LACC-II FINAL SYNTHESIS REPORT

LIVELIHOOD ADAPTATION TO CLIMATE CHANGE IN COASTAL AREA OF KHULNA AND DROUGHT PRONE HIGH BARIND TRACT AREA OF BANGLADESH

ON-FARM RESEARCH DIVISION (OFRD)
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
GAZIPUR-1701, BANGLADESH

JUNE 2009

LACC-II FINAL SYNTHESIS REPORT

LIVELIHOOD ADAPTATION TO CLIMATE CHANGE IN COASTAL AREA OF KHULNA AND DROUGHT PRONE HIGH BARIND TRACT AREA OF BANGLADESH (LACC-II, BGD/01/004/01/99): BARI-FAO COLLABORATIVE PROGRAM

By

M Yusuf Ali
M Badirul Islam
Sk Mostafa Zaman
M Shafiqul Islam
M Faruque Hossain
M Shakawat Hossain
M Musarraf Hossain
Proshanto K. Sarder

ON-FARM RESEARCH DIVISION (OFRD)
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
GAZIPUR-1701, BANGLADESH

JUNE 2009

Published by

On-Farm Research Division
Bangladesh Agricultural research Institute
Gazipur-1701, Bangladesh
June 2009

Financed by

Food and Agriculture Organization of the United Nations (LACC-II project)

Photographs and Planning

M Yusuf Ali

Design

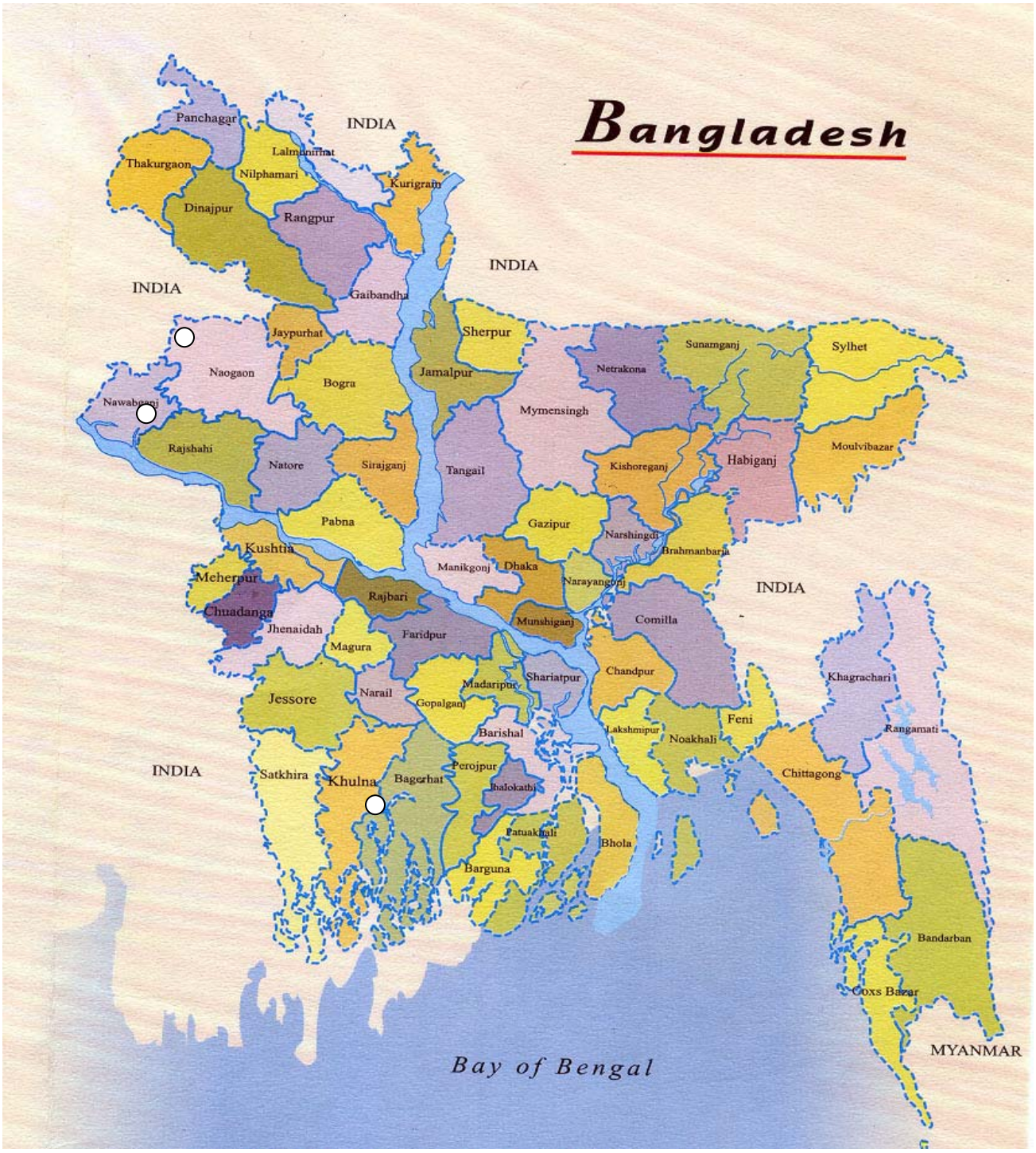
S M Obaidur Rahman

Citation

Ali, M.Y., M. B Islam. Sk. M. Zaman, M. S. Islam, M. F. Hossain, M. S. Hossain, M.M. Hossain and P.K. Sarder.2009. Livelihood adaptation to climate change in coastal area of Khulna and drought prone High Barind Tract area of Bangladesh. On-Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh.

Printed by

Suborna Printing Press
Munshipara Road, Gazipur



○ Three working locations: Nachole and Shapahar under droughty High Barind Tract and Laudove, Dakope, Khulna for coastal/saline area (not as per scale)

Program Summary

BARI started its adaptation research under LACC-II project at coastal/saline area of Laudove, Dakope Upzila of Khulna and at Nachole and Shapahar Upzila under drought-prone High Barind Tract (HBT) through three separate Focus Group Discussions (FGD) in May-June 2008.After selection of adaptation options homestead vegetable production started immediately with saline/excess soil moisture tolerant vegetables for coastal area. While drought tolerant and water efficient vegetables were selected for HBT area following Barind model. In coastal area several homestead vegetables were successfully produced through scientific management like making ridge and furrowing of bed. There was large participation of women in all the activities of home gardening –from land preparation to marketing at Laudove. Through utilization of different niches of homestead farm family succeeded to increase their vegetable consumption three to five folds more from the bench mark, though intake was below recommended level. Both women and male farmers reported improvement of their health related problems like eye-sight problem, constipation, skin diseases through intake of increased amount of fresh and nutritious vegetables. Economically homestead vegetable production was quite lucrative. Also social relationship of the farm family was improved with neighbors and relatives through free distribution of vegetables. However, farmers need more training and motivation on nutritional aspect associated with scientific management of homestead area. Kharif-I homestead vegetable production was hampered due to long and severe drought.

Short duration T.aman rice variety (cv.BINA dhan 4) was tested at Laudove for facilitating timely planting of rabi crops. It gave better yield and one month shortening of field duration was possible. Farmers kept most of the produced seed for next year cultivation. In post-rainy season (Rabi) different field crops were tested, such as relaying (for timely planting and avoiding of increased soil salinity) of mustard, wheat, cowpea and later on creeping crops like watermelon and sweet gourd. Among them cowpea, water melon and sweet gourd proved to be promising. In droughty area sole chickpea, mixed cropping of chickpea + barley and chickpea + linseed performed better under rainless non-irrigated conditions. Some problems of chickpea production were identified for optimizing yield. Yield of all the rabi dry land crops were low due to acute drought. Chickpea, barley and linseed could sequestrate more carbon deep into the soil because of their deep and prolific root systems.

For improving the adaptive capacity of farmer's different other programs were undertaken in HBT area like, vaccination of cattle, *Moringa* tree and bamboo bush management.

Alongside its own action program, BARI scientists actively helped Department of Agriculture Extension (DAE) for selecting adaptation options under LACC-II project across locations. Scientist from BARI also provided all types of technological back-up for BARI mandated crops/technologies.

LIVELIHOOD ADAPTATION TO CLIMATE CHANGE IN COASTAL AREA OF KHULNA AND DROUGHT PRONE HIGH BARIND TRACT AREA OF BANGLADESH

About 30 % area of Bangladesh belongs to coastal area which is regularly and recurrently battered by calamities like, cyclone, tidal bore/surge, inundation, intrusion of saline water etc costing thousand of lives and huge amount of properties (Amin et al. 2008). On the other hand main land like Barind area is affected by rabi, and kharif season drought resulting in crop failure/ low yield and loss of other livelihood factors (Brammer, 1999). It is assumed that global warming or climate change has a definite role on adverse climatic situations like cyclone, flood and drought. Both in coastal and Barind area large number of people depends on agriculture sector. Therefore, adaptation is important to cope with this changing climate. An array of adaptation measures were formulated in consultation with farmers, concerned researchers, extension personnel and other stakeholders along with careful review of available secondary information and previous experimental results. The adaptation options were experimented in a participatory manner in the farmer's field of Laudove, Dakope, Khulna (south-western area near Sunderban) representing coastal/saline area. While for droughty area options were tested at Nachole and Shapahar of High Barind Tract area under north-western Rajshahi region. On the basis of three focus group discussion (FGD) with the participation of different stakeholders several key problems and issues were identified (Appendices 1 and 2) and action programs were chalked out.

