**Livelihood Adaptation to Climate Change (LACC-II) Project**
(BGD/01/004/01/99)

# Technical Guideline
# on
# Establishment of Adaptation Option Demonstrations
# for
# Kharif-I/March – July
# in
# Drought prone and saline areas

**Department of Agricultural Extension**
**Food and Agriculture Organization of the United Nations**

## Introduction on the adaptation option identification, demonstration and evaluation process

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

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

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

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

Once the options are tested in the farmers' fields a two step evaluation is carried out in order to get an over all assessment of the acceptance of the technologies at the farmers level. An evaluation is done afterwards, preferably after carrying out trials for 2-3 seasons, at the scientific and technical level to find out the relevance and flexibility of the certain options in relation to climate change and development the resilience of the farming community.

The assessment and evaluation have been done so far for the options tested in the first phase of the project and therefore the recommendation has been followed in the implementation of the same in the second phase of the project. Recommendation for promotion and replication to the similar areas and upazilas are suggested based on the over all performance and acceptance ratings of the adaptation technologies. Evaluation and assessment for the new options, identified and tested in the second phase have to be done following the same framework used in the first phase. However, there have been some observations gathered from the implementation and regular monitoring of the option demonstrations in second phase and those may be considered for further implementation and replication.

The adaptation demonstrations are established in the farmers' field of the project villages who were selected through an approved criteria and maintaining certain process. As far as the project objectives are concerned mostly interested poor and female farmers having enough land, required resources and manpower have to be selected and engaged in the demonstration activities. The technical guideline with the monitoring guideline is meant to follow as hands on guidance in the implementation, day to day technical support and monitoring of the adaptation demonstrations.

Information and guidance provided in the technical guideline are mostly standard and specific as per the general and specific needs in drought and coastal areas. For example implementation of any demonstration follows almost same principle and process everywhere and however the there are differences in the selection of species or crop varieties, computation of the fertilizer doses etc which are done as per requirement of the area/upazila.

Project and DAE Officers are placed to pay regular visits to the demonstration sites, observe the status of the trial and provide on the spot technical suggestions and guidance as deemed necessary and as per need of the farmers. A monitoring register is maintained for

Social mobilization initiative like farmers' field day, result demonstrations, cross visits were arranged in order that the surrounding farming communities had opportunity to get exposed to the technologies of the demonstrations.

## General information and guidance for implementation and monitoring of the option demonstrations

### Background

This guideline is prepared based on the need received from the pilot upazilas of the LACC-II project and have been validated and cleared by the UTIWG, UDMC and NTIWG. The technical information gathered from the respective Upazila Agriculture Officers (UAO) and Field Officers (Monitoring) of the project are also incorporated in the guidelines. Necessary technical inputs were also collected from the scientists of DAE, DLS, DoF, BARI, BRRI, BLRI and BFRI. A number of technical books and papers were consulted to make the guideline as appropriate as possible. The entire technical part and tentative budget of the guideline was shared with the DAE experts, research scientists, team members at PMU and FAO, HQs and necessary adjustment has been made.

### General instruction

1. Implement the demonstration as per the time/duration provided in the guideline. Any adjustment required due to the local condition and environment may be done with prior consultation with the PMU/concerned person.
2. Farmer selection must be according to the prerequisite of the demonstration, which is essentially based on the local farmers need and it should be such that the objective of the demonstration can be achieved successfully.
3. Follow the budget break-up, procure the required materials and services, keep necessary documents and vouchers and proof evidence by attaching photograph during the re-imbursement/adjustment of the project advance.
4. A general fertilizer dose is provided in each demonstration. This may be adapted to the local condition as per the dose suggested in the recommendation by BARC/AEZ (Annex-1) and also the soil test results of particular plot.
5. The number of demonstrations i.e. the replication in each demonstration and the required budget for it is specified in the guideline. Therefore any change in this case can be done only after prior consultation with the PMU/concerned person.
6. Every single demonstration has its own monitoring requirement and accordingly a monitoring guideline and formats are provided. Timely and regular monitoring is vital for capturing the effect/impact of project intervention. Therefore it is mandatory to keep timely, authentic and verifiable data and information and prepare the report and send to the PMU/concerned person in time. An establishment/progress report has to be prepared and submitted immediately after the establishment of the demonstration (Format-I).
7. A signboard for each demo has to be prepared and placed at the demonstration site as per the sample attached with this guideline.
8. For any technical matter consultation with the scientists of local BARI, BRRI, BLRI, BFRI stations and DAE, DLS, DoF, Forest Department is essential and open.
9. Use common sense and rational judgment while taking decision in every situation and such that farmers must not be the looser.
10. PMU/concerned person may be contacted for any thing related to the demonstrations.

**Farmer selection criteria**

1. LACC project insists to work with poor farmers who really need project support in their endevour to improve their livelihood by increasing resilience to climate change.
2. LACC must work with real farmers who work by own hand not (generally) by the hired labour and who are not (generally) involved in any other business.
3. Find farmers who are really interested in the type of works LACC project intends to do with him/her and participate, contribute, share activities, resources and information.
4. Select farmers who have land/space for undertaking demonstration trial of adaptation options as decided and agreed with the farmers.
5. Identify farmers who have time to spend for the project activities, demonstration of technical options, participation in the meeting, training, contribution to the awareness programmes etc.
6. Better to select farmers who have family labour to employ in the demonstration activities so that the unused or underemployed labour gets used and money saved from hiring a labour.
7. Must make a balance in selection while distributing the adaptation trials in a village so that both male and female farmers are picked up as per the requirement and merit.
8. Should nominate farmers who are respectful to the project/DAE officers/staff (Farmers s*hould not believe that the project/DAE staff are working with them for retaining their job only*).

**Monitoring guideline and process**

1. For each option, as per the requirement and the decision, a control farmer/plot has to be selected prior to the initiation of the demonstration activities. The control farmers and plots have also to be monitored and data and information collected accordingly.
2. Baseline information of farmer/plot have to be recorded at the beginning of the demonstration activities which could be used later (preferable at the end of each activity) to compare the results and findings.
3. Soil analysis of each plot/site is a mandatory to record the soil condition i.e. the nutrient content and other aspects of the soil as per the situation need and requirement.
4. Soil and water salinity (in coastal area specially) analysis has to conducted likewise from the plots, ponds.
5. Monthly rainfall, temperature, humidity and other data can be collected from the nearest reliable sources like Upazila Agriculture Office, local Weather Station.
6. Monitoring will be done basically to record the quantitative data and appraise qualitative information from the farmers, others.
7. Monitoring indicators or variables of each option are based on the objective/s of the particular option demonstration.
8. A monitoring register/khata must be maintained at the demo farmer household and the farmer should be facilitated to understand and regularly/periodically record the data and information as per the requirement of the demonstration.

**Provision for control farmer or control plot**

Engagement with or finding out the control farmer or control plot and thus monitoring the production, management, yield and other aspects are conditional with the requirement and merit of the option which must have been decided at the beginning of the season. But, the criteria for selection of the farmer and plot, others must be same as the project/main/treatment farmer or plot.

## List of abbreviation

| | |
|---|---|
| BARC | : Bangladesh Agriculture Research Council |
| BARI | : Bangladesh Agriculture Research Institute |
| BCSIR | : Bangladesh Council for Scientific and Industrial Research |
| BFRI | : Bangladesh Fisheries Research Institute |
| BINA | : Bangladesh Institute of Nuclear Agriculture |
| BLRI | : Bangladesh Livestock Research Institute |
| BRRI | : Bangladesh Rice Research Institute |
| DAE | : Department of Agricultural Extension |
| DLS | : Department of Livestock Services |
| DoF | : Department of Fisheries |
| FYM | : Farm Yard Manure |
| GHG | : Green House Gas |
| ICS | : Improved Cooking Stove |
| IPM | : Integrated Pest Management |
| LACC-I | : Livelihood Adaptation to Climate Change, Phase-I Project |
| LACC-II | : Livelihood Adaptation to Climate Change, Phase-II Project |
| NTIWG | : National Technical Implementation Working Group |
| PMU | : Project Management Unit |
| SRI | : System of Rice Intensification |
| UAO | : Upazila Agriculture Officers |
| UDMC | : Union Disaster Management Committee |
| UTIWG | : Upazila Technical Implementation Working Group |

**Agricultural/common term**

| | |
|---|---|
| Apple kul | : An improved and introduced jujube variety |
| BAU kul | : An improved jujube variety from Bangladesh Agricultural University |
| BARI Chola 5 | : A chick pea variety released by BARI |
| Barind tract | : North-western drought prone area of Bangladesh |
| Bigha | : 1 bigha equals 33 decimal |
| Black Bengal | : A local goat variety |
| Bombai | : An improved litchi variety from India |
| Boro | : Irrigated winter rice |
| China-3 | : An improved litchi variety from China |
| Khaki Kamble | : An improved duck variety from UK |
| Kharif-I | : Early monsoon cropping season |
| Kharif-II | : Monsoon cropping season |
| Macha | : Bamboo mat/platform |
| Monga | : Seasonal famine condition in northern Bangladesh |
| Narkeli kul | : A local jujube variety found in the coastal region |
| Rabi | : Winter cropping season |
| Sarjan | : An age old composite crop production practice of coastal (Barisal) region |
| Satabdi | : A wheat variety released by BARI |
| T. Aman | : Rain fed monsoon rice |
| Til | : Bengali terminology of Sesame |

# List of Options demonstrated in Kharif-I season in the farmers' fields

# Dry seed bed method for raising rice seedlings

**A. Context and Justification:**

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

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the technology that can ensure availability of rice seedlings while the normal practice is unable to meet the timely requirement of seedlings.

Demonstrations showcase how to –

- Grow healthy and strong seedlings that can grow better in less water and other environmental stresses.
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought on the sustainability and the comparative advantages of the of the technology over wet seed bed.

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2006 | Nachole, Gomostapuir, Sapahar and Porsha | N/A |

**E. Technical details:**

***Seed bed preparation:*** The land of the seed bed should be well prepared by ploughing and laddering five to six times while there is enough moisture in the soil. Ploughing and laddering should be done in a way till the soil is thoroughly pulverized. Prepare beds of the same size as in

wet nurseries but 15 centimeters high with channels (25-30 cm wide) between them. The soil has to be mixed with compost/farm yard manure.

***Seed rate:*** 80-100 gm seed per 1 $m^2$ of seed bed.

***Seed sowing:*** Sow the seeds in a way that they are spread over the smooth soil and then seeds are covered well with the loose and fine soil at a depth of 2.5-4.0 cm so that the seeds are not exposed to the sunlight.

***Intercultural operation (after care):***
Irrigation: Allow the water to run in channels first and then raise the level of water slowly to saturate the soil of beds. Do not flood water in beds. Keep the seed bed saturated with water althrough. Maintain a thin film of water if possible after 5 days of sowing.

Pest management: Take appropriate actions if any insect or disease attacks the seed bed. IPM method is suggested for management of the pest. A regular watch is necessary to resist attack from birds, rodents etc.

***Seedling uprooting:*** It advisable to moisten the seed bed before uprooting the seedlings. A gentle and soft hand should be allowed while care must be taken that the root system of the seedlings is not damaged.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 6 Kg | 60 | 360.00 | |
| 2 | Compost | 50 Kg | 1 | 50.00 | |
| 9 | Sign board | 1 | 500 | 500.00 | |
| 10 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Nine hundred and forty only)** | | | **940.00 (US $ 14)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone in one season of 2006 in the first phase (LACC-I) of the project. As per the feedback from the farmers pulling out of the seedlings was difficult under dry conditions and required twice as much labour than for conventional wet seedling bed method. The rice root system was also damaged while pulling out from the dry seedling beds. Evaluation done through the framework below refers where little changes in the technique of bed preparation are suggested and an awareness programme may be taken up for further promotion and adoption of the technology as the situation of certain year demands.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat/ Pulse - Mango | 25, 26 | Drought spells; loss of crops | Rain fed | High barind tract | Poor/ medium farmers | 14 US $ | High | High | Yes | no increase | Recommended for further trial with little changes in technology |

# Adapting *Aus* rice cultivation to changing conditions

**A. Context and Justification:**

Coastal region of Bangladesh has been going through recurrent geo-morphological changes due to the changes in the climate and over all environment of the area. As a result rice cultivation in the coastal saline region is facing increasing challenges due to the variability and changes in the local conditions arising out of the climate changes. Increased soil and water salinity and amplified moisture stress due to the delay in the onset of monsoon have been a rising problem for the farming community in the south-western coastal region. In one hand it delays the land preparation, sowing and growing of the early monsoon (Kharif-I) rice and on the other hand it also lingers crop cultivation of the subsequent seasons. This offers an opportunity to introduce and test rice varieties those can best be suited to the changing conditions of the coastal area especially in the kharif-I season and give good yields as well. Incorporation of *Aus* rice varieties like BRRI dhan27 along with other local varieties as feasible was recommended for the coastal saline and tidal areas as an adaptation option in kharif-I season for the local farming community.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the rice varieties that can grow well in the increased drought in the north-western part and salinity in coastal areas.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the crop in comparison with the control/traditional practice.
- evaluate the economic comparison with the control/traditional practice.
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, salinity etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the local and HYV varieties rice grown in the demo.

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Dacope, Terokhada, Bhandaria and Nazirpur |

**E. Technical details:**

***Land area:***
A total of 33 decimal land may be brought in for the cultivation of the rice variety.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. For sandy

loam to silty loam soil, 2-3 ploughing to and cross plowing with subsequent 3-4 laddering are required so that the soil has a good tilth. For a clay type of soil, soil preparation requires more tillage operation at appropriate soil moisture status

***Variety:***

HYV varieties: BRRI dhan27.

Local varieties: As per the local suitability and selection of the farmers.

***Seedling raising:*** *Aus* seeds should be sown in medium high land near the main field. Before seed sowing the organic matter and other nutrient should be ensured.

***Time of seed sowing:*** The appropriate time to sowing seed is 30 March to 30 April. The time may be adapted/varied in case of local varieties.

***Seed rate*****:** Seed rate will be 4-6 kg/ bigha.

***Spacing:*** In case of line sowing, line to line spacing should be 15 cm x 20 cm.

***Fertilizer dose and timing:*** Apply fertilizer as per quantity shown in table 1 below. The application should follow the standard procedure applicable for the agro-ecological context/area/zone.

**Table 1.Fertilizer dose per pit for rice cultivation**

| **Name of Fertilizer** | **Quantity per bigha (33 dec.)** |
|---|---|
| Urea | 24-30 Kg |
| TSP | 14-20 Kg |
| MP/MOP | 10-14 Kg |
| Gypsum | 10 Kg |
| Zinc sulphate | 1 Kg |
| Boron | 1 Kg |
| Compost/cow dung | 200 Kg |

Source: BARC

***Method of Fertilizer Application:*** Half of the urea and all of other fertilizers may be applied during the last round of tillage/land preparation following broadcast method and mix the fertilizer properly with the soil. The remaining half of the urea should be applied by topdressing in two installments first one after attaining 4-5 tillers per hill and second is before 5-7 days of the dough stage (*Kiachthor*).

***Irrigation:*** Aus is predominantly a rain fed rice and can grow well with the monsoon rain. However, sometimes supplemental irrigation may be needed if any drought spell hampers crop growth or yield. In order to retain the rain water in rice field the field bund (*Aile*) should be raised enough (15 cm) so that the water is used as and whenever required.

***Weeding:*** As per the need of the field.

***Harvesting:*** While the 80% of the crop is matured, the harvesting can be initiated.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 8 Kg | 60 | 480.00 | |
| 2 | Compost | 200 Kg | 1 | 200.00 | |
| 3 | Urea | 24 Kg | 12 | 288.00 | |
| 4 | TSP | 15 Kg | 40 | 600.00 | |
| 5 | MP/MOP | 12 Kg | 35 | 420.00 | |
| 6 | Gypsum | 10 Kg | 10 | 100.00 | |
| 7 | Zinc Sulphate | 1 Kg | 150 | 150.00 | |
| 8 | Boron | 1 Kg | 150 | 150.00 | |
| 9 | Sign board | 1 | 500 | 500.00 | |
| 10 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Five thousand nine hundred and eighteen only)** | | | **2918.00 (US $ 43)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the coastal saline areas in one season 2009 in the second phase (LACC-II) of the project. It has been observed that farmers of the coastal area still prefer the local Aus varieties although they felt that the HYV variety has a potential in the area. Therefore, demonstration trials of the same variety for another 2 to 3 seasons in different locations along with awareness raising campaigns are needed for confirmation of the results and acceptance by the farmers as well. A thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Integrated rice-fish cultivation

**A. Context and justification:**

In the extensive river floodplains and deltaic lowlands of Bangladesh, where floods last several months and land goes under water or inundated from the coast (rendering the land unsuitable for crop production), fish are linked with rice cultivation. The freshwater wetlands of Bangladesh consist of the ecologically coastal low lowlands and floodplain areas are being used for rice-fish culture. Integration of fish culture enables farmers to increase overall production in the flood-prone ecosystem. Rice fish culture increases rice yields (more than 10%) and additional fish to the rice crop can be harvested. As a rule of practice no insecticides are used in rice-fish culture that guarantees an environmentally sound production system and reduce production cost. Small farmers can be benefited while providing their family labour and earning more total production from a unit land by integrating fish in the rice filed. The option was recommended for the kharif-I season for the coastal upazilas with a view to diversify the farming practice and also to increase the over all yield from the rice field.

**B. Objective:**

To promote integrated rice and fish production and provide opportunities for crop diversification, increased yield and more income.

Demonstrations showcase how to –

- evaluate suitability of the option rice and fish varieties in local conditions, also taking into consideration the future scenario i.e. increased salinity, water stagnation etc.
- assess the amount of fertilizers, organic matters and other inputs required in the cultivation of the rice-fish in comparison with the control/traditional practice.
- evaluate the economic comparison with the control/traditional and other practices.
- appraise farmers' perceived opinion about the potential effect/impact of climate change induced hazards like salinity etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the rice-fish cultivation.

