benefit was BDT 3780 to 3960 from 1 garden i.e. 0.13 ha of land.

a) Socio-economic benefits

Table 34: Economic benefits of 66 Plants Jujube Garden

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of establishment of a garden (BDT)	24000	12000	12000	16000	30769.23
2	Yield of jujube from one garden per year (kg) (1st year)	132	130	126	127	247.60
3	Economic benefit received from one garden (BDT) (1st year)	3960	3900	3780	3810	7427.88

Through farmer to farmer extension and learning visits about 215 farming households from surrounding villages participated in the implementation of the adaptation jujube gardening with the project farmers and among them 8 have started gardening in their own lands. Due to the high market value of the fruits, jujube gardening has started gaining momentum.

Jujube plants can thrive and grow well in drought condition and require less irrigation in comparison with rice and other crops. Thus, irrigation water, which is valuable in the drought prone *barind* area, can be saved and used for other crops or rice fields. This has environmental and climate change implications; water savings mean less pressure on the ground water facilitating more recharge.

In addition, the land of jujube garden can be diversified with rice, vegetables and other crops which bring additional yield and income from 0.13 ha of land for the farmers. Therefore, additional yield and income from rice, vegetables are possible from the same piece of land. At the end of each crop cycle, the branches of the jujube plants are pruned for acceleration of rejuvenation of the trees. The branches and twigs are used as fuel wood which is very scarce in the *barind* area and reduce fuel costs for a farming family. On the other hand by using tree fuels, cow dung is saved and can be used in the crop field for soil fertility improvement.

One of the unique advantages of jujube production is that a farming family can harvest fruits immediately after one year. The fruits are available in the market where very few (local) fruits are found and it is highly nutritious. A farming family can earn in such a lean period of the year while they have less access to employment and income. Jujube gardening, having more options for diversification, offers more flexibility to the farmers in planning their farming activities compared to mango.

b) Climatic and environmental benefits

Jujube is an excellent option for the drought prone areas and areas not having irrigation facilities. The plant can survive for several months in the drought condition with high temperature. Therefore, a farming family can minimize or reduce livelihood risk that may come from climate change induced problems (drought) while they have got a jujube garden in their possession.

Farmers' feedback

Farming households prefer the 66 plants gardens that offer higher benefits in terms of yield and economics.

A comparison of yield and other traits among jujube varieties, especially those suitable to drought prone conditions, like *Apple Kul, BAU Kul, Narkeli Kul,* could be conducted to derive recommendations for future promotion and expansion. .

Conclusion and recommended action for follow-up in LACC II and III

The acceptance of farmers was high; An expansion of the jujube gardening is evident in the area.

Due to the current increase in the rice price, a transitory change towards the cultivation of rice is observed, although the change appeared to be non-existent. However, due to the limited access to irrigation water, farmers found the jujube gardening still a suitable alternative for adaptation.

Jujube plant is drought and temperature tolerant and requires less irrigation water for their survival and growth and thus water is saved while irrigation is done. A critical monitoring and analysis on the amount of water used and savings will be useful for making future recommendation and expansion of the technology.

Based on the current trend of increased gardening, a marketing analysis study is needed to identify appropriate market channels to provide farming community with more choices in decision making. The study may also look into the future market potential of the fruits since fruit gardening and business is expanding.

Jujube has been competing with mango plantations especially in the rice field and has increasingly been accepted as an advantageous venture over mango by using the garden for intercropping with other crops. A study to assess and evaluate the comparative advantages of jujube and mango for intercropping over certain years would be useful.

The promotion of the adaptation option should be continued for another 2-3 seasons to allow for policy recommendation in other similar areas as a part of planned adaptation strategy. The option may be targeted to small farmers who can afford land for a perennial garden. A market study may also be undertaken to find out the comparative advantage over mango.

Table 35: Replication suitability and recommendation: 25 and 66 Plants Jujube Garden

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice, Wheat/ Fruit tree/ Fallow	25, 26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	25 US $ & 60 US $	High	High	Yes	no increase	Highly recommended as adaptation option

6.11 <u>Cultivation of Papaya</u>

Background

North-west *barind* area is predominantly a mango growing region and a very few other selected number of fruit trees like jujube, introduced recently, are seen. But short term and year round fruits that might provide regular food and nutrition to the farming family are rare in the area. Farmers of some project villages increased the demand for raising papaya trees, mainly for household consumption and for economic benefit from sale from the surplus, if any. Based on the demand from the farmers, the local agriculture office and project staff recommended the cultivation of papaya in the farmers' homesteads. The major aim of the papaya cultivation demonstration was to provide the farming households with the opportunity to produce and ensure food, nutrition and income.

