# Competitive Research Grant

# Sub-Project Completion Report

## on

## Development of agro forestry model for conversion of rice-cotton based hill farming system in the Chittagong hill tracts

### Project Duration

### July 2017 to September 2018

**Hill Cotton Research Station**
Cotton Development Board
Balaghata, Bandarban

**Submitted to**

**Project Implementation Unit-BARC, NATP 2**
**Bangladesh Agricultural Research Council**
**Farmgate, Dhaka-1215**

**September 2018**

# Competitive Research Grant

# Sub-Project Completion Report

## on

## Development of agro forestry model for conversion of rice-cotton based hill farming system in the Chittagong hill tracts

### Project Duration

July 2017 to September 2018

**Hill Cotton Research Station**
Cotton Development Board
Balaghata, Bandarban

**Submitted to**

**Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215**

**September 2018**

## Acronyms

| | | |
|---|---|---|
| BARI | - | Bangladesh Agricultural Research Institute |
| BCR | - | Benefit Cost Ratio |
| BSRI | - | Bangladesh Sugarcane Research Institute |
| BRRI | - | Bangladesh Rice Research Institute |
| CDB | - | Cotton Development Board |
| CGP | - | Comparative Grant Proposal |
| CI | - | Co-Investigator |
| DA | - | Daily Allowance |
| DAE | - | Department of Agricultural Extension |
| GO | - | Government Organization |
| ID | - | Identification |
| KGF | - | Krishi Gobeshona Foundation |
| MOA | - | Ministry of Agriculture |
| MOP | - | Muriate of Potash |
| MOU | - | Memorandum of Understanding |
| NGO | - | Non-government Organization |
| OFRD | - | On-farm Research Division |
| PI | - | Principal Investigator |
| SRDI | - | Soil Resources Development Institute |
| TSP | - | Triple Super Phosphate |
| TA | - | Travel Allowance |

# Table of Contents

# Executive Summary

Majority of hill population in Chittagong Hill Tracts (CHT) depend on the Jhum farming for livelihood support. Its sustainability has been a challenge as it reduces the vegetative cover from the hill slope and is responsible for soil erosion in the hills. Hill farmers are continuing the jhum farming due to lack of technical knowhow and absence of alternatives. The Chittagong Hill Tracts (CHT) of Bangladesh is facing a serious problem of degradation of land and forests. The degradation of the Chittagong forest has affected the livelihoods of local communities which depend largely on forests to fill their basic subsistence requirements and cash income. Due to extensive shifting cultivation linked to high population growth, agricultural yield has declined in many parts of the CHT and farmers fail to achieve even a subsistence level of production. As a result, poverty, malnutrition and other forms of deprivation are pervasive. Agro-forestry is considered as one of the major strategies for forest conservation and food crop production in Bangladesh. Against this background, Cotton Development Board has conducted intensive research program at the CHT to improve the productivity of the jhum system and successfully generated a rice-cotton intercropping technology which is found to be more profitable than existing jhum. However, for the long term sustainability of the hill farming the development of additional land use system integrating with the rice-cotton intercropping is utmost necessary. Agro forestry is considered to be environmentally suitable for the mountainous areas like CHT. While agro forestry seems to be better than shifting cultivation from social and environmental perspectives, there is a lack of hard evidence justifying this particularly in the context of CHT. The aim of this research is to identify the agro-forestry systems, in terms of structure and financial performance, and based on this to suggest a potential agro-forestry model that could better manage the degrading forest resource base whilst also meeting the financial needs of farmers in the uplands of Eastern Bangladesh. This project seeks to improve livelihood of jhum farmers and mitigating the adverse environmental effects associated with jhum farming by integrating rice-cotton intercropping system with agro forestry.The project activities were undertaken in the Bandarban hill districts to find out suitable production system integrating with the rice-cotton and Banana/ papaya intercropping during 2017 to 2018 for maximizing yield,and reducing soil erosion.

Field experiments were set up at hill slopes in 10 different locations of Bandarban hill district. Two agroforestry system viz. rice + cotton + banana and rice + cotton + papaya were compared with rice + cotton intercropping as farmers practice. Fertilizers were applied according to the Fertilizer Recommendation Guide 12 (Urea, TSP, MoP, Gypsum, Borax, Zinc Sulphate and Magnesium Sulphate). Rice and cotton was sown in row across the hill.  Cotton was sown in 12th August and harvest was done in 30th January. Two rows of rice were sown followed by one row of cotton. The spacing for cotton was 80 × 45 cm and for rice was 20 × 15 cm.  CDB recommended dose of fertilizers were applied. The showing time of Rice is 8th August and the harvesting time is 11th November. The thirty days aged seedlings of Papaya are transplanted in 10th August .and harvesting is done whenever the fruits are ripened. Three weeding was at 25, 45 and 60 days after sowing of rice and cotton. Insecticides were applied as and when necessary based on field scouting of harmful and beneficial insect as recommended by Cotton Development Board (CDB).