1. Adaptation to climate change in coastal/saline area of Khulna region

The tidal surge like SIDR has badly affected Sunderban and its adjoining areas. Over the years, (1973-2000) salinity of cultivable land of Khulna increased by 21 % (Islam et. 2008) mainly due to three reasons, viz. i) drastic deduction of sweet water flow from upstream in dry season, i.e. from the Padma (Ganges) and its tributaries, because of water diversion by India through Farakka barrage, ii) breaching of embankment by recurrent tidal surge/cyclone, iii) in some area artificial intrusion of saline water for shrimp cultivation by big fish businessmen in the cultivable land, popularly called "Gher". This is also called secondary salinity. This situation is changing the biodiversity of the vast area including crops and cropping patterns, trees, grasses etc., rendering a devastating impacts on health, livelihoods, and income of the farmers. The resource poor farmers and

fishermen are affected most. Thus coping with the changing climate is important through modern technology, crops/trees/ varieties/cropping systems/farming systems for the overall livelihoods improvements of farm community, particularly the resource poor.

1.1. Adaptation in Homestead of coastal area

On the basis of crop suitability against salinity in Rabi and Kharif-I seasons and excess soil moisture in Kharif-II season and farmer's preference the following year round homestead vegetable model was tested and recommended. Women farmer's choice was also considered, such as Tankuni (*Centella asiatica*, a medicinal plant cum vegetable)/Helencha (*Enhydra factuans*) was accommodated in the model for partially shady area cum excess moisture conditions. For open sunny space those rabi vegetables were selected which are tolerant at 4-6 dS/m salinity such as Knolkhol/Kholrabi(*Brassica oleracea*), Beet (*Beta vulgaris*), Spinach(*Beta bengalensis*) and Tomato ((Tisdale et al. 1997). In general salinity in homestead is low because of raised and modified soils. Commonly eight niches were observed in homestead area of Laudove, though some small homestead has less number of niches. Farmers were largely successful in producing both kharif and rabi vegetables (Table 1). Production per homestead was tree times more (120 kg) in rabi season than kharif (40 kg), because kharif-II production started late. Moreover kharif production was affected by excessive rainfall. Among the produced vegetables, farmers consumed 52 %, free distributed 18 % among relative and neighbor and sold 30 % for cash income, which they need for purchasing small items including children's book, pencil and other item. Most of the earned money was hold by women. There was significant improvement in kharif season vegetable intake (Table 2), more than five times (46 g/head/day) from the bench mark (8 g/head/day). Because of excessive soil moisture farmers produced only some creepers like ash gourd on roof top. But now through making ridged bed drainage of water has improved, and farmers were able to produce vegetables like amaranth, kangkong and Indian spinach. In rabi season also consumption of vegetable increased almost three times (92 g/head/day) from the base (32 g/head/day). On the average of 240 days, vegetable intake has increased more than three times(69 g/head/day) from the bench mark(20 g/head/day) through vegetable gardening, though it was far less than recommended requirement of 200 g/head/day for an adult. However, it is also a marked improvement for this remotely situated calamity affected island's poor people along side Sunderban (mangrove forest) where this type of endeavor is probably rare. In this island female has contributed more in homestead vegetable production (Table 3) from land preparation to intercultural managements except marketing. Because most of male partners are out of home for their livelihoods like fishing, Sunderban forest related business and other off/non farm activities. Economic analysis (Table 4) clearly showed that vegetable gardening is quite profitable bringing a gross margin of Tk. 1135/homestead costing only Tk 250/homestead (without family labor) with 4.54 benefit cost ratio (BCR). The amount of profit might be small but homestead vegetable gardening has a profound impact on family members' food habit, nutrition, consuming balanced diet in a carbohydrate (rice) dominated society (Table 5). Vegetable purchasing cost was reduced. It paved the path of obtaining safe vegetable at own homestead, as most of the commercially produced vegetable is sprayed with excessive systemic (long lasting effect) insecticides. Actually the program opened the path of major women

participation in all activities including meeting, training, field day and home gardening field works (Table 11). However, there are some limitations such as acute crisis of sweet water for vegetable cultivation in kharif-I season (February to May) and unavailability of quality seeds/seedlings.

Laudove Homestead Vegetable Model (for saline area of Khulna)

Niche 1: Sunny land (open space)

Bed 1: Knolkhol-Kangkong-Kangkong
Bed 2: Beet-Ladysfinger+ Red amaranth-Ladysfinger
Bed 3: Spinach-Indian spinach- Indian spinach
Bed 4: Tomato-Stem amaranth-Stem amaranth

Niche 2: On-roof

Roof-1: Bottle gourd-White gourd- White gourd
Roof-2: Sweet gourd-White gourd- White gourd

Niche 3: Trellis

Trellis-1: Bottle gourd-White gourd-Sponge gourd
Trellis-2: Country bean-Bitter gourd- Snake gourd

Niche 4: Partially shady area

CP-1: Moulavi Kaclu(aroid)- Moulavi Kaclu(aroid)- Moulavi Kaclu(aroid)
CP-2: Thankuni/Helencha- Thankuni/Helencha- Thankuni/Helencha

Niche 5: Marshy area

Panikachu (aroid)- Panikachu (aroid)- Panikachu (aroid)

Niche 6: On-tree support

Potato yam/Choi jhal- Potato yam/Choi jhal- Potato yam/Choi jhal

Niche 7: Home boundary/backyard

Local banana/Moringa- Local banana/Moringa- Local banana/Moringa

Niche 8: Home boundary fence

Country bean-Yard long bean- Sponge gourd

Table 1. Average production and disposal pattern of rabi and kharif season (240 days) vegetable per homestead at Laudove MLT site,Dacope, Khulna during Jul.2008- Feb.09

Season	Total production in240 days (kg)	Total own consumption (kg)	Own* consumption (g/head/day)	Free distribution (kg)	Sold (kg)	Total cash income (Tk)
Kharif	40.17	27.4	45.66	6.77	6.0	37.22
Rabi	120.1	55.20	92.00	22.30	42.6	405.4
All season total	**160.27**	**82.6(52)**	**68.83**	**29.07(18)**	**48.6(30)**	**442.62**

Figure in parenthesis indicates percentage. * Five members in family were considered

Table 2. Average intake of homestead vegetables of 10 farmers in kharif and rabi seasons at Laudove, Dakope, Khulna, Bangladesh during July 2008- February 2009

Season	Before intervention (g/head/day)	After intervention (g/head/day)
Kharif	8	45.66
Rabi	32	92
Total	**20**	**68.83**

*Considering only own production from homestead

Table 3. Average work distribution among the family members for the homestead vegetable production at Laudove MLT site,Dacope, Khulna during rabi and kharif season Jun.2008- Mar.09.

Name of practice	Male (%)	Female and children (%)
Land preparation	49	51
Sowing/planting	40	60
Irrigation	19	81
Intercultural operation	25	75
Harvesting	21	79
Marketing	70	30

Table 4.Economic return per homestead (240 days) at Laudove, Dakope, Khulna, 2008-09

Vegetable name	Average total production/ bed (kg)	Vegetable price (Tk/kg)	Gross return (Tk/bed)	Average production cost in Tk./ homestead (Without family labor)	Gross margin/ homestead (Tk)	Benefit cost ratio (BCR)
Knolkhol	26.8	10	268	250	1135	4.54
Beet	25	11	275			
Spinach	19	6	114			
Tomato	49.3	9.50	468			
Kangkong	12.55	7	88			
Okra	4.7	10	47			
Indian spinach	11.22	6	67			
Stem amaranth	11.7	5	58			
Total	160.27	-	1385			

Table 5. Visual impact of the vegetable gardening (not quantified for qualitative data) on the cooperating household members, Laudove, Dakope, Khulna, 2008-09

Sl. No.	Area of consideration	Impacts created
01.	Income and cost reduction	- Cash income increased though small amount but cost of vegetable purchasing was reduced significantly
02.	Family nutrition and health	- Consumption of vegetables increased - Positive change of consumption habit - Reduced disease infestation - No problem in eye-sight due to intake of more vegetable - No or less constipation - Visually health improved due to higher consumption of pest-free vegetable
03.	Resource use pattern	- Successful adaptation of new crops in saline environment - Homestead area utilized properly both kharif and rabi season - Farmers utilized all the available niches for vegetable production - Use of farm yard wastage
04.	Education and knowledge	- Increased knowledge of family members regarding vegetable cultivation and nutrition - Cultivation of vegetable in bed helped to reduce salinity and drainage in kharif season
05.	Social status	- Social status increased - Improved mental strength - Increased acceptability to people due to free distribution of vegetable among neighbor/relative
06.	Micro environment	- Household waste used for composting - New plantation improved environment
07.	Others	- Increased utilization of family labor
08	Women empowerment	- Active participation by women. In general women kept the sell proceeds of vegetable selling

Limitations

1. Lack of non-saline fresh water during dry season (January to May).
2. Soil salinity accompanied with drought, hot and humid weather due to recent climatic change make the situation more vulnerable.
3. Quality seed/seedling is not available in this island
4. Lack of awareness regarding modern vegetable production and nutrition