**C. Implementation time:**

Kharif-I/March – July

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Bhandaria |

**E. Technical details:**

***Land area:*** 1 Bigha (33 dec.).

***Land type:*** Medium high land with loam or clay loam soil, which is not flooded.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. For sandy

loam to silty loam soil, 2-3 ploughing to and cross plowing with subsequent 3-4 laddering are required so that the soil has a good tilth.

***Bund/aile preparation:*** The bund or aile should be prepared/raised up to 1 ft (30 cm.) so that 5-6 inch water (or as required for the fish variety) can be retained for fish cultivation. The base of the bund should be 50-55 cm. wide and top should be 30-35 cm. wide.

***Drainage canal preparation:*** Drainage canal should be prepared around the rice field. The depth of the canal should be 50-60 cm. and width should be 60-100 cm.

***Millpond (small pond) for fish:*** A millpond or small pond for fish should be prepared at the corner of the field for the fish to take shelter. The size may be 1 meter depth and wide.

***Variety:***
***Rice: Local varieties –***
BRRI dhan 27

***Fish and the rate* (BFRI Suggested):**
Rajpunti- 20/decimal, or
GIFT tilapia: 20/ decimal, or
Rajpunti : 15/decimal + Common carp 5/decimal, or
Common carp: 15/ decimal

Fish fingerling – Should be 2.25 cm. to 7.0 cm long and 16 to 30 days (based on the variety).

***Seedling raising:*** *Aus* seeds should be sown in medium high land near the main field. Before seed sowing the organic matter and other nutrient should be ensured.

***Transplanted in another Field:*** In case of heavy rainfall and flood situation and if the main field goes under water, 30 days old seedlings should be transferred to another field. This type of land should be flood free.

***Seed rate*:** Seed rate will be 4-6 kg/ bigha.

***Spacing:*** In case of line sowing, line to line spacing should be 15 cm.x 20 cm.

***Fertilizer dose and timing:*** Fertilizer dose is given in the budget section. The application should follow the standard procedure.

***Fish rearing in the rice field:***
Maintain the number of fish as per the rate given above. Release fish fingerling after 10-15 days of rice transplanting.

If the rice field is fertilized and manured well, field contains enough feed for fish. No need to supplement. However, if needed additional feed like rice burn, oil cake, decomposed cow dung can be applied. The general rule is that the amount of feed should be 5% of the total weight of fish or follow the standard rate.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 8 Kg | 60 | 480.00 | |
| 2 | Compost | 1000 Kg | 1 | 1000.00 | |
| 3 | Urea | 24 Kg | 12 | 288.00 | |
| 4 | TSP | 15 Kg | 40 | 600.00 | |
| 5 | MP/MOP | 18 Kg | 35 | 630.00 | |
| 6 | Gypsum | 20 Kg | 10 | 200.00 | |
| 7 | Lime | 30 Kg | 20 | 600.00 | |
| 8 | Net | 300 ft | 10 | 3000.00 | |
| 9 | Drainage pipe | 1 | 600 | 600.00 | |
| 10 | Transport cost (Lump sum) | | | 1000.00 | |
| 11 | Sign board | 1 | 500 | 500.00 | |
| 12 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Eight thousand nine hundred and twenty eight only)** | | | **8928.00 (US $ 130)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested only in one upazila of the coastal saline area in Kharif-I season of 2009. As per the result and feedback gathered so far from the farmers the option should be continued for the upazilas and with appropriate farmers for at least another one season with a thorough assessment by using the evaluation framework used in LACC-I period so that a well-informed decision and recommendation can be made.

# Mung bean cultivation as an alternative crop

**A. Context and Justification:**

Mung bean has been cultivated in many areas and widely regarded as an important pulse crop in Bangladesh. The crop has proved well suited to the flat and high barind area where farmers have been cultivating local varieties for long time. A good number of improved mung bean varieties have been released by BARI and BINA which have great potential in the barind and other areas of the country. A special trait of the crop is that the roots of mung bean plant can fix atmospheric nitrogen in the nodules through a symbiotic process. As a result requirement nitrogenous fertilizer for the crop is comparatively less than other crops. After the harvesting the entire plants of the crop can be utilized by mixing in the soil through ploughing and then allowing for decomposition and addition of the organic matter. Incorporation of improved varieties of mung bean in the existing cropping pattern was recommended as one of the important adaptation options for resource poor farmers of the Barind tracts.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the mung bean variety that can grow well in the increased drought in the north-western part and salinity in coastal areas.

Demonstrations showcase how to –

- appraise the suitability of the BARI variety as an alternative in the drought prone area of the project
- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the crop in comparison with the control/traditional practice
- evaluate the economic comparison with the control/traditional practice
- assess the nutrient status and other changes happened in the soil
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the production practice and the comparative advantages of the chick pea over other pulse crops grown in the demo

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2008 | Gomostapur | N/A |
| 2009 | Lalpur, Bagatipara and Porsha | N/A |

**E. Technical details:**

***Soil:*** Well drained medium high lands with sandy loam and alluvial soils are good for mung bean cultivation.

***Variety:*** BARI Mung-5 and BARI Mung-6. Out of these BARI Mung-5 is most preferable.

***Land preparation***: Land preparation depends on sowing method and soil type. For sandy loam to silty loam soil, 2-3 ploughing to and cross plowing with subsequent 3-4 laddering are required so that the soil has a good tilth which is expected to have a good germination. For a clay type of soil, soil preparation requires more tillage operation at appropriate soil moisture status.

***Time of sowing:*** Sowing time varies from area to area. For Kharif-1, the timing is between end of February to mid March.

***Seed rate*:** Seed rate will be 40-45 kg/ha for BARI Mung-5 and BARI Mung-6. Slightly more seed may be needed for broadcast sowing.

***Spacing:*** In case of line sowing, line to line spacing should be 30 cm.

***Fertilizer dose:*** Requires less nitrogen application. However, for initial establishment of plant starter dose of 45 kg urea/ha should be applied. For supply of phosphorus and potassium 100 kg TSP/ha and 55 kg MP/ha respectively should be applied.

***Irrigation:*** Generally no irrigation is required for cultivation of mung bean except severe drought during early Kharif season.

***Weeding:*** To get optimum yield it is essential to make the crop free from weed. For good economic return one weeding between 20-25 days after seedling emergence should be sufficient.

***Harvesting:*** Mung bean is a crop of indeterminate flowering habit, as result, the pods mature subsequently. The crop has slight shattering habit, so the mature pods are to be picked up. Generally 2-3 picking are sufficient. However, for a new flash of flower 2 more picking may be required when the cumulative harvest is increased by 30% of normal yield.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 7 Kg | 60 | 420.00 | |
| 2 | Urea | 6 Kg | 12 | 72.00 | |
| 3 | TSP | 12 Kg | 40 | 480.00 | |
| 4 | MP/MOP | 5 Kg | 35 | 175.00 | |
| 5 | Gypsum | 6 Kg | 10 | 60.00 | |
| 6 | Boron | 1 Kg | 150 | 150.00 | |
| 7 | Sign board | 1 | 500 | 500.00 | |
| 8 | Register khata | 1 | 30 | 30.00 | |
| | **Total (One thousand eight hundred and eighty seven only)** | | | **1887.00 (US $ 28)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in four drought prone upazilas in Kharif-I season of 2008 and 2009. The crop has performed extremely well and given a good yield. After harvesting the pods

for 2 to 3 times the whole plants of the crop was ploughed down and mixed with the soil and the crop land was improved with huge amount organic matter. As per the feedback gathered so far from the farmers, community people and officers of the department the option can be promoted in the fields of appropriate farmers from the seasons onwards. A thorough assessment essentially be done by using the evaluation framework used in LACC-I period so that a well-informed decision and recommendation can be made.

# Sesame cultivation as drought management strategy

**A. Context and Justification:**

Sesame is an oil crop grown especially in sandy loam to clay loam, loamy soil and has been a good source of raw oil for the industrial use. Sesame is being cultivated in some upazilas of Natore district where farmers are traditionally cultivating the crop in slightly marginal land of the upazila. In some land where cultivation of seasonal crops is possible due to the nutrient status and other inherent quality of soil sesame stands as a ready crop for cultivation. It provide the opportunity for additional yield and income from the land that otherwise might have been left fallow. Based on the recommendation from the local farmers and the upazila technical team, sesame cultivation has been taken as potential local adaptation option. The project's intervention would be to incorporate new or BARI variety and endeavour to learn the suitability of the varieties in the changing drought regime of the area.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the sesame that can grow well in the increased drought in the north-western part and salinity in coastal areas.

Demonstrations showcase how to –

- appraise the suitability of the BARI variety as an alternative in the saline area of the project
- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the crop in comparison with the control/traditional practice
- evaluate the economic comparison with the control/traditional particular land
- assess the nutrient status and other changes happened in the soil of the part
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards drought etc and other factors (price) on the sustainability of the production practice

**C. Implementation (sowing) time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Lalpur and Bagatipara | - |

**E. Technical details:**

***Soil:*** Sesame can be cultivated in any land which is free from water logging. High lands with sandy loam or loam soil is more suitable for sesame cultivation.

***Variety:*** BARI 3 and 4 variety or BINA Til 6 etc.

***Land preparation***: Land preparation depends on sowing method and soil type. For sandy loam to silty loam soil, 2-3 ploughing to and cross plowing with subsequent 3-4 laddering are required so that the soil has a good tilth which is expected to have a good germination. For a clay type of soil,

soil preparation requires more tillage operation at appropriate soil moisture status. In Kharif-I season the best time of land preparation is between last week of February to mid March.

***Sowing of seed:*** Line sowing or broadcasting method of seed sowing.

***Seed rate*****:** 5.5 -6.5 kg / ha.

***Spacing:*** In case of line sowing, line to line spacing should be 30 cm. and plant to plant 5 cm.

***Fertilizer dose:*** The following fertilizer doses as in Table 1. may be used for sesame cultivation.

**Table 1. Fertilizer doses for sesame cultivation**

| **Name of Fertilizer** | **Fertilizer dose/ha** |
|---|---|
| Urea | 100-125 kg. |
| TSP | 130-150kg. |
| MP | 40-50kg. |
| Gypsum | 100-110kg. |
| Zinc Sulphate | 0-5 kg. |
| Boron | 8-10kg. |

***Method of Fertilizer Application:*** Half of the urea and all doses of other fertilizers may be apply during the last round of tillage following broadcast method and mix the fertilizer properly with the soil. The remaining half of the urea should be applied by topdressing 25-30 days after flowering stage.

**Irrigation:** A single irrigation after 25- 30 days of sowing may be needed if the rain water is not enough to supply required moisture. In case of lack of soil moisture second irrigation can be applied after 55- 60 days at grain formation stage.

***Weeding:*** As per the need of the field.

***Harvesting:*** Harvesting time varies between 85- 95 days.

**F. Trial demonstration budget.**

| **SL #** | **Item** | **Amount of input/bigha (Kg/No.)** | **Unit cost (BDT)** | **Total Cost (BDT)** | **Remarks** |
|---|---|---|---|---|---|
| 1 | Vine cuttings | 10560 | | 1000.00 | |
| 2 | Compost | 1000 Kg | 1.00 | 1000.00 | |
| 3 | Urea | 16 Kg | 12.00 | 192.00 | |
| 4 | TSP | 20 Kg | 40.00 | 800.00 | |
| 5 | MP/MOP | 8 Kg | 35.00 | 280.00 | |
| 6 | Gypsum | 8 Kg | 10.00 | 80.00 | |
| 7 | Zinc sulphate | 1 Kg | 150.00 | 150.00 | |
| 8 | Boron | | 150.00 | 150.00 | |
| 9 | Sign board | 1 | 500.00 | 500.00 | |
| 10 | Register khata | 1 | 30.00 | 30.00 | |
| | **Total (Four thousand one hundred and eighty two taka only)** | | | **4182.00 (US $ 61)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone flat barind area in one season in 2009 in the second phase (LACC-II) of the project only. The result and experiences gained demonstrate that the option may be tested further for making well informed decision whether to promote and replicate the option in new areas. After the subsequent test a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Turmeric cultivation as an intercrop

**A. Context and Justification**: As a spice turmeric stands first for its regular utilization at the kitchen of each family and it has some other usage like herbs and cosmetics in social and religious programmes and also used in the small dying industries. Turmeric is widely adapted to various ecological zones and it has a tremendous potential in the coastal area. It grows well in the shady places of any land and can thrive well in most of climatic conditions. There has been traditional practice of growing turmeric in the open place or cultivable land in coastal low land of Pirojpur and adjacent districts. It is observed from the field assessment that there are lot of Betel nut garden and the land underneath remain almost fallow although the year and can better be used for the turmeric cultivation. Introduction of turmeric was demanded from the local farmers and as such recommended from the upazila technical implementation working group (UTIWG).

**B. Objective:**

Objectives of the demonstration are –

- to use the fallow land in the betel nut garden
- find out the suitability of the turmeric in the betel nut garden
- to evaluate the economic comparison with the control/traditional practice
- to appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like salinity etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the local and HYV varieties of turmeric

**C. Implementation time:**
Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Nazirpur |

**E. Technical details:**

***Soil:*** Clay loam , loam, sandy loam .

***Land area:***
A total of 5 dec. land may be brought in for the demonstration considering the availability of land in the garden. The land should be a single piece where crop can be accommodated.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. In order that the soil has a good tilth, 2-3 ploughing and cross plowing with subsequent 3-4 laddering are required.

***Variety:***
As per the recommendation of the final NTIWG workshop high yielding variety *Dimla* was selected for demonstration considering its comparative higher yield potential.

***Time of seed sowing:*** The appropriate time of sowing seed 15 March to 15 April.

***Seed rate*:** Rate of rhizome will be 340-345 kg/bigha (approx 10-11 Kg/dec).

***Planting of rhizome:*** Always disease free rhizome is suggested for planting. A rhizome of 15-20gm weight and having 1-2 eyes can be planted at a depth of 5-7 cm.

***Spacing:*** Line to line and plant to plant spacing should be 50 cm.x 25 cm.

***Fertilizer dose and timing:*** Fertilizer dose is given in the budget section. The application should follow the standard procedure.

**Table 1. Fertilizer doses for turmeric cultivation**

| **Name of Fertilizer** | **Fertilizer dose/ha** |
|---|---|
| Cow dung | 4-6 Ton |
| Urea | 200-240 Kg. |
| TSP | 170-190 Kg |
| MP/MOP | 160-180 Kg |
| Gypsum | 105-120 Kg |
| Zinc oxide/sulphate | 2-3 Kg |

**Method of Fertilizer Application:** Half of the urea and all doses of other fertilizers may be applied during the last round of tillage following broadcast method and mix the fertilizer properly with the soil. The remaining half of the urea should be applied by topdressing 80 and 110 days after planting the rhizome.

**Intercultural operation:** In case of lack of soil moisture irrigation may be applied after as required. Drainage should be done properly if there is any stagnation of water due to heavy rain. Cleaning and weeding has to be done as per the requirement. The soil may be loosen and the rhizome may be covered by raising the soil around the line.

***Harvesting:*** Harvesting time varies between 270-300 days after the planting time. The crop can be harvested once the leaves start drying.

**F. Trial demonstration budget:**

| **SL #** | **Item** | **Amount of input/bigha (Kg/No.)** | **Unit cost (BDT)** | **Total Cost (BDT)** | **Remarks** |
|---|---|---|---|---|---|
| 1 | Planting material/rhizome | Lumpsum | | 300.00 | |
| 2 | Compost | 500 kg | 1 | 500.00 | |
| 3 | Urea | 5 | 12 | 60.00 | |
| 4 | TSP | 4 | 40 | 160.00 | |
| 5 | MP/MOP | 3 | 35 | 105.00 | |
| 6 | Gypsum | 2 | 10 | 20.00 | |
| 7 | Zinc sulphate | 60 g | 150 | 10.00 | |
| 8 | Sign board | 1 | 500 | 500.00 | |
| 9 | Register khata | 1 | 30 | 30.00 | |

| | | | |
|---|---|---|---|
| | **Total (One thousand six hundred and eighty five only)** | **1685.00 (US $ 25)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the tidal coastal area in one season in 2009 in the second phase (LACC-II) of the project only. The result and experiences gained demonstrate that the option may be tested further for making well informed decision whether to promote and replicate the option in new areas. After the subsequent test a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Introduction of *Chui Jhal* in the coastal tidal land

**A. Context and Justification**:

A climbing herb locally named as *Chui* or *Chui Jhal* is grown in the south-western coastal districts like Bagerhat, Khulna, Satkhira, Jessore and Magura. The local community uses the crop as medicinal herb for common ailment like cold, cough and spice as well for making their regular food/curry hot and delicious that sometimes can replace hot chili. The crop already has an established market in the districts and a good potential for increasing its area of production and corresponding market. The crop is already adapted in the coastal saline environment and the crop was taken a test crop to find out its suitability in the villages of Pirojpur which is adjacent to Bagerhat district and shares more or less similar agro-ecological context. *Chui* was selected and advocated by the field staff and officers of Department of Agricultural Extension (DAE) and as such recommended from the upazila technical implementation working group (UTIWG).

**A. Objective:**

Objectives of the demonstration are –

- find out the suitability of the *chui jhal* in the villages of LACC project under Nazirpur
- to evaluate the economic value of the crop in the new areas
- to appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like salinity etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the crop

**B. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Nazirpur |

**E. Technical details:**

***Soil:*** Almost all types of soil.

***Land area:*** The crop can grow only as a climbing plant in another plant (like mango, betel nut, mahogany, etc). A single supporting plant has to be selected in any garden and accordingly the cutting should be planted near the plant so that it can climb upon the big plant.

