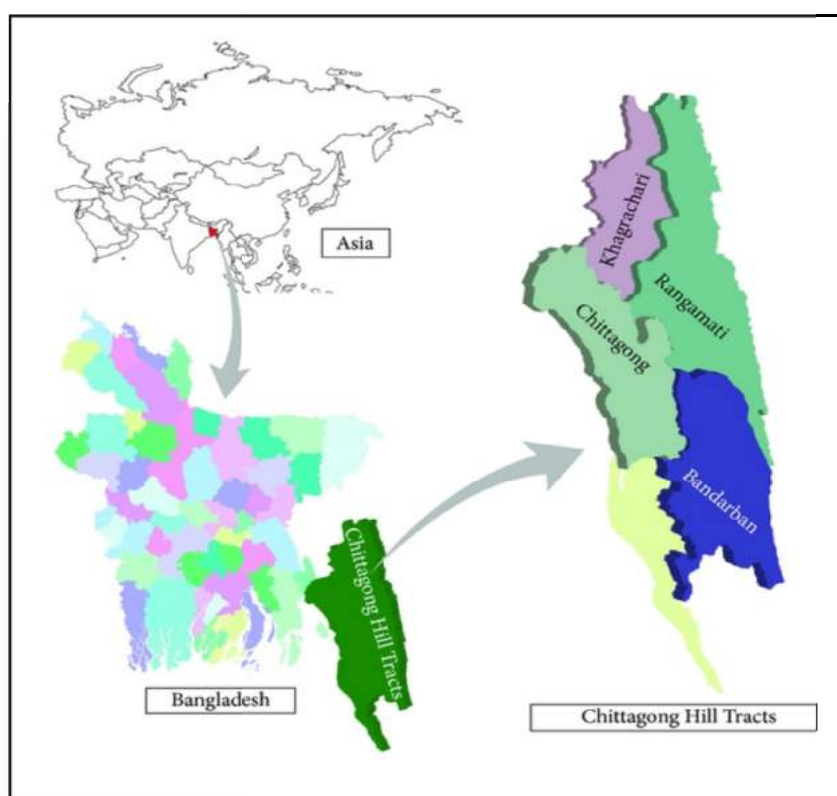




Government of the People's Republic of Bangladesh
National Agricultural Technology Program- Phase II Project (NATP-2)
Project Implementation Unit, Bangladesh Agricultural Research Council (PIU-BARC)

Information on CHT related Researches under CRG and PBRG sub-projects



February 2020



Table of Contents

	Content	Page
I	Executive Summary	3
II	Introduction	3
III	Fourteen (14) CRG sub-projects implemented in CHT region	4
	3.1 Sub-project title: Collection, conservation and maintenance of different fruits germplasm in the hilly region of Bangladesh (ID- 783)	4
	3.2 Sub-project title: Supply chain analysis of major vegetables produce in hill and coastal regions of Bangladesh (ID- 407)	5
	3.3 Sub-project title: Agricultural practices and livelihood patterns of selected tribal communities in Bangladesh (ID- 454)	5
	3.4 Sub-project title: Agro-forestry for livelihood development of Jhumia community (shifting cultivators) in Chittagram Hill Tracts, Bangladesh (ID -386)	6
	3.5 Sub-project title: Development of agro-forestry model for conversion of rice–cotton based hill farming system in the Chattogram hill tracts (ID 582)	6
	3.6 Sub-project title: Production enhancement of carps and tilapia in creeks of Chattogram hill districts (ID-833)	6
	3.7 Sub-project title: Characterization and documentation of minor fruits in Bangladesh with special emphasis on coastal and hilly areas (ID- 384)	7
	3.8 Sub-project title: Studies on the species complex and their bio-rational based management of fruit flies infesting fruits and vegetables in Bangladesh (ID- 526)	7
	3.9 Sub-project title: Development of production package with special emphasis on off season flowering of dragon fruit (ID- 538)	7
	3.10 Sub-project title: Development of eco-friendly management of sucking insects of cotton (ID- 584)	8
	3.11 Sub-project title: Improvement of spices varieties cumin, sweet pepper, chilli, turmeric and black pepper through induced mutation (ID- 804)	8
	3.12 Sub-project title: Effect of variety and fertilizer on cotton yield, fiber quality and seed oil content. (ID- 791)	8
	3.13 Sub-project title: Development of shelf stable value added products from onion, garlic and ginger (ID- 728)	9
	3.14 Sub-project title: Potentials of modernization in fisheries sector of Bangladesh: Study on the peoples' profile, technologies and policies (ID-648)	9
IV	Six (6) PBRG sub-projects/Components implemented in CHT region	10
	4.1 Sub-Project Title: Transfer of Agricultural Technologies to Farmers' level for Increasing Farm Productivity (ID 005)	10
	4.2 Sub-Project Title: Food-based initiative for improving household food security, income generation and minimize malnutrition (ID 011)	11
	4.3 Sub-Project Title: Development of lean season fruit varieties and management packages (013)	11
	4.4 Project Title: Adaptation and Scaling up Agroforestry for Livelihood Improvement of farmers in Agricultural Ecosystem of Bangladesh (ID 049)	12
	4.5 <u>Project Title:</u> Exploration, Identification, Characterization, Multiplication and <i>Ex-situ</i> Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh(074)	12
	4.6 Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources (ID 128)	13
V	Conclusions	14