1.2. Adaptation in crop field of coastal area

Within the polder T.aman rice variety BR23 is the major crop. Is it is a photosensitive long duration variety , it took around 160 days, harvested in early December, thus timely planting/sowing of following rabi crops like mustard, wheat are delayed. Moreover yield level of BR23 is also comparatively low (400 kg/Bigha or 3t/ha). To facilitate the timely planting of succeeding rabi crops T.aman rice variety BINA dhan4 was introduced for the fist time. It was harvested within 5 November and grain yield (468 kg/Bigha or 3.5 t/ha) was 500 kg/ha higher than BR23 (Table 6).But after the harvest of T.aman planting/ relaying of mustard/cowpea/maize/wheat was not possible due to excessive water in the field. As there was enough rainfall in October, 2008 (Table 13), so relaying was possible in late November. But mustard was seriously affected by fog and aphid attack, producing zero yields. While maize growth was hampered by growing salinity during February –April (Table 12), it gave very small cobs and some plants also died. Cowpea had a very good germination and later stage growth was stunted due to excessive soil moisture. Observing this situation soil was opened with a spade to reduce soil moisture content. This operation works, and cowpea gave a reasonable yield (134 kg/Bigha, or 1t/ha) also it fetched good economic return (Table 9). Wheat germination was good, but growth was less due to excessive soil moisture, however it gave a reasonable yield (267 kg/Bigha or 2 t/ha) under zero tillage condition(Table 8), but its economic return (Table 9) was not so encouraging(only 605 Taka gross margin/Bigha with 1.17 benefit cost ratio). Crops such as sesame and mungbean were also tested but serious drought along with increase of soil salinity reduced its population below threshold level. It was also not possible to irrigate as sweet water source within polder was dried (pond/canal) due to long winter drought, on the other hand outside polder pond and river water was critically salty. Two creepers, water melon and sweet gourd were also plated in January. It survived well, also produced fruit though yield was not high (Table 10). Water melon gave 685 kg/Bigha (5.12 t/ha) fruit while sweet gourd yielded 557 kg/Bigha fruit (4.15

t/ha). Both water melon and sweet gourd has market in the locality. Water melon is exported to main land and brings cash income. Along with selling, sweet gourd is used as rainy season vegetable security, because it could be stored in house easily. Market price of both water melon and sweet gourd was a bit low due to late harvest, but it could be advanced by planting one month poly bag raised seedling. Both water melon and sweet gourd creeping vines and leaves worked as soil mulch which could effectively reduce soil evaporation and prevent rising of soil salinity. It needs small amount of water only in its base, which could be possible to supply from mini pond/Kuni or small canal within the polder. Thus making small pond at one side of a big plot is important to produce commercially viable crop like water melon. But it needs some investment. The experimentation suggests that cowpea, water melon and sweet gourd could be a viable adaptation options in post rainy season. However, testing of other field crops would continue with saline tolerant varieties along with appropriate management options for reducing soil salinity and drought.

Different adaptation options were evaluated by a good number of women farmers and other stakeholders. They opined that homestead gardening could be regarded as a successful avenue through scientific management and selection of appropriate vegetables. However, for success field crops more attention would be given to small scale water harvest. They were optimistic about short duration T.aman rice BINA dhan 4.

Table 6. Yield and yield attributing characters of T.aman rice at Laudove, Dakope, Khulna, a coastal saline area of Bangladesh during kharif season 2008

Crop	Field duration (days)	Plant ht. (cm)	Tillers/ hill (No.)	Panicle length (cm)	Grains/ panicle (No.)	1000-grain weight (gm)	Grain yield (kg/bigha)	Straw yield (kg/ bigha)
T.aman (BINA dhan-4)	130	115	18	24	120	26	468	428
Traditional T.aman BR 23	162	-	-	-	-	-	401	-

BINA dhan-4-harvested on 5 November, 2008, BR23 –harvested on 7 December, 2008

Table 7. Yield and yield attributing characters of zero-tillage cowpea after T.aman rice at Laudove, Dakope, Khulna, a coastal saline area of Bangladesh during rabi season 2008-09

Crop	Plant population/ m^2	Plant ht. (cm)	Pod/plant	Seed/pod	1000-grain weight (g)	Seed yield (kg/bigha)
Cowpea (BARI Falon-1)	16	70	9.00	9.00	80.	134

Date of sowing: 27 Nov, 2008

Table 8. Yield and yield attributing characters of zero-tillage wheat ater T.aman rice at Laudove, Dakope, Khulna, a coastal saline area of Bangladesh during rabi season 2008-09

Crop	Days to heading	Days to maturity	Spike /m^2	Plant ht (cm)	Spike length (cm)	Grains/ spike (No.)	1000-grain weight (g)	Grain yield (kg/ bigha)	Straw yield (kg/ bigha)
Wheat (var. Sourov)	66	105	207	69	9.38	31	36	267	309

Date of sowing-27 Nov, 2008

Table 9. Economic return from different rabi field crops after T.aman rice at Laudove, Dakope, Khulna during rabi 2008-09

Crops	Production cost (Tk/Bigha)	Gross return (Tk/bigha)	Gross margin (Tk/bigha)	BCR
Cowpea	1200	3350	2150	2.79
Wheat	3400	4005	605	1.17

Product price: Cowpea-Tk 25/kg, Wheat-Tk 15/kg

Table10. Yield and economic return from watermelon and sweet gourd after T.aman rice at Laudove, Dakope, Khulna, 2009

Crop	Area (Bigha)	Fruit yield (kg/Bigha)	Production cost (Tk/Bigha)	Gross return (Tk/Bigha	Gross margin(Tk/Bigha	BCR
Watermelon	0.5	685	2672	4112	1440	1.54
Sweet gourd	0.5	557	2405	3343	938	1.39

Seeding date: water melon- 8 March, 2009, Sweet gourd-8 March, 2009
Price: Watermelon-Tk. 6/kg, Sweet gourd-Tk. 6/kg

1 Bigha = 33 Decimal or 1320 m^2 1 US$ = Tk. 69/-

Table 11. Different activities under LACC-II project at Laudove, Dakope, Khulna, Bangladesh, July 2008- February 2009

Activities	**Date**	**No. of participant**	**Objective**
FGD	18 May, 2008	Total-30 (male-26, Female-4)	To identify Problems and prospect of agricultural activities (eg. crops, homestead, livestock's, fisheries etc) to mitigate the drought
Farmers' Training	9 June, 2008	Total-13 Male-1, Female-13	Training on Integrated homestead vegetable cultivation for adapting with climate change
Information sharing with farmers	30 August, 2008	23, Female-23	To share information with farmers regarding cultivation of short duration T.aman rice to avoid possible cyclone and to cultivate rabi crops timely
Training on winter vegetable cultivation	20 October, 2008	Total-33, male-19, Female-14	-To build awareness on nutrition -To provide hand on training on cultivating saline tolerant vegetable
Field day on early T.aman rice	05 November, 2008	Total-61, Male-43, female-18	-To show the benefits of early T.man rice(BINA dhan 4) -To relay different rabi crops with T.aman rice
Field day on homestead vegetable cultivation	11 January, 2009	Total-71, male-42, female-29	-To encourage modern way of vegetable cultivation -To disseminate the technology among non-cooperators
Project evaluation workshop	19 march, 2009	Total-59, male-37, female-22	-To know the farmers view about kharif and rabi action research program -To identify the bottlenecks and find solution

Table 12. Salinity level of crop field at Laudove MLT site, Dacope, Khulna during rabi and kharif season Jun.2008- Mar.09

Month	Salinity (dS/m)			
	10^{th}	20^{th}	30^{th}	Average
Jun.08	5.50	4.30	4.45	4.75
Jul.08	3.30	3.85	2.08	3.08
Aug.08	4.40	4.80	5.00	4.73
Sep.08	3.00	2.85	2.08	2.64
Oct.08	3.95	4.05	4.25	4.08
Nov.08	3.60	3.75	6.02	4.46
Dec.08	5.50	6.20	7.01	6.24
Jan.09	7.00	6.99	8.20	7.40
Feb.09	7.91	8.00	8.50	8.14
Mar.09	8.22	9.00	7.99	8.40

Table13. Weekly and monthly rainfall (mm), monthly average maximum and minimum temperature (^{0}C) and monthly average maximum and minimum humidity (% recorded at Khulna (January 2008-March2009).

Month	Rainfall (mm)					Temperature (^{0}C)		Humidity (%)	
	1st week	2nd week	3rd week	4th week	**Total**	Max.	Min.	Max.	Min.
Jan. 08	00	00	00	67	**67**	25.1	13.8	-	-
Feb.08	00	03	33	0	**36**	26.8	15.3	-	-
Mar.08	02	00	15	31	**48**	32.3	22.4	-	-
Apr.08	23	13	00	0	**36**	35.0	24.5	-	-
May.08	19	47	27	58	**151**	35.9	25.3	97	44
Jun.08	13	90	60	24	**187**	32.7	26.2	81	60
Jul.08	83	43	116	59	**301**	31.5	26.3	99	69
Aug.08	44	62	36	61	**203**	32.4	26.6	98	64
Sep.08	00	53	34	292	**379**	32.8	26.2	99	61
Oct.08	11	00	00	176	**187**	31.8	23.8	100	51
Nov.08	00	00	00	00	**00**	29.6	19.6	100	42
Dec.08	00	00	00	00	**00**	26.1	16.4	99	47
Jan. 09	01	00	00	00	**00**	26.2	15.2	100	40
Feb.09	00	06	00	00	**00**	29.4	16.9	100	31
Mar.09	00	02	00	08	**10**	32.2	21.1	98	31

2.1. Adaptation in homestead of droughty High Barind Tract (HBT) area

Following Barind model (Ali et al., 2007), homestead vegetable was cultivated at Nachole and Shapahar. However, production was less compared to other areas due to late start in kharif-II season and subsequent six months acute rabi and kharif-I drought. Despite the effect of drought it succeeded to provide better vegetable and nutrition security to family members with a very minimal production cost. Among the two sites of HBT area, Shapahar farmers produced markedly more (137 kg/homestead) than Nachole farmers (83 kg/homestead). On the average (Table 14) 77 % was consumed, 15 % was free distributed among relative and neighbor and rest 15 % was sold for cash income. Before intervention per head/day vegetable intake was only 24 gram.