In this study, agroforestry system was found more profitable than intercropping of rice + cotton only. The agroforestry system offers opportunity to utilize the otherwise fallow land to generate more income round the year. Papaya cultivation in the Hilly areas has been gaining popularity commercially among the tribal farmers in hill districts by which the hilly farmers are benefitted economically. In case of rice + cotton + banana agro-forestry system the net income from farmers practice (rice+ cotton intercropping) was 46930.00 Taka/ha and from rice + cotton + banana was 139040.00 Taka/ha. In case of rice + cotton + papaya agro-forestry system the net income from farmers practice (rice+ cotton intercropping) was 55096.00 Taka/ha and from rice + cotton + papaya was 256903.00 Taka/ha. The BCR of rice / cotton /banana inter cropping system was 1.22 and rice / cotton /papaya inter cropping system was 1.82 from growing papaya in hill slope with rice + cotton intercropping. The agroforestry system offers opportunity to utilize the fallow land to generate more income round the year.

# CRG Sub-Project Completion Report (PCR)

## A. Sub-project Description

1. Title of the CRG sub-project:  Development of agro-forestry model for  conversion of rice-cottonbased hill farming system in the Chittagong hill tracts

2. Implementing organization: Hill Cotton Research Station, Cotton Development Board, Balaghata, Bandarban
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

> a). Principal  Investigator:  **MongSanueMarma**
> Senior Scientific Officer
> Hill Cotton Research Station
> Cotton Development Board
> Balaghata, Bandarban.
> Phone   : 0361 62584, cell: 01558858701,
> Email    : marma_mong@yahoo.com

> b). Co-Principal Investigator(s):  **Md. Mominul Islam**
> Senior Scientific Officer
> Cotton Development Board
> Khamarbari, Farmgate ,Dhaka-1215
> Bangladesh
> Cell      : 01815886672:
> Email    : mominhujur@yahoo.com

4. Sub-project budget (Tk):
   a. Total: 2900000
   b. Revised (if any):
5. Duration of the sub-project:
   a. Start date (based on LoA signed):09 July, 2017
   b. End date: 30 September 2018

6. Justification of undertaking the sub-project: Majority of hill population in Chittagong Hill Tracts (CHT) depend on the Jhum farming for livelihood support. Its sustainability has been a challenge as it reduces the vegetative cover from the hill slope and is responsible for soil erosion in the hills. Hill farmers are continuing the jhum farming due to lack of technical knowhow and absence of alternatives. Against this background, Cotton Development Board has conducted intensive research program at the CHT to improve the productivity of the jhum system and successfully generated a rice-cotton intercropping technology which is found to be more profitable than existing jhum. However, for the long term sustainability of the hill farming the development of additional land use system integrating with the rice-cotton intercropping is utmost necessary. Agroforestry is considered to be environmentally suitable for the mountainous areas like CHT. While agroforestry seems to be better than shifting cultivation from social and environmental perspectives, there is a lack of hard evidence justifying this particularly in the context of CHT. This project seeks to improve livelihood of jhum farmers and

mitigating the adverse environmental effects associated with jhum farming by integrating rice-cotton intercropping system with agroforestry.

7. Sub-project objective (s):
   A.  To develop a model of agroforestry system for replacing traditional jhum system
   B. To evaluate financial performance and profitability of promoted agroforestry -based farming system against existing slash- and -burn based (Jhum) farming system in the project areas.
   C.  To develop jhum farmers skill and knowledge on agroforestry system

8. Sub-project goal: Cotton yield and cottonseed oil production will increase in Bangladesh that will contribute in farmer's additional income from cotton cultivation

9. **Implementing Location(s):**Selection of sites: Five locations at  Bandarban hill tracts (Choroipara, Kohlongpara, Tungkhyangpara, Dolopara, Raicha)

10. **Methodology:**
    **a. Approaches:**

    In an approach to develop a model of agroforestry system for replacing traditional jhum system, participatory research method was adopted. The experiments were set up at the hill slopes of Chittagong Hill Tracts.  Banana or papaya was selected upon discussion with the participating farmers considering the market value and suitability for growing in the hill slope. Existing watershed  was used to irrigate the planted tree during the dry season. After harvesting the jhum crops, the crop residues were used as soil mulch to reduce the soil erosion and to increase the soil organic matter.  Economic analysis wasto know the system profitability. One inception and one closing workshops  were organized to finalize the work plan and to inform the research findings.. An internal monitoring committee  was formed to monitor the project progress in time.