I. Executive Summary

In view of diversities and potentialities prevail in Chattogram Hill Tract (CHT) consisting of three hilly districts of Bangladesh: **Rangamati, Khagrachari and Bandarban districts**, PIU-BARC, NATP-2 awarded 14 CRG sub-projects implemented by different organizations in CHT districts and 6 PBRG sub-projects/components those have been implementing in CHT region to develop location specific technologies to address different aspects of agricultural production to improve the livelihoods of the farmers of the different tribal communities/Jhumia community (Shifting cultivators)/Indigenous People (IP) living in these areas. The fourteen (14) CRG sub-projects were implemented in the CHT region covering collection, conservation, maintenance and documentation of different fruits including minor fruit germplasms, supply chain analysis of vegetables produce, agricultural practices and livelihood pattern of selected tribal communities, agroforestry for livelihood development of Jhumia community, development of rice-cotton based agroforestry, production enhancement of carps and tilapia in creeks, different IPM technologies, dragon fruit production, improvement of spices varieties (cumin, sweet pepper, chilli, turmeric, black pepper), development of shelf stable value added products (from onion, garlic, ginger), and potentials of fish production technologies and policies. Thirty two indigenous germplasm of 12 fruits have been collected from different location of CHT. Eight indigenous germplasm of 6 fruits have been identified and collected from different locations of Khagrachari. The minor fruit germplasms of five Monkey jack, eight Velvetapple, four Cowa, three Riverebony and one each of Governor's plum, Lukluki and Gutguti genotypes have been identified. Thirty three germplasm of spices have been collected. Vegetable production techniques in hilly areas have been identified and vegetables cultivation found profitable there. Tribal farmers have been engaged in agriculture as well as other income generating activities where majority of them produced agricultural commodities. The most common farming practices, agricultural technologies and constraints have been identified. Limited knowledge on agro-forestry practices; in-adequate availability of quality saplings, fertilizer and pesticides; scarcity of water and uncertainty of market price of farm products have been identified as major problems of hill farmers in agro-forestry. 12 hectares bamboo plantation has been established in the farmers' field with other agro-forestry species of timber, fruits and year round vegetables. Inter-Cropping of Rice and Cotton with Banana/Papaya has been found more profitable than Jhum crops. Fish production technology in the creeks has been adopted by the people of CHT districts. For lake fishery, overfishing, illegal gear fishing, pollution by agriculture practice should be controlled through implementing fish act and awareness and ecosystem based management. IPM technologies have been developed against fruit fly for different fruit crops, jassid population and white fly population. Off-season production of dragon fruit has been made possible by manipulating the environment through artificial lighting using 100-watt incandescent bulb (normal bulb), 20-watt LED (Light Emitting Diode) bulbs or 36-watt CFL (Compact Fluorescent Lamps). The optimum NPK requirement for the cotton varieties CB-14 and CB-15 has been found 175, 80 and 200 kg/ha respectively. High quality shelf-stable onion, garlic and ginger products have been developed by utilizing available low cost dehydration processes and post-harvest losses of these spices have been reduced to an acceptable level.

Six PBRG sub-projects have been executing in CHT regions covering transfer of agricultural technologies to farmers' level; household food security, income generation and minimize malnutrition; development of lean season fruit varieties and management packages; adaptation and scaling up agroforestry; and exploration, identification, characterization, multiplication and ex-situ conservation of endangered forest genetic resources including medicinal plants and other important plant genetic resources. The four recently generated technologies by CDP: i) CB-14 variety, ii) application of mepiquat chloride iii) removal of vegetative branches and iv) De-topping at 90 DAS (Day after sowing) were tested at Bandarban site and found more profitable and increase per hectare yield. The technological interventions made by BLRI component: distribution of goats, sheep, winter vegetables seeds and saplings, different seasonal vegetables

(capsicum, broccoli, potato, sweet potato, yard long bean, sweet gourds etc.), year round creeper vegetables (cucumber, bitter gourd, bottle gourd etc.), and fruit orchards for year round fruit production (papaya, lemon, malta, dragon) to the selected household in Khagrachari. This food-based initiative has been improving nutrition for household food security with a long-term goal for sustainable improvement of food and nutrition of the rural poor. Collection, characterization and evaluation of the promising lean seasoned fruit germplasm at BARI Hill Agriculture Research Station, Raikhali such as 3 germplasm of bullock's heart, 2 of pear and 1 each of ber, pummelo, pear, strawberry, avocado and mango were made and planted in the research field. In hill ecosystem, agroforestry (contour hedged grows) on steep hill slopes (40-50%) can reduce soil erosion by 55-80% and runoff by 30-70% compared to shifting cultivation. Different agro-forestry systems are being conducted under Bandarban. Fruit/seed of 25 threatened tree species including medicinal plants were collected for recording of phenological characteristics and transferred to the conservation stands a CU campus for improving Forest Genetic Resources and biodiversity of the country. 25-36 seedlings of each species were planted in the pre-selected site after clearing, burning and proper soil work. Collection, characterization, conservation and documentation of popularly grown crops with a view to establish IPR (Intellectual Property Right) is being done under the sub-project (ID 128). BRRI collected 103 landraces of rice from 7 Upazilas of Bandarban. BAU completed morphological characterization of 62 indigenous germplasm of banana, 30 yam and 30 aroids. The germplasm collection of more than 18 different crops by participating research institutes was 651 against the target of 570. Besides, from personal communication it is known that 15 lean season fruit germplasm collected from Rangamati for conservation and characterization for further trial, 98 ethno-medicinal plants germplasm were collected from CHT, BSRI collected 11 sugarcane germplasm from hill districts, some of the jhum rice varieties are pidi, mongbui, mongthong, etc. Training, motivation, support and extension services of different government and non-government organizations might raise the awareness about modern agricultural technologies for increasing the agricultural production as well as improving the livelihoods of the farmers in the region.

