

Sub-Project ID-074

Program Based Research Grant (PBRG)

# Sub-project Completion Report on

Exploration, Identification, Characterization, Multiplication  
and Ex-situ Conservation of Endangered Forest Genetic  
Resources including Medicinal plants of Bangladesh



Project Implementation Unit  
National Agricultural Technology Program-Phase II Project  
Bangladesh Agricultural Research Council

Farmgate, Dhaka-1215

April 2022

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#### Implementing Organization



**Coordination  
Component:**

Forestry Unit, NRM Division, Bangladesh Agricultural Research Council, Farmgate, Dhaka



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Institute of Forestry and Environmental Sciences in University of Chittagong-4331



Project Implementation Unit  
National Agricultural Technology Program-Phase II Project  
Bangladesh Agricultural Research Council  
Farmgate, Dhaka-1215

April 2022

**Citation:**

Saifullah, M., Jewel, K.N.A., Yusuf, M., Rahman, M.H., Rahim, M.A., Alam, M.A., Haider, M.R., Alam, M.S., and Rahman M.M., Hossain, M.K. and Miah, M.D. 2022. Exploration, Identification, Characterization, Multiplication and *Ex-situ* Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh, Sub-Project Completion Report, Forestry Unit, NRM Division, BARC. pp: 1-207.

**Edited by:**

Project Implementation Unit  
National Agricultural Technology Program-Phase II Project (NATP-2)  
Bangladesh Agricultural Research Council (BARC)  
New Airport Road, Farmgate, Dhaka – 1215  
Bangladesh

***Acknowledgement***

The execution of PBRG sub-project has successfully been completed by the Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh, Minor Forest Products Division, Bangladesh Forest Research Institute Sholoshahar, Chittagong and Institute of Forestry and Environmental Sciences in University of Chittagong using the research fund of WB, IFAD and GoB through Ministry of Agriculture. We would like to acknowledge to the World Bank for arranging the research fund and supervising the PBRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP-2 in respect of field implementation of the sub-project in multiple sites. Preparing the sub-project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who have made it possible, deserve appreciation. Our thanks are due to the Director PIU-BARC, NATP-2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

**Published in: April 2022****Printed by:**

College Gate Binding & Printing  
1/7 College Gate, Mohammadpur, Dhaka.

## **Abbreviation and Acronyms**

BARC	: Bangladesh Agricultural Research Council
BAU-GPC	: Bangladesh Agricultural University Germplasm Center
BBS	: Bangladesh Bureau of Statistics
BDNP	: Baryadhala National Park
BFRI	: Bangladesh Forest Research Institute
BGCI	: Botanic Gardens Conservation International
BNH	: Bangladesh National Herbarium
CBD	: Convention on Biological Diversity
CHTs	: Chittagong Hill Tracts
Co-PI	: Co-Principal Investigator
CU	: Chittagong University, Chattogram
FAO	: Food and Agriculture Organization of the United Nations
FGD	: Focus Group Discussion
FGR	: Forest Genetic Resources
HNP	: Himchari National Park
IDA	: International Development Association
IFAD	: International Fund for Agricultural Development
IFESCU	: Institute of Forestry and Environmental Sciences, Chittagong University
IPGRI	: International Plant Genetic Resources Institute
IUCN	: International Union for Conservation of Nature and Natural Resources
KNP	: Kaptai National Park
LoA	: Letter of Agreement
M&E	: Monitoring and Evaluation
MD	: Member Director
MFPD	: Minor Forest Products Division
MNP	: Madhupur National Park
MoA	: Ministry of Agriculture
NARS	: National Agricultural Research System
NATP	: National Agricultural Technology Programme
NGO	: Non-Government Organization
NRM	: Natural Resource Management
PAs	: Protected Areas
PBRG	: Program Based Research Grant
PCR	: Project Completion Report

PGR	: Plant Genetic Resources
PI	: Principal Investigator
PIU	: Project Implementation Unit
REDD+	: Reducing Emissions from Deforestation and Forest Degradation
RFC	: Relative Frequency of Citation
RH	: Rhizome
SDGs	: Sustainable Development Goals
SoE	: Statement of Expenditure
TU	: Tuber
USAID	: United States Agency for International Development
UV	: Use Value
WB	: World Bank
WHO	: World Health Organization
WP	: Whole Plant
WWF	: World Wildlife Fund

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## Executive Summary

Prevailing immense importance of traditional plants in developing countries in respect of overharvesting and loss of habitats threatening availability of forest genetic resources has prompted to undertake a study to explore, identify characterize, multiply. and ex-situ conservation of endangered forest genetic resources. The research activities are carried out by Department of Horticulture, Bangladesh Agricultural University, Mymensingh (Component-1), Minor Forest Product Division (MFPD), Bangladesh Forest Research Institute, Chattogram (Component- 2) and Institute of Forestry and Environmental Sciences, University of Chittagong, Chattogram (Component-3) in coordination with Forest Unit, Natural Resources and Management Division, Bangladesh Agricultural Research Council (BARC). As a coordinating body BARC constantly monitored and evaluated the sub-project activities through meetings, workshops, spot visits, correspondence and report compilations. Organizing workshops, desk as well as field monitoring tools have been employed in evaluating the sub-project activities. The research found, a total of 783 species were collected and conserved, and 501 species were characterized and documented by the all components.