***Land preparation:*** In order to plant the cutting a pit of 50 cmX50 cm X 50 cm has to be prepared close to the bigger supporting tree at a distance of 30 – 40 cm from the foot of the plant. The pit has to be filled with enough cow dung/compost, recommended amount of urea, TSP and MP and left for about 7 – 10 days so that everything get decomposed and mixed well with soil.

***Variety:*** As per the available information only a local variety is available which is recommended fro the UTIWG and approved at NTIWG.

***Time of seed sowing:*** Transplanting of cutting starts from 15 March and can be extended up to 15 May and sometimes goes beyond as per the moisture condition of the soil of the particular land/garden.

***Seed rate*:** Usual practice is to plant 2 cuttings per plant so that finally one can survive and grow up to the supporting plant.

***Planting of cutting:*** Always healthy and disease free cutting is suggested for planting. A cutting of 15-20 cm length and having 2-3 eyes can be planted at a depth of 5-7 cm.

***Spacing:*** As a climbing plant the crop grows well with mango, betel nut, mahogany, cotton trees. The cutting is planted at a distance of 60 – 70 cm from the foot of the plant that is selected as a support.

***Fertilizer dose and timing:*** Fertilizer dose is given in the budget section. The application should follow the standard procedure.

**Table 1. Fertilizer doses for turmeric cultivation**

| **Name of Manure/fertilizer** | **Fertilizer dose/pit** |
|---|---|
| Cow dung | 10 Kg |
| Urea | 250 gm |
| TSP | 200 gm |
| MP/MOP | 200 gm |

***Method of Fertilizer Application:*** Total amount of cow dung and all other fertilizers can be applied at the time of pit preparation. The basal dose is sufficient for the crop to grow and sustain and no further application is required.

***Intercultural operation:*** As per the need and general practice no intercultural operation is done. However, need based watering, weeding and other required care can be undertaken during the period while the plant climbs up to the supporting plant.

***Harvesting:*** Harvesting time varies between 2 – 3 years after the planting time. Only matured branches are cut off once they started drying up.

**F. Trial demonstration budget:**

| **SL #** | **Item** | **Amount of input/bigha (Kg/No.)** | **Unit cost (BDT)** | **Total Cost (BDT)** | **Remarks** |
|---|---|---|---|---|---|
| 1 | Planting material/cutting | Lump sum | | 200.00 | |
| 2 | Compost | 200 Kg | 1.00 | 200.00 | |
| 3 | Urea | 4 Kg | 12.00 | 48.00 | |
| 4 | TSP | 3 Kg | 40.00 | 120.00 | |
| 5 | MP/MOP | 2 Kg | 35.00 | 70.00 | |
| 6 | Sign board | 1 | 500 | 500.00 | |
| 7 | Register khata | 1 | 30 | 30.00 | |
| | **Total (One thousand one hundred and sixty eight only)** | | | **1168.00 (US $ 17)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the tidal coastal area in one season in 2009 in the second phase (LACC-II) of the project only and the plant could not attain the production stage. However, feedback received from the farmers and experiences gained demonstrate that the option may be tested further in similar setting for making well informed decision whether to promote and replicate the option in new areas. After the subsequent test a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Arum (*Colocasia*) cultivation in low land

**A. Context and Justification:**

Seasonal flood and tidal flood leave the low lands inundated and wet and thus often fallow for few months in some parts of south-western upazilas like Nazirpur of Pirojpur district. Farmers have little choices for growing crops in those lands except planting few local varieties of arum without giving proper attention to the appropriate cultivation and crop management techniques. In the context of increasing intensity of seasonal flood and uncertain nature of tidal surge in the coastal areas and thus inundation of more crop lands, growing crops like arum in the wet and marshy land has a good potential. Farmers of the coastal areas in particular from Pirojpur district looked for alternatives and came up with their own selection and thus the crop was recommended and approved through the usual identification and validation process of LACC project.

**B. Objective:**

Objectives of the demonstration are –

- find out the suitability of the arum in the villages of LACC project under Nazirpur
- to evaluate the economic value of the crop in the new areas
- to appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like flood, surge etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the crop

**C. Implementation time:**
Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Nazirpur |

**E. Technical details:**

***Soil:*** Silty loam and clay soil is suitable for the crop.

***Land area:***
A total of 2 dec. land may be brought in for the demonstration considering the availability of wet land in a single piece where crop can be accommodated.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. In order that the soil has a good tilth, 2-3 ploughing and cross plowing with subsequent 3-4 laddering are required.

***Variety:***
As per the recommendation of the final NTIWG workshop high yielding BARI variety was selected for demonstration considering its comparative higher yield potential.

***Time of transplanting:*** The appropriate time of transplanting is 15 March to 15 April and transplanting can be done at any time, in the southern part of the country, while there is water available in the land or the land is wet.

***Seed rate*:** Rate of rhizome/stolon will be 37000-38000/ha.

***Spacing:*** Line to line and plant to plant spacing should be 60 cm. and 45 cm respectively.

***Fertilizer dose:*** Fertilizer dose for arum production is provided in Table.1

**Table 1. Fertilizer doses for Arum Production**

| **Name of Fertilizer** | **Quantity per ha** |
|---|---|
| Cow dung | 15-20 ton. |
| Urea | 140-160 kg. |
| TSP | 120-130 kg. |
| MP | 160-190 kg. |

Source: BARI

***Method of Fertilizer application:*** All cow dung, TSP and MP should be applied at the time of planting rhizome/stolon. Urea should be applied in 2-3 splits. First split should be applied within 20-25 days of planting.

***Intercultural operations***: Maintain standing water up to 8-10 cm in the field.

**F. Trial demonstration budget:**

| **SL #** | **Item** | **Amount of input/bigha (Kg/No.)** | **Unit cost (BDT)** | **Total Cost (BDT)** | **Remarks** |
|---|---|---|---|---|---|
| 1 | Planting material/rhizome | Lump sum | | 100.00 | |
| 2 | Compost | 100 | 1.00 | 100.00 | |
| 3 | Urea | 3 | 12.00 | 36.00 | |
| 4 | TSP | 2 | 40.00 | 80.00 | |
| 5 | MP/MOP | 2 | 35.00 | 70.00 | |
| 6 | Sign board | 1 | 500 | 500.00 | |
| 7 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Nine hundred and sixteen only)** | | | **916.00 (US $ 13)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the tidal coastal area in one season in 2009 in the second phase (LACC-II) of the project only and farmers received expected yield. Feedback received from the farmers and experiences gained demonstrate that the option may be promoted and replicated in same and similar agro-ecological contest without making any further test. However, a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# ***Madraji Ol*** **(Elephant foot) cultivation as reserve crop**

**A. Context and Justification:** *Madraji Ol* stands out as a new and promising variety to the farmers of Bangladesh and in south-western districts especially where the crop has not cultivated yet. The crop can be grown in poor soil and can withstand in a relatively hazardous environment. It serves as a reserve crop for the lean period and provides enough food and cash incentive for poor farmers. There are spaces often left in and around the farmers' homesteads can better be utilized with a long duration crop like ol i.e. elephant foot. Since the crop requires less care and management the female members of the family can do the job with much involvement in the cultivation practice. In the wake of increased uncertainty of extreme climatic event like tidal surge, cyclone, salinity in the coastal area the crop has been selected by the DAE and experts as one of the potential alternatives to be grown in the farmers' fields of Nazirpur upazilas of Pirojpur district.

**B. Objective:**

Objectives of the demonstration are –

- find out the suitability of the *Maraji ol* in the villages of LACC project under Nazirpur
- to evaluate the economic value and social acceptance of the crop in the new areas
- to appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like flood, surge etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the crop

**C. Implementation time:**
Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Nazirpur |

**E. Technical details:**

***Soil:*** Silty loam and sandy loam soil is suitable for the crop.

***Land area:***
A total of 2 dec. land may be brought in for the demonstration considering the availability of wet land in a single piece where crop can be accommodated.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. In order that the soil has a good tilth, 2-3 ploughing and cross plowing with subsequent 3-4 laddering are required.

***Variety:*** Introduced variety name as *Madraji ol.*

***Time of transplanting:*** The appropriate time of transplanting is 15 March to 15 April and sometimes can be done until the end of April.

***Seed rate*:** Rate of rhizome will be 1500-2000 Kg/ha.

***Spacing:*** Line to line and plant to plant spacing should be 75 cm. and 60 cm respectively.

***Fertilizer dose:*** Fertilizer dose for arum production is provided in Table.1

**Table 1. Fertilizer doses for Arum Production**

| Name of Fertilizer | Quantity per ha |
|---|---|
| Cow dung | 15-20 ton. |
| Urea | 140-160 kg. |
| TSP | 120-135 kg. |
| MP | 160-190 kg. |

Source: BARI

***Method of Fertilizer application:*** All cow dung, TSP and MP should be applied at the time of planting rhizome/stolon. Urea should be applied in 2-3 splits. First split should be applied within 20-25 days of planting.

***Intercultural operations***: The crop does not need regular care but just looking after the crop for weeding, cleaning or fertilization at 2 weeks interval is enough.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Planting material/rhizome | Lump sum | | 300.00 | |
| 2 | Compost | 100 kg | 1.00 | 100.00 | |
| 3 | Urea | 3 | 12.00 | 36.00 | |
| 4 | TSP | 2 | 40.00 | 80.00 | |
| 5 | MP/MOP | 2 | 35.00 | 70.00 | |
| 6 | Gypsum | 3 | 10.00 | 30.00 | |
| 7 | Zinc Sulphate | 1 | 150.00 | 150.00 | |
| 8 | Sign board | 1 | 500 | 500.00 | |
| 9 | Register khata | 1 | 30 | 30.00 | |
| | **Total (One thousand two hundred and ninety six only)** | | | **1296.00 (US $ 19)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the tidal coastal area in one season in 2009 in the second phase (LACC-II) of the project only and farmers started receiving good yield. Feedback received from the farmers and experiences gained demonstrate that the option may be promoted and replicated in same and similar agro-ecological contest along with awareness raising programmes. However, a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Teasle gourd cultivation as an alternative crop

**A. Context and Justification:**

Teasle gourd is cultivated in the monsoon season of the year as a homestead as well as a field crop. The crop is cultivated in the country from plain to hilly areas based on the fact that teasle gourd can thrive in almost all soil and environment but limited adaptability to the saline prone area. There have been evidences of cultivation of the teasle gourd in the south-western districts although the adaptability is to be judged yet. As per the field level demand and technical support from BARI the crop is recommended for cultivation in the coastal saline area of the project.

**B. Objective:**

Objectives of the demonstration are –

- find out the suitability of the teasle gourd in the villages of LACC project under Bhandaria upazila
- to evaluate the economic value and social acceptance of the crop in the new areas
- to appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like flood, surge etc and other factors (price) on the sustainability of the production practice and the comparative advantages of the crop

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Bhandaria |

**E. Technical details:**

***Soil:*** Teasle gourd is grown in all types of soil. However, loam to silty loam soils are best for the cultivation of teasle gourd

***Variety:*** BARI variety or suitable and locally acceptable variety.

***Land preparation:*** To make sure that the at least 1 to 2 seedlings are retained in the pit, 4-5 seeds or plants are sown in each pit in the land.

***Time of sowing:*** Teasle gourd grows well in the Kharif-I season and can be cultivated by sowing seeds and planting seedlings. Therefore seed sowing for raising seedlings could be done between mid January to mid March.

***Seed rate:*** 1000-1500 grams/ha

***Seedling/sowing of seed:*** Seedlings can be grown in small polythene bags, which save the cost of seeds. For teasle gourd cultivation, 2- 3.5 meter distances should be maintained between the pits by sowing 4-5 seeds / seedlings in each pit.

***Fertilizer dose:*** Following dose should be followed for teasle gourd cultivation

| Fertilizers | Doses (gm/pit) |
|---|---|
| Urea | 65.0 |
| TSP | 13.0 |
| MP | 47.0 |
| Gypsum | 67.0 |
| Zinc sulphate | 3.8 |
| Boron | 1.2 |
| Cow dung | 10 Kg |

***Fertilizer Application*****:** All phosphate, potassium, sulphur, zinc, boron and organic manure should be applied in 5-7 days prior to planting. Urea should be applied around the plant by side dressing at 30 and 50 days after planting and mixed with soil.

***Intercultural operation:*** Regular watering, breaking soil crusts, making supporting structures and other intercultural operations are to be taken. Artificial pollination of pollen grains from male flowers help in increasing production.

***Other cultural practices:*** Poison baits may be used for controlling flies. Poison baits are effective in reducing the infestation of flies in gourd.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed/seedling | 100 | 5 | 500.00 | |
| 2 | Compost | 1000 Kg | 1 | 1000.00 | |
| 3 | Urea | 25 Kg | 12 | 300.00 | |
| 4 | TSP | 10 Kg | 40 | 400.00 | |
| 5 | MP/MOP | 10 Kg | 35 | 350.00 | |
| 6 | Gypsum | 5 Kg | 10 | 50.00 | |
| 7 | Boron | 1 kg | 150 | 150.00 | |
| 8 | Zinc sulphate | 1 Kg | 150 | 150.00 | |
| 9 | Trellis making materials | Lump sum | | 1000.00 | |
| 10 | Sign board | 1 | 500 | 500.00 | |
| 11 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Four thousand four hundred and thirty only)** | | | **4430.00 (US $ 65)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the tidal coastal area in one season in 2009 in the second phase (LACC-II) of the project only. No yield and thus result could be received since the demonstration crop was damaged by a sudden tidal flow in the villages. A further trial may be needed to learn and understand the performance thus to make any conclusion and recommendation. However, a thorough assessment by using the evaluation framework used in LACC-I period is needed for making a confirmed decision and recommendation.

# Pigeon pea cultivation as an alternative crop

**A. Context and Justification:**

North-western barind area has been experiencing heavy drought since long and the trend is increasing. Land utilization by the common agricultural practices is challenged over the period of time. More inputs especially huge amount of irrigation water are getting used for the regular crop like rice and vegetable cultivation. In one hand more lands are rendered fallow and in another hand more irrigation water are being used and as a result a huge climate and environmental debacle is awaiting for the area. An appropriate alternative may be to introduce crop that can thrive well in the ever increasing drought and produce an attractive yield for the local community. Cultivation of pigeon pea which can tolerate the drought condition and can easily be cultivated in the community place like by the side of dike, khari canal, pond has been identified by the local farmers and the community people and thus recommended as a suitable option for the north-western drought prone upazilas for the kharif-I season 2009.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability and thus productivity of pigeon pea that can grow well in the increased drought in the drought prone upazilas.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the crop in comparison with the control/traditional practice
- evaluate the economic comparison with the control/traditional practice
- assess the nutrient status and other changes happened in the soil
- appraise the value and implication of the community approach in the demonstration of the option
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the production practice and the comparative advantages of the pigeon pea over other pulse crops grown in the demo

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Sapahar and Porsha | - |

**E. Technical details:**

***Soil:*** Pigeon pea can be grown in almost all types of soil. However, well drained medium high lands with sandy loam and alluvial soils are good for better growth and higher yield.

***Variety:*** BARI variety or any improved variety commonly grown in the area.

***Land preparation***: Pigeon pea cultivation does not require a very good land preparation rather just a condition for soil that can contain the seeds and some moisture available for facilitating germination. A thorough and deep ploughing may only enhance germination and thus produce good yield.

***Time of sowing:*** Sowing time varies from area to area. For Kharif-1, the timing is between end of February to mid March.

***Seed rate*:** Seed rate will be 40-45 kg/ha may be needed for general types of soil.

***Spacing:*** In case of line sowing, line to line spacing should be 30 cm.

***Fertilizer dose:*** Requires less nitrogen application. However, for initial establishment of plant starter dose of 45 kg urea/ha should be applied. For supply of phosphorus and potassium 100 kg TSP/ha and 55 kg MP/ha respectively should be applied.

***Irrigation:*** Generally no irrigation is required for cultivation of pigeon pea except severe drought during early Kharif season.

***Weeding:*** Pigeon pea can thrive in almost all condition. However, incase of heavy infestation by unexpected herbs at the early stage may call for weeding.

***Harvesting:*** Pigeon pea is a crop of indeterminate flowering habit, as result, the pods mature for a longer period of time. Therefore picking up pods may go for a longer and continual period. Generally 2-3 picking are sufficient. However, for a new flash of flower 2 more picking may be required when the cumulative harvest is increased by more than 30% of normal yield.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 6 Kg | 80 | 480.00 | |
| 2 | Urea | 6 Kg | 12 | 72.00 | |
| 3 | TSP | 12 Kg | 40 | 480.00 | |
| 4 | MP/MOP | 5 Kg | 35 | 175.00 | |
| 7 | Sign board | 1 | 500 | 500.00 | |
| 8 | Register khata | 1 | 30 | 30.00 | |
| | **Total (One thousand seven hundred and thirty seven only)** | | | **1737.00 (US $ 25)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in two drought prone upazilas in Kharif-I season of 2009. The crop has performed well and given a good yield. As per the feedback gathered so far from the community people the option can be promoted in the fields of appropriate farmers from the seasons onwards. Community approach in the implementation of the demonstration of the option has been found worked well. A thorough assessment may be done by using the evaluation framework used in LACC-I period so that a well-informed decision and recommendation can be made.

# Homestead vegetable gardening for enhanced resilience

**A. Context and justification:**

Homestead gardening is an old production practice in the rural areas of Bangladesh, creating opportunity for employment and year-round income even when other sources fail due to drought. The practice was already suggested by the Bangladesh Agricultural Research Institute in the early 1980s. However at that stage it was not successful due to non-availability of drought and saline resistant vegetables. Current efforts helped to identify drought and saline resistant vegetable crops involving farmers themselves. This practice ensures year round income, nutritional security and gender involvement. Producing vegetables in the homestead can also ensure use of fallow and unexploited land and is a way of using homestead wastes, sweepings and debris as organic matter, as well as irrigation water from the homestead source. The practice was considered as a good adaptation option for improving family food and nutrition for both drought and saline coastal regions.

**B. Objective:**

To promote vegetable production for home consumption throughout the year by providing more drought and saline tolerant varieties as per the regional requirements.