Through homestead gardening it was elevated to 64 g/head/day (Table 15), though it was far less than requirement. However, farmers got some vegetable from locally grown drought tolerant *Moringa* tree. Finding its important management options on Moringa tree has undertaken along with planting of new Moringa garden (Appendix 4). For managing drought importance must be given on water harvest and water shed management along with selection of more water efficient and drought tolerant vegetables like creepers. Because water could be a more scarce resource in this area, as underground water table is going down in Barind area due to over exploitation for boro rice production (Sevaraju et al. 2006). For home gardening women have the major role in intercultural operations, harvesting and cooking, while male has a major role in land preparation and sowing (Table 16). Economically homestead vegetable production is quite profitable in both locations of HBT (Table 17 and 18) with a marginal production cost having 2.89 to 3.28 benefit cost ratio. As family labor is utilized for its production, cost is only seed and manure/fertilizer. Women and children gave time with high enthusiasm. Malnutrition is widespread among the poverty gripped children in Barind area. As vegetable production is far less than other floodplain areas, thus it cost is also higher, which the poor farmers cannot afford. As a consequence, symptoms like lip side and tongue rupture, eye sight problem, constipation and other skin diseases are quite visible among children even among elders, particularly in winter. Many farmers and housewives have reported to us that increased consumption of vegetable from home garden has relieved them form these types of symptoms and diseases (Table 19). Thus homestead gardening though a small enterprise, yet it has role for all the family members including women, men and children. Particularly supply of safe vegetable is ensured by themselves from own homestead.

Table 14. Average production and disposal pattern of homestead vegetable of 10 farmers at two different Upazila of Barind area, Rajshahi, Bangladesh, July 2008- February 2009

Location	Total production in 240 days (kg)	Total own consumption (kg)	Own consumption (g/head/day)	Free distribution (kg)	Sold (kg)	Total cash income (Taka)
Nachole	83.00	66.00	55.00	14.73	2.27	23/-
Shapahar	137.00	87.26	72.71	18.74	31.00	310/-
Mean	**110.00**	**76.63(70)**	**63.85**	**16.73(15)**	**16.63(15)**	**166.50/-**

Figure in parenthesis indicates percentage. * Five members in family were considered

Table 15. Average intake of homestead vegetables of 10 farmers at two different Upazila of Barind area, Rajshahi, Bangladesh, July 2008- February 2009

Location	Before intervention (g/head/day)	After intervention (g/head/day)
Nachole	25.00	55.00
Sapahar	22.50	72.71
Mean	23.75	63.85

Table 16. Average work distribution (%) among the family members for the homestead vegetables production, High Barind Tract(Nachole and Shapahar), Bangladesh 2008-09

Operations	**Men**	**Women and children**
Land preparation	94	6
Seed/seedling sowing	62.50	37.50
Intercultural operation	22.50	77.50
Harvesting	6.50	93.50
Cooking	0	100
Marketing	82.50	17.50

Table 17. Economic return per homestead at Naclole, Nawabjang, during 2008-09

Vegetables name	Average total vegetable production (kg/bed)	Vegetable price (Tk./kg)	Gross return (Tk.)	Average production cost in Tk./homestead (Without family labor)	Gross return /homestead (Tk.)	Benefit cost ratio (BCR)
Red amaranth	6.5	8	52	255.00	737.35	2.89
I. Spinach	9.2	8	73.6			
Kangkong	6.4	7	44.8			
Katoa	4.95	6	29.7			
Spinach	5.23	11	58			
Radish	9.95	9	89.55			
Brinjal	4.53	21	95.13			
Bush bean	3.16	17	53.72			
Bottle gourd	15.05	9	135.45			
Country bean	18.02	20	360.4			
Total	83	-	992.35	-	-	-

Table 18. Economic return per homestead at Shapahar, Naogaon, during 2008-09

Vegetables name	Total vegetable production (kg/bed)	Vegetable price (Tk./kg)	Gross return (Tk.)	Average production cost in Tk./homestead (Without family labor)	Gross return /homestead (Tk.)	Benefit cost ratio (BCR)
Red amaranth	12	10	120	305.00	1002.50	3.28
I. Spinach	8.85	10	88.50			
Kangkong	14.30	8	114.40			
Katoa	13.30	8	106.40			
Okra	4.30	15	64.50			
Spinach	10.90	8	87.20			
Radish	13.50	10	135.00			
Bush bean	3.80	12	45.60			
Batishak	11.30	8	90.40			
Bottle gourd	25.60	10	256.00			
Country bean	19.30	15	199.50			
Total	137	-	1307.5	-	-	-

Table 19. Visual impact of the vegetable gardening (not quantified for qualitative data) on the cooperating household members, High Barind Tract (Nachole and Shapahar) 2008-09

Sl. No.	Area of consideration	Impacts created
01.	Income and cost reduction	- Cash income increased though small amount but cost of vegetable purchasing was reduced significantly
02.	Family nutrition and health	- Consumption of vegetables increased - Positive change of consumption habit - Reduced disease infestation - No problem in eye-sight due to intake of more vegetable - No or less constipation - No rupture of lip side and tongue due to increased intake of vegetable - Visually health improved due to higher consumption of pest-free vegetable
03.	Resource use pattern	- Introduction of new water efficient crops - Homestead area utilized properly including use of all niches - Use of farm yard wastage
04.	Education and knowledge	- Increased knowledge of family members regarding modern vegetable cultivation and nutrition
05.	Social status	- Social status increased - Improved mental strength - Increased acceptability to people due to free distribution of vegetable
06.	Micro environment	- Household waste used for composting - New plantation improved environment
07.	Others	- Utilization of family labor increased
	Women empowerment	- Active participation from women. Mostly women kept the sell proceeds of vegetable selling

2.2. Adaptation in crop field of High Barind Tract

On the basis of secondary information and FGD field crops were selected. The drought tolerant, deep rooting, low water requiring crops like chickpea, barley and linseed (Ali et al, 2007) were selected for growing under rainfed conditions. Wheat was selected because it requires minimal (two) supplementary irrigation which could be supplied from big pond. It may be mentioned that for production of one kg wheat 1000 liter water is needed whereas boro rice requires 3000 liter water for production of one kg rice (Ali et al, 2008). Chickpea was grown as sole crop or as mixed cropping with barley or linseed to facilitate better utilization of soil nutrients, moisture, sunlight and space.

However, yield of all the dry land crops were comparatively less because of serious drought during November to April. Moreover in 2008 there was low rainfall (Table 26) , thus amount of residual soil moisture was also low. Hence, chickpea, linseed and barley crop growth was below optimum level resulting in lower yield (Table 20, 21 and 22). However, mixed cropping of chickpea with barley produced better yield at Nachole, might be due to complimentary combination along with deep and prolific root systems of barley (Ali et al. 2007). However, other possible reasons of low yield of chickpea was identified by close observation of chickpea field and subsequent soil chemical analysis. Low pH (below 5.5) of some field rendered molybdenum deficiency along with very low soil organic matter (around 0.8%) caused poor growth and yield of chickpea. Generally legume crop like chickpea needs >5.5 soil pH. Small amount of molybdenum application could increase chickpea yield significantly (Johansen et al, 2008). Long foggy weather during day time for more than one month could have hampered normal photosynthesis resulting in yield reduction. This is also applicable for wheat and other winter crops.

Wheat yield was moderate at Nachole (347 kg/Bigha or 2.6 t/ha) and at Shapahar it produced only 267 kg/Bigha or 2.2 t/ha (Table 23). Economic analysis (Table 24 and 25) suggests that chickpea and its mixed cultivation with barley and linseed was quite profitable compared to wheat, because of lower production cost and higher market price of chickpea. Across locations wheat gave 1.18-1.37 benefit cost ratio (BCR), whereas sole

chickpea had 2.45-2.68 BCR, chickpea+barley fetched 3.43 BCR and chickpea +linseed gave 2.38 BCR. Thus as a dry land crop chickpea, linseed and barley has more prospect for coping with drought and climatic change because of their low water requirement (except germination) and deep and prolific root systems. Also above three crops could sequestrate more carbon deep into the soil through deep and prolific root systems.