The Component-1 had undertaken base line survey and focus group discussion (FGD) to explore, identify and collect medicinal plants from the selected five districts, *i.e.*, Natore, Tangail, Jamalpur, Sherpur and Mymensingh during July 2018 to June 2019. Multiplication and *Ex-situ* conservation were done in the BAU-GPC, Mymensingh. In total 10 FGD were conducted from the surveyed areas. The highest number of medicinal plants were recorded from Modhupur (71) followed by Natore (57), Mymensingh (23), Sherpur (17) and the lowest from Jamalpur (9). In Natore, Aloe vera (150ha), Shimul (100ha) and Ashogandha (20ha) are cultivated commercially. During the sub-project period 126 different saplings/seeds/seedlings of medicinal plant were collected. All the collected medicinal plants were planted at BAU-GPC using appropriate design for *Ex-situ* conservation. Morphological characterization of 108 medicinal plants on growth habit, plant height, growth performance, canopy spreading, leaf shape, size, color of leaf, *etc.*, were also done. Molecular characterization of three medicinal plants, *e.g.*, *T. chebula*, *T. ballirica*. and *T. arjuna* were conducted. The primers OPA02 and OPA18 produced clear and reproducible polymorphic fragments in all five germplasm of *T. chebula* collected from five districts. In total 11 amplified bands with 6 (six) monomorphic and 5 (five) polymorphic bands were scored. In *T. chebula* propagation, the fastest germination, the highest germination percentage (85.25%), survival percentage (85.21%), leaf number (51.38), leaf area (34.99 cm<sup>2</sup>) and total length (52.33 cm) of the seedlings were found when the seed were soaked in cowdung slurry for 6 (six) days. The above parameters were found superior when the seed were being soaked after 10 days of fruit collection. In *T. arjuna* the fastest germination, the highest germination percentage, survival percentage, leaf number, leaf area and total length of the seedlings were found in larger fruits soaked in cow dung slurry for 36 hrs. Multiplications of some other medicinal plants like *Vitex negundo* (nishinda), *Justicia adhatoda* (bashak), *Withania somnifera* (ashwagandha), *Codariocalyx motorius* (torupchonda), *Ocimum tenuiflorum* (tulsi), *Cissus quadrangularis* (harzora), *Bryophyllum pinnatum* (pathorkuchi), and *Aloe barbadensis* (aole vera) were done. Trial plot at Natore with 37 different medicinal plants species was setup. Two day long trainings for motivation and awareness on the importance and cultivation of medicinal plant were conducted at BAU-GPC in 2019 and 2020 with 30 participants in each batch from the selected districts. Among the participants 53 were male and seven were female. One hundred fifty seedlings/saplings of medicinal plants were distributed among the participants. *Aloe barbadensis*, *Terminalia chebula*, *Terminalia bellirica*, *Justicia adhatoda*, *Vitex negundo*, *Andrographis paniculata*, *Bryophyllum pinnatum* and *Ocimum tenuiflorum* were distributed among the participants.

Component-2 has conducted the studies in three hill districts, namely, Bandarban, Khagrachari and Rangamati. Out of 26 Upazilla in CHT's 12 Upazilla (four Upazilla from each district) were selected purposively based on the communication and socio-political situation of CHT. Exploration of ethnomedicinal plant species were conducted through group discussion and individual interviews of selected 60 herbal practitioners (locally called *Boiddays*), with five *Boiddays* from each Upazilla. Ethnomedicinal information was recorded using the standard method and a structured questionnaire. Collection and processing of ethnomedicinal plant specimens were done through standard procedure and

identified and compared with the help of expert plant taxonomist, with the specimens in the Herbarium of BFRI and BNH and pertinent literature. Propagules (seeds, cutting and rhizomes) of potential ethnomedicinal plants were collected during field visits and conserved at Germplasm center of MFPD, BFRI following standard procedure of PGR. Recolonization of threatened ethnomedicinal plant species was completed by establishing two medicinal plants garden at Bandarban and Rangamati. Use Value (*UV*) and Relative Frequency of Citation (RFC) were also determined. Analysis of collected information was carried out through Microsoft Excel Software. The informations regarding the ethnomedicinal plants and their uses were collected from 60 herbal practitioners of the study area. Furthermore, most of the informants have no formal educations except one or two have got the opportunity to attend elementary school. Among the informants or herbal practitioners 22 belongs to Chakma tribe, followed by Marma (19), Tripura (10), Tonchongya (7) and Khumi (2). During the study 561 plant samples were collected. Out of them, 266 (47.42%) plant samples were common among herbal practitioners for their use. The study reveals that a total of 300 plant species belongs to 97 families and 228 genera used for the treatment of 139 diseases. The herbal practitioners of CHT's described 10 different plant parts used in the treatment of different diseases. Leaves were the most dominant plant parts (43%), followed by whole plants (20%), roots (13%), stems (7%), rhizome and bark (5%), tuber and seeds (1%) used as medicinal plants parts. Almost 65% of ethnomedicines are administered orally, and herbal medicines are given in seven different forms. The most common form was found juice followed by eating fresh, paste, decoction, powder and poultice. Vegetative parts or propagules of 64 ethnomedicinal plant species were collected and conserved at germplasm center of BFRI. Eight thousand seedlings of 13 priority ethnomedicinal plant species were raised in the nursery and distributed among herbal practitioners of the study area and two medicinal gardens established in Bandarban and Rangamati. The study reveals that ethnobotanical indices, Use Value (*UV*) ranged from 0.18- 0.88 and RFC varied from 0.02 to 0.38 for collected plant species. Out of 300 ethnomedicinal plant species, 33 plants were identified with *UV* greater than 0.65. The ethnomedicinal plant species with higher RFC value indicate the fact that these plant species are well known to the most of the herbal practitioner.

