FINAL SYNTHESIS REPORT

Findings from the BARI-FAO collaboration under CDMP subcomponent 4b implemented by FAO and DAE

IMPROVED ADAPTIVE CAPACITY TO CLIMATE CHANGE FOR SUSTAINABLE LIVELIHOODS IN THE AGRICULTURAL SECTORS – THE CASE OF THE HIGH BARIND TRACT

ON-FARM RESEARCH DIVISION (OFRD)
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
GAZIPUR-1701, BANGLADESH
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IMPROVED ADAPTIVE CAPACITY TO CLIMATE CHANGE FOR SUSTAINABLE LIVELIHOODS IN THE AGRICULTURAL SECTORS (BGD/01/004) – THE CASE OF HIGH BARIND TRACT

By

M Yusuf Ali
M Alimur Rahman
M A Quayyum
M Badirul Islam

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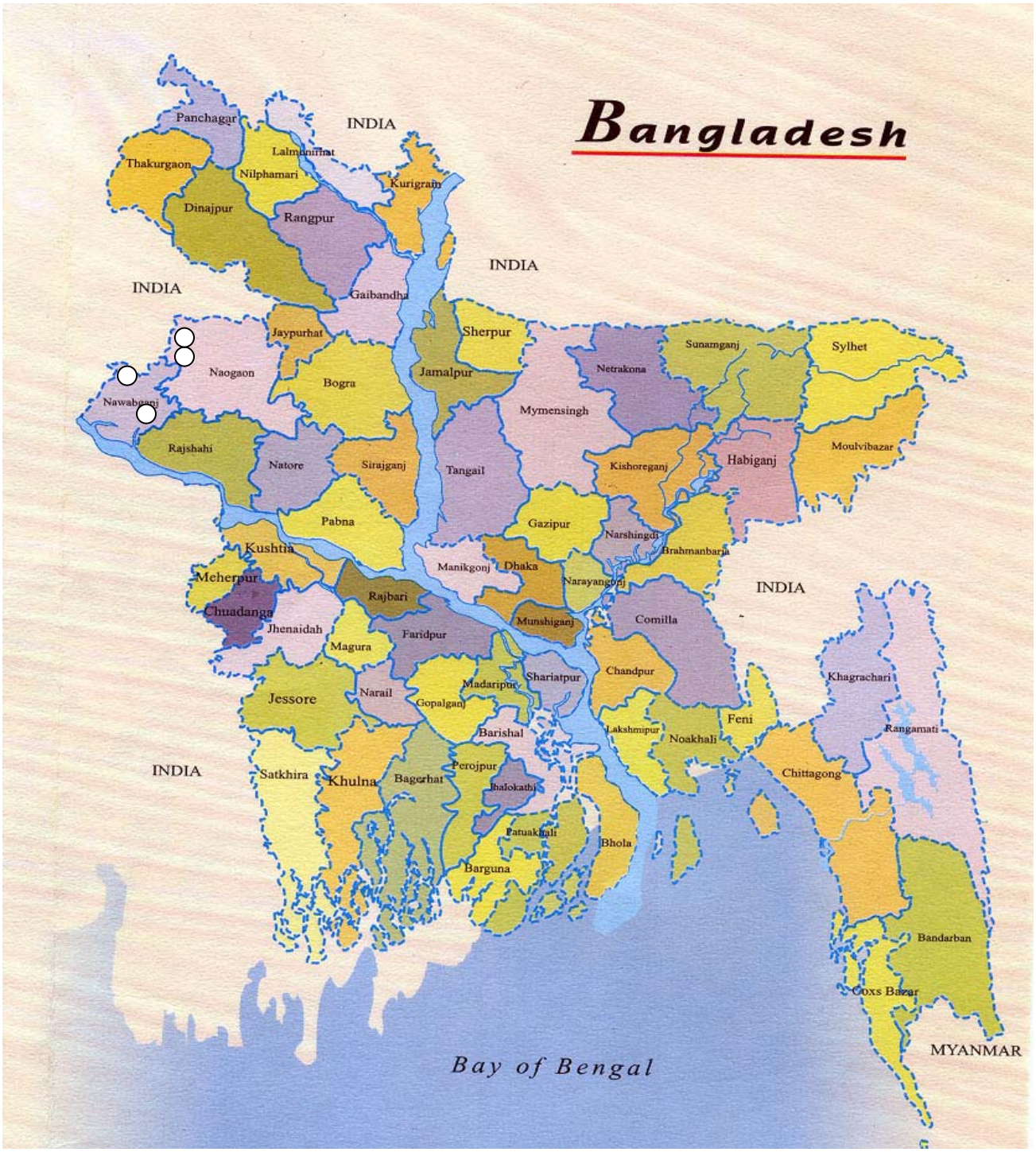