Demonstrations showcase how to –

- select suitable vegetable species/varieties that grow and produce well in drought prone and saline areas.
- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the vegetables in comparison with the control/traditional practice.
- calculate the economic benefits in comparison with the control/traditional practice.
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, salinity etc on the sustainability of the production of vegetables in the homestead garden.
- evaluate the improvement in home surrounding environment (qualitative).
- appraise the involvement of the women members in the demonstration activities.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2006 | Nachole, Gomostapur, Sapahar and Porsha. | N/A |
| 2007 | Nachole, Gomostapur, Sapahar and Porsha. | N/A |
| 2008 | Nachole, Gomostapur, Sapahar and Porsha. | - |

| | | |
|---|---|---|
| 2009 | Lalpur and Bagatipara | Terokhada |

**E. Technical details:**

e.1. Lay out (Figure-1) of the plot/bed:-

- Area of homestead garden is 1 decimal or 36 $m^2$.
- No. of bed are 5 (in the north-south directions to ensure equal distribution of sunlight).
- The length of each bed is 550 cm and width of each bed is 90 cm.
- Width and depth of boundary drain are 25 cm and 10 cm. respectively.
- The height of the seedbeds will be 15 cm.

e.2. Other technical aspects:-

- Five recommended cropping pattern of vegetables may be followed for five beds so that diversified vegetables are available throughout for family consumption.
- A strong boundary fence is required to establish (with bamboo or other low-cost materials) to protect crops from cattle, goats, etc.
- In the boundary canal aroid and on the fence bitter gourd, country bean, yard long bean, sponge gourd can be grown.

e.3. The recommended vegetables for homestead garden:- Following species of vegetables are selected following BARI recommendation, local suitability and may be grown as per the distribution per bed of the garden.

| Beds no. | Drought prone area | Coastal saline area | Remarks |
|---|---|---|---|
| Bed–1 | Red amaranth | Red amaranth | Same/different variety |
| Bed–2 | Okra | Bringal | Different species |
| Bed–3 | Indian spinach | Spinach | Different species |
| Bed–4 | Kang kong | Batishak | Different species |
| Bed–5 | Bringal | Kang kong | Different species |

As far as the assessment from the regions, there are very few species of vegetables which are particularly adaptable either to drought or to the coastal saline condition. Most of the species grown in both areas are same, although there are variations in case of the varieties of a particular species. As for example Kang kong is widely cultivated in each and every place of the country and it is regarded as one of the most ecologically suitable species in almost all soils and conditions. However there is a variety of stem amaranth called *Katoa* which is better suited in drought prone area and bitter gourd grows better in the coastal saline region.

Similar and suitable crops/vegetables can be grown round the year as per the seasonal requirement and with farmers' own inputs and technical guidance from the project/DAE.

*Note: The model called Kalikapur and the lay out and crop combination of the said model are recommended from BARI. There are few other models developed by BARI being practiced like the Barind model in high-low barind area (Chapai Nawabganj, Naogaon), Goyeshapur model in the flat barind area (Natore), Laudobe model in the Dacope upazila. The model/s can be adapted as per the suitability in any area and the technical details should be followed accordingly.*

*The concept of community based vegetable cultivation was introduced in the year 2009 based on lessons of previous years. In community based vegetable cultivation the technical requirement is same as homestead vegetable cultivation. The difference is only in the involvement of more*

*number of farmers under a single option and a more opportunity for sharing in all respects of production and management among the fellow farmers.*

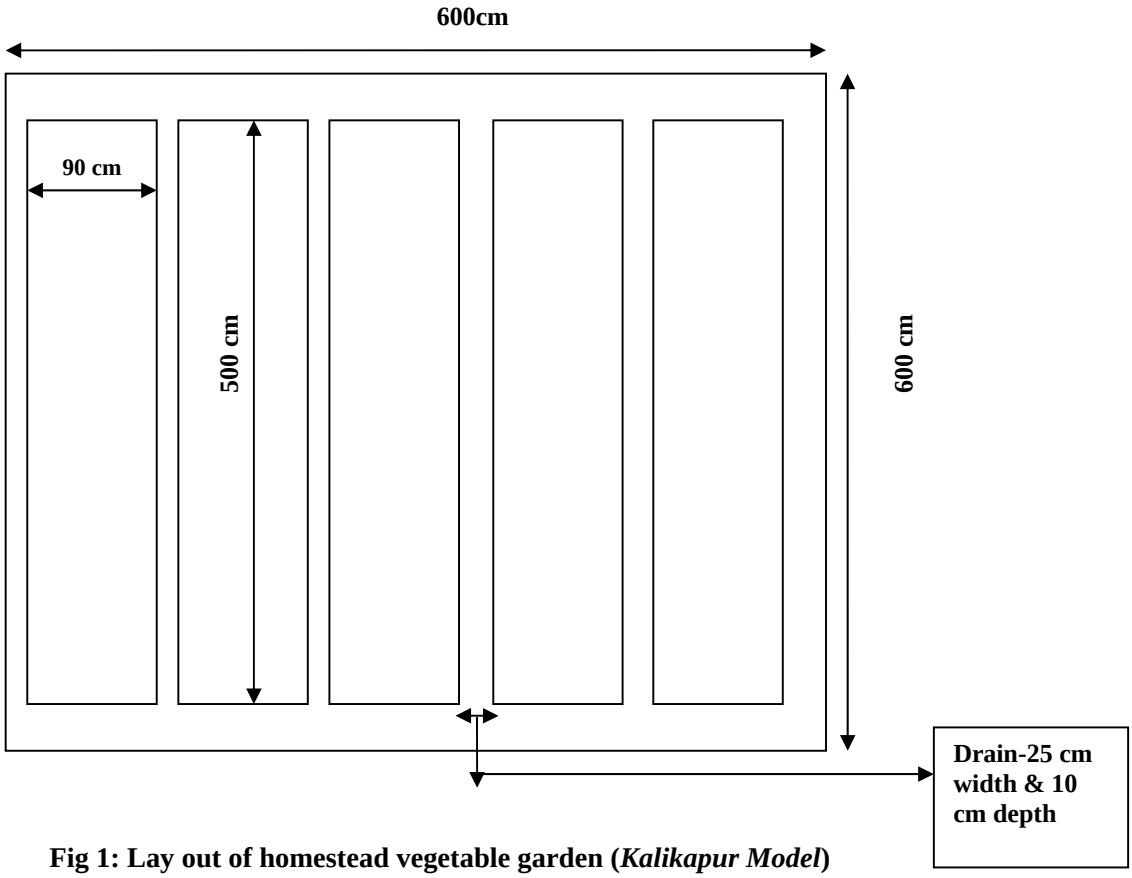


**Fig 1: Lay out of homestead vegetable garden (*Kalikapur Model*)**

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed (Lump sum) | | 400 | 400.00 | |
| 2 | Compost | 100 Kg | 1 | 100.00 | |
| 3 | Urea | 5 Kg | 12 | 60.00 | |
| 4 | TSP | 2 Kg | 40 | 80.00 | |
| 5 | MP/MOP | 2 Kg | 35 | 70.00 | |
| 6 | Watering cane | 1 | 500 | 500.00 | |
| 7 | Fencing (Lump sum) | | 700 | 700.00 | |
| 8 | Sign board | 1 | 500 | 500.00 | |
| 9 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Two thousand four hundred and forty only)** | | | **2440.00 (US $ 36)** | |

**G. Replication suitability and recommendation:**

As per the lessons from the first and second phases (LACC-I and LACC-II) and evaluation done through the evaluation framework below, promotion of the technology has been recommended to continue as a routine activity with more drought and saline tolerant varieties in the homesteads of landless and marginal farmers.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social feasibility** | **No/ marginal increase of GHG** | |
| Vegetables/ fruit, tree/ timber, tree/ livestock/ poultry | 25, 26 | Drought spells; loss of crops | Irrigated/ rain fed | High and low barind tract | Poor/ medium farmers with land ownership | 36 US $ | High | High | Yes | No increase | Highly recommended as adaptation option |

# Papaya cultivation as a livelihood support activity

**A. Context and Justification:**

Papaya is cultivated in almost all agro-ecological zones and accepted as a high value, delicious and nutritious fruit in Bangladesh. It is one of the rare crops in Bangladesh which is taken both as vegetable at the green stage and fruit at the ripening stage. It is known that papaya can grow well in a dry climate with a meager rainfall and produce sweet–testing fruits. Farmers of north-western drought prone barind area identified papaya as a promising crop based on the information of its ecological advantage, market value and other good traits and selected for cultivation in their homestead lands. Based on the demand from the farmers, the local agriculture office and project staff recommended the cultivation of papaya in the farmers' homesteads. The major aim of the papaya cultivation demonstration trial was to provide the farming households with the opportunity to produce and ensure food, nutrition and income.

**B. Objective:**

To promote cultivation of papaya with am aim to provide farmers with an alternative in order for diversification of their livelihood, income opportunities and development of resilience of the farming community.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the papaya cultivation in comparison with the control/traditional practice, other crops.
- calculate the economic benefits in comparison with the control/traditional production practice, other crops.
- appraise farmers' perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the production practice in comparison with other practices.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Nachole, Gomostapur, Sapahar and Porsha. | N/A |

**E. Technical details:**

***Variety:*** The popular varieties are BARI Papaya-1or Shahi or Bhadsha (Ishurdi).

***Seedling raising:*** Seeds are sown on raised seed beds at a depth of 1 cm in rows spaced 15 cm apart and the seeds spaced 2.5 cm apart. The seed beds should be watered with a watering can immediately after sowing and every morning and evening except during the rains. Seeds start germinating within 15 -20 days .This can be faster, if they are soaked in water for 48 hours before sowing. Seedling raised in polythene bags are the best as the roots of the papaya plant are not capable of tolerating transplanting shock. Two to three seeds can be sown in each bag (10x15cm

size) filled with a mixture of sieved soil, farmyard manures and sand in equal proportions. Only one seedling should be kept in each bag after 2-3 days of germination. Seedling aged 20-25 days should be irrigated with 20 gm urea per litre of water at an interval of 15 days, to enhance growth.

***Soil:*** A well drained, sandy loam soil, rich in organic matter is good for papaya. The soil pH for papaya cultivation should be between 6.0-7.0.

***Land and pit preparation:*** The land should be well prepared by plowing and harrowing three to four times. Pits of 60 cm cube are spaced 2x2m apart. The top half of the pit soil should be placed one side of the pit with the bottom half placed on the other. The pit should be filled with top soil, and organic manure, TSP, Gypsum, Zinc oxide and boric acid at the rate of 10 kg, 500 g, 250g and 25g, respectively. The soil of the pit needs to be watered. A trench or drain may be made in between two rows, in order to drain out the rain water and raise the beds

***Planting:*** Seedlings of 45 to 60 days old should be planted. Three seedlings should be planted 20cm apart per pit in a triangular fashion. After planting, the soil around the plant needs to be firmly pressed and well irrigated. Transplanting of seedlings should be done at least 10 days after pit preparation, perfectly in the afternoon. The best time to plant the seedlings is March.

***Fertilization:*** Since, papaya grows vigorously and continuously it has a constant demand for nutrients. The basal dose should be applied during pit preparation. The first top dressing (TD) should be done when the seedlings are established about 2 months after transplanting. The rest of the fertilizers may be applied at an interval of 45 days from the first top dressing. Urea and MP are applied at the rate of 50 g per plant up to flowering and thereafter the doses are doubled. After each application of fertilizer, the area should be irrigated and fertilization should be stopped two months before final harvest.

***Irrigation:*** Regular irrigation helps plant and fruit development. It is however, important to prevent water-logged conditions, especially around the plant. Generally plants are irrigated twice in a month but it is good to irrigate weekly in drought conditions. Irrigation should be carried out by making trenches in between the two rows which will prevent the irrigation water from coming into direct contact with the stem, thus preventing collar rot disease.

***Table: fertilizer rate and method of application***

| **Manures and fertilizer** | **Doses/Plant** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Basal | 1st TD | 2nd TD | 3rd TD | 4th TD | 5thTD | 6thTD |
| Urea (g) | 450 | - | 50 | 50 | 50 | 100 | 100 | 100 |
| TSP(g) | 450 | Entire | - | - | - | - | - | - |
| MP(g) | 450 | - | 50 | 50 | 50 | 100 | 100 | 100 |
| Gypsum(g) | 250 | Entire | - | - | - | - | - | - |
| Zinc Sulphate (g) | 15 | Entire | - | - | - | - | - | - |
| Borax | 25 | Entire | - | - | - | - | - | - |
| Organic manure (kg) | 10 | Entire | - | - | - | - | - | - |

***Removal of excess plants*:** As soon as the papaya flowers appear and are large enough to determine the male or female plants, most of the male plants should be uprooted, leaving about 10% in the field for pollination. Similarly, only one robust female plant should be left in each pit.

In case of hermaphrodite varieties, which produce only female and hermaphrodite plants, the common practice is to remove all the female plants and keep one hermaphrodite per pit.

***Fruit thinning:*** Some times papaya plant bears several fruits in a cluster, instead of a single fruit at each node and can create a crowded condition. So, a thinning of the fruit cluster should be done immediately after fruit set allowing a single fruit per node to develop properly.

***Propping:*** Papaya is soft wooded heavy bearing plant coupled with a hallow stem, which makes it highly vulnerable to wind damage. So, the plants need support by bamboo, other strong pole.

***Harvesting:*** Papaya fruits are very soft, they ripe rapidly once it attained maturity. So it is advisable to harvest the fruits as soon as they are mature. The fruits should be harvested individually by hand or by net, taking care to avoid all possible injuries.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 20 gm | 10.00 | 200.00 | |
| 2 | Compost/cow dung | 200 | 1.00 | 200.00 | |
| 3 | Urea | 15 | 12.00 | 180.00 | |
| 4 | TSP | 15 | 40.00 | 600.00 | |
| 5 | MP/MOP | 15 | 35.00 | 525.00 | |
| 6 | Gypsum | 8 | 10.00 | 80.00 | |
| 7 | Boron | 0.5 | 150.00 | 75.00 | |
| 8 | Zinc Sulphate | 0.5 | 150.00 | 75.00 | |
| 9 | Sign board | 1 | 500 | 500.00 | |
| 10 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Two thousand four hundred and sixty five only)** | | | **2465.00 (US $ 36)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone barind area in one season in 2007 in the first phase (LACC-I) of the project only. Yield of the demonstrations was not consistent throughout the season and the areas and farmers were not satisfied with the result of the demonstrations. Recurrent and incessant rainfall during the growing period hampered the growth and damaged the papaya trees in some demonstrations. All demonstrations of Gomostapur upazila were fully damaged due to the nonstop rain and hence no result could be obtained from the upazila. Heavy soil of the *barind* tract was also not very suitable for the papaya cultivation as there drainage capacity is low and water stagnation damaged the papaya trees which are very weak and sensitive to stagnant water.

The result of papaya demonstrations illustrates that every option must be selected through a rigorous process where experts, scientists and others can provide their judgment and clarification on every aspect of the demonstration including technical suitability and socio-economic acceptability. The project discontinued the demonstration of the option after the feedback from the farmers and others concerned. Further trials may be taken up if suitable varieties for drought prone areas are recommended by the research institutes.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommend ation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat/ Fruit tree/ Fallow / Poultry | 25, 26 | Drought spells; loss of crops | Irrigated/ rain fed | High and low barind tract | Small/ medium farmers with land ownership | 36 US $ | Medium | Low | No | no increase | Not recommended |

# Jujube Gardening for exploiting drought and salinity conditions

## A. Context and Justification:

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

Two new/improved varieties of jujube i.e. *Apple kul and BAU kul* are getting fast popularity due to their yield and market potential. These varieties are expanding as a usual manner to every corner of Bangladesh and thus taken up by the farmers of coastal area as well. There is a jujube variety called *Narkeli kul* is found available and indigenous to the coastal saline areas. In the coastal districts jujube gardening has been taken as a new option to learn and evaluate the suitability in the advent of increasing threat of salinity and other natural hazards. In addition a comparison among the improved varieties and the local variety has been one of the major focuses in the coastal area.

## B. Objective:

To provide the farmers with opportunity for learning the suitability of the wheat varieties that can grow well in the increased drought in the north-western part and salinity in coastal areas.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the cultivation of the jujube in comparison with the control/traditional practice, other crops
- calculate the economic benefits in comparison with the control/traditional production practice, other crops
- find out other additional benefit like fuel, etc
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, etc and other factors (price) on the sustainability of the production practice in comparison with the autonomous mango adaptation, other practices

## C. Implementation time:

Kharif-I/March - July.

## D. Successfully tested sites/upazilas:

| Year | North-west | South-west |
|---|---|---|

| | | |
|---|---|---|
| 2006 | Nachole, Gomostapur, Sapahar and Porsha. | N/A |
| 2007 | Nachole, Gomostapur, Sapahar and Porsha. | N/A |
| 2008 | Sapahar and Porsha. | N/A |
| 2009 | - | Dacope |

**E. Technical details:**

***Land area:*** 1 Bigha (33 dec.).

***Soil:*** Satisfactory production is possible from any type of land. Jujube plant can tolerate both salinity and drought condition. But heavy and slightly alkaline sandy loam soil is good for jujube production.

***Variety:*** *Apple kul, BAU kul, Narkeli kul* (as suitable to the area concerned). Apple kul is mostly selected by the north-western upazilas and Narkerli kul is indigenous to the coastal saline area for their already adaptive characters to the respective areas. BAU kul is a new variety and have been selected for both drought prone and coastal areas.

***Land preparation:*** Prepare the pit and apply organic matter 10-12 days before transplanting the sapling**.**

***Method of transplanting:*** For jujube garden square planting method is good. Planting distance should be 3.5-4 meters (12ft X 12ft). Spacing may be increased or reduced depending on the variety and place. 1metre x 1meter x 1metre pit should be prepared one month prior to planting. Total number of saplings should be 66 per bigha.