Implementation process

Farmers who had around 0.13 ha of land in and around the homestead were selected for the papaya cultivation demonstrations in the Kharif-II season 2007. A total of 16 demonstrations were implemented in field/homesteads of 16 farming families of the project villages.

Table 36: Implementation of Papaya Cultivation

Sl. No.	Parameters	Upazilas			Total
		Nachole	Sapahar	Porsha	
1	Total no. of garden established	4	6	6	16
2	Total no. of farmers benefited (directly)	4	6	6	16
3	Total area of land brought under the option (ha)	0.18	0.97	0.73	1.88
4	No. of other farming households participated in the demonstration of the technology	40	6	3	49
5	No. of other farming households replicated the technology on own cost	0	0	0	0

Results and benefits

a) Socio-economic benefits

Table 37: Economic benefits of Papaya Cultivation

Sl. No.	Parameters	Upazilas			Average/ha
		Nachole	Sapahar	Porsha	
1	Cost of cultivation (BDT)	34467	51700	50000	72429.25
2	Yield from the demonstration (kg)	4544	1260	996	2385.96
3	Economic benefit received from the demonstration per acre (BDT)	27272	9450	6420	15137.54

Yield of the demonstrations was not consistent throughout the season and the areas. Recurrent and incessant rainfall during the growing period hampered the growth and damaged the papaya trees in some demonstrations. All demonstrations of Gomostapur upazila were fully damaged due to the nonstop rain and hence no result could be obtained from the upazila.

The yield and economic benefits received by the farmers were not satisfactory and the damage and interruption of various activities due to non-stop rain questioned further demonstration. The heavy soils of the *barind* tract were also not very suitable for the papaya cultivation as there drainage capacity is low and water stagnation damaged the papaya trees which are very weak and sensitive to stagnant water.

b) Climatic and environmental benefits

No particular climatic/environmental benefits could be identified.

Farmers' feedback

Farmers were not satisfied with the result of the demonstrations. They felt the cultivation of papaya is possible only when the problem of rainfall and soil can be adequately addressed.

Conclusion and recommended action for follow-up in LACC II and III

The result of papaya demonstrations illustrate that every option must be selected through a rigorous process where experts, scientists and others can provide their judgment and clarification on every aspect of the demonstration including technical suitability and socio-economic acceptability.

The project discontinued the demonstration of the option after the feedback from the farmers and others concerned. The promotion of the option should not be continued. Further trials may be taken up if suitable varieties for drought prone areas are recommended by the research institutes.

Table 38: Replication suitability and recommendation: Papaya Cultivation

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat/ Fruit tree/ Fallow/ Poultry	25, 26	Drought spells; loss of crops	Irri-gated/ rain fed	High and low barind tract	Small/ medium farmers with land ownership	130 US $ & 60 US $	Me-dium	Low	No	no increase	Not recommended

6.12 Cultivation of Maize

Background

Facing with recurrent drought and struggling with shortage of irrigation water, farmers of the drought prone *barind* area are always in search of alternatives, technologies, crops to enable them to cope with the situation. As common traits, farmers of the areas are looking for more drought-tolerant crops, which maintain higher yield level and require fewer inputs and are thus less time intensive technologies. In the context of unavailability of appropriate alternatives, Maize comes as an option despite several demerits. The crop was recommended for the farming community for cultivation in the rabi 2006 and the project demonstrated the practice in the field of few farmers.

Implementation process

Demonstrations of maize production were established in relatively marginal land that had little or no opportunity for use in the same season. The demonstrations were only implemented in few areas of Nachole and Gomostapur upazilas. A high yielding variety of maize was transplanted and other management activities were done according to the production routine.

In the rabi 2006 season only 6 demonstrations were executed in 6 farmers fields in the pilot villages of two upazilas.

270 farmers participated in the demonstrations, and 25 of them also implemented the technology on their own.

Table 39: Implementation of Maize Cultivation

Sl. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Total
1	Total no. of garden established	3	3	6
2	Total no. of farmers benefited (directly)	3	3	6
3	Total area of land brought under the option (ha)	1.2	1.36	2.56
4	No. of other farming households participated in the demonstration of the technology	120	150	270
5	No. of other farming households replicated the technology on own cost	10	15	25

Results and benefits

a) Socio-economic benefits

The benefits received by the farmers from the demonstrations in terms of yield and economics were satisfactory compared to traditional practice and other varieties. In addition, the maize provided some fodder for the cattle and fuel for the farming families.