○ **Working locations of each two Upzilas of C.Nawabganj and Naogaon Districts under High Barind Tract (not as per scale)**

Program Summary

In Bangladesh the High Barind Tract (HBT) of north-west Rajshahi division is different from other parts of the country due to its undulating topography having compact and low fertile soils. The region experienced high temperature with limited soil moisture storage along with low and erratic rainfall. Moreover no river/water bodies are present within the HBT. Also vegetation is scanty compared to other parts of the country. These situations make the area drought prone along with poor crop productivity. Monsoon T.aman rice is the major crop and backbone of the rural economy. Thus the areas livelihood is often vulnerable to climate change particularly to drought. In this context FAO funded pilot production program was undertaken to cope with the situation in four Upzials of HBT viz. Nachole, Gomastapur, Porsha and Shapahar during the period January, 2006 to March, 2007. Through a workshop at local FAO office, Dhaka, BARI scientists took the following activity for implementation, based on their 25 years of research and development experience : i) homestead vegetable production, ii) chickpea block production after T.aman rice, iii) publication and distribution of two technology booklets, iv) publication and distribution of a poster on homestead vegetable production and reduction of poverty and malnutrition, v) help the extension personnel to plan and set demonstration along with appropriate technology. BARI scientists successfully implemented all the scheduled works. Apparently those work created a visible impact among the stakeholders which could help them to adapt with the changing climate facilitating better livelihoods. However, for sustainability continuous endeavor is needed for several years.

Through homestead vegetable production program intake of vegetable of cooperating farmers increased three folds, thus food and nutrition insecurity were reduced. Also a small amount of cash income was generated which mostly owned by women. Most of the homestead garden works were done by the women, enhancing their employment and empowerment. While drought tolerant chickpea production in post-rainy season (rabi season) on fallow land gave a good economic (profitability was more than double, in comparison to traditional single T.aman rice) return with small cost of production. Technology books (in Bengali language) and posters (on homestead vegetable production) were widely distributed for making the best options available to farmers. The chickpea technology book was immediately used to control pod borer and Botrytis gray mould disease of chickpea by the farmers and extension personnel. The achievement of the program is highly significant for the sustainability of livelihood of the farmers. However for any research and development works 2-3 years continuous endeavor is needed for acclimatization and sustainable adaptation. Hence back-up research and development works should be undertaken for the development of diversified options for tackling the changing climate and ensuring sustainable livelihoods.

1. Title: Homestead vegetable production in the Droughty High Barind Tract of Bangladesh: Means of reducing food and nutrition insecurity and poverty , women empowerment for ensuring sustainable livelihoods

The study was undertaken in four different locations viz. Nachole, Gomastapur. Porsha and Shapahar during the kharif-I, kharif-II seasons of 2006 and rabi season of 2007 to intensify the use of homestead spaces for increased vegetable production and to meet the demand of family nutrition. A total of 12 households (three household from each location) were selected mostly from small, marginal and landless group of farmers. Round the year vegetable patterns were selected for different niches (such as open sunny land) based on farmers options/agreement. Only vegetable seeds and some critical inputs were freely distributed to initiate the program, all other inputs and labors were provided by the farmers.