Table 20 .Pilot production program of chickpea under Chickpea-T.aman cropping pattern, High Barind Tract, Rajshahi, 2008-09

Parameter	Nachole	Shapahar	Effect of drought
Date of sowing	24-26 Nov., 2008	25-30 Nov., 2008	During chickpea growing period (November-march) almost there was no rainfall; moreover often deep fog hampers photosynthesis of the crop. Additionally there was small rainfall in October, that is residual soil moisture storage was low, resulting in low growth of chickpea crop
Date of harvest	24-26 Mar., 2009	30 Mar., 2009	
Field duration (days)	119	120	
Plant population/m2	17	37	
Plant height (cm)	30	36.7	
No. of pod/plant	24	30.5	
No. of seed/pod	1.3	2.0	
Grain yield (kg/Bigha)	73	82	
Biomass yield (kg/Bigha)	77	80	

20 Bigha in each location

Table 21. Pilot production program of mixed cropping of chickpea with barley (20 %) under Chickpea + barley-T.aman cropping pattern, High Barind Tract, Nachole, Nawabjang, 2008-09

Parameter	Chickpea	Barley	Effect of drought
Date of sowing	18 Nov.2008	18 Nov., 2008	During crop growing period (November-march) almost there was no rainfall, moreover often deep fog hampers photosynthesis of the crop. Additionally there was small rainfall in October, that is residual soil moisture storage was low, resulting in low growth of chickpea crop
Date of harvest	26 Mar., 2009	26 Mar., 2009	
Field duration (days)	128	128	
Plant population/m2	13	04	
Plant height (cm)	47	67	
No. of pod/plant No. spikelet/panicle	42	18	
No. of seed/pod No. of grains/panicle	1.2	54	
Grain yield (kg/Bigha)	107	40	
Biomass yield (kg/Bigha)	93	60	

3 Bigha block

Table 22. Pilot production program of mixed cropping of chickpea with linseed under Chickpea + linseed -T.aman cropping pattern, High Barind Tract, Shapahar, Naogaon, 2008-09

Parameter	Chickpea	Linseed	Effect of drought
Date of sowing	27 Nov.2008	27 Nov., 2008	During crop growing period (November-march) almost there was no rainfall, moreover often deep fog hampers photosynthesis of the crop. Additionally there was small rainfall in October, that is residual soil moisture storage was low, resulting in low growth of chickpea crop
Date of harvest	30 Mar., 2009	30 Mar., 2009	
Field duration (days)	123	123	
Plant population/m2	32	60	
Plant height (cm)	34.2	66	
No. of pod/plant No. spikelet/panicle	29	23.6	
No. of seed/pod No. of grains/panicle	2	8.2	
Grain yield (kg/Bigha)	80	10	
Biomass yield (kg/Bigha)	72	14	

3 bigha block

Table 23. Pilot production program of Wheat under Wheat-T.aman cropping pattern, High Barind Tract, Rajshahi, 2008-09

Parameter	Nachole	Shapahar	Effect of drought
Date of sowing	24 Nov.2008	18 Nov., 2008	During crop growing period (November-march) almost there was no rainfall, moreover often deep fog hampers photosynthesis of the crop. Additionally there was small rainfall in October, that is residual soil moisture storage was low, resulting in low growth of chickpea crop
Date of harvest	25 Mar., 2009	22 Mar., 2009	
Field duration (days)	120	123	
No. of effective tiller/m2	241	251	
Plant height (cm)	92	95.2	
No. spikelet/panicle	18	14.1	
No. of grains/panicle	33	34.8	
Grain yield (kg/bigha)	347	296	
Biomass yield (kg/bigha)	681	-	

3 bigha block

Table 24. Economic return from different rabi crops after T.aman rice at Nachole, High Barind Tract during rabi 2008-09

Crops	Production cost (Tk/Bigha)	Gross return (Tk/bigha)	Gross margin (Tk/bigha)	BCR
Sole chickpea	1100	2695	1595	2.45
Chickpea+Barley	1250	4285	3035	3.43
Wheat	4008	5505	1497	1.37

Table 25. Economic return from different rabi crops after T.aman rice at Shapahar, High Barind Tract during rabi 2008-09

Crops	Production cost (Tk/Bigha)	Gross return (Tk/bigha)	Gross margin (Tk/bigha)	BCR
Sole chickpea	1100	2950	1850	2.68
Chickpea+Linseed	1270	3029	1759	2.38
Wheat	4008	4740	732	1.18

Biomass return included in both Nachole and Shapahar> Product price in both location: Chickpea-Tk 35/kg, Barley-Tk 10/kg, Wheat-Tk 15/kg, Linseed-Tk 15/kg

Table 26. Twelve years (1998- May 2009) monthly rainfall (mm) of Rajshahi, Bangladesh

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1998	12	5	51	33	129	92	436	276	280	208	33	0	1555
1999	5	8	25	9	144	348	347	310	502	155	108	0	1961
2000	4	7	27	136	200	244	117	191	642	85	0	0	1653
2001	0	4	9	13	214	324	337	211	97	185	1	0	1395
2002	11	1	21	111	195	223	316	240	281	49	11	0	1459
2003	2	19	64	44	84	280	238	131	262	293	0	8	1425
2004	10	0	0	63	85	503	305	217	361	152	0	0	1696
2005	13	1	101	34	106	92	493	147	115	268	0	0	1370
2006	0	0	7.4	37.2	191.2	189	120.4	217.8	304	35.2	10.4	0	1112.6*
2007	0	26.6	59.4	54	125.6	309.6	325	235.7	306.9	75.4	0.6	0	1518.8
2008	25	0.6	0.4	22.4	131.6	256.9	221.5	245.5	127.5	127	0	0	1158.4*
2009	1	7	27.9	0	-	-	-	-	-	-	-	-	-
Mean	**6.92**	**6.60**	**32.76**	**46.38**	**145.95**	**260.14**	**295.99**	**220.18**	**298.04**	**148.42**	**14.91**	**0.73**	**1482.16**
SD (±)	**7.57**	**8.26**	**30.54**	**40.68**	**46.97**	**116.99**	**116.53**	**51.69**	**163.98**	**85.24**	**32.46**	**2.41**	**240.05**

*Exceptionally high rainfall year. ** Exceptionally low rainfall year , i.e. drought.

- High standard deviation (SD) indicates uncertainty of monthly rainfall

Table 27. Five years (2005 - May 2009) average temperature (^{0}C) of Rajshahi, Bangladesh

Month	2005		2006		2007		2008		2009	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
January	9.4	26.4	6.5	29	6.2	18.3	11.09	23.74	12.35	24.49
February	8.9	33.2	12.8	35.4	10.6	30.5	11.96	25.59	12.56	29.45
March	15.2	36	13.7	39.6	11.9	37.5	20.12	33.03	17.96	33.39
April	18.9	38.6	20	38.8	18.5	39	23.07	36.33	23.89	37.44
May	19.4	39.8	21	39	20.9	39.2	24.25	35.43	-	-
June	24	42.4	22.5	36.8	25.59	33.77	25.71	32.64	-	-
July	24	34	25.2	36.4	26.05	32.45	25.98	31.95	-	-
August	24.2	35.5	25.2	35.8	26.56	33.17	26.37	32.77	-	-
September	23.4	36.2	24	35.5	26.06	32.85	25.84	32.24	-	-
October	19	33	21.7	34.6	23.29	31.9	22.56	31.79	-	-
November	14	31.4	10.4	31.5	18.45	29.75	16.55	29.59	-	-
December	10.2	27.8	9.7	27.4	11.54	25.42	15.04	25.01	-	-
Mean	**17.55**	**34.53**	**17.73**	**34.98**	**18.80**	**31.98**	**20.71**	**30.84**	**-**	**-**

2.3. Improved livestock management for livelihood adaptation in High Barind Tract

Livestock (poultry, goose, goat. sheep, cow and buffalo) is an integral part of farm family's livelihoods. It not only provides draft power, meat, and milk or cash income by selling, but its dung is used as manure for fertilizing crop field/homestead and also used as fuel (dung cake). Moreover, many landless and marginal farmers major income source is grazing of cattle, goat and sheep in the Barind area. However, village area livestock is generally out of modern veterinary care, which makes it vulnerable to deadly diseases. Thus loss of birds and animal has a tremendous negative impact on the poor farmer's

livelihood. Therefore, to create farmers awareness vaccination program was arranged with the help of local veterinary doctor against major diseases. Both in Nachole and Shapahar 411different birds and animal were vaccinated Table 26 & 27).

Table 26. Livestock improvement program under LACC-II, Nachole, Nawabjang, 2008

Activities	Number of Cooperators	Date of vaccination	No. of animal vaccinated	Name of vaccine
Vaccination of Poultry	35	03.09.2008	285	RDV & Duck Plague
Vaccination of Goose	25	do	63	do
Vaccination of Goat	10	do	15	PPR
Vaccination of Cattle	25	do	13	FMD & Anthrax
De-worming of cattle	10	do	35	-
	Total =		**411**	**-**

Table 27. Livestock improvement program under LACC-II, Shapahar, Noagaon, 2008

Activities	Number of Cooperators	Date of vaccination	No. of animal vaccinated	Name of vaccine
Vaccination of Poultry	25	06.08.2008	156	RDV & Duck Plague
Vaccination of Goose	10	do	55	do
Vaccination of Goat	15	do	20	PPR
Vaccination of Cattle	32	do	160	FMD & Anthrax
De-worming of cattle	12	do	50	-
	Total =		**441**	**-**

Table 28. Different activities under LACC project at two different Upazila of Barind area, Rajshahi, Bangladesh, July 2008- February 2009

Location	Activities	Date	No. of participant	Objective
Nachole	FGD	05.06.2008	27	To identify Problems and prospect of agricultural activities (eg. crops, homestead, livestock's, fisheries etc) to mitigate the drought
	Farmers' Training	03.07.2008	25	Training on Integrated Farming Systems for adapting with climate change
	Meeting with farmers	13.04.2009	15	To collect information about non-bearing of drumstick pod in current season at Bashbaria, Nachole due to environmental variation
Sapahar	FGD	04.06.2008	22	To identify Problems and prospect of agricultural activities (eg. crops, homestead, livestock's, fisheries etc) to mitigate the drought
	Farmers' Training	02.07.2008	25	Training on Integrated Farming Systems for adapting with climate change

3. Publications of booklet/poster for farmers and other stakeholders

Two technology booklets in Bengali language (1.Intensive cultivation of homestead vegetable; 2.Miracle and drought tolerant tree-Moringa: production technology, nutrition and utilization) are on the process of publishing along with one four colored poster on Moringa-its role on reducing malnutrition and diseases. Final synthesis report is also on the process of publication. All those publications would be distributed among the project area farmers and other stakeholders.