    Ten hill slopes from 3 union of Bandarban hill district were selected for field experiment as given below. The area of each plot was 0.1378 ha.

    | Locations | No of plots |
    |---|---|
    | Choroipara | 2 |
    | Kohlongpara | 2 |
    | Tungkhyangpara | 2 |
    | Dolopara | 2 |
    | Raicha | 2 |

After clearing of land, papaya (5sites) and banana (5 sites) were planted maintaining the spacing 2 × 2

m. Fertilizers were applied according to the Fertilizer Recommendation Guide 2012 of BARC.

Rice and cotton were sown in row across the hill.  Two rows of rice were sown followed by one row of cotton. The spacing for cotton was 80× 45 cm and for rice was 20 × 15 cm.  CDB recommended dose of fertilizers were applied. Uniform management practices were adopted for all plots. Yield and yield

contributing characters of the component crops were recorded and  analyzed by statistical software considering each farmer plot as one replication.

## 11. Results

### A. Rice + cotton + banana system

The performance of rice + cotton + banana intercropping system was compared with farmer's practice i.e. intercropping of rice + cotton grown in the same hill slope. The average rice and cotton yields obtained from farmer's practice were 1695 kg/ha (Table 1) and 1375 kg/ha (Table 2) respectively. The net income obtained from farmer's practice was 46930 Taka/ha (Table 3).

The average rice and cotton yields obtained from rice + cotton + banana were 1592 kg/ha (Table 4) and 1076 kg/ha (Table 5) respectively. The net income obtained from rice and cotton from rice + cotton + banana intercropping was 26926 Taka/ha (Table 6). In addition to that the net income from banana was 112114 Taka/ha (Table 7).

### B. Rice + cotton + papaya system

In case of rice + cotton + papaya system, the average rice and cotton yields obtained from farmer's practice were 1571 kg/ha (Table 8) and 1669 kg/ha (Table 9) respectively. The net income obtained from farmer's practice was 55096 Taka/ha (Table 10).

The average rice and cotton yields obtained from rice + cotton + papaya were 1387 kg/ha (Table 11) and 1191 kg/ha (Table 12) respectively. The net income obtained from rice and cotton from rice + cotton + papaya intercropping was 32319 Taka/ha (Table 13). In addition to that the net income from papaya was 224584 Taka/ha (Table 14).

**Table 1. Rice yield and yield contributing characters at farmers practice**

| Farmers name | Location | No. of hill/m$^2$ | No. of tiller/hill | No. of panicle/hill | No. of grain/ panicle | wt. of 100 grain | Rice yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 17 | 9 | 8 | 46 | 2.7 | 1689 |
| RumyAktar | Bakichara, Bandarban | 16 | 10 | 8 | 49 | 2.8 | 1756 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 16 | 10 | 8 | 51 | 2.6 | 1697 |
| NatunBala | Lemujiri, Bandarban | 17 | 9 | 7 | 51 | 2.8 | 1683 |
| JhotimoyChakma | Raicha, Bandarban | 17 | 9 | 7 | 50 | 2.8 | 1649 |
| Average | | 16.6 | 9.4 | 7.6 | 49.2 | 2.74 | 1695 |
| CV% | | 3.3 | 5.8 | 7.2 | 4.0 | 3.3 | 2.3 |

**Table 2. Cotton yield and yield contributing characters at farmers practice**

| Farmers name | Location | No. of plant/m$^2$ | Plant height (cm) | No. of vegetative branch/ plant | No. of fruiting branch/ plant | No. of boll/ plant | Single boll weight (g) | Seed cotton yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 2.8 | 128.7 | 0.9 | 20.3 | 12.87 | 4.8 | 1730 |
| RumyAktar | Bakichara, Bandarban | 2.7 | 118.2 | 1 | 20.9 | 10.47 | 4.6 | 1301 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 2.8 | 130.9 | 1.3 | 17.3 | 10.71 | 4.4 | 1320 |
| NatunBala | Lemujiri, Bandarban | 2.7 | 105.9 | 1.6 | 13.8 | 10.57 | 4.7 | 1341 |
| JhotimoyChakma | Raicha, Bandarban | 2.7 | 120.2 | 1.6 | 13.1 | 9.52 | 4.6 | 1183 |
|  | Average | 2.74 | 120.8 | 1.28 | 17.08 | 10.83 | 5 | 1375 |
|  | CV% | 2.0 | 8.2 | 25.6 | 21.0 | 11.4 | 3.2 | 15.1 |