Data analysis (Table 1) revealed that intake of vegetable increased to a significant level (on the average 136 g/h/day instead of 40 g/h/day base mark), which helped the farmers to meet the demand of vegetables and to reduce the daily expenditure of vegetable purchase. Though the intake of 136 was below the recommended daily vegetable consumption (200 g/h/day). Despite that wide spread

malnutrition was reduced to a marked level, hence nutrition and food insecurity were marginalized. Actually yield of vegetable was reduced in rabi season due to serious water

crisis/drought and farmers engagement for T.aman rice harvesting and processing. It may be mentioned that droughty area farmers face from food and nutrition insecurity due to low production of vegetables and rice and other crops due to water scarcity and high temperature. Farmers also earned a small amount of cash income from vegetable selling after meeting their daily requirement and free distribution among the relatives and neighbors. From house to house enquiry it was found that most of the sell proceeds were kept by women (Table 2) and they used this money for children education and for meeting small needs. A good social and environmental impacts (Table 2) were also created among the cooperator farmers in the society, which gave them mental satisfaction and increased their acceptability in the locality. In the homestead/market new leafy vegetables like Kangkong (*Ipomea aquatica*) and Batisak (Chinese cabbage) were introduced, these two crops produced good amount of biomass in comparison to water requirement (i.e. water efficient). For drought prone area, water use efficiency of the selected vegetable would preferably be high to adapt with the local conditions. Moreover locally

adapted stem amaranth (Katora danta, taste sweet)) was also grown, which was also well adapted to low soil moisture and high temperature. Most of other vegetables were also adapted to Barind conditions, as the vegetables were selected after long trials in another area of High Barind Tract (Godagari Upzila of Rajshahi district). From Table 3 it was observed that except land preparation and marketing, most of other works were done by women and children. Thus it created women employment, as well as empowerment, also mentally they become satisfied as they have done something important for the family. Moreover, on daily basis they took fresh, nutritious and poison free vegetables. It may be mentioned that in the most of the commercially produced vegetables, pesticides are frequently applied without following safety rules. Farmers were keeping some seeds for the next year production. However seed production and preservation in high temperature and high humid conditions are highly technical job, thus farmers need training. In general in the local market quality seed is not available. For sustainability and up-scaling of the pilot work 2-3 years continuous endeavor along with hand-on training, more demonstration, field day, nutrition education, consumption fare along with back-up research are crucial. Participation of both men and women would be ensured equally from planning to

execution and in training program for sustainability of the round the year vegetable production movement.

Introduction

Landless, marginal and small households comprises of >70% of the rural population and among them 34% have only homestead. Homesteads are the resources that provide major share of livelihood especially for poor farmers. Those resource poor farmers (RPF) get about 50% of their food and cash from homestead. In these circumstances, OFRD of BARI initiated homestead vegetable production model known as "Kalikapur model" in 1984. Later on it was felt to modify the model based on the existing eco-systems (niches) of each homestead, along with vegetables and different fruits were also included. Thus productivity and nutrition supplying capacity of each homestead increased to a significant level (3-4 times than previous). OFRD, Barind, Rajshahi also developed a homestead vegetable pattern known as Barind Model, which need to disseminated to other specific locations.

The BARI scientists exposure visit and need analysis in program areas revealed that homestead spaces available for cultivation of fruits and vegetables are in partial use by space and time. Such short comings can be over come by using different niches (7-9 spaces) with fruits and vegetables organized in patterns as indicated by the farmers. However, it was observed that sustainability of the production program was fragile due to scarcity of quality seeds/seedlings/saplings and also due to lack of proper motivation. In reality the developed production models were formulated mostly through researcher's managed trial. It is needless to say that for greater motivation it should mostly be

participatory. However, those developed vegetables/fruits patterns would be a valuable basis for creating a homestead productivity revolution. It may be mentioned that High Barind Tract area is an acutely vegetable deficit area due to drought and other socio-economic factors. The relationship between climate change, particularly that of drought is that it causes low production and less diversification of vegetables and field crops, which ultimately render low intake of food. Hence drought area people are vulnerable to malnutrition and poor health.

Thus on the basis of earlier recommendation different vegetable patterns were tested in the four selected upzilas of drought-prone high Barind Tract for utilization of fallow homestead spaces and family nutrition.

Program objectives

- To utilize maximum resources of the homestead for growing vegetables
- To enhance intake of vegetables for ensuring family nutrition for ensuring sustainable livelihoods
- To increase cash income and facilitates women empowerment

Expected outcome

- Utilization of homestead spaces round the year by farmers
- Increased intake of fruits and vegetables by farm family members
- Improved adaptation of family members with climate change particularly against drought conditions

Methodology

1. Twelve small, marginal and landless farmers were selected from Nachole, Gomastapur, Porsha and Shapahar (three households from each location). The selection of farmers were made on the basis of homestead suitability for vegetable production and eagerness and cooperativeness of the farmers. Farmers were selected jointly by BARI scientists and DAE staff through on the spot visit.