4. Manpower placement, logistic support and collaboration

Two scientific Assistants have been placed at both Nachole and Shapahar and three at Laudove, Dakope, Khulna for successful conduction of action research and pilot program under LACC-II project. Scientists from BARI, Gazipur and local office Scientists regularly visited and shared with the farmers on adaptation to climate change and attended different programs. BARI provided all types of logistic support like vehicle, motor cycle, telephone, scientific instruments and site level office room etc. From the planning to execution stages local DAE officers, SAAO and FOM (FAO) were involved along with the farmers. Dr Stephan Baas, Lead Technical Officer, LACC-II project, FAO, Rome, Italy and other consultants and Sub-component Manager of LACC-II, DAE visited OFRD, BARI office, Gazipur for discussion and collaboration.

5. Participation in workshop

OFRD, BARI scientists participated and presented BARI developed technologies for managing drought and salinity in the context of climate change, based on 25 years of experience, research & development works in the High Barind Tract and coastal areas in the workshops. The Focal Point Scientist has regularly attended National Validation Workshop organized by LACC-II, DAE, and all other meetings organized by FAO or DAE and had given valuable suggestions regarding adaptation options. Besides, The Focal Point Scientist has attended as resource speaker in two training courses on climatic risk management in Agricultural sector, organized by DAE. Moreover, The Focal Point Scientist has validated and modified adaptation options of LACC-II, DAE through dozens of E-mail.

6. Visit of the project area by the BARI scientist and field workers

Nine different levels of BARI scientists and field workers including its Director for Research (Dr M Azizur Rahman) visited the project areas 150 times (cumulative) since the inception of works from May, 2008 to May, 2009. Different levels of DAE officials, NGO personnel and farmers group visited the project sites.

References

Ali, M. Y., M. A. Rahman, M. A. Quayyum and M. B. Islam. 2007. Improved adaptive capacity to climate change for sustainable livelihoods in the agricultural sectors-The case of High Barid Tract: BARI-FAO collaborative program. On-Farm research Division, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh.

Ali, M. Y., S. Ahmed, C. Johansen, D. Harris and JVDK Kumar Rao.2007. Root traits of different crops under rainfed conditions in the High Barind Tract of Bangladesh. J.Plant Nutr.Soil Sci, 170: 296-302.

Ali, M. Y., S. R. Waddington, D. Hodson, J. Timsina and J.Dixon. 2008. Maize-rice cropping systems in Bangladesh: status and research opportunities. Mexico, D. F.: CIMMYT, P. 5.

Amin, M., M. A. Rahman, S. M. Zaman, M. I. A. Howlader, M. Z. Hossain and M. S. Islam. Cropping system in coastal and Barind area. Paper presented in National workshop on Multiple Cropping, held at BARC, Farmgate, Dhaka on 23-24 April, 2008.

Brammer, H. Agricultural disaster management in Bangladesh.1999. University Press Limited. pp. 273-74, 331.

Islam, M. B., M. Y. Ali, M. Amin and SK. M. Zaman 2008. Climatic variations: Farming systems and livelihoods in the High Barind Tract and coastal areas of Bangladesh. Paper presented

in the international symposium on climate change and food security in South Asia held on 25-30 August 2008, Dhaka, Bangladesh.

Johansen, C., A. M. Musa, J. V. D. K. Kumar Rao, D. Harris, M. Y. Ali, A. K. M. Shahidullah and J. G. Lauren. 2008. Correcting molybdenum deficiency of chickpea in the High Barind Tract of Bangladesh. J.Plant Nutr.Soil Sci, 170: 752-761

Sevaraju, R., A.R. Subbiah, S. Baas and I. Juergens. 2006. Livelihood adaptation to climate variability and change in drought-prone areas in Bangladesh. Asian Disaster Preparedness Centre and Food and Agriculture of the United Nations, Rome. pp.2, 21.

Tisdale, S. L., W.L. Nelson, J.D. Beaton and J.L.Havlin.1997. Soil fertility and fertilizers. Fifth edition. Pub. by Prentice-Hall of India Pvt. Ltd. New Delhi-110001, pp. 396-400.

7. Expenditure Statement

Sl No.	Description of activities	Budget provision (Taka)	Budget Received (Taka)	Expenditure (Taka)	Balance
1	Contribute to development of adaptation option menus	170,875	128156	128156	Nil
2	Participation at workshop etc	34,175	25156	25156	Nil
3	Field level demonstration and meeting	205,050	153788	153788	Nil
4	Training material	68,350	51263	51263	Nil
5	Travel	68,350	51262	51262	Nil
	Total	**5,46,800**	**4,10,100**	**4,10,100**	**Nil**

Rest BDT 136700/- is to be released by FAO immediately for funding the printing of final synthesis report, 2 technology booklets and one poster along with other associated costs.

Appendices

1. Focal Group Discussion (FGD) under LACC-II project was held at Laudove Union Parisad, Dakope, Khulna on 18 May, 2009, organized by OFRD, BARI, Daulatpur, Khulna

A FGD was organized at Laudove Union Parisad office of Dakope Upzila of Khulna on 18 May, 2009 by On-Farm Research Division (OFRD) of Bangladesh Agricultural Research Institute (BARI), Daulatpur, Khulna on LACC-II Project. A lively discussion was held in context of livelihood adaptation to climate change in the agriculture sectors particularly in response to salinity and fierce coastal environment. Male and women farmers, local leaders, representatives of different development partners from GO and NGO attended and participated in the FGD (list enclosed). The following problems and prospects came out from the discussion:

- Soil salinity increases from February and continue up to May i.e. till the onset of monsoon
- Late release of land from T.aman rice due to cultivation of long duration rice like BRRI dhan 23 delays the planting of rabi crops
- In general yield of T.aman rice (BRRI dhan 23) is only 10-12 maunds /Bigha
- Sweet water crisis in rabi season hampers cultivation of rabi crops
- Serious crisis of natural grass and other fodder for livestock particularly after the Sidre of November, 2007.
- Siltation of natural canal where rain water could be stored, so excavation is essential
- Leasing of big canal to big shrimp businessmen, they are making intrusion of saline water to crop land of common farmers
- For control of salinity and crop cultivation leasing provision of big canals from government department should be cancelled
- All silted canals should be excavated for preserving rain water, by this water irrigation in rabi crops could be ensured
- Need technology on de-salinization of shallow tube-well lifted water in a reservoir for subsequent irrigation to rabi crops
- Presently irrigation in watermelon and other vegetables is applied from 6-7 feet deep dug-well which is very laborious, mainly lifted manually by women by bucket/pitcher
- There are scope of three crops/year where sweet water is available (such as Boro/vegetable-Aus.rice- T.aman)
- Creation of market facilities/export of vegetables and watermelon to mainland is important for getting reasonable price

However, despite difficulties of crop production in rabi season farmers of Laudove are cultivating different field crops (mainly creeper) in small scale with dug-well water and under rainfed conditions:

- Water melon
- Bitter gourd
- Sweet gourd
- Ribbed gourd
- Ladies finger
- Chilli
- Sesame
- Also relaying Aus rice with water melon, sweet gourd and chilli/sesame
- Bee keeping near Sunderban area (few person is involved)

Homestead: In homestead farmers are sporadically growing few vegetables and fruits. But vegetation is less in homestead, i.e. homestead is under-utilized

- Some creeper like white gourd, bottle gourd, sponge gourd
-Naturally grown medicinal plants like Thankuni, Helencha

Livestock: Except an Artificial Insemination (AI) centre in adjacent union, service from government livestock service as well as from NGOs is almost absent due to poor communication and natural hazards like cyclone and flood. However, there are scope of ram rearing, duck in few place, cattle fattening, UMS, cultivation of grass, de-worming of cattle

Fisheries: Except shrimp cultivation by big businessmen modern technology is yet to be disseminated. But there are scope of pond fisheries along with rearing of natural fish like Koi, Sing, Magur, Takii and Soal in canals/natural depression

After a discussion with farmers and on the basis of previous experimental results conducted in farmers field by OFRD, BARI, Khulna at Laudove the following pilot program/adaptive trials will be conduction from Khaif-II and Rabi seasons of 2008-09.