Table 40: Economic benefits of Maize Cultivation

Sl. No.	Parameters	Upazilas		
		Nachole	Gomostapur	Average/ha
1	Cost of cultivation (BDT)	15411	15600	12113.67
2	Yield from demonstration (kg)	2700	3279	2335.55
3	Economic benefit received from the demonstration (BDT)	18750	22446	16092.18

b) Climatic and environmental benefits

Although maize has a strong adaptive capacity in most of the geographical and hazardous areas, there are negative aspects to the cultivation: Maize is an exhaustive crop that depletes most of the nutrients of the soil and thus leaves the land very unproductive for the following seasons.

Farmers' feedback

Farmers who carried out the demonstrations admitted that they needed to add more manure and fertilizers for subsequent cropping to compensate the loss of soil fertility during maize cultivation that incurred substantial amount money by the farmers.

Conclusion and recommended action for follow-up in LACC II and III

After one season of demonstration, the project discontinued the activity based on the feedback from the farmers and considering other environmental implications like loss of soil fertility, require increased amount of chemical fertilizers that costs additional money for farmers. Time was also too short, to discuss the suitability of the option with other stakeholders, in particular scientists. The option should not be promoted further,

Table 41: Replication suitability and recommendation: Maize Cultivation

Suitable for replication under the following conditions					Primary target group	Investment costs for replication	Environ-mental benefits	Justification for replication			Recommendation (remarks)
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				Increase of CC resilience	Economic and social feasibility	No/ marginal increase of GHG emission	
Rice-Rice/Wheat	25, 26	Drought spells; loss of crops	Irri-gated/ rain fed	High barind tract	Small/ medium farmers with land ownership	25 US $	No	No	Yes	no increase	Not recommended

6.13 <u>Establishment of Mini Nursery</u>

Background

The impacts of climate variability and change are critical in the north-western high *barind* tract where drought spells are becoming more frequent and intense. Due to the increasing temperature and change in the rainfall pattern, the vast area is left barren in the severe drought months. One practicable livelihood adaptation strategy is establishing mini nursery for tree sapling production thereby encouraging community for planting trees in order to increase green coverage of the drought prone area which will increase moisture retention capacity of the soil, ensure water infiltration and reduce soil erosion. The huge number of tree in the drought prone *barind* land will serve as a big sink for the carbon dioxide and carbon fixation. The activity is also a suitable option for increasing the resilience of the farming community, especially in the drought ridden food and income deficient period of the year, by ensuring employment and earning opportunities throughout the year.

Implementation process

Farmers who can afford some land, have time and family labour and are able to spend additional money in the enterprise were selected for the mini nursery demonstrations. About 0.26 ha were selected close to the homestead so that the members of the farming family can look after and work their conveniently. Selected farmers were provided with one day practical training on the establishment and management of the nursery from the experts of Horticulture Training and Demonstration Center, Chapai Nawabganj.

In order to enable the farmer to initiate the nursery activities, seed, other planting materials, nursery equipments and tools were provided from the project as assets for the business.

With 24 farming families, till the end of Kharif-II 2007, 24 mini nurseries were established in 12 pilot villages of project.

Table 42: Implementation of Mini Nursery Establishment

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of mini nursery established	6	6	6	6	24
2	Total no. of farm family benefited (directly)	6	6	6	6	24
3	Area of land brought nursery demonstration (ha)	1.46	1.46	1.46	1.46	5.84
4	Number of varieties of sapling/seedlings grown	15	7	6	5	33
5	No. of other farming households participated in the demonstration of the technology	0	5	2	2	9
6	No. of other farming households replicated the technology on own cost	0	1	1	1	3

Results and benefits

a) Socio-economic benefits

The average additional income per farming family (4000 BDT/ha) from a mini nursery is not very high, but it provides an incentive for the lean season of the year especially in the drought months when farming communities are left with minimum or no income opportunity. Therefore, this amount of money provides them some flexibility for their total livelihood support system.

The mini nursery enterprise enables the local community to get sapling and seedlings to be grown in the homestead and on public places cheaper and easier than from outside. It encourages the community people to establish more tree plantation in the drought prone areas which is critically important to increase the green coverage.