2. Farmers' homestead available resources, needs and choice assessment were done with active participation of the family members (both male and female) through discussion between BARI scientist, farmers, DAE staffs and FOM (Field Officer Monitoring).

3. OFRD, BARI supplied the critical inputs like fruit and vegetable seed/seedlings, net (for fencing), watering cane etc. Primarily, the seeds were supplied on free of cost to the farmers with condition to produce and preserved it for next year use.
4. The data on total production and disposal patterns per homestead were collected and documented in a register by the Scientific Assistant (SA) of BARI.
5. Regular monitoring and visit were made in every household by BARI, HQ and local scientists.
6. Other qualitative and quantitative data were recorded by the scientist on the basis of field observation and conversation with the farmers, particularly with the women.
7. For the dissemination of technology field visit was arranged and colored poster was distributed among the farmers and DAE/NGO personnel.

A. Barind homestead Model: *Actually round the year homestead vegetable production model was developed at Farming Systems Research and Development(FSRD) site of OFRD, BARI situated at Chabbisnagar, Godagari, Rajshahi (another High Barind Tract area)after sever years of adaptive trials during 1998 to 2001. In the model locally adapted low water requiring vegetables and other quick growing vegetables got preference. In general eight niches (ecosystems) are available in the HBT area, it might be less depending on household homestead area. By sunny land, we mean the portion of the homestead area where good sunlight is available, where in bed different vegetables are grown. For homestead vegetable production this area is important, as maximum harvest come from this portion of land round the year. Comparatively from other niches small amount of harvest is obtained.*

Niche 1: Sunny land

Bed 1: Cabbage - Red amaranth - Indian spinach

Bed 2: Brinjal + Red amaranth – Kangkong

Bed 3: Spinach- Stem amaranth (Katua data)

Bed 4: Carrot/Batishak - Onion – Chilli

Bed 5: Okra

Niche 2: On-roof: Country bean – Sweet gourd

Niche 3: Trellis: Bottle gourd – White gourd

Niche 4: Tree support: Potato yam/Sponge gourd

Niche 5: Partially shady area: Elephant foot/arm (Moulavi kachu)

Niche 6: Fence: Yard long bean/ bitter gourd/ country bean/Cucumber

Niche 7: Muddy wall: Country bean – Sponge gourd

Niche 8: Back yard: Drum stick/Plantain banana

Table 1. Average production and disposal pattern of Kharif and Rabi seasons (330 days) homestead vegetable of twelve farmers at four different upazilas of Barind area, Rajshahi, Bangladesh, May, 2006- March, 2007.

Location	Total production in 330 days (Kg)	Total own consumption (Kg)	Own consumption (g/head/day)*	Free distribution (Kg)	Sold (Kg)	Total Cash income (Taka)
Porsha	320	272 (85)**	165	35 (11)	13 (4)	156
Shapahar	259	205 (79)	124	15 (6)	39 (15)	468
Nachole	330	218 (66)	132	33 (10)	79 (24)	948
Gomastapur	257	198 (77)	120	41 (16)	18 (7)	216
Mean	292	225 (77)	136	29 (10)	38 (13)	456

*Five members in a family were considered

** Figure in parenthesis indicates percentage

Table 2. Visual impact of the vegetable gardening (not quantified for qualitative data)

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	- Consumption of vegetables increased - Change consumption habit - Reduced disease infestation
03.	Resource use pattern	- Introduction of new crops - Homestead area utilized properly - Use of farm yard wastage
04.	Education and knowledge	- Increased knowledge of family members
05.	Social status	- Social status increased - Improved mental strength - Increased acceptability to people
06.	Micro environment	- Household waste used for composting - New plantation improved environment
07.	Others	- More utilization of family labor
08	Women empowerment	Major participation by women. Mostly women kept the sell proceeds of vegetable selling

Table 3. Average work distribution among the family members for the homestead vegetable production, High Barind Tract, Bangladesh, 2006-07.