Programs for Kharif-II-08 and Rabi. 2009

Homestead vegetable cultivation- 10 household (vegetable patterns will be finally selected after preliminary trial and based on farmers choice and market price)

Niche/ecosystem	**Vegetable**
Sunny area	-Kangkong (Gima Kolmi), -Indian spinach, -Ladies finger, -Stem amaranth
Shady area	- Mankachu (aroid) -Moulovi kachu (aroid) -Helencha/Thankunhi
Marshy area	Panikachu (aroid)
Tree support	Sponge gourd Ash gourd Potato yam
Trail	Bottle gourd Sweet gourd Country bean
On house roof	Ash gourd Sweet gourd
House boundary fence	Yard long bean/country bean Sponge gourd
House boundary/backyard	Napier grass/cowpea Local banana
Fruit tree	Sapota, mango, coconut, lemon, Apel kul, hog plum, One bunch of chewing sugarcane (Gandari)/house
Field crop	
Kharif II	**Rabi**
T.aman (BINA dhan 4) (Preferably 10 bigha block)	-Relay mustard - Minimum tillage wheat -Dibbling maize - Cowpea (BARI Fallon-1) - Sweet gourd (BARI sweet gourd 1) -Water melon(seedling raised in poly bag)

Major cropping patterns and fallow area in different season in Dakope Upzila, Khulna

Cropping pattern	Area (%)	Fallow/seasonal fallow land (ha)			Remarks
		Rabi	Kharif-I	Kharif-II	
Fallow-Fallow-T.aman	56	18550	11905	630	Rabi and Kharif-I fallows are mainly due to sweet water crisis and other reasons
Fallow-Fish-T.aman	40.15				
Fallow-Water melon/sesame – T.aman	0.83				
Vegetable-Fallow-T.aman	1.50				
Potato-Fallow-T.aman	0.50				
vegetable-Vegetabe-vegetable	0.77				
Vegetable-Vegetable-T.aman	0.25				

List of participants in FGD on LACC-II project, Dakope, Khulna, 18 May, 2008

SI. No	Name and Address
01.	Dr. M. Yusuf Ali, Principal Scientific Officer, On-Farm Research Division, BARI, Gazipur.
02.	Sheikh Mostafa Zaman, SSO, OFRD, BARI, Khulna
03.	Mr. Monohar chandra Mondol, Farmer, Village- poschim dhanmari dacope, khulna.
04.	Honerdra Nath sarkar, Upazilla fisheries Officer, Dacope, Khulna
05.	Sk Jubaraj Chairman Laoudove Union Parishad Dacope, khulna.
06	Diopendra chandra sarkar, Field Officer (Monitoring), FAO, Representation in Bangladesh.
07	Nirebindir Golder, Agri-Extension Officer,dacope, khulna
08.	John Byapari (Program officer), Jaudob ADP, World Vision BGD, dacope, khulna.
09.	Bijan kumar Roy Sub Assistant Agri Officer, Laudove Block dacope, khuna.
10	Krishna padob Bachhar, Farmer, Village-Laudove, dacope khuna.
11	Monoj kanti Roy, Farmer, Vill- Amtala, Banishanta, Dacope, Khullna
12.	Kallyani Mondol, Farmer, Vill- Khutakhali, Laudove, Dacope, Khulna
13	Sumon Saha, Supervisor, Bangladesh Najarine Mission
14.	Gazi Fazlur Rahman, UP Member, 3no , Laudove UP Dacope, Khulna
15.	Tarun Mondol, Farmer, Vill- Khutakhali, Laudove, Dacope, Khulna
16	Bivash sarker, Farmer, Vill-Kalika bati , Laudove, Dacope, Khulna
17	Shilpi Mondol , Farmer, Vill- Dhopadi, Koilashgonj, Dacope, Khulna
18	Ashok Sarker , Farmer, Vill- Bajua, Dacope, Khulna
19	Dev Prosad Gaine, Chairman, Bajua UP Dacope, Khulna
20	Sapon Roy, SA, Agri Research Sub certer, OFRD, BARI, Daulotpur, Khulna.
21.	Madhob chandra Balla, Member, 3no , Laudove UP, Dacope, Khulna
22	Md. Abu Hanif, Upazilla livestock Department Dacope, Khulna
23.	Md. Motiar Rahman, SA, OFRD, BARI, Daulatpur, Khulna
24.	Md. Monirujjaman, SA,OFD, BARi, Daulatpur, Khulna
25	Naresh chandra koyal, Farmer, Laudove, Dacope, Khulna
26	Sukhendu Roy, Farmer, Vill- Laudove, Dacope, Khulna
27	Rita Sarkar , Farmer, Vill- Horintana, Laudove, dacope, khulna
28	Jharna Roy Boidya, Farmer, Member 7, 8, 9 ward, Laudove, Dacope, Khulna
29	Proshanto Biswas Nishi, Farmer, Laudove, Dacope, Khulna
30	Md.Ashraful Islam, Farmer, Laudove, Dacope, Khulna

2. Focal Group Discussion (FGD) under LACC-II project was held at MLT site office Sapahar, Naogoan on 4 June 2008 and Bashbaria village, Nachole, Chapai Nawabgong on 5 June 2008 organized by OFRD, Barind station, BARI, Rajshahi

Two FGD were organized at MLT site office, Sapahar, Naogoan on 04 June, 2008 and Bashbaria village, Nachole, Chapai Nawabgong on 5 June 2008 by On-Farm Research Division (OFRD), Barind Station, Bangladesh Agricultural Research Institute (BARI), Rajshahi on LACC-II Project. A lively discussion was held in context of livelihood adaptation to climate change in the agriculture sectors particularly in response to drought environment. Farmers, local leaders, representatives of different development partners from GO and NGO were attended and participated in the FGD (list enclosed). The following problems and prospects came out from the discussion:

Problems-

- Acute water scarcity in Rabi and kharif-I season and water table goes below 100 ft
- Due to siltation, depth of pond has reduced , hence, storing of surface water has also decreased
- In dry season, pond water is being sold @ Tk. 80,000/ac for crop cultivation
- Pod borer is major problem for chickpea cultivation
- Late release of land from T.aman rice due to cultivation of long duration rice Swarna which delays the planting of rabi crops
- Drying of harvested T.aman on the crop field create problem for preserving soil moisture, because of this practice soil moisture quickly goes out and rabi crop could not be established
- Farmers prefers comparatively fine rice, so that they cultivate long duration T.aman rice (Swarna) which delay/hamper planting of rabi crop
- Short duration T.aman rice (BRRI dhan 32, 33, 39) gave low yield in comparison to Swarna. The above BRRI dhans gave 4-5 maund/bigha less than Swarna.
- Due to unavailability of surface water natural fish has almost disappeared
- Scarcity of fodder/green grass due to drought causes poor health of livestock
- Because of fuel crisis, farmers are using cowdung as fuel which hampers use of cowdung in crop field.

Prospects-

- T. aman (Swarna), chickpea, linseed, barley and black gram can be cultivated in rainfed condition. On the other hand, water melon, khira, aroid, sweet gourd, mustard, potato (local), onion, garlic, cabbage, cauliflower and bitter gourd can also be cultivated with the help of pond and 'khari" (natural small canal) water.
- For preservation of surface water excavation and re-excavation of ponds and kharies should be done.
- Case fish culture is possible in khari/pond
- Drought tolerant crop like mankachu, moulovikachu, drumstick and sponge gourd should be cultivated in homestead
- Neem, palm tree and date palm tree (khejur) should be planted for biodiversity and extra income. Those threes are drought tolerant.
- Mango and jujube fruit saplings should be planted in homestead and adjacent fields, as those are also drought tolerant, bring a good ensured return
- Ram and goose raring should be increased, as these two can survive by grazing i.e raring cost is very small
- For increasing soil fertility, compost should be made in each homestead.

- For Barind a new pulse crop like mungbean may be cultivated in kharif-1 season using small pond water and after pod harvesting brown manuring should be done for maintaining soil organic matter.
- Rain water harvest may be initiated for drinking/household use and irrigation
- Creation of market facilities vegetables and watermelon to city is important for getting reasonable price
- Farmers training should be given on different crop, livestock and fisheries technologies`

After discussion with the farmers and on the basis of previous experimental results conducted in farmer's field by OFRD, Barind station, BARI, Rajshahi at Sapahar/ Nachole the following pilot program/adaptive trials will be conduction from Khaif-II and Rabi seasons of 2008-09.