Component-3 has carried out field survey in the natural remnant forests of CHT, Chattogram, Cox's Bazar, and Tangail for identifying the status of threatened tree species. Fruits/seeds of 90 tree species, were collected and recorded phenological characteristics. Detailed seed biology experiments of 27 tree species were established in the propagator house, polypots, seedbed, and in seed germination trays. Seedlings of 90 tree species were planted in the Conservation stand of CU campus. Survival percentage and height (cm) measurement was taken when the plantations are 30 months (43 species), 18 months (35 species) and 6 months old (12 species), respectively. A total of 3,169 seedlings were planted in 2019 (1586 seedlings), in 2020 (1288 seedlings) and 295 seedlings were planted in 2021. Survival percentage of 30 months old seedlings (1586 seedlings of 43 tree species) varied from 83-100%. The 18 months' seedlings showed the same survival percentage (83-100%) except the species *Caryota urens* which showed only 10% survival percentage. In 2021, 295 seedlings of 12 species revealed 100% survivability. At the age of 30 months, *Trewia nudiflora* (Pitali) attained the maximum height (591 cm) followed by Paduk (540 cm), Chikrasi (482 cm), Jamal gota (451 cm). Ten species attained height (cm) more than 400 cm, seven species more than 300 cm. The low height was recorded in Mirian (28 cm), followed by Modonmosta (72 cm), Bhuiya gach (73 cm) and Bon naranga (78 cm). Chundul attained maximum height (418 cm) at the age of 18 months followed by Kainjal bhadi (390 cm), Dumur (369 cm) and Bon litchi (320 cm). The lowest height was found for Chaogota (23 cm) followed by Lomba tasbi (32 cm), Dewa (35 cm) and Barpata (44 cm). Seedlings of 12 species at the age of 6 months old showed that Chesra koroï attained maximum height (109 cm) followed by Puti jam (75 cm), whereas the lowest height was recorded in Hargeza (25 cm), Moos (34 cm) and Gutu jam (38 cm). The growth performance may be attributed by slow growing nature of species along with the edaphic and climatic variations prevailing in the to the sites. In addition, about 8,200 seedlings were distributed to different organizations for *Ex-situ* conservation program. Vegetative propagation of six tree species was also studied in the hedgebed and propagator house to assess the rooting potentiality.

**Keywords:** Forest Genetics Resources, Threatened Tree, *Ex-situ* Conservation, Deforestation, Medicinal Plants, Ethnomedicinal plants, germplasm conservation and characterization.

# PBRG Sub-Project Completion Report (PCR)

## A. Sub-project Description

1. **PBRG Sub-project Title:** Exploration, Identification, Characterization, Multiplication and *Ex-situ* Conservation of Endangered Forest Genetic Resources including Medicinal Plants of Bangladesh

### 2. Implementing Organization(s)

Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202; Minor Forest Products Division, Bangladesh Forest Research Institute, Chattogram, and Institute of Forestry and Environmental Sciences, University of Chittagong, Chattogram

**Cordination Component:** Forest Unit, NRM Division, Bangladesh Agricultural Research Council, Farmgate, Dhaka

### 3. Name and full address with phone, cell and E-mail of Coordinator, Associate Coordinator, PI/Co-PI (s)

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#### Principal investigator(s)

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## 4. Sub-project budget (Tk)

- 4.1. Total approved Budget : Tk. 2,71,61,506.00
- 4.2. Latest Revised (Tk) : Tk. 2,71,61,506.00

## 5. Duration of the sub-project

- 5.1 Start date (based on LoA signed): 10 June 2018
- 5.2 End date : 31 May 2022

## 6. Background of the sub-project

The natural forest of Bangladesh comprising various herbs, shrubs and trees is supporting a number of algae, lichens, mosses, ferns, orchids, parasites, climbers, insects, birds and wildlife, constituting an excellent ecosystem habitat good for maintaining a sustainable environment and livelihood of inhabitants dwelling therein. But the biodiversity of the forest ecosystem has been eroding due to rapid population growth, energy deficit, over exploitation, poor management and lack of motivational efforts for management of forest ecosystem. Rapid loss and degradation of natural forest genetic resources has brought depletion at an alarming rate beyond expectation, requiring their conserving endeavors, as being unique and irreparable resources. Unfortunately, very limited activities are being carried out on their conservation and related efforts like exploration, identification, collection of propagules from remnant natural forests and develop propagation techniques for multiplication and ex-situ conservation. As such an initiative titled 'Exploration, Identification, Characterization, Multiplication and ex-situ Conservation of Endangered Forest Genetic Resources Including Medicinal Plant' has been undertaken as a coordinated sub-project.

According to Sarasan *et al.* (2006), International Union for Conservation of Nature and Natural Resources (IUCN) were recorded 8321 plant species in the Red List of Threatened Species during 1996-2004. During the period they noted that the number of plants recorded as 'Critically Endangered' is increased by over 60%. International Union for Conservation of Nature (IUCN) and the World Wildlife Fund (WWF) estimated that up to 60,000 higher

plant species could become extinct or nearly extinct by 2050, if current trend of utilization continues (Etkin, 1998; Kumar et. al, 2011). On the other hand, medicinal plants are valuable gift of nature constituting an important component of Forest Genetic Resources (FGRs). As per World Health Organization (WHO, 2003) estimates, nearly 80% of the population of the developing countries depend on traditional medicines, mostly on plant drugs, for their primary health care needs. About 20,000 plant species are used as medicine in the third world countries. These are containing large number of secondary metabolites and essential oils of traditional and therapeutic importance (Ghani, 1998). Medicinal plants are the important component of plant diversity of Chattogram Hill Tracts (CHT) comprising three hill districts, namely, Rangamati, Bandarban and Khagrachari, which are being used by the 11 tribal population dwelling over there for treating various diseases over generations. Therefore, these valuable indigenous plants with medicinal importance along with their traditional knowledge are to be identified, explored and measured for conservation.