Operations	Men	Women and children
Land preparation	98	2
Seed/seedling sowing	60	40
Intercultural operations	15	85
Harvesting	08	92
Cooking	0	100
Marketing	81	19

Limitations:

i) Quality seed of improved variety is not available to the farmers.

ii) Drought and high temperature hampered the program.

iii) Lack of sufficient water for growing vegetables in dry season (Feb-May).

iv) Most of the cowdung is being used as cooking fuel not as manure, due to severe fuel crisis in the Barind area.

v) Lack of proper knowledge in preparing compost.

vi) Tedious, laborious and continuous work, need skills in production techniques of huge number of crops. Need one/two years of practice to start as a regular work by farmers. Also more trained manpower is needed for regular data recording.

vii) Creeper crop got less emphasis, with lack of application of adequate amount of organic matter, small size of pit, fertilization and other cares.

viii) Lack of easy analytical tool to interpret data comfortably. (Needs a computer programming on analysis of results)

c) Financial

- Lack of sufficient fund for oil-fuel and transport
- Lack of sufficient fund for training, farmers motivation, field day at proper time

Future plan

1. The project should be continued for sustaining the ‘‘year round homestead vegetable production technology’’.
2. The program should be extended in other locations of Barind area to ensure the family nutrition of the poor farmers family to make them ready with the changing climate

Research Need

Research work should be undertaken to find out more number of drought tolerant, short duration and water efficient vegetables and fruits along with development of their management packages ,so that the technology could cope with the change of climate in the near future. Water shed management concept might get preference for the better livelihood of resource poor farmers in the drought prone High Barind Tract.

Conclusion

The program created great enthusiasm among the women farmers. Vegetable consumption was increased considerably. However, to make the enterprise sustainable, 2-3 years continuous technical back-up is needed along with imparting of training and nutrition education. Besides more cooperation from DAE personnel is needed for dissemination of the technology to larger area.

2. Title: Pilot production of chickpea after the traditional single T.aman rice (monsoon rice): Vehicle for increasing farmers income and improve soil fertility in the quest of adaptation to climate change

High Barind Tract (HBT) is situated in the northwestern Rajshahi division of Bangladesh. This region has a distinct physiography of terraced lands at about 30 m above sea level situated at latitude 24^{o} 25'to 25^{o} 10' N and longitude 88-89^{o} E. The region is characterized by low annual rainfall (1363 ± 311mm) compared to

other parts of Bangladesh with uneven rainfall distribution and wide variation from year to year (Appendix C) and high summer temperature (Appendix D). The HBT is not a stable ecosystem and its farming is vulnerable to interruption because of a) absence of large water bodies, b) sparse vegetation, c) low and erratic rainfall with limited resources of groundwater and high temperature in summer (Hunt, 1984). The HBT covers 160,000 ha of which 90% is rainfed in the rabi season (November- March). Of the rainfed area 55 % is fallow (Ali, 1998). In the kharif season (June-October) the major area is under long duration transplanted aman (T. aman) rice (wet season rice), which hampers timely planting of postrainy season crops like chickpea .The predominant cropping patterns of these rainfed lands are: Fallow- T aman- Fallow . But the research work of On-Farm Research Division (OFRD) of the Bangladesh Agricultural Research Institute (BARI) through its FSRD site, Chabbisnagar, Godagari, Rajshahi proved that chickpea could be cultivated after the harvest of T.aman rice in residual soil moisture under rainfed conditions i.e. non-irrigated

condition (OFRD, 1990). However, endeavor was limited only in the southern part of HBT, but it was rarely fielded in remote and distanced area of HBT (i.e. northern HBT). In may be mentioned that chickpea is a deep rooting and low water requiring grain legume , so it is well adapted to low soil moisture and drought conditions (Saxena, 1984, Ali, 2000), also it can endure a certain degree of high temperature in comparison to other cool season legumes. As a legume, chickpea has beneficial effect on soil fertility, particularly through its capacity to fix aerial nitrogen (N), thus it could enhance soil fertility which in turn facilitate better yield of subsequent crops. For adaptation with the climate change and ensuring sustainable and better livelihood, chickpea cultivation after T.aman rice could be an alternative. Agriculture or crop cultivation is the main source of income for the people of this area, but due to single crop, they are under constant and acute poverty and often suffer from food insecurity and malnutrition. Chickpea is also a very good source of digestible protein, calorie and mineral nutrition. Thus block (each block was 10 Bigha) production of chickpea was undertaken at two locations (Nachole and Shapahar) of the HBT after the harvest of T.aman rice. Block