II. Introduction

Chattogram Hill Tracts (CHT) the only extensive hill area in Bangladesh lies in southeastern part of the country (21°25'N to 23°45'N latitude and 91°54'E to 92°50'E longitude) bordering Myanmar on the southeast, the Indian state of Tripura on the north, Mizoram on the east and Chattogram district on the west. The area of the CHT is about 13,184 sq km, which is approximately one-tenth of the total area of Bangladesh (Banglapedia, 2015). CHT consists of three hilly districts of Bangladesh: **Rangamati, Khagrachari and Bandarban districts**. The mountainous rugged terrain with deep forests, lakes and falls gives it a divergent character from the rest of Bangladesh. Besides, CHT has also divergent characteristics on climate, soil conditions, vegetation, physiography, topography, geology, population, economy and even communication. Moreover, CHT is an immense reservoir of medicinal plant resources. In fact the Chattogram Hill Tracts host thirteen different tribes who are divided into nearly a hundred different sects. Total population enumerated in the 1991 census was 1.042 million of which 562,597 were male and 479,776 female (Banglapedia, 2015). In view of diversities and potentialities prevail in CHT, 14 CRG sub-projects were implemented in CHT districts involving at least one location and 6 PBRG sub-projects/components have been implementing in CHT region to develop location specific technologies to address different aspects of agricultural production to improve the livelihoods of the farmers of the different tribal communities/Jhumia community (Shifting cultivators)/Indigenous People (IP) living in these areas. The Project Implementation Unit, Bangladesh Agricultural Research Council (PIU-BARC) is one of the five inter-related components of National Agricultural Technology Program-Phase II Project (NATP-2) deals with enhancing agricultural technology generation through implementing CRG (Competitive Research Grant) and PBRG (Program Based

Research Grant) sub-projects. The salient features of these 14 CRG and 6 PBRG sub-projects awarded by PIU-BARC, NATP-2 are described as follows:

III. Fourteen CRG sub-projects implemented in CHT region

The first window of NATP-2 research investment is Competitive Research Grant (CRG) program that promotes demand driven basic, strategic, applied and adaptive research with better research-extension-farmer linkages. Better linkages make new technology more relevant and speed up dissemination. CRG critically targets to mobilize research capacity, stimulate creativity and promote efficiencies in the research system. CRGs are open to all research providers-National Agricultural Research Institutes (NARIs) and non-NARI research providers (Public Universities, NGOs and Private Organizations). In the CRG system, research providers are selected on competitive basis using calls for research proposals and subjected them to rigorous review by the peer reviewers before being selected for funding. The PIU-BARC awarded 190 CRG sub-projects of which 14 are related to researches in CHT region. The salient features of the 14 sub-projects are described as follows:

3.1 Sub-project title: Collection, conservation and maintenance of different fruits germplasm in the hilly region of Bangladesh (ID- 783)

Bangladesh Agricultural Research Institute (BARI), Gazipur had been implementing the sub-project at **Khagrachari** for the period from April 2017 to September 2018 with the objectives of i) Collection of Indigenous germplasm of diversified fruit species from different locations of **Khagrachari**, ii) Conservation of collected germplasms through ex-situ methods of conservation and iii) Maintenance of germplasm for further research works and varietal development activities. Thirty two indigenous germplasm of 12 fruits have been collected from different location of CHT. Nine mango (6 late and 3 early), 1 jackfruit (year round), 3 burmese grape (regular bearer), 2 guava (attractive colour & taste), 3 sweet orange (Juicy, sweet, large fruit size), 1 kaffir lime (Juicy, sweet), 2 mandarin (Juicy, sweet, large fruit size), 1 pomegranate (Large fruit size & taste), 1 sweet lime (Small, thin & sweet skin), 1 olive (Large fruit size & taste), 1 bel (Large fruit size & bitter less) and 1 Indian plum (medium fruit size & profuse bearing) germplasm have been collected. Eight indigenous germplasm of 6 fruits have been identified and collected from different locations of **Khagrachari**.

3.2 Sub-project title: Supply chain analysis of major vegetables produce in hill and coastal regions of Bangladesh (ID- 407)

The sub-project was implemented by the Bangladesh Agricultural Research Institute (BARI), Gazipur at **Rangamati, Khagrachari, Bandarban, Patuakhali, Satkhira and Cox's Bazar** for the period from July 2017 to September 2018 with the objectives of i) To analyze input supply, production system and profitability of major vegetables in hill and coastal region, ii) To examine the existing market, marketing system and supply chain of selected vegetables in those areas, iii) To identify the linkage/integration between local market and different city market of selected vegetables and iv) To identify the production and marketing drawbacks and suggest some policy recommendations for improving the vegetables supply chain. Vegetable production techniques in hilly (Homestead, plain land & jhum cultivation) and coastal regions (Plain land cultivation, sorjon method and composite agriculture -Gher based agriculture) have been identified. Maximum quantities of produced vegetables have been consumed within the district and minimum quantities have been marketed at distance market after fulfilling local demand. Identified major supply chains are: Farmer cum Retailer-Consumer, Farmer-Retailer-Consumer, Farmer- Bepari-Arathdar-Retailer-Consumer and Farmer-Arathdar- Paiker cum Retailer –Consumer. Major constraints have been found in the vegetables supply chains are in the area of production (salinity, heavy rain, drought, ignorance about the modern technology,

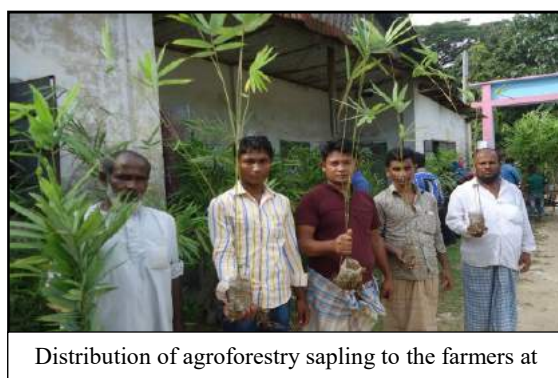
lack of irrigation facilities etc.), marketing (high transportation cost ,lack of traders, shortage of capital, lack of permanent retail market etc.) and linkage of rural market with urban market (lack of market information & road communication, high transport cost etc.). Vegetables cultivation has been found profitable in hill and coastal region.