Database regarding the quantitative biodiversity in Bangladesh is poor and often based on scarce information. One of the essential elements of the Convention of Biological Diversity (CBD) is a government commitment to survey their natural living resources, both domesticated and wild to conserve noted sites for their biological diversity as well as threatened species and domesticated varieties. But effort on identification of various important component of biodiversity through scientific approach is not adequate. Thus, it becomes important to explore the status of the endangered species for both in situ and ex situ conservation programs. Efforts on exploration, identification, collection of propagules from remnant natural forest and development of propagation techniques for multiplication and *Ex-situ* conservation are urgently required, considering significance of conserving rare FGRs from natural forests. Such efforts after implementation are assumed to have multiple effects on conservations through sustainable management of forest resources along with suitable propagation techniques over years. Furthermore, threatened species including medicinal plants are available in abundance entailing sustenance opportunities of traditional, experiences and livelihood of future generations, in addition, reducing chances of full extinction. In these context an initiative titled 'Exploration, Identification, Characterization, Multiplication and ex situ Conservation of Endangered Forest Genetic Resources including Medicinal Plants' was executed as an coordinated approach with Bangladesh Agricultural Research Council as coordinating organization and three implementing organizations viz. Department of Horticulture, Bangladesh Agricultural University, Mymensingh (Component-1), Bangladesh Forest Research Institute (Component-2) and University of Chittagong (Component-3) in coordination of Bangladesh Agricultural Research Council (BARC) with funding support from PIU, BARC, NATP-2.

## **7. Sub-project general objective(s)**

- a) Collection, identification and characterization of forest genetic resources and medicinal plants of Bangladesh
- b) Documentation of the status, scope and *Ex-situ* conservation of the selected Forest Genetic Resources (FGRs) including ethno-medicinal plant in Bangladesh.

## **8. Sub-project specific objective(s)**

- 8.1. Coordination Component (BARC)
  - Coordinate, backstop, monitor and evaluate the activities of the participating organizations.
- 8.2. Component-1 (BAU)
  - Conduct survey on medicinal plant status and scope in Bangladesh

- Collection, conservation documentation and conservation of medicinal plants for varietal development and protection from piracy
  - Explore the factors that motivate the farmers in cultivating medicinal plants and conduct adaptability trial at farmers field in selected locations of Natore and Mymensingh.
- 8.3. Component-2 (BFRI)
- Collection, identification and characterization of medicinal plants in Chattogram and Chattogram Hill Tracts (Khagrachari, Rangamati and Bandarban hill districts)
  - Collection of the specimen/fruits/seeds/vegetative propagules, multiplication and germplasm conservation of medicinal plants at BFRI campus and at suitable field stations at Khagrachari and Bandarban hill districts.
- 8.4. Component-3 (IFESCU)
- Utilization and exploration of endangered Forest Genetic Resources (FGRs) in different natural forests.
  - Determining the phenology (leaf-fall, flowering, fruiting and fruit maturity) of the selected FGR in different test areas;
  - Studies on the seed biology, development and standardization of propagation techniques of the selected FGRs and
  - Establishment of “Conservation Centre” with at least 100 individuals of each species at Chittagong University campus, Chattogram for ensuring future seed sources.

## 9. Implementing location(s)

- 9.1. **Component-1 (BAU):** Bangladesh Agricultural University Germplasm Center (BAU-GPC), Mymensingh, Tangail and Natore District.
- 9.2. **Component-2 (BFRI):** Chattogram and Chattogram Hill Tracts (Khagrachari, Rangamati and Bandarban hill districts).
- 9.3. **Component-3 (IFESCU):** Threatened forest genetic resources are explored in the natural forests of Tangail (Madhupur National Park), Chattogram (Hazarikhil Wildlife Sanctuary and Bariyadhala National Park), Ukhiya and Bamu Reserved forest, Kaptai National Park (Rangamati) and Srimai forest of Chattogram South Forest Division and forests of Cox’s Bazar were explored for assessing the status of the FGRs (native and naturalized tree species). Fruits and seeds were collected, sorted, studied and processed for seedling raising in Seed Research laboratory, Nursery, Propagator House and finally establish the seedlings in the Chittagong University campus.

## 10. Methodology in brief (with appropriate pictures)

The methodology followed to implement the sub-project are as follows:

### 10.1 Coordination Component: (BARC)

#### Services of BARC existing staff, Consultant and sub-project’s new staff

The whole process of recruitment of the project staff has been followed by the recruitment policy. Accordingly, on 03 July 2018 one Senior Scientific Officer joined and assisted the project coordinator in methodical implementation. The Consultant also recruited and joined on 10 February 2019.

## Inception workshop

A day long inception workshop has been organized by the Coordination Component (BARC) on 05 November 2018 at the training building of BARC under the sub-project (Fig. 1). The objectives of the inception workshop were (a) Familiarization on the project work plan, and (b) accomplish the mandate/obligation of PIU-BARC, NATP-2 for further fund disbursement.



**Fig. 1.** The Chief guest Dr. Md. Kabir Ikramul Haque, Executive Chairman, BARC delivered his speech at inception workshop

Forty-two scientist/academia from different six organizations/universities namely BARC, BAU, IFESCU, BARI, NATP and SAC attended the inception workshop. On the basis of experts' comments/recommendations, some activities were revised as mentioned in the inception report. The participating organizations formulated the specific information in quantitative terms in regard to their intervention. The information gave the base lines in assessing the changes that were achieved on completion of the project.

## Annual Review Workshops

A day long 1<sup>st</sup> year annual review workshop has been organized on 02 September 2019 at the training building of BARC. The objectives of the workshop were (a) exploring the 1<sup>st</sup> year activities of the project, (b) Familiarization with the project work plan, and (c) accomplish the mandate/obligation of PIU-BARC, NATP-2 for further fund disbursement (Fig. 2).



**Fig. 2.** Coordinator and Associate Coordinator delivering their speech at 1<sup>st</sup> Year Annual Review Workshop

The 2<sup>nd</sup> year annual day long review workshop has been organized on 17 September 2020 at the Auditorium (2<sup>nd</sup> floor) of BARC. The objectives of the workshop were (a) exploring the 1<sup>st</sup> year activities of the project, (b) Familiarization with the project work plan for the

next year, and (c) accomplish the mandate/obligation of PIU-BARC, NATP-2 for further fund disbursement (Fig. 3).



**Fig. 3.** Coordinator delivering their speech at 2<sup>nd</sup> Annual Workshop

### **Attended on Annual Review Workshop organized by PIU-BARC, NATP**

Presented the 1<sup>st</sup> year annual progress report by the coordinating component-BARC and the participating organizations (BAU-Horticulture, BFRI, and IFESCU) in 17 November 2019 during the Annual Review Workshop organized by PIU-BARC, NATP-II (Fig. 4).