production was ensured to create grater impact and to avoid stealing and cattle grazing, as most of the area was fallow. A field day was also arranged to disseminate the technology among the farmers. A technology book on chickpea (in Bengali) was also widely distributed among the farmers to made the best research based protocol on the hand of farmers. After chickpea harvest, door to door survey revealed that farmers would keep 60-70 % of their produce for own sowing in the next year and also for selling as seed (for getting higher price). They will consume and sell (at farm gate) rest 30-40%. However, from the experience it was observed that farmers often sell their stored seed to mitigate sudden crisis. Thus quality seed supply should be ensured at the sowing time at reasonable price both through government machinery and development of entrepreneurship. While attending field day farmers requested for supply of chickpea seed for brining more areas under chickpea. Scientists of BARI opined that only through seed exchange program farmers could get seed (i.e. after harvest farmers will back equal quantity of seed to BARI staff). However, more multi-facial motivation work is needed for rapid expansion of the technology. As land tenure is often a hindrance to chickpea

cultivation (land lords are absentee and town dweller , they want only T.aman rice ignoring other rabi crops cultivation).

From agronomic data (Table 4 & 5) it was observed that chickpea sowing was a bit late due to late release of land from long duration T.aman rice, which was one of the reason of low chickpea grain yield (123-153 kg/Bigha) in comparison to potential (266 Kg/Bigha) along with the acidic soil. Thus trial should be undertaken to select comparatively short duration T.aman rice to ensure timely planting of chickpea. From cropping pattern basis economic analysis (Table 6) it was found that traditional T.aman-Fallow cropping pattern gave only 6033 Taka gross return having 2.32 benefit cost ratio, while recommended T.aman-Chickpea fetched almost double gross margin (11553 Taka) with higher benefit cost ratio (3.21). Chickpea production was highly profitable with 4.91 to 6.13 benefit cost ratio compared to 2.10-2.54 benefit cost ratio of T.aman rice (Table 7). As cost of chickpea cultivation is low (as it is a legume) compared to other cereal/vegetable crops. Only 5-6 kg seed and 10 -13 kg triple super phosphate fertilizer per Bigha are needed for its production along with control of pod-borer (through IPM/pesticide). Thus chickpea production after the harvest of T.aman rice could ensure food/nutrition security as well as it would

increase income of farmers which in turn would ensure sustainable livelihoods matching with the changing climate.

Research Need

Research work would be undertaken to find out better adapted and more prolific and deep rooting genotypes of chickpea with shorter life span for better yield after the harvest of T.aman rice. Causes of low yield of chickpea would be find out, including mitigation of low soil pH. T.aman rice with shorter growth duration having yield potential like local Shorna variety would be find out with repeated trial. Moreover search for other low water requiring and remunerative crops would be find out for crop rotation and diversification.. Diversification is one of the way of adaptive mechanism for the changing climate.

Table 4. Agronomic performance of T.aman rice (cv. Sharna) in the two locations of the High Barind Tract, Rajshahi, Bangladesh, 2006.

Parameter	Nachole	Shapahar
Date of sowing in seed bed	10-12 June, 2006	2 July, 2006
Date of tranplanting	10-14 July, 2006	9 August, 2006
Date of harvest	10-15 Nov, 06	18 Nov, 06
Duration (days: seed to seed)	153	138
Plant height (cm)	114.6	122
No. of effective panicle/m2	12.6	12

No of filled gran/panicle	97.4	90.3
Grain yield (kg/Bigha)	660	547

Table 5. Agronomic performance of Chickpea (cv. BARI Chola 5) under T.aman – Chickpea cropping pattern in the two locations of the High Barind Tract, Rajshahi, Bangladesh, 2006-07.

Parameter	Nachole	Shapahar
Date of sowing	19-22 Nov, 06	22-24 Nov,06
Date of harvest	30 March,07	31 March,07
Duration (days)	130	129
Plant height (cm)	37	36
Plant population/m2	30	27
No. of pod/plant	48	40
No.of seed plant	1.5	1.6
Grain yield (Kg/Bigha)	153	123

Table 6. Average (two locations) comparative economic performance of traditional T.aman rice-Fallow cropping pattern and recommended T.aman rice-Chickpea cropping pattern, High Barind Tract, Rajshahi, Bangladesh, 2006-07.