3.3 Sub-project title: Agricultural practices and livelihood patterns of selected tribal communities in Bangladesh (ID- 454)

The sub-project was conducted by the Sylhet Agricultural University (SAU), Sylhet at Sylhet and Chattogram divisions for the period of July 2017 to September 2018 with the objectives of i) To identify the socioeconomic profile and livelihood pattern of tribal farmers' of Sylhet and Chattogram regions, ii) To know the agricultural practices of tribal farmers' and iii) To explore the potentiality of the use of agricultural technologies to improve the livelihood of tribal farmers. Tribal peoples have been observed lag behind the mainstream of the country in terms of socioeconomic development and livelihood. Tribal farmers have been engaged in agriculture as well as other income generating activities where majority of them produced agricultural commodities. The most common farming practices have been observed- Crop-Livestock-Poultry (C-L-P), Crop- Poultry-Homestead enterprise (C-P-H) and Crop-Livestock-Homestead enterprise (C-L-H), which have also been found more or less profitable. Agricultural technologies like betel leaf, betel nut and ell fish production (Cuchia), agro-forestry plantation, coffee tree cultivation, jhum cultivation, medicinal plant cultivation and rice cultivation (local) have been practiced by the tribal farmers. Constraints like lack of knowledge on agricultural technologies, lack of extension service, high price of inputs, etc. have been hindered the agricultural development of the tribal communities. Training, motivation, support and extension services of different government and non-government organizations might raise the awareness about modern agricultural technologies for increasing the agricultural production as well as improving their livelihood.

3.4 Sub-project title: Agro-forestry for livelihood development of Jhumia community (shifting cultivators) in Chittagong Hill Tracts, Bangladesh (ID -386)

Bangladesh Forest Research Institute (BFRI), Chattogram had been implementing the sub-project at Chittagong, Cox's Bazar, Rangamati, Khagrachari and Bandarban for the period from July 2017 to September 2018 with the objectives of i) To improve the capacity of household and *jhum* land based agroforestry systems to enhance livelihoods of *Jhumia* community, ii) To introduce sustainable land use system on hill farming for optimizing the yield of food, fodder, timber, fuel-wood, bamboo, cane, medicinal plants etc. and iii) To assess



Distribution of agroforestry sapling to the farmers at

socio economic and environmental benefit based on sustainable hill farming practices. Limited knowledge on agro-forestry practices; in-adequate availability of quality saplings, fertilizer and pesticides; scarcity of water and uncertainty of market price of farm products have been identified as major problems of hill farmers in agro-forestry. Sixty hill farmers of Bandarban have been trained on agro-forestry systems, nursery establishment and pest & disease control measures. 12 hectares bamboo plantation has been established in the farmers' field with other agro-forestry species of timber, fruits and year round vegetables. 5 nurseries at farmers' field have been established for raising seedlings of different timber, non-timber and medicinal plants. Farmers have been producing seedlings of bamboos and other plants for selling and earning extra money to improve their livelihood.

3.5 Sub-project title: Development of agro-forestry model for conversion of rice–cotton based hill farming system in the Chattogram hill tracts (ID 582)

Cotton Development Board (CDB), Dhaka had been conducting the sub-project during the period from July 2017 to September 2018 with the objectives of i) To assess the current status of jhum system, ii) To develop a model of agroforestry system to replace traditional jhum system and iii) To develop jhum farmers skill and knowledge on agroforestry system. Inter-Cropping of Rice and Cotton with Banana/Papaya have been found more profitable than Jhum crops. Banana and Papaya have been covered the fallow land after crops harvest and farmers have earned money throughout the years by selling Papaya or Banana. It seems to be better than shifting cultivation from social and environmental perspectives.

3.6 Sub-project title: Production enhancement of carps and tilapia in creeks of Chattogram hill districts (ID-833)

The sub-project was implemented by Bangladesh Fisheries Research Institute (BFRI), Mymensingh at **Rangamati and Khagrachari** for the duration of April 2017 to September 2018 with the objectives of i) To popularize fish production technology in the creeks of Chattogram hill districts, ii) To increase fish production in the Chattogram hill districts area and iii) To provide alternative livelihood to the fishers during fishing ban in Kaptai Lake. Fish production technology in the creeks has been adopted by the people of Chattogram hill districts. Targeted beneficiaries have been involved with fish culture as their alternative means of income. Growth and production have been found good. Alternate livelihood opportunity has been created due to fish culture in the fishing ban period in Kaptai Lake.