**Fig. 4.** Director PIU-BARC, NATP-2 delivering his Speech at Annual Review Workshop

### **Reporting**

The sub-project implementing organizations have prepared monthly SoEs, half-yearly reports, annual reports and baseline survey report. The coordinating component of BARC compiled these reports (half-yearly and annual) after editing. Fund has been disbursed by the authority on the basis of satisfactory reports.

### **Compilation and submission of half yearly and annual reports**

The participating organizations have prepared their half yearly reports as well as annual reports and send to the coordination component for evaluation and compilation. BARC evaluated their performance individually on the basis of the satisfactory research activities. The compiled 1<sup>st</sup> year and 2<sup>nd</sup> year Half Yearly report was submitted to Director, NATP-II on 04 April 2019 and 19 July 2020, respectively. The compiled 1<sup>st</sup> year and 2<sup>nd</sup> year annual reports were submitted to Director, NATP-II on 09 October 2019 and 21 September 2020, respectively.

### **Training**

A two-day long training on “Medicinal and Aromatic plants in Bangladesh” held at the training building of BARC during 26-27 January 2020 of the sub-project funded by the

NATP Phase-II and implemented by the Coordination component, BARC. Ten different contemporary lectures were delivered by various experts. Thirty participants attended the training program. They are highly encouraged and motivated after receiving training. Certificates were distributed among participants at the end of the training (Fig. 5).



**Fig. 5.** Speech delivered by the chair and certificate distribution among participants by the organizer

### Monitoring and evaluation of intervening activities

The BARC staff and project personnel constantly monitored and evaluated the activities of the sub projects through desk monitoring and/or the reports from the participating organizations. BARC is giving advisory services to the participating organizations, as and when needed. Consequently, BFRI and IFESCU implemented areas (Chottagram, and Rangamati) were visited by Dr. Sultan Ahmmad, Member Director (NRM) and Coordinator, and Kazi Noor-E-Alam Jewel, Senior Scientific Officer, PBRG sub project ID 074 in 02 and 03 February 2019. Fifteen local traditional herbal medical practitioners (*Boddy*) form Rangamati Sadar, Kawkhali and Kaptai Upazilla were present and took part in discussion regarding the plants and the effective part of plants they usually used for treatment.



**Fig. 6.** Discussion meeting with the farmers/stakeholders of Rangamati

The scientist from BFRI discussed about how the plants part be upkept scientifically. After the meeting the team went to collect specimens from different places of Rangamati district.

In the next day the team visited the chamber of Romoni Mohon Chakma the beneficiaries of the project at Vadvadi in Rangamati.



**Fig. 7.** Visited team involved in specimens collection from different places at Rangamati

There the stakeholders came with the specimen of medicinal plants. The monitoring team found the BFRI activities very satisfactory and encouraging.



**Fig. 8.** Collection of medicinal plants specimen

After completion of monitoring activities at Rangamati, the team moved to IFESCU, Chottogram and discussed with PI of the sub-project about the research activities.



**Fig. 9a.** Discussion meeting with PI

**Fig. 9b.** Propagation Chamber of IFESCU

Then the team visited newly established Propagation Chamber financed by the sub-project of NATP-2. Later on visited the seed Research Laboratory of the institute. The research activities found inspiring and running smoothly.



**Fig. 10.** Seed Research Laboratory of IFESCU

The Coordinator and associate coordinator visited BAU, Mymensingh on 12-13 February 2019 to monitor the progress of sub-project activities and discuss on the preparation of baseline survey report. They also visited the Germplasm Centre of BAU. The research activities and progress were found satisfactory.



**Fig. 11.** Visit at GPC, BAU, Mymensingh

- **Coordination meetings**

A Coordination meeting held at the chamber of Associate Coordinator on 18 November 2019 to share and coordinate projects' plans for upcoming fund release. They discussed cross-project collaborations development and its impact as a whole. The coordinator clarified the members about their roles and responsibilities. Assistant Coordinator remind member components to concentrate their research activities with the objective of the project (Fig. 12).



**Fig. 12.** A coordination meeting held with PIs at Associate coordinator's room

Through the mechanism of coordination, all organizations have the opportunity to identify the needs of the emergency and to participate in an organized strategic planning process.

Another coordination meeting was held on 14 July 2020. The project coordinator, Dr. Sultan Ahmmmed welcomed all the participants namely Associate Coordinator, Consultant, PIs, Co-PIs and SSO of the project to join this meeting through Zoom Video Conference due to COVID-19 pandemic situation. After exchange greetings, the project coordinator, requested the individual participants of each component to present progress report of their project (Fig. 13).



**Fig. 13.** A coordination meeting on Zoom held with PIs and Co-PIs of the sub-project

PIs and other project personnel committed to continue project activity as per work plan and complete project activities as much as possible under this situation within the project period. As there was no other issue to discuss, the chairperson ended the meeting at 02.15 pm giving thanks to the participants for their cooperation.

- ***Procurement of capital items***

Procurement plan was submitted in 30 October 2018 to the Director, NATP and approved on 29 November 2018. RFQ process was followed for procurement of capital items. Procurement of Goods was segmented as GD<sub>1</sub>. GD<sub>1</sub> consisted computer and accessories, e.g., Laptop Computer (1), Tabloid (1), Desktop Computer (2), Digital Camera (1). Total cost of purchase was Tk. 2,28,800/-, and was completed following PPR 2013.

- ***Video documentation***

Combined video document titled ‘Germplasm Conservation of Medicinal Plants and Trees’ (ঔষধী উদ্ভিদ ও বৃক্ষের কৌলীসম্পদ সংরক্ষণ) was prepared by the coordination component. The script and direction of video documentary was prepared by Mr. Kazi Noor-E-Alam Jewel. The technical support was given by Mr. Ahmed Mafuz Moin, Consultant Video Documentation. The documentary is available at “Agroforesry Lover” in the YouTube Channel.