Table 43: Economic benefits of Mini Nursery Establishment

Sl. No.	Parameters	Upazilas				Average/ ha
		Nachole	Gomostapur	Sapahar	Porsha	
1	Cost of nursery establishment	93000	93000	93000	93000	63698.63
2	Total number of sapling and seedlings grown	30000	35000	25000	17000	18321.92
3	Total number of sapling and seedlings sold	500	1135	700	600	502.57
4	Total amount of sale from the nursery (BDT)	4500	10000	4600	4500	4041.09

The *barind* area is dominated by few varieties of fruit and timber trees and scarcity of irrigation limit production and plantation of trees. The nurseries when focusing on producing drought resistant tree saplings was not viable economically and a more diversified range of crops must be offered to the community and market by the nursery owners. Introduction and promotion of more suitable and acceptable varieties of saplings and seedlings at affordable prices is considered a more sustainable approach of the nursery business.

b) Climatic and environmental benefits

The north-western drought *barind* region is less green with trees. Tree plantations in the drought prone area serve as a sink for the carbon dioxide and carbon fixation and thus contribute to climate change mitigation. They also conserve moisture in the soil and therefore increase ground water availability which is critically important of the drought prone area.

Farmers' feedback

The amount of net return from the nursery enterprise did not convince the farming families. The persistent water crises around the area become also a limiting factor for the production of saplings in huge amounts. Farmers recommended more financial support for a longer period that would facilitate them to make the business sustainable and afterwards they could build on that.

Conclusion and recommended action for follow-up in LACC II and III

Accessibility of water and operational funds are two major factors for nursery business especially in the *barind* area. For further promotion of the nursery enterprise, it should be established in an area or land where irrigation water is available through out the year.

The general choice of the *barind* people is mango or jujube saplings. Any nursery business producing and running only on the mango and/or jujube is risky. Therefore, possibilities of diversifying with other species and varieties and their market potential should be looked into before establishing any nursery as an alternative income generating activity for the farmers.

For the moment the project may not want to promote the technology. However, interested farmers having enough space, water and ability to take-up as an alternative livelihood support enterprise may be facilitated with information and minimum input supports. The market feasibility should also be taken into consideration before establishing any such activity.

Table 44: Replication suitability and recommendation: Mini Nursery Establishment

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
Rice-Wheat/ Vege-tables/ Fruit tree/ Fallow	25, 26	Drought spells; loss of crops	Irri-gated	High and low barind tract	Poor/ small farmers with land ownership	125 US $	High	High	Yes	no increase	Recommended with assured water supply and market potential

6.14 <u>Mango Gardening</u>

Background

In the *barind* tract of Bangladesh, fruit trees are cultivated as a viable strategy to reduce drought impact. Fruit tree such as mango thrive well in the drought prone environment and are recommended in the uplands of the *barind* tract. This tree species is suitable to be intercropped with T. Aman and boro rice as well as with vegetables, allowing for a diversification of the household diet. Tree plantation is a way of securing the growth of cash crops that may constitute an alternative source of income in moments of crisis, especially if high value crops are chosen. Besides being a source of wood fuel, a greater presence of trees contributes to decreasing temperatures and to increasing rainfall, thus contrasting the negative environmental impact of deforestation. Farmers of the project area proposed the option and based on the farmers need the local agriculture office recommended the option in order to diversify the cropping field and also to ensure farmers' economic benefit.

Implementation process

Farmers who had minimum of 0.13 ha rice field were selected for the mango gardening demonstration. Mostly marginal or high land was chosen.

Till the end of Kharif-II 2007, 8 mango gardens were established in 8 farmers' fields in 6 pilot villages of project.

Table 45: Implementation of Mango Gardening

Sl. No.	Parameters	Upazilas		Total
		Sapahar	Porsha	
1	Total no. of mango garden demonstrations established	4	4	8
2	Total no. of farmers benefited (directly)	4	4	8
3	Total area of land brought under the option (ha)	0.52	0.52	1.04
4	No. of other farming households participated in the demonstration of the technology	15	30	45
5	No. of other farming households replicated the technology on own cost	0	0	0

Results and benefits

a) Socio-economic benefits

The mango tree was only a few months old and could not attain fruiting stage. Therefore, no yield and economic return could be recorded.

b) Climatic and environmental benefits

No particular climatic/environmental benefits could be identified.

Farmers' feedback

Farmers were very satisfied and claimed to get more and bigger gardens in their area to support their livelihood and increase their resilience in current climate related problems and future risks.