**Table 3. Cost benefit analysis of farmers practice**

| Farmers name | Location | Rice yield (kg/ha) | Seed cotton yield (kg/ha ) | Cotton equivalent yield (kg/ha) | Gross income (Taka) | Total cost (Taka) | Net income (Taka) |
|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 1689 | 1730 | 2406 | 150353 | 85400 | 64953 |
| RumyAktar | Bakichara, Bandarban | 1756 | 1301 | 2003 | 125216.5 | 75900 | 49316.5 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 1697 | 1320 | 1999 | 124932 | 83600 | 41332 |
| NatunBala | Lemujiri, Bandarban | 1683 | 1341 | 2014 | 125879 | 84000 | 41879 |
| JhotimoyChakma | Raicha, Bandarban | 1649 | 1183 | 1843 | 115171 | 78000 | 37171 |
| | Average | 1694.912 | 1375 | 2052.9648 | 128310.3 | 81380 | 46930 |
| | CV% | 2.3 | 15.1 | 10.2 | 10.2 | 5.1 | 23.4 |

**Table 4. Rice yield and yield contributing characters as affected by rice + cotton + banana intercropping**

| Farmers name | Location | No. of hill/m$^2$ | No. of tiller/hill | No. of panicle/hill | No. of grain/ panicle | wt. of 100 grain | Rice yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 16 | 9 | 8 | 48 | 2.8 | 1720 |
| RumyAktar | Bakichara, Bandarban | 17 | 8 | 7 | 47 | 2.9 | 1605 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 16 | 9 | 8 | 49 | 2.7 | 1693 |
| NatunBala | Lemujiri, Bandarban | 15 | 9 | 7 | 51 | 2.8 | 1499 |
| JhotimoyChakma | Raicha, Bandarban | 17 | 8 | 6 | 51 | 2.8 | 1442 |
| | Average | 16.2 | 8.6 | 7.2 | 49 | 2.8 | 1592 |
| | CV% | 5.2 | 6.4 | 11.6 | 3.7 | 2.5 | 7.6 |

**Table 5. Cotton yield and yield contributing characters as affected by rice + cotton + banana intercropping**

| Farmers name | Location | No. of plant/m$^2$ | Plant height (cm) | No. of vegetative branch/ plant | No. of fruiting branch/ plant | No. of boll/ plant | Single boll weight (g) | Cotton yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 2.7 | 126.4 | 3.9 | 13.1 | 9.2 | 4.8 | 1192 |
| RumyAktar | Bakichara, Bandarban | 2.7 | 138.6 | 2 | 17.9 | 8.33 | 4.8 | 1080 |
| ThwaychingMong Marma | Tunkhapara, Bandarban | 2.6 | 110.2 | 2.6 | 15.8 | 9.89 | 4.1 | 1054 |
| NatunBala | Lemujiri, Bandarban | 2.6 | 120.4 | 3 | 15.9 | 9.31 | 4.2 | 1017 |
| JhotimoyChakma | Raicha, Bandarban | 2.8 | 120.3 | 2.3 | 16 | 8.8 | 4.2 | 1035 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Average | 2.68 | 123.2 | 2.76 | 15.74 | 9.106 | 4 | 1076 |
| CV% | 3.1 | 8.4 | 26.7 | 10.9 | 6.4 | 7.9 | 6.4 |

**Table 6. Net income from rice and cotton as affected by rice + cotton + banana intercropping**

| Farmers name | Location | Rice yield (kg/ha) | Seed cotton yield (kg/ha ) | Cotton equivalent yield(kg/ha) | Gross income (Taka) | Total cost (Taka) | Net income (Taka) |
|---|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 1720 | 1192 | 1880 | 117508 | 83000 | 34508 |
| RumyAktar | Bakichara, Bandarban | 1605 | 1080 | 1722 | 107617 | 81000 | 26617 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 1693 | 1054 | 1731 | 108211 | 79000 | 29211 |
| NatunBala | Lemujiri, Bandarban | 1499 | 1017 | 1617 | 101047.5 | 75000 | 26047.5 |
| JhotimoyChakma | Raicha, Bandarban | 1442 | 1035 | 1612 | 100744.5 | 82500 | 18244.5 |
| | Average | 1592 | 1076 | 1712 | 107026 | 80100 | 26926 |
| | CV% | 7.6 | 6.4 | 6.4 | 6.4 | 4.1 | 21.9 |