Production of carps and tilapia at creeks in CHT

3.7 Sub-project title: Characterization and documentation of minor fruits in Bangladesh with special emphasis on coastal and hilly areas (ID- 384)

Bangladesh Agricultural University (BAU), Mymensingh had been conducting the sub-project at BAU-GPC for the period of May 2017 to September 2018 with the objectives of i) To collect and conserve the important minor fruits from coastal and hilly areas of Bangladesh, ii) To characterize the physio-morphological features and nutritional status of collected minor fruits from coastal and hilly areas of Bangladesh and iii) To document the information for future use in varietal improvement also protect these local landraces from piracy. Collection and conservation of selected minor fruits from coastal and hilly areas of Bangladesh have been completed. Morphological characterization and nutritional status of all the selected minor fruits have been completed. Five Monkey jack, eight Velvetapple, four Cowa, three Riverebony and one each of Governor's plum, Lukluki and Gutguti genotypes have been identified.

3.8 Sub-project title: Studies on the species complex and their bio-rational based management of fruit flies infesting fruits and vegetables in Bangladesh (ID- 526)

Bangladesh Agricultural Research Institute (BARI), Gazipur had been conducting the sub-project at Gazipur, Jeshore, Chapainawabgonj, Rangpur, Jamalpur, Barishal and **Khagrachari** for the period from April 2017 to September 2018 with the objectives of i) Identification and documentation of species composition of fruit flies infesting fruits and vegetables using morphometric and molecular tools, ii) Development of bio-rational based management options of different fruit fly species and iii) Field validation of the developed

technologies in the farmer's field. Among the four major species group viz. *Bactroera dorsalis* (13 isolates), *B. tau* (8 isolates), *B. cucurbitae* (4 isolates), and *B. scutellata* (2 isolates); three group viz. *Bactroera dorsalis*, *B. tau* and *B. cucurbitae* have been found the most prevalent. *Ceratitis capitata*, which is popularly known as Mediterranean fruit fly (Medfly) is one of the world's most destructive fruit pest has been collected and morphologically identified from Rahmatpur, Barishal. However, through COI sequencing it has been identified as *Bactroera tau*. Sanitation + pheromone mass trapping followed by sanitation + attract & kill method has been found very much effective against cucurbit fruit fly, while sanitation + attract & kill method has been observed effectively control fruit fly complex in different fruit crops.



3.9 Sub-project title: Development of production package with special emphasis on off season flowering of dragon fruit (ID- 538)

Bangladesh Agricultural Research Institute (BARI), Gazipur had been executing the sub-project at Narsingdi, Gazipur and **Rangamati (Raikhali)** for the period from June 2017 to September 2018 with the objectives of i) To develop off season production technique of dragon fruit and ii) To standardize a production package of dragon fruit cultivation. Off-season production of dragon fruit has been made possible by manipulating the environment through artificial lighting using 100-watt incandescent bulb (normal bulb), 20-watt LED (Light Emitting Diode) bulbs or 36-watt CFL (Compact Fluorescent Lamps). Irrespective of time cutting length has been observed important for dragon fruit propagation. The longer cuttings have showed superiority over shorter cuttings. The cuttings prepared with 30 cm length have performed better followed by cuttings of 20 cm length in all the growth parameters. But considering number of propagule 20 cm length has been found suitable. Higher doses of fertilizers have been observed positive effect on plant growth and reproductive behavior compared to control (no fertilizer). 250 % of the fertilizer dose (540g N, 315g P and 250g K_2O) applied in three to four split application has been found suitable considering growth, flowering and fruiting of dragon fruit. Fruits of BARI Dragon fruit-1 have been reached physiological maturity at 28 DAA. At this stage of maturity, fruit has attained 250 g in weight in an average having light pinkish colour. Moreover, fruit has contained 12.2% TSS, 78.45 mg/100g of vitamin-C and 5.58 μ g/100g of β Carotene, which are the important quality attribute of fresh fruit. Besides, shelf life of fruits has been observed 14 days at ambient condition.

3.10 Sub-project title: Development of eco-friendly management of sucking insects of cotton (ID- 584)

The sub-project was implemented by the Cotton Development Board (CDB), Dhaka at Gazipur, Dinajpur, Jeshore, Rangpur and **Bandarban** for the period from July 2017 to September 2018 with the objectives of i) To develop suitable sucking insect-pest management practices under climate change and ii) To reduce dependency on chemical approaches. Application of Azadiractin (Bioneem plus 1% EC) @ 1 ml/ L of water) + Spinosad (Success 2.5 SC) @ 1 ml / litre of water) + Yellow sticky trap has been found effective against jassid population. Application of Azadiractin (Bioneem plus 1% EC) @1ml/litre of water) + Yellow sticky trap has been observed effective for controlling white fly population.



3.11 Sub-project title: Improvement of spices varieties cumin, sweet pepper, chilli, turmeric and black pepper through induced mutation (ID- 804)

Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh had been implementing the sub-project at Mymensingh, **Khagrachari**, Magura, Cumilla and Rangpur for the period from April 2017 to September 2018 with the objectives of i) Collection of local and exotic germplasm of cumin, sweet pepper, chilli, turmeric and black pepper, ii) Screening of the collected germplasm of these spices and irradiation of the seeds for generating mutants and iii) Selection and evaluation of desirable mutants for developing varieties with high yield potential, good aroma and flavour. Thirty three germplasm of spices have been collected. LD50 / GR50 has been estimated for Chilli: 75 – 100Gy, Capsicum: 75-105 Gy, Turmeric: 2-3 Gy, Cumin: 3-5 Gy. M₁ populations of chilli, capsicum and turmeric have been harvested. M₂ screening of turmeric has been conducted at Mymensingh, Magura and Khagrachori. Multi-location trials of promising mutants of chilli and turmeric would be conducted and evaluated for registration of variety.