Conclusion and recommended action for follow-up in LACC II and III

The activity was stopped after one season demonstration based on project analysis that mango plantation is an autonomous adaptation spreading rapidly which can pose a future threat for the rice production of the area. Therefore, promotion through the project seemed not to be necessary and also not reasonable. The project anticipated that under changing climatic conditions, high temperature induced synchronized maturity may lead to price drop. Further, it threatens to replace rice completely causing food insecurity and aggravate *monga* (seasonal famine conditions). Moreover, mango plantation favours rich farmers or land owners, while poor and landless farmers who sell their labour in rice cultivation months may loose their jobs if the rice fields are engulfed by the mango plantation.

A study on the impact of the autonomous mango cultivation on market prices and livelihood opportunities in view of climate change and future threats may be considered (outside the project). The promotion of the technology should be discontinued.

Table 46: Replication suitability and recommendation: Mango Gardening

Suitable for replication under the following conditions					Primary target group	Investment costs for replication	Environ-mental benefits	Justification for replication			Recommendation (remarks)
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				Increase of CC resilience	Economic and social feasibility	No/ marginal increase of GHG emission	
Rice-Wheat/ Vege-tables/ Fruit tree/ Fallow	25, 26	Drought spells; loss of crops	Rain Fed	High barind tract	Small/ medium farmers with land ownership	225 US $	Me-dium	No	Me-dium	no increase	Not recommended

6.15 Improved Stove

Background

In Bangladesh every year more than 39 million tons of traditional fuels are used for cooking and other purposes, and the figures are rising due to population growth. About 50% of the fuel comes from agricultural residues, depriving the soil from organic matter and essential micro nutrients. Increased need for fuel wood encourages deforestation, increasing environmental degradation. The situation is even worse in the drought prone north-western districts where almost 100% of rice straw and cow dung are burnt to meet household level fuel needs, resulting in declining soil fertility. The use of appropriate appliances such as improved stoves, being promoted by the project, may diminish the need for fuel and improve energy efficiency, thus saving wood, organic matter, money as well as cooking time. By releasing less green house gas i.e. carbon dioxide, it also contributes to climate change mitigation. Therefore, improved stoves act as a win-win situation in adaptation and mitigation.

Implementation process

Farming families who have been using traditional stoves and are unable to cope with the current critical shortage of fuel woods were selected for the option. The option was mainly managed by the female members of the family. Improved stoves were promoted as a year round adaptation option.

A local technician was trained from the project on the making of improved stove. The technician moved around the project area and made the stove with nominal fees. The model followed by the project was taken form Bangladesh Council of Scientific and Industrial Research (BCSIR). The option was implemented in the Kharif-I season (April-July) of 2007.

Till the end of Kharif-II 2007, 28 improved stoves were made in 28 farming families in 12 pilot villages of project.

Beyond the project farming families, 165 families were exposed to the improved stove technology while they visited the demonstration and among them about 15 have taken up the technology for their family use.

Table 47: Implementation of the Improved Stove

Sl. No.	Parameters	Upazilas				Total
		Nachole	Gomostapur	Sapahar	Porsha	
1	Total no. of improved stove made	10	6	6	6	28
2	Total no. of farm family benefited (directly)	10	6	6	6	28
3	No. of other farming households replicated the technology on own cost	5	4	3	3	15
4	No. of other farming households participated in the demonstration	25	50	40	50	165

Results, benefits and lessons

a) Socio-economic benefits

Table 48: Economic benefits of the Improved Stove

Sl. No.	Parameters	Upazilas				Average/ stove
		Nachole	Gomostapur	Sapahar	Porsha	
	Cost of making one improved stove (BDT)	10000	6000	6000	6000	1000
	Amount of fuel required for cooking per day (kg)	75	45	54	48	7.99
	Amount of fuel saved per day in cooking by improved stove compared to traditional stove (%)	30	30	25	33	.29.5
	Amount of time saved per day in cooking by improved stove compared to traditional stove (%)	35	30	30	35	32.5
	Amount of money saved per day in cooking by improved stove compared to traditional stove (%)	35	30	30	35	32.5

A farming family spent only about BDT 1000 (less than 15 US$) for making an improved stove.