***Fertilizer Application and dose:*** Apply fertilizer 10 to 12 days before plantation as indicated in budget break-up.

***Intercultural Operation:*** For good production irrigation should be done once in a month during flowering and fruiting time in dry season. In case of saplings branches up to 75 cm from the bottom should be allowed to grow to make the plant more strong.

***Pruning or Removal of undesired parts:*** During pruning cut the branch leaving some portion at the joint. In addition cut of weak, disease affected, insect attacked thickly grown branches. Afterwards when new branches will come, then keep the strong branches and remove weak ones.

***Pest and disease Management:*** Powdery mildew of a jujube is a dangerous disease. After flowering spray any fungicide (*Thiovit*) to control powdery mildew disease at the rate of 2 gm. in 1 litre of water or Tilt 250 EC at the rate of 0.5 ml in 1 litre of water. Afterwards, spray 2 times at an interval of 15 days.

***Harvesting:*** Fruits generally collected in January to March depending on the variety. Start harvesting when the fruits start becoming light green or yellow.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Sapling | 66 | 60 | 3960.00 | |
| 2 | Compost | 100 Kg | 1 | 100.00 | |
| 3 | Urea | 17 Kg | 12 | 204.00 | |
| 4 | TSP | 17 Kg | 40 | 680.00 | |
| 5 | MP/MOP | 17 Kg | 35 | 595.00 | |
| 6 | Zinc sulphate | 4 Kg | 150 | 600.00 | |
| 7 | Fencing (Lump sum) | | | 2000.00 | |
| 8 | Plantation cost (Lump sum) | | | 1200.00 | |
| 9 | Sign board | 1 | 500 | 500.00 | |
| 10 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Nine thousand eight hundred and sixty nine only)** | | | **9869.00 (US $ 144)** | |

**G. Replication suitability and recommendation:**

As per the lessons from the first phase (LACC-I) and evaluation done through the evaluation framework below, the promotion of the adaptation option was continued for another 2-3 seasons to allow for policy recommendation in other similar areas as a part of planned adaptation strategy. The option may be targeted to small farmers who can afford land for a perennial garden. A market study may also be undertaken to find out the comparative advantage over mango.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice, Wheat/ Fruit tree/ Fallow | 2 5, 2 6 | Drought spells; loss of crops | Rain fed | High and low barind tract | Poor/ medium farmers with land ownership | 144 US $ | High | High | Yes | no increase | Highly recommended as adaptation option |

# Mango gardening as a drought enduring strategy

**A. Context and Justification:**

In the *barind* tract of Bangladesh, fruit trees are cultivated as a viable strategy to reduce drought impact. Fruit tree like mango thrive well in the drought prone environment and is recommended in the uplands of the *barind* tract. This tree species is suitable to be intercropped with T. Aman and boro rice as well as with vegetables, allowing for a diversification of the household diet. Tree plantation is a way of securing the growth of cash crops that may constitute an alternative source of income in moments of crisis, especially if high value crops are chosen. Besides being a source of wood fuel, a greater presence of trees contributes to decreasing temperatures and to increasing rainfall, thus contrasting the negative environmental impact of deforestation. Farmers of the project area proposed the option and based on the farmers need the local agriculture office recommended the option in order to diversify the cropping field and also to enhance a sustained income and long term asset for the farmers.

**B. Objective:**

To encourage farmers to use their fallow/marginal lands into a profitable mango garden and earn a sustainable income.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the mango gardening in comparison with the control/traditional practice, other crops.
- calculate the economic benefits in comparison with the control/traditional production practice, other crops.
- appraise farmers' perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the production practice in comparison with other practices.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Sapahar and Porsha. | N/A |

**E. Technical details:**

***Variety:*** Local improved and BARI varieties include especially BARI Mango 4.

***Transplanting of Saplings:*** Before transplanting mango saplings the pits should be prepared well and filled with decomposed organic matters and other fertilizers. The pits of about 1 m x 1 m x 1 m should be dug in square system of planting. Planting of Saplings should be done at the start of the monsoon and can also be done at the end of the rainy season i.e., in the month of September. Line to line distance of mango tree should be 8-10 meters and Plant to plant distance be also 8-10 meters.

***Fertilizer Application in pit and dose:*** Apply fertilizer in pits 10 to 12 days before plantation of saplings as indicated in Table 3.1.

**Table 3.1: Fertilizer doses per pit for mango plant**

| Name of Fertilizer | Quantity per pit (gram) |
|---|---|
| Organic matter | 18 – 22 Kg |
| TSP | 450-550 |
| MP | 200-300 |
| Gypsum | 200-300 |
| Zinc Sulphate | 40-60 |

***Irrigation:*** In the early stage the plants require 8 to 10 irrigation per year while full grown bearing trees require watering at weekly intervals to secure higher fruits, reduced fruit drop and improved fruit size. Irrigation can be done by flooding or furrow system depending on the availability and source of water.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Mango saplings | 25 | 50.00 | 1250.00 | |
| 2 | Compost/cow dung | 500 | 1.00 | 500.00 | |
| 3 | TSP | 15 | 40.00 | 600.00 | |
| 4 | MP/MOP | 8 | 35.00 | 280.00 | |
| 5 | Gypsum | 8 | 10.00 | 80.00 | |
| 6 | Zinc Sulphate | 2 | 150.00 | 300.00 | |
| 7 | Sign board | 1 | 500 | 500.00 | |
| 8 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Three thousand five hundred and forty only)** | | | **3540.00 (US $ 36)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone barind area in one season in 2007 in the first phase (LACC-I) of the project only. Farmers were very satisfied and claimed to get more and bigger gardens in their area to support their livelihood and increase their resilience in current climate related problems and future risks. The activity was stopped after one season demonstration based on project analysis that mango plantation is an autonomous adaptation spreading rapidly which can pose a future threat for the rice production of the area. Therefore, promotion through the project seemed not to be necessary and also not reasonable. The project anticipated that under changing climatic conditions, high temperature induced synchronized maturity of mango may lead to price drop. Further, it threatens to replace rice completely causing food insecurity and aggravate seasonal crisis. Moreover, mango plantation favours rich farmers or land owners, while poor and landless farmers who sell their labour in rice cultivation months may loose their jobs if the rice fields are engulfed by the mango plantation. A study on the impact of the autonomous mango cultivation on market prices and livelihood opportunities in view of climate change and future threats may be considered.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat/ Vegetables/ Fruit tree/ Fallow | 25, 26 | Drought spells; loss of crops | Rain Fed | High barind tract | Small/ medium farmers with land ownership | 52 US $ | Medium | No | Medium | no increase | Not recommended |

# Mixed fruit gardening for exploiting drought and salinity conditions

**A. Context and Justification:**

Fruit tree gardening in the open land is a way of securing the growth of cash crops that may constitute an alternative source of income in moments of crisis, especially if high value species are chosen. Besides being a source of food, nutrition and cash incentive, wood fuel, a greater presence of trees contributes to decreasing temperatures and to increasing rainfall, thus contrasting the negative environmental impact of deforestation. Mixed fruit gardening either by incorporating jujube, mango or other species in the litchi garden or other way around is a well known practice in the drought prone areas and coastal regions of Bangladesh. The practice is same or similar in both the regions with a particular difference in species or varieties suitable to the regions. There are species like litchi is suitable to the low barind area of Natore and *Narkeli kul* in the coastal saline areas which are cultivated by the farmers in a mixed plantation in order that their yield, income support their livelihood on a year round basis especially in the vulnerable period.

**B. Objective:**

To promote improved variety of the fruits with am aim to provide farmers with the alternative in order for diversification of their livelihood, income opportunities and development of resilience against climate change.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the mixed fruit gardening in comparison with the control/traditional practice, other crops.
- calculate the economic benefits in comparison with the control/traditional production practice, other crops.
- find out other additional benefit like fuel, etc.
- appraise farmers' perceived opinion about the potential effect/impact of climate change induced hazards like drought, salinity etc and other factors (price) on the sustainability of the production practice in comparison with other practices.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Lalpur and Bagatipara upazilas. | Terokhada, Bhandaria and Nazirpur upazilas. |

**E. Technical details:**

***Land area:*** 1 Bigha (33 dec.).

***Soil:*** Deep, well drained, fertile sandy or loamy soil is suitable.

***Land preparation***: Select high and medium high land. Make the land plain, weed free

by ploughing and laddering.

***Variety:*** Combination of Litchi (varieties Bombai and Chaina-3) and Jujube (BAU kul) for the drought prone upazilas where litchi is mostly suitable due to its tolerance to drought.

And a mixture of Jujube (BAU kul and Narkeli kul) and herbal plants are recommended for the coastal area. Narkeli kul is already adapted to the local condition and the other jujube variety and the herbal plant are selected for the testing the suitability as new varieties.

***Sapling selection:*** Select one year old healthy and strong grafted saplings.

***Transplanting time:*** Mid March to mid July.

***Planting distance:*** 10 meters.

***Pit size:*** 1 meter x 1 meter x 1 meter

***Fertilizer dose:*** Apply fertilizer as per quantity shown provide in the budget section.

***Method of Fertilizer application:*** Apply fertilizers in 3 installments. First installment at the time of flowering, 2nd installment at the time when fruits become like pea grain and third installment two weeks before fruits ripe.

***Sapling transplantation:*** After 10-15 days of filling the pit, the sapling with ball is placed at the center of the pit. After plantation irrigate water, fix a pole and fence. After 6 month of plantation apply 300-350 gm. urea.

***Irrigation:*** Irrigate frequently to enhance growth of the saplings. If there is no rainfall, irrigate at the time of flowering and at the time of getting the fruit size like pea.

***Weeding:*** Always keep the pit weed free.

***Pruning:*** Cut off undesirable branches to allow sufficient light and air.

***Attack by birds:*** Trees should be covered by net in ripening period.

***Harvesting:*** Start collecting litchi with the branches as soon as litchis show reddish tinge.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Sapling (Jujube) | 66 | 60 | 3960.00 | |
| 2 | Sapling (Litchi/Mango) | 25 | 150 | 3750.00 | |
| 3 | Compost | 200 Kg | 1 | 200.00 | |
| 4 | Urea | 24 Kg | 12 | 288.00 | |
| 5 | TSP | 24 Kg | 40 | 960.00 | |
| 6 | MP/MOP | 24 Kg | 35 | 840.00 | |
| 7 | Zinc sulphate | 8 Kg | 150 | 1200.00 | |
| 8 | Fencing (Lump sum) | | | 2000.00 | |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Plantation cost (Lump sum) | | | 1200.00 | |
| 10 | Sign board | 1 | 500 | 500.00 | |
| 11 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Fourteen thousand nine hundred and twenty eight only)** | | | **14928.00 (US $ 218)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in two upazilas each of the drought prone area and coastal saline area in 2009. The results are yet to be tested and based on the result and lessons and also a thorough assessment by using the evaluation framework used in LACC-I period a well-informed decision and recommendation can be made. However, as a common practice, it may be inferred that at least another one to two times tests are required to inform the decision making process.

# Mango orchard management

**A. Context and Justification:**

Mango, the single most predominant species is planted spontaneously and unsystematically, in garden or in the rice field, mostly to fetch the economic benefit. In the north-western district there has been a remarkable shift of cropping pattern from rice based traditional practice to the expansion of mango orchard. This trend is evidently increasing in various upazilas of Chapai Nawabganj and Naogaon districts. The shift is a kind of adaptation due the change happened from increasing water stress in the area concerned and also from economic motivation as the income from mango has been in rise for years. As a common practice of the area, mango trees are fed with manure and fertilizers before and after the harvest of the fruits in each season/year. The need for appropriate dose and appropriate method of application articulated, mostly by the farmers and field staff, led to the demonstration of the mango orchard management. The orchard management activity was undertaken with a view to understand the yield performance between the treatment plant and the control plants which are traditionally managed by the farming community in the monsoon season.

**B. Objective:**

To promote orchard management for mango in order that farmers get more yield and income from the mango orchard and thus develop the resilience to climate change vulnerability.

Demonstrations showcase how to –

- assess the amount of water and other inputs (e.g. fertilizer, energy) required in the mango orchard management in comparison with the control/traditional practice, other crops.
- calculate the economic benefits in comparison with the control/traditional production practice, other crops.
- appraise farmer's perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the management practice in comparison with other practices.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Gomostapur, Sapahar and Porsha. | N/A |

**E. Technical details:**

The demonstration is consists of three technical interventions – manuring & fertilization, irrigation and mulching.

***Manuring and fertilization:***

The nutritional requirements may vary with the region, soil and age of the tree. The year to year dosage of manure and fertilizer is indicated here.

| Manures and fertilizers | Age of plants (years) | | | | | |
|---|---|---|---|---|---|---|
| | 2-4 | 5-7 | 8-10 | 11-15 | 16-20 | Above 20 |
| FYM or cow dung or compost (kg) | 10-15 | 16-20 | 21-25 | 26-30 | 31-40 | 41-50 |
| Urea (gm) | 250 | 500 | 750 | 1000 | 1500 | 2000 |
| TSP (gm) | 250 | 250 | 500 | 500 | 750 | 1000 |
| MP (gm) | 100 | 200 | 250 | 350 | 450 | 500 |
| Gypsum (gm) | 100 | 200 | 250 | 350 | 400 | 500 |
| Zinc sulphate (gm) | 10 | 10 | 15 | 15 | 20 | 25 |

Fertilizers are suggested to apply in two split doses, one half immediately after the fruit harvest in the month of June-July and the other half in September-October at the end of the rainy season.

Manures and fertilizers may be applied into the ground of the in trenches that may be 30cm wide, 15-20cm deep and 30cm away from the base of a one year old plan. Following this criteria, the circular trench/canal around the tree, may have to be 2-3m away from the trunk in 10-12 years and 4m away in about 30 years. The manure and fertilizers should be applied evenly in the trench/canal, which is then fill back with soil. The manure and fertilizers may also be applied by spading or ploughing the soil around the soil around the plant up to the area shaded by the plant at noon. The manure and fertilizers should be spread over all but 1m away from the trunk of the plant and then mixed with the soil. The soil must be irrigated after each application of manures and fertilizers.

***Irrigation:***

Amount and frequency of irrigation to be given depends upon the type of soil, climatic conditions, especially rainfall and its distribution and the age of trees. Nevertheless, it does sound sensible that in the pre bearing age, the plants must be irrigated frequently. The need for irrigation will be more urgent during the drier part of the year from November to April and less urgent in summer (May – June). They clay or heavier soils, will need to irrigated less frequently than the lighter soils (e.g. sandy loam). Considering all these factors, plants up to the age of six months need to be irrigated at an interval of 2 – 6 days, plants between 6 months and 18 months every 4 – 12 days and those aged 1.5 – 5 years after an interval of 1 – 3 weeks.

When the trees are in full bearing stage, generally two irrigations are needed by using the basin method. The first at full bloom and the second at the pea stage of the fruit. This reduces fruit drop and improves fruit size. In modified basin method dike should be constructed around each tree, to prevent water run-off during irrigation.

In order to obtain good flowering one must stop irrigating at least 2-3 months before the flowering period. Irrigation during this period may promote vegetative growth, which will be detrimental to flowering.

***Mulching:***

Mulching is the spreading of dried organic materials such as straw, leaves, grass and water hyacinth on the top soil around and between the crops. The primary purpose of mulching is to retain soil moisture especially in sandy soils or on raised beds which dry out quickly.

Mulching should be done in the area around the mango tree up to the area shaded by the plant just at the noon. The area should be shallowly spaded or ploughed and covered by water hyacinth or rice based on the availability. If water hyacinth is not available mulching could be done with rice

straw. The optimum amount of mulch is approximately 2-3 inches thick for fluffy materials like straw and water hyacinth. After mulching irrigation should be done 10-15 days interval to make it productive, when it gets dry.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Cost of manure and fertilizer | Lump sum | | 2000.00 | |
| 2 | Cost of rice straw | Lump sum | | 500.00 | |
| 3 | Labour cost for ploughing and spading for mulching. | Lump sum | | 200.00 | |
| 4 | Sign board | 1 | 500 | 500.00 | |
| 5 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Three thousand two hundred and thirty only)** | | | **3230.00 (US $ 47)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone barind area in one season in 2007 in the first phase (LACC-I) of the project only. No yield and economic benefits were accumulated because the mango plants did not produce fruits while the project collected data and information. Therefore no comparison and other analysis whatsoever could be done in this regard.

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

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat / Pulse-Mango | 25, 26 | Drought spells; loss of crops | Irrigated | High barind tract | Medium/wealthier farmers | 47 US $ | Medium | Medium | No | no increase | Not recommended |

# Establishment of mini nursery for livelihood resilience development

**A. Context and Justification:**

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

**B. Objective:**

To make additional income for the family and also for making seedling/sapling available in the project area which will encourage the community people for tree plantation and ultimately contribute to the green coverage and better ecological balance in the draught prone area.

Demonstrations showcase how to –

- calculate the cost of inputs required and assess the economic benefits from the enterprise.
- appraise farmers' perceived opinion about the potential effect/impact of climate change induced hazards like drought and other factors (price) on the sustainability of the enterprise in comparison with other practices.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2006 | Nachole. | N/A |
| 2007 | Nachole, Gomostapur and Sapahar. | N/A |
| 2008 | Sapahar and Porsha. | N/A |

**E. Technical details:**

***Area:*** Total area of the mini nursery will be 400 $m^{2\ or}$ about 10 decimals. The mini nursery should have nursery blocks, its beds, roads for inspection, irrigation and drainage cannels. There may be following blocks in the nursery.

- Seedling raising blocks.
- Soil preparation and potting blocks.

- Compost block.
- Working shed.
- Seed germination block.
- Drainage canal.

***Lay out of nursery:*** Total nursery site will have to be divided into number of blocks. Each block may have 10-12 beds based on the objective and plan of the nursery owner. The beds will be arranged in east–west directions to ensure equal distribution of sunlight. Each bed will be 1 meter in breadth and 3-4 meter or more in length. There have to be seedling/sapling beds, seed germination bed and beds for younger and disease infested seedling/saplings.