3.12 Sub-project title: Effect of variety and fertilizer on cotton yield, fiber quality and seed oil content. (ID- 791)

Cotton Development Board (CDB), Dhaka had been implementing the sub-project at the five research stations of CDB located at Gazipur, Jessore, Dinajpur, Rangpur and **Bandarban** for the period from July 2017 to September 2018 with the objectives of i) To determine the NPK requirements of cotton variety CB 14, ii) To determine the NPK requirements of cotton variety CB 15 and iii) To know the effect of various rates of NPK on cotton seed oil content. The optimum NPK requirement for CB-14 and CB-15 has been found 175, 80 and 200 kg/ha respectively. N has positive correlation with fibre length, strength and fineness for both CB-14 and CB-15. P has positive correlation with fibre length but negative correlation with fibre strength and fineness for both CB-14 and CB-15. K has positive correlation with fibre length and strength but negative correlation with fineness for CB-14 while positive correlation with fibre length and fineness and negative correlation with SFI in case of CB-15.

3.13 Sub-project title: Development of shelf stable value added products from onion, garlic and ginger (ID- 728)

The sub-project was being implemented by the Bangladesh Agricultural Research Institute (BARI), Gazipur at Bogura, Lalmonirhat, Rajshahi, Pabna, Faridpur and **Khagrachari** for the duration of April 2017 to September 2018 with the objectives of i) To identify post-harvest practices and to determine the post-harvest losses of onion, garlic and ginger in farmers field, ii) To study storage stability and determine organoleptic acceptability of developed products and iii) To minimize the post- harvest losses and optimize process parameter to obtain high quality process products of onion, garlic and ginger. The traditional storage practices of onion, garlic and ginger has not been found good enough to minimize the postharvest losses. High quality shelf-stable onion, garlic and ginger products have been developed by utilizing available low cost dehydration processes and post-harvest losses of these spices have been reduced to an acceptable level. The storage stability and organoleptic acceptability of these developed products have been found satisfactory. Farmers have been interested to use these processed spices in curry.

3.14 Sub-project title: Potentials of modernization in fisheries sector of Bangladesh: Study on the peoples' profile, technologies and policies (ID-648)

The sub-project was executed by the Sylhet Agricultural University (SAU), Sylhet at Bagerhat, Bhola, Chandpur, Chattogram, Cumilla, Cox's Bazar, Dhaka, Gazipur, Jeshore, Jhenaidah, Khulna, Kurigram, Munshigonj, Mymensingh, Noakhali, Patuakhali, **Rangamati**, Sirajgonj, Sunamgonj and Sylhet for the duration of July 2017 to September 2018 with the objectives of i) To unfold the technological change and

modernization which have taken place in the fisheries sector, ii) To assess how far technological changes and modernization affected the socio-economic condition of the fisher folk as well as the sustainability of the fishery resources and iii) To assist stakeholders (government, private sector, and civil society) in designing and implementing specific policy-oriented activities to shift towards more sustainable fish production through modernization the sector. For pond farming, cooperative farming of multiple ownership pond, access to new and available technologies, soft loan facilities, training and extension services are required. For shrimp industry, practice of semi intensive farming, ensure SPF, improved hatchery, training, awareness and maintenance of bio-security and management are important. For lake fishery, overfishing, illegal gear fishing, pollution by agriculture practice should be controlled through implementing fish act and awareness and ecosystem based management. Jalmahal Policy is required for maintenance of baor fisheries productivity. Establishment of Marine Protected Areas in the coastal critical habitat and migration routes. Strict regulation and strengthening quarantine system are required for importing and use of aqua drugs and chemicals. Indiscriminate use of pesticides should be prohibited to prevent from aquatic environmental degradation in floodplain. GAP rules and regulation should be practiced in fish drying practices.

IV. Six PBRG sub-projects/Components implemented in CHT region

The PBRG program is a long-term (up to 4 years) coordinated research program following inter-disciplinary or inter-institutional approach to promote demand led, strategic, and cross cutting research issues to conduce team building holistic research culture for achieving desired output for commodities and production practices. Most importantly, coordinated PBRG program amongst NARIs will widen scopes in integrating multiple organizations for jointly combating national agricultural problems and strengthening their research and research management capability apart from effective and proper resource uses in national perspectives. PBRG programs are being coordinated involving at least two research providers: coordination can be inter-institutional or it can be interdisciplinary within the institute. NARIs, Public University and Private Research Providers were considered for PBRG program. Total of 51 Program Based Research Grant (PBRG) sub-projects with 190 components were awarded by PIU-BARC since the inception of NATP-2 covering different aspects of crop, livestock and fisheries production. Fifty one PBRG sub-projects with 190 components have been implementing by 27 institutes/organizations under five coordinating institutes/organizations to generate technologies related to crops, fisheries and livestock production along with their supply chain and marketing, etc. Out of 51 PBRG sub-projects, 6 are related to researches in CHT are briefly described below.

4.1 Sub-Project Title: Transfer of Agricultural Technologies to Farmers' level for Increasing Farm Productivity (ID 005)

The sub-project has been implementing by BARI, BINA, BSRI, BLRI, BFRI, SRDI, CDP, BJRI, BRRI, BWMRI under the coordination of Director, TTMU, BARC, Farmgate, Dhaka for the duration of May 2018 to Jun 2021 with the general objective of to transfer NARS institutes generated economically viable technologies rapidly for higher agricultural productivity and profitability with solving problems at farmers' level. The Field activity is being done in **Bandarban site** under CDB component. The **CDP** recently has generated 4 technologies: i) CB-14 variety, ii) application of mepiquat chloride iii) removal of vegetative branches and iv) De-topping at 90 DAS (Day after sowing). These four technologies have



the potentiality to increase per hectare yield. CB-14 is a disease resistant full-season variety with high yield potential (4-5 t/ha) better than existing varieties and with high fiber quality. Four sprays of Mepiquat chloride, at the rate of 1.75 ml/10 liter of water starting from 30 DAS at 15 days interval, suppress excessive plant growth and increase cotton yield (25%) over control. In the first year, field trials (Demonstration) were conducted on 08 farmers' field under 03 Zonal offices of CDB. Two field trials conducted at Thakurgoan and Khagrachari zone and 4 field trial conducted at Bandarban Zone. In the first year, results found that yield of 08 trials ranged from 575 kg (14.38 mound) per 33 decimal to 685kg (17.13 mound) per 33 decimal. Converted in ton ha⁻¹ yield ranged from 4.31 to 5.14 t/ha which was higher/ equal to Chinese hybrid varieties. In this study, CDB generated 04 technologies found more profitable and increase per hectare yield.