• **Publications**

- A Bangla leaflet has been published titled ‘Conservation of Medicinal Plants and Endangered Forest Genetic Resources’ (ঔষধী বৃক্ষ ও বিলুপ্তপ্রায় বনজ কৌলীসম্পদ সংরক্ষণ) in June 2021.
- A Bangla booklet titled ‘Conservation of Endangered Forest Genetic Resources and Medicinal Plants’ (বিলুপ্তপ্রায় বনজ কৌলীসম্পদ ও ঔষধী বৃক্ষ সংরক্ষণ) published in September 2021.
- Two books titled “Endangered Forest Genetic Resources in Bangladesh” and “Ethnomedicinal Plants of Chattogram Hill Tracts in Bangladesh” published in May 2022.



Fig. 14.1. Booklet and leaflet published by the coordination component

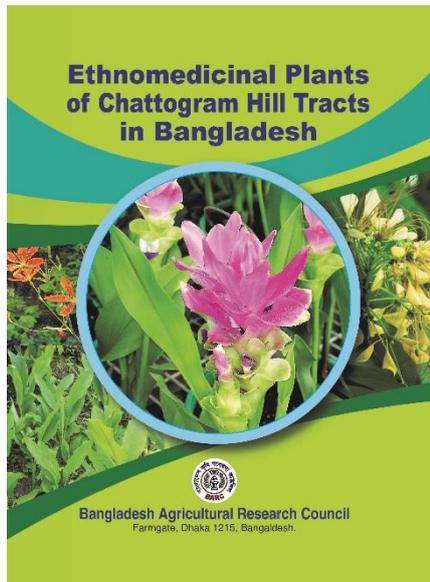


Fig. 14.2. Cover page of “Ethnomedicinal Plants of Chattogram Hill Tracts in Bangladesh”

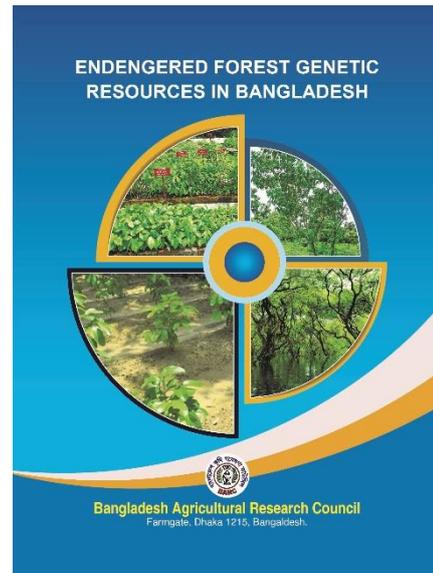


Fig. 14.3. Cover page of “Endangered Forest Genetic Resources in Bangladesh”

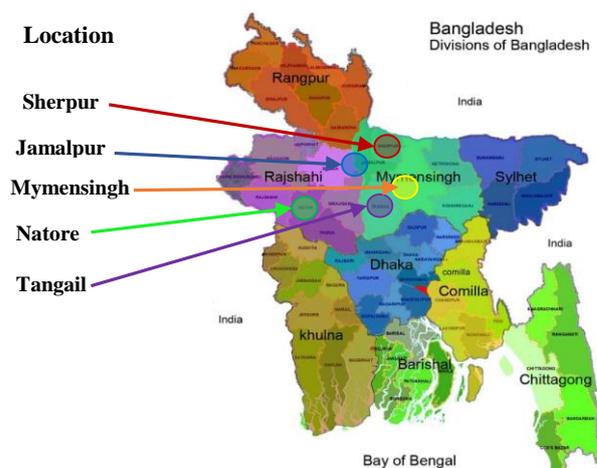
## 10.2 Component-1 (BAU-Horticulture, Mymensingh)

### *Survey of medicinal plant*

The survey was carried out during 2018-2019 at five selected districts like Natore, Tangail (Modhupur), Jamalpur, Sherpur and Mymensingh to investigate the availability, production, marketing, processing, uses, economic benefits, habitat loss, future prospects etc. The geological location of the study area are shown in figure 15.

### *Focus group discussion (FGD)*

Focus group discussion at five selected districts with local inhabitants was conducted to gather information on medicinal plant species. Informants included male, female respondents and traditional healers. Data on age, gender, educational status and linguistics of respondents are also gathered. Information regarding the local plant names, useful part(s), preparation methods and application were documented. In total 10 FGD were conducted using checklist (Two FGDs for each location) (Fig. 26). The local people/ farmers/villagers/healers/traders, *etc.*, at Natore (a & b), Tangail (Modhupur) (c & d), Jamalpur (e & f), Sherpur (g & h) and Mymensingh (i & j) were interviewed. For each FGD 10 individuals were selected with eight males and two females.



**Fig. 15. Study location of the sub-project**

### *Collection and identification of medicinal plant species*

The PI Prof. Dr. Md. Habibur Rahman, Co-PI Prof. Dr. M. A. Rahim, PhD. fellow Md. Ashraful Alam of the sub-project and farmers of the selected study areas conducted extensive field visits to collect medicinal plant species and information of their uses with the help of villagers. The oral discussion with people was mainly concentrated to the details like endemic and less known plants, vernacular names, flowering and fruiting period, medicinal and economic usage regarding each plant species was collected. The medicinal plant species used by the local communities of the study area were authenticated using the international plant name index (<http://www.ipni.org>), the plant list ([www.theplantlist.org](http://www.theplantlist.org)) and GRIN taxonomy site (<http://www.ars-grin.gov/cgi-bin/npgs/html/queries.pl>), while that of families follow Angiosperm Phylogeny Group (APG) system. The species entries were complemented along with data on taxonomic position (family), vernacular name, common name, flowering period, life form and folk medicinal uses. The life form was categorized into herbs, shrubs, grasses and trees (annual, biennial or perennial).