A small space has to be left for construction of nursery shed at one corner. Some spaces at other corners are required to keep for compost pits, potting and bagging and also spaces for management practices.

A small pathway of 45 cm breadth will be in between two beds. The portion will have drainage canal of 15-20 cm in depth that will help in drainage of water during monsoon. A path way of 90cm will have to be there between two blocks. Both side of the path way will have 90cm x 90 cm deep canal for quick drainage of water during monsoon. The entry road to the nursery should be adequately spacious for transportation of products by vehicles. The main road will have connection with other road s or pathways in a planned manner.

***Nursery soil, sand and compost:***

**Soil** – To raise poly bag seedling huge amount of nutrient rich soil are required and soil should be collected during the dry season. It is suggested to collect soil from the following sources.

- Top soil from farm land.
- Soil under trees especially leguminous trees.
- Soil from garden/orchards.
- Soil from pond soles and beds.

**Sand** – Sand is required to make the soil lighter and loose to facilitate easy germination and root penetration. Fine and dry sand may be collected from rive bed or from reliable sources. If soil is clayey then it is required to add sand but if the soil is already sandy then addition of sand is not required.

**Compost** – As the seedlings grown in a limited amount of area of seedling bed and poly bag, they consume nutrients from the soil. Therefore the soil of the seedling bed and poly bag must be provided with additional nutrients by adding organic matter. Compost will have to be added to the soil which is a rich source of organic matter that supplies sustained nutrients required by the seedlings. Therefore compost will have to be prepared regularly in the nursery site.

***Identification of good quality seed:*** Importance of good quality seed is immense based on the fact that the fate of nursery business and profit depends on the production of quality seedlings. Good quality seeds come from trees or fruits which are:

- Well matured, ripened, full and firm.
- Comparatively large in size.
- Good shaped.
- Bright coloured.

- Free from disease and pests.
- Collected from good mother trees.

***Seedling production:***

**Preparation of germination bed:** The ideal germination bed size should be 4 ft X 10 ft. Follow the steps for preparation:

- Dig the soil 25-30cm deep and pulverize thoroughly, break lumps of earth and remove remaining roots and rhizomes. Allow the soil to dry in the sun for 2-3 days for sterilization to help prevent damping off.
- Add 8-10 baskets (a medium size bamboo basket commonly used by villagers) of sand and 2-3 baskets of well decomposed compost. Mix thoroughly and raise the bed.
- Level the bed with a stick and allow to rest for few days.
- Water the bed thoroughly 6-12 hours before sowing seeds.

**Preparation of seedling bed for transplanting:**

- Cultivate the land by spade, break lumps of earth and remove all debris. Allow to dry for 2-3 days.
- Spread 15-20 baskets of good compost for every for every 120cm X 600cm bed and mix well so that the soil becomes loose and soft.
- Raise the bed by 7-10cm to facilitate drainage. Level the bed with a stick and expose to sunlight for 2-3 days for sterilization.
- Water the bed thoroughly 6-12 hours before planting.

**Preparation of poly bags for transplanting or sowing:**

**Size of poly bag** – Chose according to species characteristics and length of time the seedling will be in bed. For timber, leguminous species and for smaller fruit species like citrus, guava and papaya 10cm X 15cm poly bags are ideal. For seedlings to be kept for longer period and for larger fruit seedling like mango, jackfruit 15cm X 25cm should be used.

**Filling poly bags with soil** –

- Make 4 to 6 drainage holes in the poly bag using punch machine, pointed iron rod, pencil or stick.
- Mix thoroughly 3 parts of soil with 1 part of compost and 1 part of sand (based on the texture of the soil being used).
- Sieve the soil mixture and make it loose and remove the debris, hard particles and lumps.
- Fill the poly bag up to the brim with the prepared soil and pack firmly enough to stand but do not over compact.

**Bed preparation for poly bag** – Level the land with spade and prepared beds 120cm X 600cm in size. Make frames around the bed to keep the poly bags in an upright position. A frame can be made with locally available materials like bamboo, bricks and poles.

***Nursery tools:*** To perform nursery activities efficiently different tools are required. Most of the tools are readily available to the villages and others may be procured. Following list of materials is suggested.

- Spade.
- Dao/knife.

- Shovel/belcha.
- Sieve/chalni.
- Sprinkler/jharna.
- Bucket/balti.
- Secateur.
- Hoe/khurpi/nirani.
- Bamboo busket/jhuri.
- Seed germination tray.
- Pointed dibble stick.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Fencing of the nursery | Lump sum | | 2000.00 | |
| 2 | Construction of Nursery Shed | Lump sum | | 500.00 | |
| 3 | Preparation of nursery blocks and beds, irrigation and drainage canals | Lump sum | | 1000.00 | |
| 4 | Preparation of bamboo structure for seed bed shades and purchase of polythene | Lump sum | | 2000.00 | |
| 5 | Purchase of seeds | Lump sum | | 500.00 | |
| 6 | Purchase of fertilizer and cow dung | Lump sum | | 500.00 | |
| 7 | Purchase of nursery instrument like spade, plastic bucket with a mug, shower, etc. | Lump sum | | 1000.00 | |
| 8 | Sign board | 1 | 500 | 500.00 | |
| 9 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Eight thousand and thirty only)** | | | **8030.00 (US $ 117)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone barind area in Kharif-I of 2006, 2007 and 2008 both in the first phase (LACC-I) and second phase (LACC-II) of the project. The amount of net return from the nursery enterprise did not convince the farming families. The persistent water crises around the area became a limiting factor for the production of saplings in huge amounts. Farmers recommended more financial support for a longer period that would facilitate them to make the business sustainable and afterwards they could build on that. Based on the limitation and lessons, the project did not recommend the option further in the barind area.

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

*barind* people is mango or jujube saplings. Any nursery business producing and running only on the mango and/or jujube is risky. Therefore, possibilities of diversifying with other species and varieties and their market potential should be looked into before establishing any nursery as an alternative income generating activity for the farmers. Interested farmers having enough space, water and ability to take-up as an alternative livelihood support enterprise may be facilitated with information and minimum input supports. The market feasibility should also be taken into consideration before establishing any such activity.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat/ Vegetables/ Fruit tree/ Fallow | 25, 26 | Drought spells; loss of crops | Irrigated | High and low barind tract | Poor/ small farmers with land ownership | 117 US $ | High | High | Yes | no increase | Recommended with assured water supply and market potential |

# Excavation of mini pond for supplemental irrigation

**A. Context and justification:**

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

**B. Objective:**

To create opportunity of Small and marginal farmers to provide supplementary irrigation in their rain fed *T. Aman* rice field in case of scarcity of moisture.

Demonstrations showcase how to –

- find out the frequency and amount of irrigation provided to the rice fields.
- determine the area of rice field provided with the irrigation water.
- assess the farmers' opinion about the possible impact of using supplemental irrigation to the rice fields and contribution to the development of climate change resilience in drought condition.

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2006 | Nachole, Gomostapur, Sapahar and Porsha | N/A |
| 2007 | Nachole, Gomostapur, Sapahar and Porsha | N/A |
| 2008 | Sapahar and Porsha | N/A |
| 2009 | Nachole, Gomostapur, Sapahar and Porsha | N/A |

**E. Technical details:**

***Size:*** Size of the mini pond will be 10 meter x 10 meter x 2 meter.

***Location of pond:*** Pond will be at one corner of the rice field.

*Note: At the beginning, as per the barind Multipurpose Development Authority (BMDA) model, mini-ponds of 5m x 5m x 2m (length x breadth x depth) size were preferred on small farms.*

*However, based on the feedback from the farmers, larger ponds (10m x 10m x 2m) were excavated in the following seasons.*

**F. Trial demonstration budget (10m x 10m x 2m):**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Soil digging cost (200 cubic meter) | 200 cu.m. | 40.00 | 8000.00 | |
| 7 | Sign board (90×65cm) | 1 | 500 | 500.00 | |
| 8 | Register Khata | 1 | 30 | 30.00 | |
| | **Total (Eight thousand five hundred and thirty only)** | | | **8530.00 (US $ 125)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in the drought prone barind area in the kharif-I season of 2006, 2007, 2008 and 2009. Farmers have accepted the mini pond and rated very high as per a performance assessment done by the project with the farmers. From the farmers' perspective, the size of the mini pond was enlarged and more diversification with vegetables on the pond bank and quick growing fish in the pond water was done.

The size of the pond should be dependent on the farmers land size and other socio-economic factors. The 10mX10mX2m or even bigger size pond is suggested for richer farmers while the earlier size, i.e. 5mX5mX2m, may be promoted further for the poorer ones. The option can be promoted through the usual extension system of DAE. More social mobilization programmes for greater dissemination of the technology may be undertaken.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG** | |
| Rice-Wheat/Pulse | 25, 26 | Drought spells; loss of crops | Rain fed | High and low barind tract | Poor/ medium farmers with land ownership | 125 (more or less) US $ | High | High | Yes | no increase (Use of surface water) | Highly recommended as adaptation option |

# Fodder cultivation for sustained feed supply

**A. Context and justification:**

Fodder is a vital ingredient while rearing cattle especially the milking cows. Green fodder is not much available in Bangladesh based on the fact that the grazing lands are being continually shifted to crop field or for other socio-economic uses. The increasing intensity of drought in the north-western barind area and tidal inundation, salinity intrusion in the coastal area also poses additional problems for non-availability of natural green grasses which were available everywhere in Bangladesh. As a result farmers are forced to depend on the dried concentrate feeds and are not getting desired out put from their cattle. The dried feeds are not likely to supplement the green fodder and farmers incurred additional cost without substantial benefits. National livestock research institute is producing and promoting improved fodder varieties. Project is undertaking adaptation trials in northern drought prone areas and southern coastal saline regions with different varieties of fodder with a view to provide farmers with alternatives for cattle feeding.

**B. Objective:**

To promote improve fodder cultivation in the area where green grass are not available and accessible to the poor farmers for their cattle farming.

Demonstrations showcase how to –

- assess the suitability of the species selected for local soil and water conditions
- assess the amount of fertilize, manure, water and other inputs required in the cultivation of the fodder in comparison with the control/traditional practice
- evaluate the (economic) savings farmers can make out of the production and feeding to the cattle with comparison to the cost they have to bear for purchasing
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, salinity etc on the sustainability of the production of fodder/s in the farmers field.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Nachole, Gomostapur, Sapahar and Porsha. | - |

**E. Technical details:**

***Land area:*** 10 dec.

***Land and soil type:*** Can be grown in any type of soil from drought to saline area.

***Land preparation:*** The land should be well prepared by ploughing and harrowing three to four times. Fertilizer should be applied in appropriate dose at the time of land preparation. The cutting can be transplanted even at the moist land after flooding.

***Variety:***
Napier and German and *Jambu* varieties were recommended for the drought prone upazilas.

Para was particularly selected for the coastal upazilas and Napier was also on the list.

***Spacing:***
Spacing for cutting transplantation – line to line 70 cm and cutting to cutting 35 cm (may little vary based on the variety)

***Fertilizer application:***
Should be applied during land preparation.

***Harvesting:***
At summer – 30 – 35 days interval.
At winter – 35 – 45 days interval.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Cutting | 200 | 1 | 200.00 | |
| 2 | Compost | 200 Kg | 1 | 200.00 | |
| 3 | Urea | 7 Kg | 12 | 84.00 | |
| 4 | TSP | 3 Kg | 40 | 120.00 | |
| 5 | MP/MOP | 4 Kg | 35 | 140.00 | |
| 6 | Grass cutter/knife | 1 | 100 | 100.00 | |
| 7 | Sign board | 1 | 500 | 500.00 | |
| 8 | Register khata | 1 | 30 | 30.00 | |
| | **Total (One thousand three hundred and seventy four only)** | | | **1374.00 (US $ 20)** | |

**G. Replication suitability and recommendation:**

The option has been accepted well by the farmers of both drought prone upazilas as per the informal assessment by the project. The trend so far shows very good potential in areas where there is a lack of natural grass and where farmers own cattle. Till this time the farmers of four upazilas of Chapai Nawabganj and Naogaon districts have shown more interest and involvement in the options. Therefore the option may be replicated through the ongoing extension mechanism of DAE and few more test for demonstrations may be continued for the coastal upazilas.

# Silage preparation as source of stored feed

**A. Context and justification:**

Scarcity of cattle feeds is very common in most regions and areas of Bangladesh. Farmers are losing their interest in rearing cattle since they do not have good access to green fodder or other feeds around the place they live. Silage, a technology for making cattle feeds, may serve as ready made and year round a source of feeds for the cattle. There are some green ingredients for silage available in most of the time of the year and some can also be made available with little efforts. In most areas of the barind tract farmers produce crops like mung bean, maize and other soft and succulent species which can easily be used for preparation of cattle feeds through silage. Crop residues and left over are often lost and not used properly which can rather use a good source or ingredients for preparation of alternative feeds through some technology like silage. The idea of silage preparation was given from the scientist of Bangladesh Livestock Research Institute and was accepted by the upazila level officers of DAE and project and thus got the approval from the technical clearing house.

**B. Objective:**

To test the potential of silage in the area where cattle feeds are scarce and farmers have willingness to use the technological option as a source of alternative feeds for cattle farming.

Demonstrations showcase how to –

- assess the suitability of the crop species selected for the silage preparation
- assess the amount of ingredients and inputs required for the preparation of silage
- evaluate the (economic) savings farmers can make out of the preparation of silage and feeding to the cattle with comparison to the cost they have to bear for purchasing
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought on the cattle rearing/farming and thus the relevance of silage preparation for feeds

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Gomostapur, Lalpur and Bagatipara | - |

**E. Technical details:**

***Production of green ingredients:*** Green crops and crop residues of the some species are used as the raw materials/ingredients for silage. Maize and Mung bean can be used as source of raw materials/ingredients for the preparation of the silage. Maize, mung bean and other crops are cultivated through the usual methodologies and techniques that are commonly followed.

***Cutting and chopping of the crops/parts:*** Once the crops are matured or attain a certain growth stage, the green leaves, stalks and other parts of the whole plant are ready as ingredients for

silage. The ultimate intended parts of the crops i.e. grain, fruits are harvested and separated from the plants and the rest are used as the raw materials/ingredients to be used in the silage.

Incase of maize the once the mature cobs are separated out from the plants and the whole plant body is chopped into pieces of 7-10 cm size. In case of mung bean the whole parts of the plant, leaving the grains separated, can be used as material for silage, chopping may not be needed.

***Preparation of silo/pit:*** The pit for the preparation of silage is called *silo*, is prepared on the ground with 3 ft depth, 3 ft wide and 8 to 10 ft long as per the requirement or availability of the raw materials for silage. The silo should be made in a higher ground water rain water can not stay and thus can not damage the silage.

***Preparation of silage:*** The raw materials are piled in the silo/pit in a way that they are tight enough and air can no be passed through it. Once the pit is covered with the materials it has to be closed with a lit such that normal air and water can not get into the pile.

***Use of the silage feed:*** The silage material can be used as feed since it is prepared and can continue feeding the cattle as long as things are there.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Cost for green raw material /ingredient (maize/mung bean/other) production | Lump sum | | 1000.00 | |
| 2 | Labour cost for chopping the raw materials | Lump sum | | 500.00 | |
| 3 | Labour cost for silage pit preparation | Lump sum | | 1000.00 | |
| 4 | Polythene sheet | 1 | | 500.00 | |
| 5 | Sign board | 1 | | 500.00 | |
| 6 | Register khata | 1 | | 30.00 | |
| | **Total (One thousand three hundred and seventy four only)** | | | **3530.00 (US $ 52)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in three drought prone upazilas in Kharif-I season of 2009. The results and feedback from the farmers could not be completely taken since it continues fro a longer period than the usual seasonal cycle. However, the general impression from the farmers and the officers involved demonstrate a positive observation towards the option. It is noted that the option may be suitable for the farmers who have got cattle and needs for additional feeds. A thorough assessment may be done by using the evaluation framework used in LACC-I period so that a well-informed decision and recommendation can be made.

# Duck rearing for livelihood resilience

**A. Context and justification:**

In many rural areas of Bangladesh, duck rearing has been practiced as a household level small scale income generating activity. The duck rearing enterprise requires minimum technical skill and as well as small financial inputs. Duck can depend on the natural feed and thrive well in unfavourable condition which is regarded as on of many advantages of rearing duck. There are varieties of duck that can grow up well and produce good number of eggs in both drought prone area and coastal zone. Farmers having less livelihood opportunities especially in the drought hit period and saline conditions can take up the duck rearing enterprise as an option which provide some flexibility in their livelihood planning and income.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the wheat varieties that can grow well in the increased drought in the north-western part and salinity in coastal areas.

Demonstrations showcase how to –

- evaluate the economic benefits farmers can get out of the practice and its contribution to the family food and other well-beings (*livelihood support*) in the drought hit period and salinity condition especially
- assess the amount of water and other inputs required in rearing ducks in comparison with the control/traditional and other practices
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, etc on common livestock and poultry production practices and comparative advantages of duck rearing

**C. Implementation time:**
Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Dacope and Terokhada |

**E. Technical details:**

***Land area:*** Open, as the rearing will be done in the homestead space and/or the adjacent pond/water body. The extensive system of duck rearing will be followed.

***Duck Variety:*** Khaki Kamble.

***Number of Duck:*** 20 (as per the proposal from Upazila).

***Feed for duck:***

Feed 2-3 times per day for duckling of 4 weeks.
Feed 2 times per day for adult duck.

Provide food to the duck in the form of pellet or tablet otherwise they can not take it.