**Table 7. Banana yield and economic return**

| Farmers name | Location | No. of plant/ha | No. of banana bunch/ha | Gross income (Taka/ha) | Production cost (Taka/ha) | Net income (Tk/ha) |
|---|---|---|---|---|---|---|
| WangchingMarma | Balaghata, Bandarban | 3090 | 3090 | 630360.00 | 514510.00 | 115850.00 |
| RumyAktar | Bakichara, Bandarban | 3090 | 3090 | 624180.00 | 526330.00 | 97850.00 |
| ThwaychingMongMarma | Tunkhapara, Bandarban | 3090 | 3090 | 621090.00 | 528850.00 | 92240.00 |
| NatunBala | Lemujiri, Bandarban | 3090 | 3090 | 667440.00 | 530660.00 | 136780.00 |
| JhotimoyChakma | Raicha, Bandarban | 3090 | 3090 | 648900.00 | 531050.00 | 117850.00 |
| | Average | 3090 | 3090 | 638394 | 526280 | 112114 |
| | CV% | 0 | 0 | 3.05 | 1.30 | 15.79 |

**Table 8. Rice yield and yield contributing characters at farmers practice**

| Farmers name | Location | No. of hill/m$^2$ | No. of tiller/hill | No. of panicle/hill | No. of grain/ panicle | wt. of 100 grain | Rice yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 16 | 10 | 8 | 46 | 2.6 | 1531 |
| HorimohonChakma | Bakichara, Bandarban | 17 | 8 | 7 | 51 | 2.8 | 1683 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 16 | 9 | 8 | 43 | 2.7 | 1486 |
| ChinghlaMarma | Lemujiri, Bandarban | 17 | 9 | 7 | 50 | 2.8 | 1649 |
| AlpanaChakma | Raicha, Bandarban | 16 | 10 | 8 | 42 | 2.8 | 1505 |
| | Average | 16.4 | 9.2 | 7.6 | 50 | 2.74 | 1571 |
| | CV% | 3.3 | 9.1 | 7.2 | 7.6 | 3.3 | 5.7 |

**Table 9. Cotton yield and yield contributing characters at farmers practice**

| Farmers name | Location | No. of plant/m$^2$ | Plant height (cm) | No. of vegetative branch/ plant | No. of fruiting branch/ plant | No. of boll/ plant | Single boll weight (g) | Seed cotton yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 2.6 | 120.2 | 1.5 | 19.9 | 14.98 | 4.8 | 1869 |
| Horimohon Chakma | Bakichara, Bandarban | 2.8 | 135 | 1 | 17.3 | 13.68 | 4.4 | 1685 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 2.7 | 120.2 | 1.7 | 18.7 | 13.54 | 4.7 | 1718 |
| ChinghlaMarma | Lemujiri, Bandarban | 2.7 | 132.4 | 2.9 | 16.3 | 12.5 | 4.1 | 1384 |
| AlpanaChakma | Raicha, Bandarban | 2.8 | 111.9 | 1.4 | 18.5 | 12.58 | 4.8 | 1690 |
| | Average | 2.72 | 123.9 | 1.7 | 18.14 | 13.46 | 5 | 1669 |
| | sd | 0.08 | 9.58 | 0.72 | 1.38 | 1.01 | 0.30 | 176.30 |
| | CV% | 3.1 | 7.7 | 42.2 | 7.6 | 7.5 | 6.7 | 10.6 |

12

**Table 10. Cost benefit analysis of farmers practice**

| Farmers name | Location | Rice yield (kg/ha) | Seed cotton yield (kg/ha ) | Cotton equivalent yield (kg/ha) | Gross income (Taka) | Total cost (Taka) | Net income (Taka) |
|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 1531 | 1869 | 2481 | 155085 | 95000 | 60085 |
| HorimohonChakma | Bakichara, Bandarban | 1683 | 1685 | 2358 | 147379 | 89500 | 57879 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 1486 | 1718 | 2312 | 144527 | 88000 | 56527 |
| ChinghlaMarma | Lemujiri, Bandarban | 1649 | 1384 | 2044 | 127734 | 78000 | 49734 |
| AlpanaChakma | Raicha, Bandarban | 1505 | 1690 | 2292 | 143257 | 92000 | 51257 |
|  | Average | 1571 | 1669 | 2296 | 143596 | 88500 | 55096 |
|  | sd | 89.09 | 176.30 | 159.78 | 9986.21 | 6442.05 | 4420.76 |
|  | CV% | 5.7 | 10.6 | 7.0 | 7.0 | 7.3 | 8.0 |