A significant amount of fuel can be saved from cooking by an improved stove. It was found that a farming family used around 12 kg of fuel per day in a traditional stove for cooking. In the improved stove they used only 7.99 kg of fuel in the improved stove per day. It was estimated that about 29.5% of fuel was saved in cooking by the improved stove. Fuel used for the household cooking is generally cow dung stick, cake and tree twigs or branches. The saved amount of cow dung can be used in the crop field to improve soil fertility and the saving of trees in the *barind* area is another environmental benefit. Thus the technology provides multiple benefits including money savings from buying fuel and chemical fertilizer, improvement of soil fertility and reduced fuel wood requirements.

A woman takes about 6 hours per day for cooking family meals with a traditional stove while she takes 4 to 4.25 hours with the improved stove. The amount of time saved in cooking by the improved stove in comparison to the traditional stove is 1.75 to 2 hours i.e. 32.5%. Traditionally, Bangladeshi women take care of the family food, children and other household activities. By saving time from cooking, a woman can spend more time in the other family activities especially taking care of small children, the elderly and other family well beings which are important aspects of the traditional rural lives.

b) Climatic and environmental benefits

The technology contributes to climate change mitigation through reduced energy needs for chemical fertilizer production and the reduced extraction of fuel wood that serve as a carbon sink. The release of less smoke also implies reduced emissions of the greenhouse gas carbon dioxide thus also contributing to climate change mitigation. Improved stove is a win-win technology both for adaptation and mitigation.

Due to the structure of the improved stove, it releases less smoke and transports it out of the kitchen through exhaust pipe, in contrast to the traditional stove with open mouth. Improved stove therefore leaves the kitchen and home environment smoke free, clean and healthy and the cook/woman feels comfortable while cooking with the improved stove.

Farmers' feedback

As an improved appliance in cooking, the improved stove has been greatly appreciated by the project farming families. They rated the performance of the stove as very high. However, considering the cost of making, they proposed to make some changes especially in the materials. According to the farming family, instead of cement soil/mud may be used for making the stove.

Conclusion and recommended action for follow-up in LACC II and III

A high demand for the improved stove has already been observed in the community, meaning high potential for lateral expansion is possible in the project area. Yet the cost of making a stove remains a hurdle, in particular for the poor families. Therefore, bringing some changes in the materials for making stove and introducing some low cost materials may enhance the acceptance in the community.

Further assessment could address also the amount of cow dung saved and used for the crop field, the amount of money saved from buying chemical fertilizer and the amount of emissions reduced through savings in chemical fertilizer.

The promotion of the option should be continued. The stove is suitable for farmer and community people of all socio-economic classes. However, using local and low cost materials for making the stove would encourage more households, especially the poorer, to implement the option.

Table 49: Replication suitability and recommendation: Improved Stove

Suitable for replication under the following conditions					**Primary target group**	**Investment costs for replication**	**Environ-mental benefits**	**Justification for replication**			**Recommendation (remarks)**
Farming system	AEZ	Hazard type/ impacts	Water mgt system	Micro-topography/ terrain				**Increase of CC resilience**	**Economic and social feasibility**	**No/ marginal increase of GHG emission**	
-	-	-	-	-	all farmers	15 US $	High	High	Yes	no increase (reduction)	Ideal for promotion in any area of the country (ideally combined with FYM)

7 CONCLUSIONS

The project implemented the demonstrations of the adaptation options at the farmers' field in close partnership with the farmers with technical support from the research institutes and other organizations. The project has been able to sensitize the farming community towards accepting the fact that the climate variability and change will further exacerbate their agricultural practices and other livelihood strategies in the four *barind* upazilas and that suitable adaptation measures need to be implemented to address the problem. Some positive results and effects are evident in the farming families at the end of the 1st phase of the project. The result obtained and lessons gathered so far are valuable for implementation of the adaptation options in the 2nd and 3rd phase of the project.

More than 292 demonstrations of 15 viable adaptation technologies were implemented in 5 seasons (Rabi 2005 to Kharif II 2007) in 4 project upazilas. The demonstrations of the adaptation options were implemented in the farmers' fields as per the seasonal cycle and the technical guidelines of the research institutes and organizations. Once the demonstrations were established in the farmers' field, they were followed-up and monitored on a regular basis by the responsible officers and field staff.

Table 50 summarizes the additional yield and resulting economic benefits received by the farmers from the adaptation technologies tested.[2] The additional yield gained from the implementation of the technologies demonstrated is substantial. The economic return from the sale value of the product from the adaptation technologies is also considerable.