**Duck feed – Preparation of 1 Kg feed**

| Feed ingredient | Percentage ingredients for different groups | |
|---|---|---|
| | **Duckling (gm)** | **Adult (gm)** |
| Half messed wheat | 450 | 450 |
| Rice bran | 270 | 300 |
| Sesame cake | 140 | 120 |
| Fish meal powder | 120 | 100 |
| Shell (*Jhinuk*) powder | 15 | 25 |
| Salt | 5 | 5 |
| Vitamin-Mineral Premix | 1.5 gm/Kg | 2 gm/Kg |

***Duck shed:***
Height of the shed – 4-5 ft.
Mat for the duck shed floor – bamboo mat.
Materials for the roof – Straw, long grass, gol/palm leaves.
Enough light should come into shed.

***Space required for duck:***

| Age | Space for each duck (Sq. ft) (Layer) |
|---|---|
| 4 weeks to 8 weeks | 1.0 |
| 8 weeks to 12 weeks | 2.0-2.5 |
| 12 weeks and more | 3.0 |

***Measurement for Feeding pan and water pot required for duck:***

| Age | Space for each duck (Inch) | |
|---|---|---|
| | Feeding pan | Water pot |
| 4 weeks to 8 weeks | 3.0 | Big pot |
| 8 weeks to 12 weeks | 4.0 | Big pot |

***Age of duck to release in water:***
Common practice is that the duckling can be released to water once it attains 1 month of age. It is better to release only after the end of brooding period when duckling is physically strong enough. At the beginning starts in a small water body to have practice. In the summer period the duckling can be released even after 15 days.

***Diseases and other problems management:***
Ducks are resistant to most of the common problems and diseases. However, two infectious diseases especially the duck plague and duck cholera may create huge loss to the whole lot of ducks. Therefore, care must be taken and necessary measures have to be taken in close cooperation with the concerned officer/s of the upazila livestock department.

Duck plague – This is contaminated *virus* disease and duck of any age can be infected by this disease. General symptom is that the duck gets weak, can not stand on feet and walk properly and

does not want to swim. To protect duck form the disease, vaccination must be done, the infected duck should be kept aside from the fresh lot and clean the shed, feeding pan, water pot properly etc.

Duck cholera – This is contaminated *bacterial* disease and duck of any age can be infected by this disease. General symptom is that the duck loss appetite, want to drink more water and release slippery substance from the mouth. To protect duck form the disease, vaccination must be done and apply some sulphur based medication etc.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Duckling (3 weeks) | 20 | 90.00 | 1800.00 | |
| 2 | House | 1 | 1500.00 | 1500.00 | |
| 3 | Feed | 60 Kg | 25.00 | 1500.00 | |
| 4 | Vaccine | | | 500.00 | |
| 5 | Duck carrying cost (Lump sum) | | | 500.00 | |
| 6 | Sign board | 1 | 500.00 | 500.00 | |
| 7 | Register Khata | 1 | 30.00 | 30.00 | |
| | **Total (Six thousand three hundred and thirty only)** | | | **6330.00 (US $ 93)** | |

**G. Replication suitability and recommendation:**

As new intervention from the poultry sub-sector in the changing climatic condition and as an alternative initiative for farmers' livelihood support the option has so far been doing well. However there have been differences in performance not only due to the varietal difference but also due to the management process also. A thorough and critical assessment is needed before recommending the option for replication.

# Sheep rearing for livelihood resilience

**A. Context and Justification:**

Sheep is one of the productive household animal species in Bangladesh. Rearing sheep is profitable for the poor and landless farmers for its growth, production and cash incentives. It produces quality meat and wool which have a good demand in the local market. Sheep has got a strong adaptability to extreme condition like high temperature induced drought condition, salinity and other environmental stress. Although as a local practice sheep rearing has been found in the rural areas of the drought prone and saline coastal upazilas of the project but the production and return is limited due to non-accessibility of technical information and services. The option recommended from the farmers and UTIWG was approved in the NTIWG by the scientists and experts for the drought and saline prone villages. The option is expected to validate the wider adaptability of sheep in the increased threat of temperature, salinity and other climate problems in the drought prone area.

**B. Objective:**

To test the wider adaptability of sheep in the increased threat of temperature and salinity and sheep rearing as an alternative livelihood option while farmer can improve their food and income security and thus their resilience to the changing climate.

Demonstrations showcase how to –

- evaluate the economic benefits farmers can get out of sheep rearing and its contribution to the family food and other well-beings (*livelihood support*) in the environmental stress period especially.
- assess the suitability of the sheep variety in the drought and salinity condition whether it can sustain in drought prone area.
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like increased drought, salinity etc on common livestock and poultry production practices and comparative advantages of sheep rearing.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Sapahar upazila | - |

**E. Technical details:**

***Land area:*** Open, as the rearing will be done in the homestead space and the adjacent pond. The open system of sheep rearing is followed.

***Goat Variety:*** Local.

***Age of goat:*** 1 year plus.

***Number of goat to be given:*** 2 female sheeps per family as per the proposal from Upazila (UTIWG).

***Fodder/feed for sheep:***

The sheep will be fed with local available grass in open grazing and also confined feeding process. In the period of high temperature, salinity and any other natural hazards, the sheep will be fed with additional/prepared feed. The feed is available in the local market prepared with rice bran, molasses and some other ingredients. The rate of the feed will 1.5 Kg/sheep/day. If it is needed, feed may be prepared and fed to the goat as per following combination.

| Feed ingredients | Amount (%) |
|---|---|
| Wheat husk | 45 |
| Rice bran | 20 |
| Grind grass pea | 18 |
| Sesame cake | 16 |
| Salt | 0.9 |
| Ambavit | 0.1 |

***Sheep shed:***

Shed for sheep should be in a sunny, airy place so that it remains clean, dry and free from bad smell. An adult sheep requires a space of 1.0 – 1.5 sq. meter or 10 – 15 sq. ft.

While the demonstration starts with 2 female sheeps, there is a likely possibility that the sheeps give birth about 10-13 sheeps in a year. So, for the whole family a bamboo platform (*Macha*) of 60 (6X10) sq. ft may be constructed. The shed/roof may be prepared by tin, leaves and straw. The height of the shed (*macha*) from the ground should be 3 ft.

There should be interspace of 0.5 inch between two bamboo pieces to allow/facilitate the litter and debris to pass out or clean. If the platform is of soil, it should be covered with sand/sandy soil. In the winter specially, the ground should be covered with straw to make bed (thick 4-5 inch).

***Disease problems for sheep:***

Sheep is resistant to almost all types of problems. However enough care and cleanliness should be provided so that a preventive condition is created. Proper vaccination and after care are must for sheep rearing. For any problem, regular consultation with the upazila level livestock and veterinary specialist need to be made.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Sheep | 2 | 1200 | 2400.00 | |
| 2 | Housing | 1 | 1500 | 1500.00 | |
| 3 | Feed | 40 Kg | 25 | 1000.00 | |
| 4 | Vaccination (Lump sum) | | | 500.00 | |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Transport (Lump sum) | | | 500.00 | |
| 6 | Sign board | 1 | 500 | 500.00 | |
| 7 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Six thousand four hundred and thirty only)** | | | **6430.00 (US $ 140)** | |

**G. Replication suitability and recommendation:**

The options has just tested for the first time in one drought prone upazila and the results are yet to come and confirm whether to recommend for further trial or replication of the same in other areas.

# Fish rearing in the small pond

**A. Context and justification:**

Farmers of the coastal upazilas under the project areas are often left with no option to diversify the production of their small ponds which are mostly used as place for bathing and cleaning. Although a traditional practice of rearing local fishes in some ponds in the area is not very exceptional. However, selection of appropriate species and provision of and access to updated technical information are still inadequate in the area. Based on the farmers demand and recommendation from the upazila level technical group the option was approved by the national technical group with a view that the local farmers are exposed to the updated and useful technology in rearing fishes in the small ponds.

**B. Objective:**

To optimize the use of small pond and promote the practice of fish rearing in the pond where water is not used for irrigation and provide farmers with the opportunity for additional food, nutrition and income.

Demonstrations showcase how to –

- assess the suitability of the fish species selected for pond water condition.
- assess the amount inputs required in the fish rearing in comparison with the control/traditional practice
- evaluate the additional economic benefits farmers can get from the fish rearing which can support their livelihood in the crisis period
- appraise farmers' perceived opinion about the sustainability of the fish rearing practice due to the potential effect/impact of climate change induced hazards like drought etc.

**C. Implementation time:**

Kharif-I/March – July.

**D. Implementation sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | - | Nazirpur upazila |

**E. Technical details:**

***Pond preparation:***

During the preparation of the pond for stocking i.e. before harvesting of rain water the pond may be cleaned properly. Cleaning of unwanted grasses, debris and other inert materials and addition of lime, if needed, may be done earlier to the rain.

Fertilizer/manure application during the pond preparation -
Lime at the rate of 1 Kg lime/dec. of pond.
Decomposed cow dung, at 3-4 Kg/dec. may be added to the pond after adding the lime.
If needed, urea and TSP may be applied at a rate of urea-100 gm and TSP-200gm per dec.
Salt may be added, if needed, to the water at the following rate per dec.

*For Raj puti only – 250 gm at 15 days interval.*

*For Tilapia – 250 gm at 30 days interval.*

***Stocking density:***

Any one of the following single species or combination can be followed

- Tilapia – 150 pieces per dec. of 8-10 gm body weight of each fingerling.
- Raj puti – 20 pieces per dec. of 1 inch length
- Raj puti + Common carp – 7 to 8 pieces per dec. of 1 inch length
- Common carp – 15 pieces per dec. of 4 inch (3 months age) or 3 inch (4 months age)

***Feed supply:***

Supplying feed for the fish will entirely depend on the objective/s of the farmer whether s/he wants to provide supplemental irrigation to the rice field and then rearing fish afterwards in the remaining water or fish rearing is the sole objective. In that case the feed preparation and supply is as under.

Oil cake (25%) + rice-bran (75%) and start at a rate of 20% of the body weight of the fish. The amount will be increased as the fish grows. Rice-bran may only be applied, in case oil cake is not accessible/available. *Source: Dr. Moniruzzaman, SO, BFRI and BFRI leaf lets.*

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Fish fingerlings | 440 | 5 | 2200.00 | |
| 2 | Cow dung | 150 Kg | 1 | 150.00 | |
| 3 | Urea | 16 Kg | 12 | 192.00 | |
| 4 | TSP | 10 Kg | 40 | 400.00 | |
| 5 | Lime | 6 Kg | 20 | 120.00 | |
| 6 | Oil cake | 25 Kg | 25 | 625.00 | |
| 7 | Rice bran | 25 Kg | 15 | 375.00 | |
| 8 | Sign board | 1 | 500 | 500.00 | |
| 9 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Four thousand five hundred and ninety two only)** | | | **4592.00 (US $ 67)** | |

**G. Replication suitability and recommendation:**

The option has been accepted well by the farmers as far understood through informal meeting and discussion. The option may be replicated through the ongoing extension mechanism of DAE and few more test for demonstrations may be continued for the new villages and areas in the next phase of the project.

# Green manuring by cultivating leguminous crops

**A. Context and Justification:**

The term green manuring is commonly expressed as a practice that includes cultivation of soft, succulent plant species and thus ploughed down at early green stage to the crop land for improving its fertility. Cultivation of leguminous crops and integrating in the rice cropping system is regarded as a good practice to improve soil fertility and as a consequence improve the yield of the following rice crop. In addition, use of legumes to improve soil fertility may reduce the needs for use of chemical fertilizers and therefore help to reduce the use of energy for production of fertilizers in the factory. The leguminous crops belong to the family *Leguminosea* and they have the ability to improve soil through the fixation of atmospheric nitrogen through their plant system. It is commonly grown on the dikes between rice paddies, along roadsides and in backyard vegetable gardens. Leguminous crops like sesbania (*Dhaincha*), mung, *mashkalai* have been proved to extremely popular due to in part to their fast growth and also because of their wide use as manure, fuel wood, fodder etc. Most of the species are proved to be extremely tolerant of a wide range of climatic and environmental such as drought, salinity, water logging etc. The option was selected and thus recommended both for the drought prone and coastal upazilas in the kharif-I season for the rice field for Aman season.

**B. Objective:**

To provide the farmers with opportunity for learning the suitability of the plant species that can grow well and improve the fertility of the crop field in the increased drought in the north-western barind tract and salinity in coastal areas.

Demonstrations showcase how to –

- appraise the suitability of the plant species that better improves soil fertility
- assess the nutrient status and other changes happened in the soil
- appraise farmers perceived opinion about the potential effect/impact of climate change induced hazards like drought, salinity and other factors (price) on the sustainability of the practice and the comparative advantages of the any species over others

**C. Implementation time:**

Kharif-I/March – July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2009 | Nachole, Gomostapur, Porsha and Sapahar | Dacope |

**E. Technical details:**

***Soil:*** All types of soils are suitable, however, the leguminous crops perform better in loam or sandy/clay loam.

***Variety:***
Local variety for Sesbania.

Improved/BARI variety for Mung bean

***Land preparation***: Land preparation depends on sowing method and soil type. For sandy loam to silty loam soil, 2-3 ploughing to and cross plowing with subsequent 3-4 laddering are required so that the soil has a good tilth which is expected to have a good germination. For a clay type of soil, soil preparation requires more tillage operation at appropriate soil moisture status.

***Time of sowing:*** Following the onset of the rains and the wetting of the upper 30 cm of soil, sowing can commence. Although sowing time varies from area to area. For Kharif-1, the suitable timing is between end of February to mid March.

***Seed rate*****:** Seed rate will be 40-45 kg/ha for Mung and 40-50 kg/ha for Sesbania. Germination rate can be increased by soaking in water overnight and rubbing them on a rough surface before sowing. Germination rates can also be increased by dipping in warm water for a minute and drying them by spreading in the shade.

***Fertilizer dose:*** No fertilizers are used as a common practice. However, TSP @ 17 kg/ha may be applied in order to increase the number of nodules in the roots.

***Irrigation:*** Generally no irrigation is required for cultivation of the sesbania or mung bean except severe drought during early Kharif season to allow the crops to decompose.

***Weeding:*** No weeding is required unless there is heavy infestation and chance for reducing the over all performance.

***Harvesting/manuring:*** The crops are subject to incorporate into the soil of the crop field and thus decompose to improve the fertility of the soil of the land. In general when the crop/s are ploughed down and mixed with the soil after 6 to 8 weeks. Availability of water in the crop field during the mixture would facilitate fast decomposition of the crops.

**F. Trial demonstration budget:**

**f.1 Budget for green manuring by mung bean**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 7 Kg | 80 | 560.00 | |
| 2 | Urea | 6 Kg | 12 | 72.00 | |
| 3 | TSP | 12 Kg | 40 | 480.00 | |
| 4 | MP/MOP | 5 Kg | 35 | 175.00 | |
| 5 | Gypsum | 6 Kg | 10 | 60.00 | |
| 6 | Boron | 1 Kg | 150 | 150.00 | |
| 7 | Sign board | 1 | 500 | 500.00 | |
| 8 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Two thousand and twenty seven only)** | | | **2027.00 (US $ 30)** | |

**f.2 Budget for green manuring by sesbania**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Seed | 35 Kg | 50 | 1750.00 | |
| 2 | Urea | 1 Kg | 12 | 12.00 | |
| 3 | TSP | 7 Kg | 40 | 280.00 | |
| 4 | MP/MOP | 6 Kg | 35 | 210.00 | |
| 5 | Gypsum | 10 Kg | 10 | 100.00 | |
| 6 | Sign board | 1 | 500 | 500.00 | |
| 7 | Register khata | 1 | 30 | 30.00 | |
| | **Total (Two thousand eight hundred and twenty seven only)** | | | **2882.00 (US $ 42)** | |

**G. Replication suitability and recommendation:**

The adaptation option was tested in both drought prone and coastal saline upazilas in Kharif-I season of 2009. The crops grown and thus ploughed down and mixed with the soil have thought to perform well. But after harvesting the aman rice and thus assessment of the yield and also analysis of the soil may tell the yield performance and other advantages. As per the feedback gathered so far from the farmers, community people and officers of the department the option can be promoted in the fields of appropriate farmers from the seasons onwards. A thorough assessment should essentially be done by using the evaluation framework used in LACC-I period so that a well-informed decision and recommendation can be made.

# Farm yard manure (FYM) preparation for soil health improvement

**A. Context and Justification:**

The vulnerability of the agriculture sector is high and increasing due to growing water requirements, cropping intensity and population pressure. Climate change phenomena are posing an additional burden, in particular in the *barind* area and south-west *coastal* region where agriculture is exposed to a number of climate change hazards. The organic matter content of the *barind* tract and coastal area is exceptionally low which is not enough to support agricultural production. External addition of organic matter like cow dung and household sweeps is not possible because these are used as fuel due lack of fuel woods in the areas. Enhancing the organic matter level in soils improves soil structure, moisture retention, erosion stability and water infiltration and hence strengthens the resilience of farming systems to drought, climate variability, increasing temperatures and salinity problems. This can be achieved by the preservation and increased application of Farm Yard Manure (FYM), which is organic matter prepared from various kinds of animal excreta mixed with other organic materials.

**B. Objective of FYM Preparation:**

To promote the practice for conservation and use of organic matter in the crop land for soil improvement and over all yield increase and also to serve the mitigation purpose by reducing the use of chemical fertilizers.

Demonstrations showcase how to –

- find out the amount of organic matter produced which is readily available to be used in the crop field, in comparison to the traditional way of preparing the same.
- determine the amount of chemical fertilizers and amount of money saved from being used in the crop.
- determine the status of nutrient content and make comparison with the earlier nutrient status of the soil.
- assess the farmers opinion about the possible impact of using organic matter to the fertility and productivity crop field and contribution to the management of climate change induced drought and salinity.