**Table 11. Rice yield and yield contributing characters as affected by rice + cotton + papaya intercropping**

| Farmers name | Location | No. of hill/m$^2$ | No. of tiller/hill | No. of panicle/hill | No. of grain/ panicle | wt. of 100 grain | Rice yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 17 | 8 | 6 | 49 | 2.6 | 1286 |
| HorimohonChakma | Bakichara, Bandarban | 16 | 8 | 7 | 48 | 2.7 | 1452 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 17 | 8 | 7 | 51 | 2.5 | 1502 |
| ChinghlaMarma | Lemujiri, Bandarban | 16 | 7 | 6 | 51 | 2.8 | 1371 |
| AlpanaChakma | Raicha, Bandarban | 16 | 8 | 6 | 53 | 2.6 | 1323 |
| | Average | 16.4 | 7.8 | 6.4 | 50 | 2.64 | 1387 |
| | CV% | 3.3 | 5.7 | 8.6 | 4.0 | 4.3 | 6.4 |

**Table 12. Cotton yield and yield contributing characters as affected by rice + cotton + papaya intercropping**

| Farmers name | Location | No. of plant/m$^2$ | Plant height (cm) | No. of vegetative branch/ plant | No. of fruiting branch/ plant | No. of boll/ plant | Single boll weight (g) | Seed cotton yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 2.6 | 120.4 | 0.8 | 18.3 | 11.13 | 4.2 | 1215 |
| Horimohon Chakma | Bakichara, Bandarban | 2.7 | 127.1 | 1.3 | 16.5 | 10.45 | 4.9 | 1383 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 2.7 | 128.6 | 1.5 | 15 | 8.68 | 4.5 | 1055 |
| ChinghlaMarma | Lemujiri, Bandarban | 2.7 | 118.5 | 0.5 | 18.4 | 10.16 | 4.2 | 1152 |
| AlpanaChakma | Raicha, Bandarban | 2.7 | 135.7 | 1.2 | 14.9 | 9.47 | 4.5 | 1151 |
| | Average | 2.68 | 126.1 | 1.06 | 16.62 | 9.978 | 4 | 1191 |
| | CV% | 1.7 | 5.5 | 38.1 | 10.2 | 9.4 | 6.5 | 10.2 |

**Table 13. Net income from rice and cotton as affected by rice + cotton + papaya intercropping**

| Farmers name | Location | Rice yield (kg/ha) | Seed cotton yield (kg/ha ) | Cotton equivalent yield (kg/ha) | Gross income (Taka) | Total cost (Taka) | Net income (Taka) |
|---|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 1286 | 1215 | 1729 | 108093 | 76000 | 32093 |
| HorimohonChakma | Bakichara, Bandarban | 1452 | 1383 | 1964 | 122725.5 | 74000 | 48725.5 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 1502 | 1055 | 1656 | 103496.875 | 79000 | 24496.875 |
| ChinghlaMarma | Lemujiri, Bandarban | 1371 | 1152 | 1700 | 106272 | 74000 | 32272 |
| AlpanaChakma | Raicha, Bandarban | 1323 | 1151 | 1680 | 105009.5 | 81000 | 24009.5 |
| | Average | 1386.775 | 1191.2 | 1745.91 | 109119.38 | 76800 | 32319 |
| | sd | 89.45 | 121.51 | 124.65 | 7790.88 | 3114.48 | 9993.25 |
| | CV% | 6.4 | 10.2 | 7.1 | 7.1 | 4.1 | 30.9 |

**Table 14. Papaya yield and economic return**

| Farmers name | Location | No. of plant/ha | Papaya yield kg/ha | Gross income (Taka/ha) | Production cost (Taka/ha) | Net income (Tk/ha) |
|---|---|---|---|---|---|---|
| UmachingMarma | Balaghata, Bandarban | 3090 | 35702 | 714040 | 506250 | 207790 |
| HorimohonChakma | Bakichara, Bandarban | 3090 | 34882 | 697640 | 528100 | 169540 |
| MongpruThuiMarma | Tunkhapara, Bandarban | 3090 | 36457 | 729140 | 530815 | 198325 |
| ChinghlaMarma | Lemujiri, Bandarban | 3090 | 38550 | 771000 | 535985 | 235015 |
| AlpanaChakma | Raicha, Bandarban | 3090 | 42330 | 846600 | 534350 | 312250 |
| | Average | 3090 | 37584.2 | 751684 | 527100 | 224584 |
| | CV% | 0.00 | 7.93 | 7.93 | 2.29 | 24.18 |