### *Ex-situ Conservation of collected medicinal plant at BAU GPC*

#### **Land Development at BAU-GPC**

The basic requirement for *Ex-situ* conservation is selection of suitable site for planting of medicinal plant germplasm collected from selected five districts. The suitable dedicated place at BAU-GPC having the characteristics of high land, fertile, organic matter rich,

well drained and protected from animals and thief is selected for conservation of collected medicinal plant germplasm. The land was developed using fertile loamy soil.



**Fig. 16.** FGD conducted at Natore (a & b), Modhupur (c & d), Jamalpur (e & f), Sherpur (g & h) and Mymensingh (i & j)

## Pit/plot preparation and planting of medicinal plants

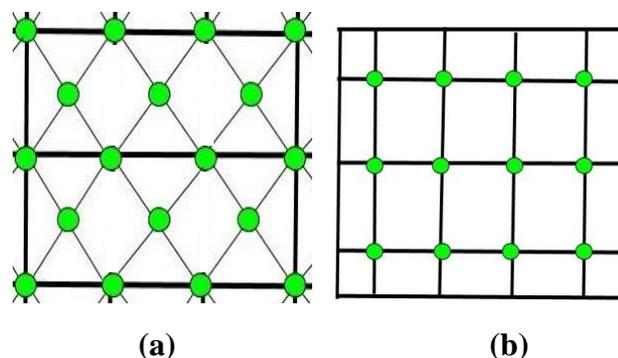
Pits were prepared at a marked place with 60x60x60cm size. Soil were dug out and after 10-15 days again filled with well decomposed cowdung soil and fertilizers. The land was tilled and levelled properly to make it porous and friable. Manure was incorporated during land preparation. Weeds stubbles, roots of previous plants were removed. For vine type medicinal plants support was given. Medicinal plants were planted according to their collection date for *Ex-situ* conservation (Fig. 16).



**Fig. 17.** Conservation of medicinal plant germplasm (a, b, c, d, e, f) at BAU-GPC

### Spacing, planting system and plot size

Spacing was maintained according to the growth and branching habit of tree and canopy volume of the medicinal plants. Spacing used for different medicinal plants are given in Table 1. Hexagonal system was followed for planting perennial tree medicinal plants and square planting system were used for herb, shrub and other medicinal plants (Fig. 18). Plot size depends on number of plants per plot, spacing and planting systems. Size of the plots were 1m x 1m, 1.5m x 1.5m, 2m x 2m, 3m x 3m, etc.



**Fig. 18.** Hexagonal (a) and square (b) planting system for medicinal plants

### Care and management of medicinal plants

Proper care and management were provided for establishment of sapling and subsequent growth and development of the medicinal plant germplasm. Manures and fertilizers were applied according to the requirement of the age and species of medicinal plants. Well drainage facilities were ensured to avoid water logging. Irrigation, weeding, insect pest control measures was undertaken as required. Plants were protected from harmful animals.

**Table 1.** Planting system and spacing of medicinal plants, BAU-GPC, Mymensingh

SLNo.	local name	Scientific Name	Planting system	Spacing
01.	Bashok	<i>Justicia adhatoda L.</i>	Hexagonal	2 m
02.	Olotkombol	<i>Abroma augusta L</i>	Hexagonal	3 m
03.	GritoKumari	<i>Aloe barbadensis L.</i>	Square	50 cm
04.	Horitoki	<i>Terminalia chebula</i>	Hexagonal	3 m
05.	Kalomegh	<i>Andrographis paniculata</i>	Square	25 cm
06.	Agor	<i>Aquilaria malaccensis</i>	Hexagonal	3 m
07.	Sotomuli	<i>Asparagus racemosus</i>	Square	50 cm
08.	Neem	<i>Azadiracht aindica L.</i>	Hexagonal	3 m
09.	White Kanchon	<i>Bauhinia acuminata</i>	Hexagonal	2 m
10.	Punarnava	<i>Boerhavia diffusa L.</i>	Square	50 cm
11.	Polas	<i>Butea monosperma</i>	Hexagonal	3 m
12.	Mahua	<i>Madhuca indica</i>	Hexagonal	3 m
13.	Sonalu	<i>Cassia fistula</i>	Hexagonal	3 m
14.	Korpur	<i>Cinnamomum camphora L</i>	Hexagonal	3m
15.	Harzora	<i>Cissus quadrangularis L.</i>	Hexagonal	2 m
16.	Vuikumra	<i>Ipomoea mauritiana</i>	Square	50 cm
17.	Sarpogandha	<i>Rauwolfia serpentina</i>	Square	50 cm
18.	Bherenda	<i>Jatropha gossypifolia</i>	Hexagonal	2 m