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested site/upazila:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Lalpur, Bagatipara, Nachole, Gomostapur, Porsha and Sapahar upazilas | N/A |
| 2008 | Sapahar and Porsha upazilas | - |
| 2009 | Lalpur, Bagatipara, Nachole, Gomostapur, Porsha and Sapahar upazilas | Terokhada and Nazirpur upazilas |

**E. Technical details:**

f.1. Lay out (Figure-1) of the FYM pit:-

Number of chamber = 2 chambers
Length of the chamber = 1.5 m
Width of the chamber = 1.5 m
Depth of the chamber = 1 m
Gap between 2 chambers = 50 cm

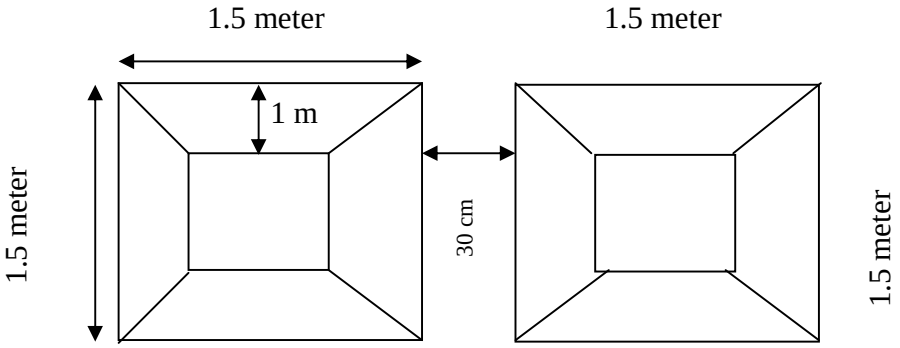


**Fig-1: Lay out of two-chamber FYM pit**

f.2. FYM pit shed/roof and boundary wall:-

To protect FYM from sun and rain a shed/roof made of local material such as bamboo and rice straw/polythene has to be constructed over the pit where FYM is heaped. The structure should be sufficiently strong to withstand winds. To protect the pit from entering rain and flood water, a barrier or boundary wall with mud around the pit can be made.

f.3. Piling dung, debris, wastes and FYM use:-

Collection of raw cow dung, urine soaked litter, kitchen wastes, vegetables waste, house sweeping, etc. should be done every day and pour it into one component until full. After full filling one chamber cover the chamber by plastering with mud mixed with dung and allow the materials to decompose. Afterwards fill the next chamber in the same way.

Sprinkle the FYM pit with water when the FYM becomes too dry. Decomposition may take 6-8 weeks depending on the ratio of dung to other organic materials used. Apply the decomposed FYM at the time of land preparation to any crop for improved and sustainable production.

f.4. Use of FYM in crop field
Arrange an informal trial in a definite crop where FYM will be used and there will a control plot with the same area and same crop where FYM will not be used. Application of other things like chemical fertilizer, water, intercultural operations will remain same for both FYM plot and control plot. Use FYM as per the common guideline used in the DAE.

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Shade making materials (Bamboo, wood, nails rope) | | | 1,200.00 | |
| 2 | Pit digging cost | 1 | 400.00 | 400.00 | |
| 3 | Signboard | 1 | 500.00 | 500.00 | |
| 4 | Register Khata | 1 | 30.00 | 30.00 | |
| | **Total (Two thousand one hundred and thirty only)** | | | **2130.00 (US $ 31)** | |

**G. Replication suitability and recommendation:**

Based on the lessons and recommendation from the first phase, the option has been released to the farmers for continuation in all agro-ecological settings from the drought upazilas to the coastal areas. As per the suggestion made in the first phase retesting the option in combination with the improved stove has been testing in some upazilas and the results may confirm for further replication or promotion. Regular social mobilization programme is needed for awareness raising on the benefits and technical aspects that would encourage a higher adoption of the option among the farming families.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social feasibility** | **No/ marginal increase of GHG emission** | |
| Rice-Wheat/ Pulse-Mango | 25, 26 | Drought spells; loss of crops | Rain fed | High and low barind tract | Poor/ medium farmers | 31 US $ | High | High | Yes | no increase | Ideal as single option or combined with improved stove |

# Improved cooking stove for win-win adaptation and mitigation

**A. Context and Justification:**

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

**B. Objective:**

To promote the practice to reduce the use of wood, organic matter and crop residue as fuel and thus facilitating the use of organic matter in the crop field and also to serve the mitigation purpose by releasing less green house gas to the atmosphere.

Demonstrations showcase how to –

- compare the amount of fuel and time consumed for cooking required in improved and traditional stoves
- evaluate the (economic) savings a farmer can make from the fuel in comparison to the traditional practice
- assess the amount of organic matter (cow dung) savings made and its contribution to the soil fertility maintenance
- appraise farmers perceived opinion about the health condition, over all home environment, mitigation that improved stove can contribute to in the wake of the potential effect/impact of climate change induced hazards

**C. Implementation time:**

Kharif-I/March - July.

**D. Successfully tested sites/upazilas:**

| Year | North-west | South-west |
|---|---|---|
| 2007 | Nachole, Gomostapur, Sapahar and Porsha upazilas | N/A |
| 2008 | Sapahar and Porsha upazilas | - |
| 2009 | Lalpur and Bagatipara upazilas | Terokhada and Nazirpur upazilas |

**E. Technical details:**

Follow the technical guideline from Bangladesh Council for Scientific and Industrial Research (BCSIR) for making improved stove and the figure (Fig.2).

Both cement and mud can be use for making the stove. However, experience says that cement stove may crack and it is costlier. Therefore, mud can be used instead which is also liked by the farming family.

These stoves are of two types: (i) efficient stoves without chimney and (ii) efficient stoves with chimney. The models developed by BCSIR are (i) single-mouth domestic improved cook stove, half-underground, with iron rod or cast iron grate, (ii) single-mouth commercial efficient stove with iron rod or cast iron grate, (iii) double mouth domestic improved cook stove, half underground, coupled with chimney, (iv) double-mouth domestic improved cook stove, on-ground, coupled with chimney and (v) commercial improved cook stove coupled with chimney. .

The improved double-mouth domestic cook stove is constructed on the ground with a chimney. This consists of one outer frame, above ground, and is made of mud. Two holes at the bottom of the frame on both sides act as air entry and ash outlets. One fuel feed hole is provided above the grate. One grate made of cast iron is placed in the first pothole at a certain distance from the top of the stove. A chimney made of RCC pipe is provided, along with a chimney cap to protect it from rainwater. This improved model is suitable for burning fuel wood, briquettes, branches and twigs.

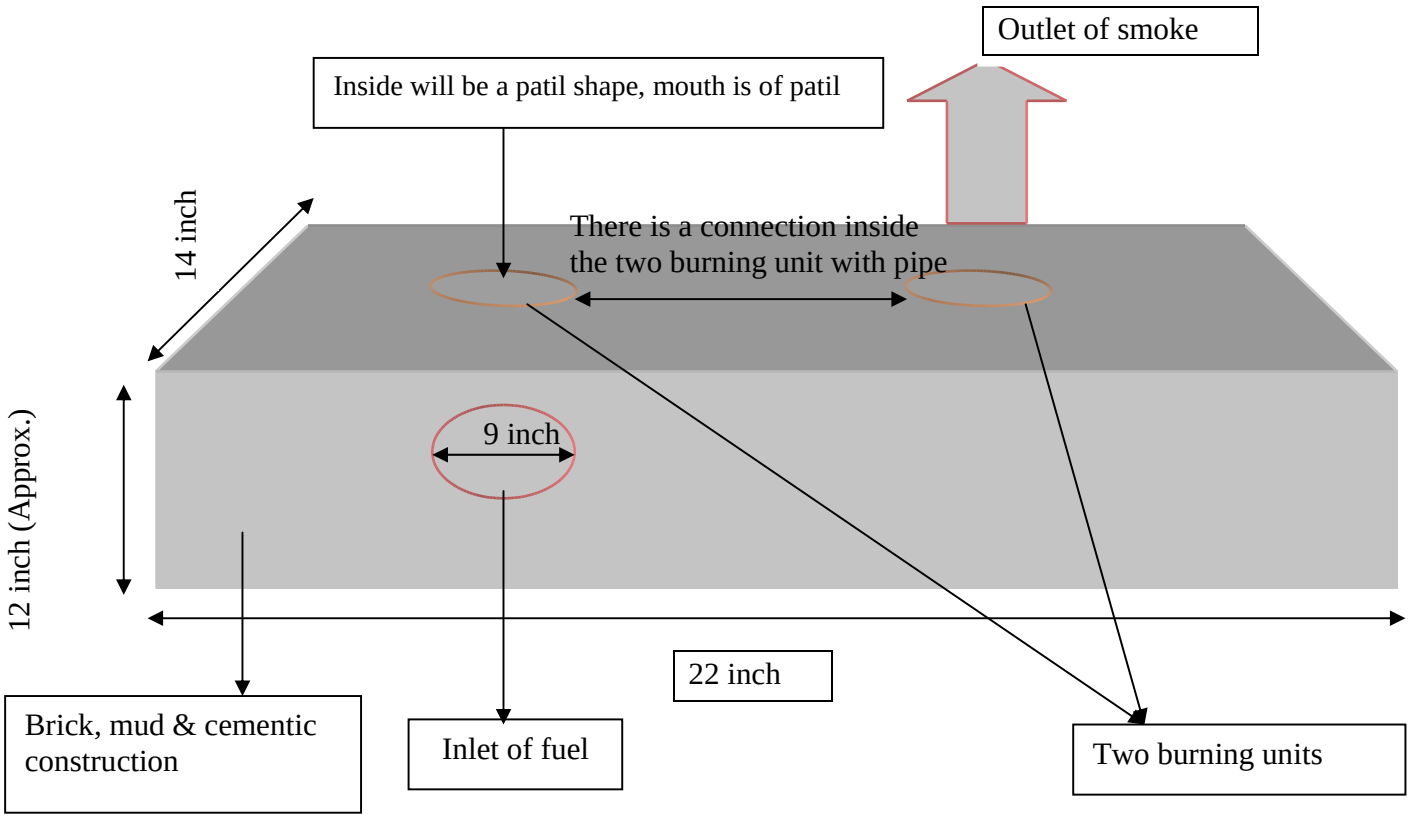


**Fig-2. Double mouth Improved Cooking Stove (*BSCIR Model*)**

**F. Trial demonstration budget:**

| SL # | Item | Amount of input/bigha (Kg/No.) | Unit cost (BDT) | Total Cost (BDT) | Remarks |
|---|---|---|---|---|---|
| 1 | Cost of Outlet pipe | 2 | 200 | 400.00 | |
| 2 | Iron Rod | 1 kg | 80 | 80.00 | |
| 3 | Cover lid | 1 | 120 | 120.00 | |
| 4 | Earthen pot/Patil | 1 | 25 | 25.00 | |
| 5 | Labour Cost | 2 | | 300.00 | |
| 6 | Transport cost (Lump sum) | | | 150.00 | |
| 7 | Sign board (90×65cm) | 1 | 500 | 500.00 | |
| 8 | Register Khata | 1 | 30 | 30.00 | |
| | **Total (One thousand six hundred and five only)** | | | **1605.00 (US $ 24)** | |

G. Replication suitability and recommendation:

Based on the results and lessons from the trials done in the first phase, some changes have been made especially in the materials for making stove and introduction some low cost materials may enhance the acceptance in the community. The promotion of the option should has been continued to new upazilas and villages under the second phase. The stove is suitable for farmer and community people of all socio-economic classes. However, using local and low cost materials for making the stove has encouraged more households, especially the poorer, to implement the option. Awareness raising programme especially on the win-win adaptation and emission reduction benefits is felt highly important.

**Table: Evaluation framework for recommendation and replication**

| **Suitable for replication under the following conditions** | | | | | **Primary target group** | **Investment costs for replication** | **Environ-mental benefits** | **Justification for replication** | | | **Recommendation (remarks)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Farming system | AEZ | Hazard type/ impacts | Water mgt system | Micro-topography/ terrain | | | | **Increase of CC resilience** | **Economic and social** | **No/ marginal increase of GHG emission** | |
| - | - | - | - | - | all farmers | 24 US $ | High | High | Yes | no increase (reduction) | Ideal for promotion in any area of the country (ideally combined with FYM) |

**Annex-1**

# AEZ – BARC FERTILIZER RECOMMENDATION

## AEZ 10: Lalpur, Bagatipara

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land, Medium High land, medium high land O M; Low-medium, pH- 6.5 - 7.9, Texture: loamy - clay, K - Bearing minerals: Medium- high | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | | Wheat | | 97.65 | 50.8 | 36 | 44.48 | 0 | 1.39 | 2.94 | 0 |
| | | Chickpea | 1.5+_ 0.5 | 32.55 | 91.44 | 30 | 44.48 | 0 | 2.78 | 2.94 | 0.5 |
| | | Seasame | 1.0+_ 0.1 | 117.18 | 45.72 | 22 | 44.48 | 0 | 0 | 0 | 0 |
| | Kharif I | Mugbean | .7+_0.1 | 15.19 | 25.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kharif II | T. Aman | 4.0+_.4 | 86.8 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |

## AEZ 11: Lalpur, Bagatipara, Gomostapur, Terokhada

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- low land, O M: Low- medium, pH- 6.1 - 7.9, Texture: Sandy loam- clay, K - Bearing minerals: Medium- high | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | | Wheat | 2.5+_ 0.25 | 97.65 | 50.8 | 0 | 16.68 | 0 | 1.39 | 2.94 | 0 |
| | | Mug bean | .7+_0.1 | 15.19 | 25.4 | 22 | 0 | 0 | 0 | 0 | 0 |
| | | Seasame | 1.0+_ 0.1 | 117.18 | 45.72 | 72 | 27.8 | 0 | 0 | 0 | 0 |
| | Kharif II | T Aman | 4.0+_.4 | 868 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |

## AEZ 12: Dacope, Nazirpur, Bhandaria

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- low, O M; Medium, pH- 6.2 - 7.7, Texture: Silt loam, K - Bearing minerals: Medium- high | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | Kharif I | Aus Rice | 3.5+_0.3 | 117.18 | 30.48 | 10 | 5.56 | 0 | 0 | 0 | 0 |
| | Kharif II | T Aman | 4.0+_.4 | 86.8 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |

## AEZ 13: Terokhada, Dacope, Nazirpur, Bhandaria

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- low, O M: medium, pH- 6.5 - 7.0, Texture: loamy, K - Bearing minerals: Medium | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | Kharif I | Jujube | | | | | | | | | |
| | | Aus Rice | 3.5+_0.3 | 117.18 | 30.48 | 10 | 5.56 | 0 | 0 | 0 | 0 |
| | Kharif II | T Aman | 4.0+_.4 | 86.8 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |

## AEZ 14: Terokhada, Dacope, Nazirpur, Bhandaria

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- very low land, O M:Medium, pH- 5.0 - 7.7, Texture: Clay, K - Bearing minerals: High | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | | Seasame | 1.0+_ 0.1 | 117.18 | 45.72 | 22 | 27.8 | 0 | 0 | 0 | 0 |
| | | Potato | 25+_2.5 | 208.32 | 81.28 | 64 | 44.48 | 1.5 | 1.39 | 0 | 0 |
| | | Grass pea | 1.2+_0.1 | 8.68 | 40.64 | 8 | 2.78 | 0 | 0 | 0 | 0 |
| | Kharif I | Aus Rice | 3.5+_0.3 | 117.18 | 30.48 | 10 | 5.56 | 0 | 0 | 0 | 0 |

## AEZ 25: Nachole, Gomostapur, Porsha, Sapahar

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- low land, O M:low, pH- 5.0 - 5.7, Texture: Loamy, K - Bearing minerals:low | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | | Wheat | 2.5+_ 0.25 | 97.65 | 50.8 | 36 | 16.68 | 0 | 4.17 | 2.94 | 0 |
| | | Chickpea | 1.5+_ 0.5 | 32.55 | 91.44 | 30 | 27.8 | 0 | 2.78 | 2.94 | 0.5 |
| | | Seasame | 1.0+_ 0.1 | 117.18 | 45.72 | 22 | 27.8 | 0 | 2.78 | 0 | 0 |
| | | Mugbean | .7+_0.1 | 15.19 | 25.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | White gourd | | 21.7 | 91.44 | 12 | 0 | 0 | 2.78 | 0 | 0 |
| | | Sesbania (GM) | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kharif II | T Aman | 4.0+_.4 | 86.8 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |
| | | Chini Atop | 3.0+_0.3 | 97.65 | 25.4 | 30 | 33.36 | 0 | 2.78 | 0 | 0 |

## AEZ 26: Nachole, Gomostapur, Porsha, Sapahar

| Soil Characteristics | Cropping Pattern | | Yield Goal t/ha | Fertilizer Recommendation (kg/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seasons | Crops | | Urea | TSP | MOP | Gypsum | Mg | Zinc Sulphate | Boric Acid | Mo |
| Land Type: High land- medium high land, O M:low, pH- 4.8 - 5.9, Texture: Loamy, K - Bearing minerals:low | Rabi | Boro rice | 6.0+_ 0.6 | 260.4 | 71.12 | 72 | 44.48 | 0 | 2.78 | 0 | 0 |
| | | Chickpea | 1.5+_ 0.5 | 32.55 | 91.44 | 30 | 27.8 | 0 | 2.78 | 2.94 | 0.5 |
| | | Seasame | 1.0+_ 0.1 | 117.18 | 45.72 | 22 | 27.8 | 0 | 0 | 0 | 0 |
| | Kharif I | Mugbean | .7+_0.1 | 15.19 | 25.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Aus Rice | 3.5+_0.3 | 117.18 | 30.48 | 10 | 5.56 | 0 | 0 | 0 | 0 |
| | | White gourd | | 21.7 | 91.44 | 12 | 0 | 0 | 2.78 | 0 | 0 |
| | | Sesbania (GM) | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Kharif II | T Aman | 4.0+_.4 | 86.8 | 30.48 | 36 | 38.92 | 0 | 2.78 | 0 | 0 |
| | | Chini Atop | 3.0+_0.3 | 97.65 | 25.4 | 30 | 33.36 | 0 | 2.78 | 0 | 0 |