17

Rice + Cotton + Banana Agro-forestry System

Rice + Cotton + Banana Agro-forestry System

Rice + Cotton + Papaya Agro-forestry System

Rice + Cotton + Papaya Agro-forestry System

Farmers Training

Farmers Training

Research Field Monitoring by BARC Team

Research Field Monitoring by BARC Team

**12. Research highlight/findings:**

Rice and Cotton yields are lower in   agro-forestry system,
- Agro-forestry system is more profitable than intercropping of  rice + cotton only
- Rice + cotton + banana is more profitable than rice + cotton intercropping
- Rice + cotton + papaya is more profitable than rice + cotton intercropping
- Rice + cotton + papaya is more profitable than rice + cotton + banana  agro-forestry system
- Banana and Papaya cover the fallow land after crops harvest and Farmers can earn money throughout the years by selling Papaya or Banana.

**B. Implementation Position**

**1.   Procurement:**

| Description of equipment and capital items | PP Target | | Achievement | | Remarks |
|---|---|---|---|---|---|
| | Phy (#) | Fin (Tk) | Phy (#) | Fin (Tk) | |
| (a) Office  equipment | 1..Desktop | 60,000 | 1..Desktop | 58,500 | Used for research purpose |
| | 2..UPS | 10,000 | 2..UPS | 10,000 | |
| | 3. .Scanner | 10,000 | 3. .Scanner | 9,500 | |
| | 4 Laser printer | 20,000 | 4 Laser printer | 20,000 | |
| | 5.Digital camera | 25,000 | 5.Digital camera | 25,000 | |
| (b) Lab &field equipment | Lux meter-1 | 1,00,000 | Lux meter-1 | 99,000 | Used for research purpose |
| | ii) Hand sprayer-5 | 75,000 | ii) Hand sprayer-5 | 72,500 | |
| | iii) Water cooler 4HP disel pump | | iii) Water cooler 4HP disel pump | | |

|  | with 100ft pipe-5 | 1,25,000 | with 100ft pipe-5 | 1,22,500 |  |
|---|---|---|---|---|---|
| (c) Other capital items |  |  |  |  |  |

**2. Establishment/renovation facilities:** N/A

| Description of facilities | Newly established | | Upgraded/refurbished | | Remarks |
|---|---|---|---|---|---|
| | PP Target | Achievement | PP Target | Achievement | |
| N/A | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**3. Training/study tour/ seminar/workshop/conference organized:**

| Description | Number of participant | | | Duration (Days/weeks/ months) | Remarks |
|---|---|---|---|---|---|
| | Male | Female | Total | | |
| (a) Training | 5 | 5 | 10 | 5 | Farmer develop skinless on rice–cotton-Banana and rice–cotton-Papaya based hill farming system |
| (b) Workshop | - | - | - | - | - |

**C. Financial and physical progress**

**Fig in Tk**

| Items of expenditure/activities | Total approved budget | Fund received | Actual expenditure | Balance/ unspent | Physical progress (%) | Reasons for deviation |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| A. Contractual staff salary | 210718 | 210718 | 210718 | 0 | 100% | |
| B. Field research/lab expenses and supplies | 1897973 | 1725304 | 1725304 | 0 | 100% | |
| C. Operating expenses | 259309 | 257605 | 257605 | 0 | 100% | |
| D. Vehicle hire and fuel, oil & maintenance | 181000 | 193971 | 193971 | 0 | 100% | |
| E. Training/workshop/seminar etc. | 150000 | 150000 | 150000 | 0 | 100% | |
| F. Publications and printing | 50000 | 41500 | 41500 | 0 | 100% | |
| G. Miscellaneous | 0 | 0 | 0 | 0 | 100% | |
| H. Capital expenses | 151000 | 151000 | 151000 | 0 | 100% | |