Programs for Kharif-II-2008 and Rabi, 2008-09 (for both Sapahar and Nachole)

Homestead vegetable cultivation- 10 household (vegetable patterns will be finally selected after preliminary trial and based on farmers choice and market price)

Niche/ecosystem	**Vegetable**
Sunny area	-Kangkong (Gima Kolmi), -Indian spinach, -Stem amaranth -Red amaranth
Shady area	- Mankachu (aroid) -Moulovi kachu (aroid)
Tree support	Sponge gourd Ash gourd Potato yam
Trail	Bottle gourd Sweet gourd Country bean
On house roof	Ash gourd Sweet gourd
House boundary fence	Sponge gourd /country bean
House boundary/backyard	Drumstick-2 plants/ homestead Papaya-2-3 plants/homestead
Fruit tree	Jujube (Apple kul and BAU kul)-2 plants/ homestead

Field crop

1. Early T.aman (Swarna)-Chickpea (Two block preferably 10 bigha/block for each location)-farmers of the block should be ensured to transplant T.aman rice at the earliest to pave the way for timely release of land for chickpea
2. Mixed crop-Chickpea with linseed/barley-1-2 Bigha/location
3. Wheat-Mungbean-T.aman (with supplementary irrigation)-1-2 Bigha/location

Other activities:

- At least 6 bamboo bunch management (by BFRI technology)should be done (as bamboo is a drought tolerant scarce resource in Barind area, can generate cash at the time of need). As bamboo head is dying by fungal disease which could be improved through use of proper fungicide along with adopting other management in March-April).
- Creation of at least one Drumstick (cv. Baromasi) garden (4-5 decimals)/location
- Compost preparation (by using household and kitchen waste and cowdung) at least in 6-homestead should be done and subsequently apply it in vegetable crop/field crop
- Case culture of fish in khari/pond may be conducted- 6 case/location
- De-worming and vaccination of cattle, goat and ram should be done-100 animals/location
- 2-3 lines of Napier grass in the outer boundary of homestead (those farmers have cattle)

NB. In general all the creeper (such as different types of gourd, water melon, Khira i.e. cucumber) are pit based and requires less water. Chickpea, linseed (flux) and barley are deep rooted (up to 1 m root depth in Barind soil) and drought tolerant crops, needs soil moisture at field capacity level only for germination. Its deep and prolific root has the capacity to take up water from deeper soil layer. Drumstick also requires less water, grows well under drought condition, its pod is precursor against cancer and its leaf is very good source of Vit A. Within drumstick garden (as leaves are small and spaced, i.e. sun light can penetrate) different vegetables/other crops could easily be grown. Now it is very costly and popular vegetable in Barind area and across the country. After seed germination papaya also needs no extra water. It gives a good amount of vegetable/fruit beginning from around 6 months and a plant could produce fruits over the years without any care. No problem of animal/bird damage due to its latex.

Kangkong/Indian spinach produces huge biomass, i.e water efficient. Several cuttings could me made in a season. Aroids are also drought tolerant.

Fish culture: as water is a very scarce resource in Barind, available water should be used not only for crops but appropriate fish culture should be ensured. Case culture is one of the way to culture fish in open water. The program would be implemented with technical assistance from Upzila fisheries department.

De-worming: Common problem for most of the livestock (cattle/goat/sheep), but remedy cost is small, would be conducted with the technical assistance from Upzila Livestock office.

Training: Immediately training of male and female farmers would be ensured for production, consumption and seed preservation of different crops, **particularly for homestead vegetable in this season.**

Technology transfer: Books/pamphlet/poster would be published later on. Field visit/exchange visit of farmers would be arranged along with organization of field days.

List of participants in FGD on LACC-II project, Sapahar, Naogoan on 4 June 2008, organized by OFRD, Barind station, BARI, Rajshahi

SI. No	Name and Address
01.	Dr. M. Yusuf Ali, Principal Scientific Officer, On-Farm Research Division, BARI, Gazipur.
02.	Md. Shafiqul Islam, SSO, OFRD, BARI, Rajshahi
03.	Md. Faruque Hossain, SO, OFRD, BARI, Rajshahi
04.	Md. Shakhawat Hossain, SO, OFRD, BARI, Rajshahi
05.	A.B.M. Mostafizar Rahman, UAO, Sapahar, Naogaon
06.	S.M. Azharul Islam, UFO, Sapahar, Naogaon
07.	Prodip Kumar Ray, Monitoring Officer-FAO, Sapahar, Naogaon
08.	Md. Maksedur Rahman, Trial Monitor, PROVA, Sapahar, Naogaon
09.	Md. Ataur Rahman, SAAO, Sapahar, Naogaon
10.	Sree Dinesh Chandra Sarker, UAO, Sapahar, Naogaon
11.	Md. Golam Rabbani Raton, SA, MLT site, Sapahar, Naogaon
12.	Manik Chandra Roy, MFMSP,Technical Officer, RIC, Sapahar, Naogaon
13.	Md. Niaz Mahmud, CCA-DTT project,DABI, Sapahar, Naogaon
14.	Md. Nurul Islam, UP-member, Tulsipara, Sapahar, Naogaon
15.	Md. Abdur Rahman, Farmer, Tajpur, Sapahar
16.	Md. Hossain Ali, Farmer, Tulsipara, Sapahar
17.	Md. Saheb Babu, Farmer, Tulsipara, Sapahar
18.	Md. Abdul Satter, Farmer, Tulsipara, Sapahar
19.	Md. Ramjan Ali, Farmer, Tulsipara, Sapahar
20.	Md. Alamgir Hossain, Farmer, Tulsipara, Sapahar
21.	Md. Yousuf Ali, Farmer, Tulsipara, Sapahar
22.	Md. Mossarraf Hossain, Principal, Ashuranda Collage, Sapahar

List of participants in FGD on LACC-II project, Nachole, Chapai Nawabgong on 5 June 2008, organized by OFRD, Barind station, BARI, Rajshahi

SI. No	Name and Address
01.	Dr. M. Yusuf Ali, Principal Scientific Officer, On-Farm Research Division, BARI, Gazipur
02.	Md. Shafiqul Islam, SSO, OFRD, BARI, Rajshahi
03.	Md. Faruque Hossain, SO, OFRD, BARI, Rajshahi
04.	Md. Shakhawat Hossain, SO, OFRD, BARI, Rajshahi
05.	Md. Abul Kalam Azad, UAO, Nachole, Chapai Nawabgong
06.	Md. Shamsul Alam Shah, SUFO, Nachole, Chapai Nawabgong
07.	Md. Mezleemur Rahman, MO-FAO project, Nachole, Chapai Nawabgong
08.	Md. Golam Morttuza, SAAO, Nachole, Chapai Nawabgong
09.	Md. Abul Kalam Azad, SSA, MLT site, Nachole, Chapai Nawabgong
10.	Md. Rezaul Karim, SA, MLT site, Nachole, Chapai Nawabgong
11.	Sree Nitai Chandra Barman, Farmer, Hat Bakal, Nachole, Chapai Nawabgong
12.	Md. Abdul Based, Farmer, Basbaria, Nachole, Chapai Nawabgong
13.	Md. Abdul Hoque, Farmer, Basbaria, Nachole, Chapai Nawabgong
14.	Md. Ala Uddin, Farmer, Basbaria, Nachole, Chapai Nawabgong
15.	Md. Khodabox, Farmer, Basbaria, Nachole, Chapai Nawabgong
16.	Md. Aminul Haque, Chairman, Basbaria, Nachole, Chapai Nawabgong
17.	Md. Abdul Khalek, CMES, Nachole, Chapai Nawabgong
18.	Miss. Shabera Khatun, CMES, Nachole, Chapai Nawabgong
19.	Md. Nurul Islam, Farmer, Basbaria, Nachole, Chapai Nawabgong
20.	Md. Saiful Islam, Farmer, Basbaria, Nachole, Chapai Nawabgong
21.	Md. Sumon, Farmer, Basbaria, Nachole, Chapai Nawabgong
22.	Md. Towfick, Farmer, Basbaria, Nachole, Chapai Nawabgong
23.	Md. Islam, Farmer, Basbaria, Nachole, Chapai Nawabgong
24.	Md. Rafiqul Islam, Farmer, Basbaria, Nachole, Chapai Nawabgong
25.	Md. Rezaul Karim, Farmer, Basbaria, Nachole, Chapai Nawabgong
26.	Md. Motiur Rahman, Farmer, Basbaria, Nachole, Chapai Nawabgong
27.	Md. Asraful, Farmer, Basbaria, Nachole, Chapai Nawabgong

3. On-going and proposed activities of Kharif-II season, 2009 under LACC-II at Laudove, Dakope, Khulna

Sl. No.	Name of activities	Date of sowing /planting	Area/No.of farm family	No. of farmer	Present status
1	Year round vegetables cultivation at farmers' homestead area	June 2009	10 farm family	10	Kharif cultivation going on
4	Adaptive trial of short duration T.aman rice for avoiding cyclone and ensuring early planting of rabi crops	Seed to be sown in seed bed in late June	02 bigha	06	Seed collection is going on
3	Compost preparation at homestead level	July09	10	10	Preparation going on
4	Planting of coastal/saline adapted fruit trees/Moringa tree	July-Aug, 2009	5 saplings	30	Sapling collection plan and pit preparation plan
5	Management of existing fruit trees	July-September, 2009	20	20	Pit preparation going on
6	Management of Bamboo bunch	-	3	03	Cleaning as well as burning completed and other management will be done soon.

4. On-going activities of Kharif season, 2009 under LACC-II at HIgh Barind Tract (Nachole, Shapahar)

Sl. No.	Name of activities	Date of sowing /planting	Area/ No. of farm family	No. of farmer	Present status
1	Year round vegetables cultivation at farmers' homestead area	July 2008	10 farm family	10	Kharif cultivation going on
4	Production program of wheat under wheat-Mungbean-T.aman cropping pattern	Mungbean 19 April 2009	02 bigha	01	harvested
3	Compost preparation at homestead level	August 08	10	10	Compost preparation going on
4	Integrated Management Options for Moringa (Drumstick) Tree under Moringa based Agroforestry System	03 Sep 08	15 deci	01	Fertilizer application completed and flowering initiation going on.
5	Drumstick gardening at homestead area	-	5 deci	01	Branch cutting plated completed
6	Management of Bamboo bunch	-	3	03	Cleaning as well as burning and other management completed