Cropping pattern	Production cost (Tk./Bigha)	Gross return (Tk/.Bigha)	Gross margin (Tk./Bigha)	Benefit cost ratio
Traditional T.aman-Fallow	2600	6033	3433	2.32
Recommended T.aman-Chickpea	3600	11553	7953	3.21

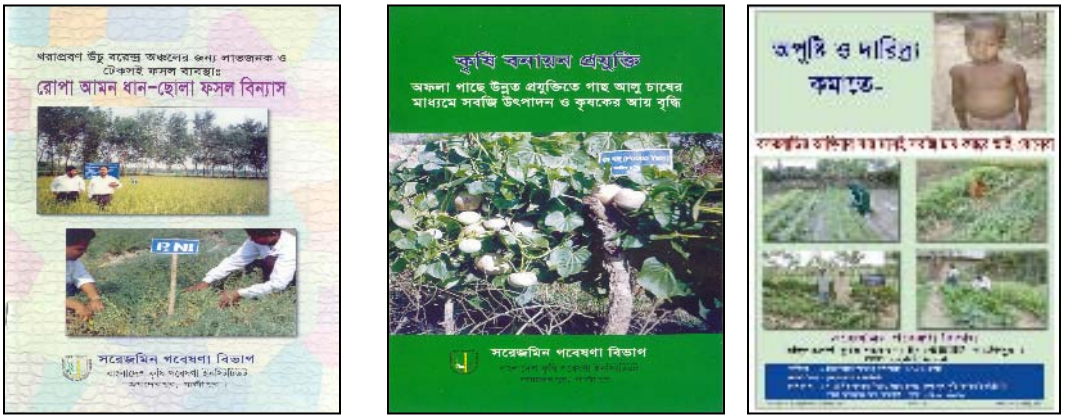
Table 7 : Economic performance of recommended T.aman rice-Chickpea cropping pattern at two different location of the High Barind Tract, Rajshahi, Bangladesh, 2006-07.

Location	Production cost (Tk./Bigha)			Gross return (Tk./Bigha)			Gross margin (Tk/Bigha)			Benefit cost ratio		
	T.aman	Chickpea	Total	T.aman	Chickpea	Total	T.aman	Chickpea	Total	T.aman	Chickpea	Total
Nachole	2600	1000	3600	6600	6133	12733	4000	5133	9133	2.54	6.13	3.54
Shapahar	2600	1000	3600	5467	4907	10374	2867	3907	6774	2.10	4.91	2.88

Price: T.aman rice grain- Tk. 10/Kg, Chickpea grain-Tk. 40/Kg
1 Bigha: 33 Decimal or 1320 m^2
1 USD = Tk. 70/-

3. Publications of Booklet /brochure/poster for farmers

Two technology booklets in Bengali language (T.Aman-Chickpea cropping pattern and *Dioscorea* i. e. potato yam cultivation on non-fruit trees) were published and distributed among the farmers /extension/NGO personnel of the project area. A colored and picture dominated poster on malnutrition, poverty reduction and homestead vegetable cultivation was published and distributed among the stakeholders as per plan. Thus planned option menus preparation, publication and distribution programs were executed fully.



Published technology booklet and poster

4. Manpower placement and collaboration

Two Scientific assistants have been placed at Nachole and Shapahar for regular monitoring and successful conduction of the present pilot production program. Rajshahi based and Head quarter (Gazipur) based scientists had regularly visited farmers field.

From planning to implementation stages local DAE officers, SAAO and FOM (FAO) were involved along with farmers.

5. Participation in workshop

OFRD scientists participated and presented BARI developed technologies for mitigating drought, based on 25 years of experience and research & development works in the High Barind Tract areas. Besides, OFRD scientists have participated regular meetings of FAO and DAE and had added valuable contribution/suggestions.

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

Thirteen different levels of BARI scientists and field workers including its Director for Research (Dr M Abu Sufian) visited the project areas 188 time (cumulative) since the inception of works from February, 2006 to March, 2007.Also from FAO head quarter, Rome, Dr I. Juergens (SDRN) visited the BARI working site. Different levels of DAE officials, NGO personnel and farmers group visited the project sites.