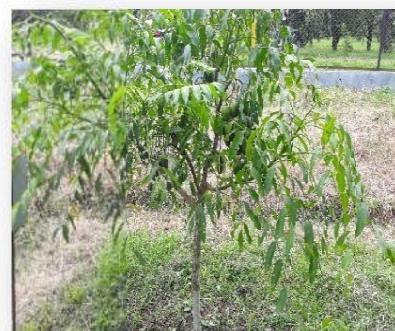
4.2 Sub-Project Title: Food-based initiative for improving household food security, income generation and minimize malnutrition (ID 011)

The sub-project has been executing by BLRI and NSTU under the coordination of Member Director (Fisheries), BARC, Farmgate, Dhaka for the period of April 2018 to March 2021 with the general objective of to identify the present socio-economic situations and livelihood pattern of the ethnic and coastal people by studying pattern and biological productivity of homestead resources (livestock and fisheries) with a view to increase food security and adequate dietary intake in terms of energy, protein, fat, vitamin and other micronutrients. Therefore, a food-based initiative to improving nutrition for household food security in Bangladesh have undertaken by the BLRI component of the sub project with a long-term goal for sustainable improvement of food and nutrition of the rural poor. The eastern hill district **Khagrachari** is comparatively less developed area due to natural position and agro-ecosystem, low level of management in agriculture, migratory nature of people and distance form headquarters of development agents. The technological interventions made: distribution of goats, sheep, winter vegetables seeds and saplings, different seasonal vegetables (capsicum, broccoli, potato, sweet potato, yard long bean, sweet gourds etc.), year round creeper vegetables (cucumber, bitter gourd, bottle gourd etc.), and fruit orchards for year round fruit production (papaya, lemon, malta, dragon) to the selected household.



4.3 Sub-Project Title: Development of lean season fruit varieties and management packages (013)

The sub-project has been being implementing by Pomology, Pathology and Entomology Divisions of BARI under the coordination of Chief Scientific Officer, Pomology Division, HRC BARI, Gazipur-1701 for the duration of June 2018 to May 2021 with the general objective of the development of lean season, high yielding and good quality fruit varieties and management technologies including insects and diseases to Improve income and livelihood of the people. The project is being implemented by Pomology Division, Horticulture Research Centre, BARI, Gazipur; Breeder Seed Production Centre, Debiganj, Phanchagarh; **Hill Agriculture Research Station, Raikhali, Rangamati**



and Regional Agricultural Research Station, Rahmatpur, Barishal. Collection, characterization and evaluation of the promising lean seasoned fruit germplasm has been started at all the project locations under BARI. At Hill Agriculture Research Station, Raikhali; 3 germplasm of bullock's heart, 2 of pear and 1 each of ber, pummelo, pear, strawberry, avocado and mango were collected and planted in the research field.

4.4 Project Title: Adaptation and Scaling up Agroforestry for Livelihood Improvement of farmers in Agricultural Ecosystem of Bangladesh (ID 049)

The sub-project has been being implementing by OFRD, BARI, Gazipur; OFRD, Pabna; OFRD, Rajshahi; OFRD, Rangpur; OFRD, Patuakhali; **OFRD, Bandarban** under the coordination of Chief Scientific Officer, On-Farm Research Division, BARI, Gazipur for the duration of December 2017 to June 2021 with general objective of the farmers livelihood improvement and ensuring food security through adoption of innovative agro-forestry technologies. In hill ecosystem, agroforestry (contour hedged grows) on steep hill slopes (40-50%) can reduce soil erosion by 55-80% and runoff by 30-70% compared to shifting cultivation (Khisa, 2001). Different agro-forestry systems are being conducted under study. Guava based systems is conducted at FSRD site, Gongarampur, Pabna; Litchi based system at FSRD site Ojoddapur, Rangpur Sadar, Rangpur and Mango based agro-forestry system at FSRD site Bashantapur, Godagari, Rajshahi. However, implementation of agroforestry system are in progress in OFRD, Patuakhali and OFRD, Bandarban.