Table 50: Summary of the additional yield and economic benefits received by the farmers from the adaptation technologies tested in their fields

Sl. No.	Name of the adaptation option/technology	Additional yield gained from the implementation of the technology (kg)/ha[3]		Additional economic benefit received from the implementation of the technology (BDT)/ha[4]	
		Irrigated village	Non-irrigated village	Irrigated village	Non-irrigated village
Agronomic management					
1	Dry seed bed method for raising rice seedlings	n/a	292	n/a	2922
Water harvesting					
2	Excavation of Mini pond (5mX5mX2m)	n/a	1697	n/a	16977
3	Excavation of Mini pond (10mX10mX2m)	n/a	1761	n/a	17616
Water use efficiency					
4	Impact of water saturated soil condition on rice cultivation	189	n/a	2167	n/a
5	Cultivation of Linseed	n/a	251	n/a	8452
Crop intensification					
6	Cultivation of short duration T. Aman as an alternative technology	n/a	387	n/a	3871
7	Cultivation of Chick pea after T. Aman	n/a	55	n/a	1481
Alternative crop/livelihood enterprise					
8	Establishment of Jujube garden (66 plants)	88	176	2635	5288
9	Homestead vegetable gardening	18572	26828	91860	132695
10	Cultivation of Papaya	650	1735	4137	11000
11	Cultivation of Maize	778	1557	5364	10728
12	Establishment of Mini nursery[5]	n/a	n/a	1229	2458
	Total	**20277**	**34739**	**107392**	**213488**

[2] The table does not show the results for all options tested: Jujube gardening (25 plants), mango gardening, mango orchard management were established in the Kharif-II season (July-October) of 2007 and the plants did not start producing fruits. Therefore, yield data could not be collected. Farm yard manure (FYM) was promoted to encourage farmers to use organic matter in the crop field. Yield performance of crops using the manure of the technologies was not assessed.

[3] Yield gain in unit area (ha) in comparison to the land in previous use/traditional practice.

[4] Income gain in unit area (ha) in comparison to the land in previous use/traditional practice.

[5] Yields from the nursery are not included in the table. In total, 107000 saplings and seedlings have been produced from 24 mini nurseries.

8 RECOMMENDATIONS FOR FUTURE PROMOTION AND REPLICATION OF THE ADAPTATION OPTIONS

Based on the farmers' feedback, assessment from the field level officers and response from the community people, which have been described in the previous chapters, a summary of the adaptation technologies is followed.

As per the over all assessment and conclusion jujube gardening, excavation of mini pond, homestead vegetable cultivation, T. Aman and chick pea cropping pattern and improved stove are among the most preferred adaptation technologies promoted by the project.

Recommendation for promotion and replication to the similar areas and upazilas are suggested based on the over all performance and acceptance ratings of the adaptation technologies. The suitability and the recommendation for further replication of the various adaptation options tested are presented below in Table 51.

8.1 Technical Robustness to Further Improve Adaptation Options

- At this stage of the project after having done field trials at various agro-ecological setting and diverse socio-economic groups of farmers, some innovative approaches of testing the options with a combination of practices are called for. Farmers could get a leverage of yield, economic benefits as well as climate change resilience by undertaking several adaptation options at the same time which are mutually supportive.

- The project believes in and maintains a living process of continually developing and updating the Adaptation Options Menu with technological practices.

- Climatic and other relevant data and information on salinity, soil nutrients, high-tide and low-tide from the local level, community, upazila agriculture office and local meteorological offices should be regularly collected and documented for use in the seasonal and other reports.

8.2 Methodological Aspects of the Adaptation Demonstration Process

- One of the major limitations was to record and interpret the climate and other environment related data and information in relation to the implementation of the adaptation demonstrations. Limited access to the data and information at the local level and ability to use, interpret the same have been remain a major tasks to be taken up in the next phase.

- Preparation and application of a complete monitoring process and tools for the 2nd phase (LACC-II) of the project will be critical to undertake periodic assessments of the project activities, results and impact.

- The monitoring process, tools and sheet/formats need to be tailor-made to all types of users from farmers to the field staff and project management unit. The data and information has to be documented and analyzed and information and derived knowledge has to be made accessible to a wider audience.

- Farmers perceived opinions about climate change and variability and their potential impact on the agricultural sector and other livelihood ventures and how the project promoted technologies are being suitably adapted in this condition need to be critically appraised to understand the qualitative change at the their level.