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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	197100	197100	197100	Nil
2	Participation at workshop etc	32850	32850	32850	Nil
3	Field level demonstration and meeting	131400	131400	131400	Nil
4	Training material	98550	98550	98550	Nil
5	Travel	65700	65700	65700	Nil
	Total	**5,25,600**	**5,25,600**	**5,25,600**	**Nil**

Appendices

A. List of cooperator farmers for Homestead vegetable production

1. Md. Shafiqul Islam, Village- Sovapur, Nitpur, Upzila- Porsha, District- Naogaon
2. Md. Abdul Kader, Village- Sovapur, Nitpur, Upzila- Porsha, District- Naogaon
3. Md Abdur Rashid, Village- Sovapur, Nitpur, Upzila- Porsha, District- Naogaon
4. Md. Nurul Islam, Village-Bashbari, Hatbakol, Upzila-Nachole, Dis.-C. Nawabgonj
5. Mrs. Kubera, Village-Bashbari, Hatbakol, Upzila-Nachole, Dis.-C. Nawabgonj
6. Md. Affan Ali, Village-Bashbari, Hatbakol, Upzila-Nachole, Dis.-C. Nawabgonj
7. Md. Hasan Ali, Village- Basuldanga, Picholdanga, Village-Shapahar, Dist-Naogaon
8. Md. Belal Hossain, Village- Basuldanga, Picholdanga, Village-Shapahar, Dist-Naogaon
9. Md. Bulbul Rahman, Village- Basuldanga, Picholdanga, Village-Shapahar, Dist-Naogaon
10. Md. Kamruzzaman, Village-Malpur, Baradadpur, Upzila-Gomastapur, Dist-C. Nawabganj
11. Md. Nader Ali, Village-Malpur, Baradadpur, Upzila-Gomastapur, Dist-C. Nawabganj
12. Md Reaz Uddin, Village-Malpur, Baradadpur, Upzila-Gomastapur, Dist-C. Nawabganj

B. List of cooperator farmers for Pilot production of Chickpea after T. aman rice

1. Md, Khalaque Amin, Village-Bashbaria, Upzil-Nachole, Dist-C. Nawbabganj
2. Md. Modul Islam, Village-Bashbaria, Upzil-Nachole, Dist-C. Nawbabganj
3. Md. Shafiqul Islam, Village-Bashbaria, Upzil-Nachole, Dist-C. Nawbabganj
4. Md. Jahir Uddin, Village- Bahapur, Upzila-Shapahar, District-Naogaon
5. Md. Habibur Rahman, Village- Bahapur, Upzila-Shapahar, District-Naogaon
6. Md. Shariful islam, Village- Bahapur, Upzila-Shapahar, District-Naogaon

Appendix C: Ten years (1998- May, 2007) monthly rainfall (mm) of High Barind Tract, 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	1465
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	-	-	-	-	-	-	-	-
Mean	5.7	7.2	36.5	53.4	147.4	255	301	215.6	316	152.2	18.1	0.9	1514.8
SD (±)	5.3	18.9	31.7	40.8	49.3	129.5	127.1	56.6	172.1	83.6	35.4	2.7	239.8

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

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

Appendix D. Three years (2005- May, 2007)average Temperature (^{o}C) of High Barind Tract, Rajshahi, Bangladesh

Month	2005		2006		2007 (January to May)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January	9.4	26.4	6.5	29.0	6.2	18.3
February	8.9	33.2	12.8	35.4	10.6	30.5
March	15.2	36.0	13.7	39.6	11.9	37.5
April	18.9	38.6	20.0	38.8	18.5	39.0
May	19.4	39.8	21.0	39.0	20.9	39.2
June	24.0	42.4	22.5	36.8	-	-
July	24.0	34.0	25.2	36.4	-	-
August	24.2	35.5	25.2	35.8	-	-
September	23.4	36.2	24.0	35.5	-	-
October	19.0	33.0	21.7	34.6	-	-
November	14.0	31.4	10.4	31.5	-	-
December	10.2	27.8	9.7	27.4	-	-
Mean	16.2	31.87	16.36	32.29		