4.5 Project Title: Exploration, Identification, Characterization, Multiplication and Ex-situ Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh (074)

The sub-project has been executing by BAU, BFRI, and University of Chattogram under the coordination of Member Director (NRM), Forest Unit, BARC, Farmgate, Dhaka for the period of June 2018 to June 2021 with the general objective of the collection, identification and characterization of forest genetic resource and medicinal plants of Bangladesh and

Documentation of the status, scope and *Ex-situ* conservation of the selected Forest Genetic Resources (FGR) including ethno-medicinal plant in Bangladesh. The biodiversity of the forest has been heavily degraded during last few decades due to rapid population growth, energy deficit, over exploitation, poor management and lack of motivation on the needs of biodiversity conservation. But, identification of various important components of biodiversity through systematic and scientific approach is still inadequate in Bangladesh. Bangladesh is an immense reservoir



of medicinal plant resources particularly in the biodiversity rich areas in the Chittagong Hill Tracts (CHTs). Herbal medicine has been widely and effectively used for the remedy of various diseases in the region by the tribal people over generations. Thus this valuable indigenous wealth of the plant species for medicinal values including knowledge of their uses in the CHTs need to be explore, identify and measures for their conservation. The present sub-project has been designed to consider the above facts and to document the selected Forest Genetic Resources (FGR) including ethno-medicinal plant in Bangladesh. The field survey were done in the natural remnant forests of Chattogram, Cox's Bazar, and Tangail for identification the status of threatened tree species in these forests. Fruit/seed of 25 tree species were collected for recording

of phenological characteristics and transferred to the conservation stands at CU campus. 25-36 seedlings each species were planted in the pre-selected site after clearing, burning and proper soil work. The species planted in the conservation stand are shown in table 1 where about 25 threatened tree species (25-36 seedlings for each species) were established in the University campus. The stands shall conserve the threatened tree species and shall be the source of fruits/seeds for future regeneration programs.

Table 1: Seedlings of the species planted in the Conservation Stand

No.	Vernacular name	Botanical Name	Planted seedlings	Average ht. (cm)
1	Baruna	<i>Crataeva magna</i>	36	44.2
2	Batna	<i>Lithocarpus acuminata</i>	36	60.8
3	Bhela	<i>Semecarpus anacardium</i>	25	22.2
4	Bhutum	<i>Hymenodictyon orixensis</i>	36	15.2
5	Boilam	<i>Anisoptera scaphula</i>	36	54.5
6	Bon-amra	<i>Spondias pinnata</i>	36	42.4
7	Chikrassi	<i>Chukrasia tabularis</i>	36	33.8
8	Civit	<i>Swintonia floribunda</i>	36	73.2
9	Dharmara	<i>Stereospermum personatum</i>	36	29.5
10	Elena	<i>Antidesma ghaesambilla</i>	36	49.9
11	Euveria	<i>Uvaria hirsuta</i>	36	30.4
12	Faisa udal, Mula Udal	<i>Firmiana colorata</i>	36	40.0
13	Haritaki	<i>Terminalia chebula</i>	36	39.1
14	Jalpai	<i>Elaeocarpus floribundus</i>	36	40.7
15	Jamalgota	<i>Croton tiglium</i>	36	48.8
16	Kala-huja	<i>Ehretia serrata</i>	36	74.7
17	Kanaidinga	<i>Oroxylum indicum</i>	36	52.5
18	Kechhra bhadi	<i>Engelhardtia spicata</i>	36	45.2
19	Latkon	<i>Baccaurea ramiflora</i>	36	42.3
20	Ormosia	<i>Ormosia robusta</i>	36	17.2
21	Paduak	<i>Pterocarpus indicus</i>	36	31.9
22	Pitali pitagola	<i>Trewia nudiflora</i>	36	102.0
23	Raktachandan	<i>Adenanthera pavonina</i>	36	22.8
24	Sada Garjan	<i>Dipterocarpus alatus</i>	36	78.5
25	Sonalu	<i>Cassia fistula</i>	36	31.2
Total seedlings planted			889	

4.6 Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources (ID 128)

The sub-project has been implementing by BARI, BRRI, BJRI, BSRI, BINA, CDB, BSRTI and BAU under the coordination of Member Director (Crops), BARC, Farmgate, Dhaka for the duration of January 2018 to December 2020 with the general objective of collection, characterization and documentation of plant genetic resources including released varieties and GI crops of Bangladesh for establishing their intellectual property rights (IPR). Nationally, proper documentation of genetic resources particularly GI crops is very important in respect of IPR issues. Therefore, the GI crops, released varieties and landraces need to be characterized continuously. Genetic diversity is in danger of being lost due to natural calamities, habitat loss, unplanned urbanization, industrialization, human population pressure, deforestation, etc. Considering the

present situation and future need, Bangladesh should address the importance of plant genetic resources management and immediately undertaking program on collection, characterization and conservation. To address the issue 08 NARIs are involved in carryout the present research sub-project. Collection, characterization, conservation and documentation of popularly grown crops with a view to establish IPR (Intellectual Property Right) is being done under the sub-project. BRRI collected 103 landraces of rice from 07 Upazilas of Bandarban. BAU completed morphological characterization of 62 indigenous germplasm of banana, 30 yam and 30 aroids. The table 1 is shown the progress of germplasm collection of different crops by participating research institutes.



Table 2: Collection of germplasm by the participating research institutes

NARIs	Target (#)	Achievement (#)	Crop coverage
BARI	200	200	Pumpkin, cucumber, brinjal etc.
BRRI	70	166	Rice
BJRI	30	27	Jute
BSRI	25	18	Sugarcane
BINA	50	48	Rice, chilli, bitter gourd, peanut, brinjal, black gram and turmeric
CDB	120	117	Cotton
BSRTI	45	45	Mulberry
BAU	30	30	Banana, yam and aroids

IV. Conclusion

Production potentials, constraints and mitigation measures have been identified and accordingly sustainable land use system on hill farming for optimizing yield of food, fodder, timber, fuel-wood, bamboo, cane, medicinal plants, etc have been introduced to develop sustainable hill farming practices in the CHT region. Training, motivation, support and extension services of different government and non-government organizations might raise the awareness about modern agricultural technologies for increasing the agricultural production as well as improving their livelihood. The information/technologies generated through these sub-projects should be disseminated to extension components of the project for the livelihood improvement of farmers through increasing crop, livestock and fisheries production in the hilly region.