**D. Achievement of Sub-project by objectives: (Tangible form)**

| Specific objectives of the sub-project | Major technical activities performed in respect of the set objectives | Output(i.e. product obtained, visible, measurable) | Outcome(short term effect of the research) |
|---|---|---|---|
| To assess the current status of jhum system | Data had been taken from 50 Jhum farmers | i) In Jhum system farmers cultivate cotton , rice, maize, chilies, sesame, Marpha, pigeon pea etc. in the same pit at a time in hill slope | For intra and inter species competition the yield of cotton, rice and other component crops is low and unstable |

| | | ii) Crop has to compete to each other for nutrient, moisture, sunshine, air and other growth factors | |
|---|---|---|---|
| To develop a model of agroforestry system to replace traditional jhum system | 20 experiments conducted at 5 research sites | i) Inter-Cropping of Rice and Cotton with Banana/Papaya found more profitable than Jhum crops<br><br>ii)Banana and Papaya covered the fellow land after crops harvest and Farmers can earn money throughout the years by selling Papaya or Banana.<br><br>ii)It is better than shifting cultivation from social and environmental perspectives. | i) Long term sustainability of the hill farming the development of additional land use system integrating with the rice-cotton intercropping.<br><br>ii)Improve livelihood of jhum farmers and mitigating the adverse environmental effects associated with jhum farming by integrating rice-cotton intercropping system with agro forestry.<br><br>iii) Identify the agro-forestry systems, in terms of structure and financial performance, and based on this to suggest a potential agro-forestry model that could better manage the degrading forest resource base whilst also meeting the financial needs of farmers in the uplands of Eastern Bangladesh |
| To develop jhum farmers skill and knowledge on agroforestry system | 20 farmers trained | Farmer develop skinless on rice–cotton-Banana and rice–cotton-Papaya based hill farming system. | Agroforestry model had been adaptedthe hill farmers forJhum Cultivation |

**E. Materials Development/Publication made under the Sub-project:**

| Publication | Number of publication | | Remarks (e.g. paper title, name of journal, conference name, etc.) |
| --- | --- | --- | --- |
| | Under preparation | Completed and published | |
| Technology bulletin/ booklet/leaflet/flyer etc. | | Completed and published | **Distributing** |
| Journal publication | | | |
| Information development | | | |
| Other publications, if any<br><br>Training Manual | | Completed and published | farmers trainning |

**F. Technology/Knowledge generation/Policy Support (as applied):**

    i.       **Generation of technology (Commodity & Non-commodity)**

Inter-Cropping of Rice and Cotton with Banana/Papaya in hill slope which is more profitable

thanJhum cultivation**.**

    ii.       **Generation of new knowledge that help in developing more technology in future**

Long term sustainability of the hill farming the development of additional land use system, reduced soil erosion and mitigate  environmental pollution integrating with the rice-cotton intercropping.

    iii.       **Technology transferred that help increased agricultural productivity and farmers' income**

Improve livelihood of jhum farmers and mitigating the adverse environmental

effects associated with jhum farming by integrating rice-cotton intercropping

system with agro forestry.

iv.    **Policy Support**

Identify the agro-forestry systems, in terms of structure and financial  performance, and based

on this to suggest a potential agro-forestry model that could better manage the degrading forest

resource base whilst also meeting the financial needs of farmers in the uplands of Eastern

Bangladesh

## G. Information regarding Desk and Field Monitoring

i)    **Desk Monitoring[description & output of consultation meeting, monitoring workshops/seminars etc.):  N/ A**
- Inception workshop - August 2017

- Six monthly report - workshop

- Annual Report - workshop

ii)    **Field Monitoring (time& No. of visit, Team visit and output):**

| Name of visitors | Designation | Date(s) of visit | Total visit till date (No) | Remarks |
|---|---|---|---|---|
| Dr. Farid Uddin | ED, CDB | 03-10-2017 | 1 | |
| Dr. Akteruzzaman | AD, CDB | 17-10-2017 | 1 | |
| Dr. MGG Mortuja | PD, CDB | 17-10-2017 | 1 | |
| Dr. Kamrul  Islam | SSO, CDB | 02-02-2018 | 4 | |
| Dr.  Alamgir  Hossain Mirdha | CCDO, Bandarban | 08-02-2018 | 7 | |
| Dr. NurulAlom | Coordinator, KGF | 14-02-2018 | 1 | |
| Dr. Abdul Hamid | Chairman, ARF | 30-01-2018 | 3 | |

**H. Lesson Learned/Challenges (if any)**

i) Inter-cropping of Rice and cotton with Banana/Papaya found more profitable than jhum crops

ii) Banana/Papaya covered the fallow land after crops harvest and farmers can earn money throughout the years by selling Papaya or Banana

iii) It is better than shifting cultivation from social and environmental perspectives

**I. Challenges (if any)**

- Most farmers operate under subsistence condition
- Market has not developed; non-farm activities are rarely visible
- Poor communication
- Farming practices are largely primitive
- Poverty is widespread
- Unable to understanding language

Signature of the Principal Investigator
Date ………………………….
Seal

Counter signature of the Head of the
organization/authorized representative
Date …………………………..
Seal