- An in-depth and thorough study of production, livelihood and marketing aspects, especially of those potentially affected by climate change, should be undertaken to establish a long term perspective especially for the area concerned.
- The options identified in the farming community should be based on the real need of the farmers and community and must be recommended for the field trial after rigorous process of validation with the experts and scientists that follows a bottom-up and top-down approach.
- A periodic or annual evaluation of the tested options, by farmers, community people, union representatives and upazila level officers, is needed for refinement and improvement of the option and recommendations regarding further expansion and adoption.

Table 51: Overview of Suitability and Recommendation for Replication

CCA Option	Suitable for replication under the following conditions					Primary target group	Investment costs for replication	Environ-mental benefits	Justification for replication			Recommendation (remarks)
	Farming System	Agro-ecological zone(s)	Hazard type and impact(s)	Water mgt system	Micro – topography/ terrain				Increase of CC resilience	Economic and social feasibility	No or marginal increase of GHG emission	
Dry seed bed method for raising rice seedlings	Rice-Wheat/ Pulse-Mango	25,26	Drought spells; loss of crops	Rain fed	High barind tract	Poor/ medium farmers	15 US $	High	High	Yes	No increase	Recommended for further trial with little changes in technology
Farm yard manure	Rice-Rice/ Wheat/ Pulse-Mango	25,26	Drought spells; loss of crops	Irrigated/ rain fed	High and low barind tract	Poor/ medium farmers	30 US $	High	High	Yes	No increase	Ideal as single option or combined with improved stove
Management of mango orchard	Rice-Rice/ Wheat/ Pulse-Mango	25,26	Drought spells; loss of crops	Irrigated	High barind tract	Medium/ wealthier farmers	50 US $	Medium	Medium	No	No increase	Not recommended
Excavation of mini pond	Rice-Wheat/ Pulse	25,26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	60 - 100 US $	High	High	Yes	No increase	Highly recommended as adaptation option
Impact of water saturated soil condition of rice cultivation	Rice-Rice/Wheat	25,26	Drought spells; loss of crops	Irrigated	High and low barind tract	Poor/ medium farmers with land ownership	60 US $	High	Medium	Yes	Marginal increase (use of energy irrigation)	Recommended as adaptation option with secured irrigation (from mini pond)
Cultivation of linseed	Rice-Wheat/ Pulse/Oils	25,26	Drought spells; loss of crops	Rain fed	High barind tract	Poor (share-cropper) farmers	20 US $	High	Medium	Yes	No increase	Highly recommended as adaptation option
Cultivation of short duration T. Aman as an alternative technology	Rice-Wheat/ Pulse	25,26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	90 US $	High	High	Yes	No increase	Highly recommended as adaptation option

Cultivation of chick pea after T. Aman	Rice-Wheat/ Pulse	25,26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	60 US $	High	High	Yes	No increase	Highly recommended as adaptation option
Homestead vegetable gardening	Vegetables/ fruit tree/ timber tree/ livestock/ Poultry	25,26	Drought spells; loss of crops	Irrigated/ rain fed	High and low barind tract	Poor/ medium farmers with land ownership	20 US $	High	High	Yes	No increase	Highly recommended as adaptation option
Jujube gardening	Rice-Wheat/ Fruit tree/ Fallow	25,26	Drought spells; loss of crops	Rain fed	High and low barind tract	Poor/ medium farmers with land ownership	25 - 60 US $	High	High	Yes	No increase	Highly recommended as adaptation option
Cultivation of papaya	Rice-Wheat/ Fruit tree/ Fallow/ Poultry	25,26	Drought spells; loss of crops	Irrigated/ rain fed	High and low barind tract	Small/ medium farmers with land ownership	130 US $	Medium	Low	No	No increase	Not recommended
Cultivation of maize	Rice-Rice/Wheat	25,26	Drought spells; loss of crops	Irrigated	High barind tract	Small/ medium farmers with land ownership	25 US $	No	No	Yes	No increase	Not recommended
Establishment of mini nursery	Rice-Wheat/ Vegetables/ Fruit tree/ Fallow	25,26	Drought spells; loss of crops	Irrigated/ rain fed	High and low barind tract	Poor/ small farmers with land ownership	125 US $	High	High	Yes	No increase	Recommended with assured water supply and market potential
Mango gardening	Rice-Wheat/ Vegetables/ Fruit tree/ Fallow	25,26	Drought spells; loss of crops	Rain fed	High barind tract	Small/ medium farmers with land ownership	225 US $	Medium	No	Medium	No increase	Not recommended
Improved stove	-	-	-	-	-	All category of farmers	15 US $	High	High	Yes	No increase	Ideal for promotion in any area of the country