**Table 1. Contd. ....**

SLNo.	local name	Scientific Name	Planting system	Spacing
19.	Simul	<i>Bombax ceiba</i> L.	Hexagonal	3 m
20.	Ashok	<i>Saraca asoca</i>	Hexagonal	3 m
21.	Arjun	<i>Terminalia arjuna</i> L.	Hexagonal	3 m
22.	Bohera	<i>Terminalia bellirica</i>	Hexagonal	3 m
23.	Morinda	<i>Morinda Citrifolia</i>	Hexagonal	2 m
24.	Nisinda	<i>Vitex negundo</i> L	Hexagonal	3 m
25.	Ashogandha	<i>Withania somnifera</i> L.	Square	50 cm
26.	Misridana	<i>Kaempferia rotunda</i>	Square	25 cm
27.	Piper longan	<i>Piper longum</i> L.	Square	50 cm
28.	Tejpata	<i>Cinnamomum tamala</i>	Hexagonal	3 m
29.	Torup Chondal	<i>Codariocalyx motorius</i>	Hexagonal	3 m
30.	Joba	<i>Hibiscus rosa-sinensis</i>	Square	1m
31.	Lojjaboti	<i>Mimosa rubicaulis</i>	Square	1 m
32.	Akondo	<i>Calotropis gigantea</i>	Hexagonal	2 m
33.	Aporajita	<i>Clitoria ternatea</i>	Square	2 m
34.	Hijol	<i>Barringtonia acutangula</i>	Hexagonal	3 m
35.	Tomal	<i>Diospyros montana</i>	Hexagonal	3 m
36.	Pathorkuchi	<i>Bryophyllum pinnatum</i>	Rectangular	50 cm
37.	HostikornPolas	<i>Leea macrophylla</i>	Hexagonal	1 m
38.	Stevia	<i>Stevia rebaudiana</i>	Square	50 cm
39.	Joggo Dumur	<i>Ficus racemosa</i>	Hexagonal	2 m
40.	Hazari Bely	<i>Clerodendrum fragrans</i>	Square	50 cm
41.	Gynura	<i>Gynura procumbens</i>	Square	40 cm
42.	Arhar	<i>Cajanus cajan</i>	Square	1 m
43.	Nayantara	<i>Catharanthus roseus</i>	Rectangular	60 cm
44.	Pudina	<i>Mentha spicata</i>	Square	25 cm
45.	Moringa	<i>Moringa oleifera</i>	Hexagonal	3 m
46.	Lemon grass	<i>Cymbopogon citratus</i>	Square	50cm
47.	Marigold	<i>Tagetes</i> spp.	Square	50 cm
48.	Kontikari	<i>Solanum sisymbriofolium</i>	Square	50 cm
49.	Nageshar chapa	<i>Mesua nagassarium</i>	Hexagonal	2 m
50.	Naglingom	<i>Couroupita guianensis</i>	Hexagonal	2 m
51.	Kiamul	<i>Costus speciosus</i>	Square	50 cm
52.	Ishwar mul	<i>Aristolochia indica</i>	Square	1 m
53.	Goniori	<i>Premna integrifolia</i>	Square	1 m
54.	Euphorbia	<i>Euphorbia milii</i>	Square	50cm
55.	Boichi	<i>Flacourtia indica</i>	Hexagonal	2 m
56.	Ritha	<i>Sapindus trifoliatus</i>	Hexagonal	2 m
57.	Alkananda	<i>Allamanda catharica</i>	Hexagonal	1 m
58.	Cat's tail	<i>Acalypha hispida</i>	Hexagonal	2 m
59.	Choi jhal	<i>Piper chaba</i>	Square	1 m
60.	Joypal/Jamalgot	<i>Croton tiglium</i>	Hexagonal	2 m
61.	Golap	<i>Rosa rubiginosa</i>	Square	1 m
62.	Hatir shoor	<i>Heliotropium indicum</i>	Square	25 cm
63.	Bael	<i>Aegle marmelos</i>	Hexagonal	3 m
64.	Bilimbi	<i>Averrhoa bilimbi</i>	Hexagonal	3 m

**Table 1. Contd. ....**

SLNo.	local name	Scientific Name	Planting system	Spacing
65.	Kumarilota	<i>Smilax</i> spp.	Square	1 m
66.	Amloki	<i>Phyllanthus emblica</i>	Hexagonal	3 m
67.	Boula gota	<i>Cordia dichotoma</i>	Hexagonal	3 m
68.	Commifora	<i>Commiphora wightii</i>	Square	1 m
69.	Petari	<i>Abutilon indicum</i>	Hexagonal	2 m
70.	Kanaidinga	<i>Oroxylum indicum</i>	Square	1 m
71.	Nil chita	<i>Plumbago capensis</i>	Square	50 cm
72.	Coffee	<i>Coffea arabica</i>	Hexagonal	3 m
73.	Rongdana	<i>Bixa orellana</i>	Hexagonal	3 m
74.	Nagdana	<i>Artemisia annua</i>	Square	50cm
75.	Shalpani	<i>Desmodium gangeticum</i>	Square	1 m
76.	Sugondhibala	<i>Plectranthus amboinicus</i>	Square	50cm
77.	Ashoth	<i>Ficus religiosa</i>	Hexagonal	2 m
78.	Bot	<i>Ficus benghalensis</i>	Hexagonal	2 m
79.	Telakucha	<i>Coccinia grandis</i>	Square	1 m
80.	Plantain	<i>Plantago lanceolata</i>	Square	25 cm
81.	Amada	<i>Cucuma amada</i>	Square	50cm
82.	Kodbel	<i>Limonia acidissima</i>	Hexagonal	3 m
83.	Bokul	<i>Mimusops elengi</i>	Hexagonal	2 m
84.	Orboroi	<i>Phyllanthus acidus</i>	Hexagonal	3 m
85.	Polao pata	<i>Pandanus odoratissimus</i>	Square	25cm
86.	Gonga Sagor	<i>Cissus</i> sp.	Square	50cm
87.	Kalo nirbish	<i>Curcuma rubescens</i>	Square	50cm
88.	Sada nirbish	<i>Curcuma</i> sp.	Square	50cm
89.	Kantati	<i>Barleria prionitis</i>	Square	50cm
90.	Nagdana	<i>Artemisia vulgaris</i>	Square	1 m
91.	Dad mordon	<i>Senna alata</i>	Hexagonal	3 m
92.	Punnag champa	<i>Alpinia zerumbet</i>	Square	1 m
93.	Roselle	<i>Hibiscus sabdariffa</i>	Square	1 m
94.	Gurbach	<i>Acorus calamus</i>	Square	50cm
95.	Bisulla koroli	<i>Altheria brasiliiana</i>	Square	1 m
96.	Pitari	<i>Abutilon indicum</i>	square	2 m
97.	Tulsi	<i>Ocimum tenuiflorum</i>	Square	50cm
98.	Kalo Tulsi	<i>Ocimum tenuiflorum</i>	Square	50cm
99.	Tulsi (Lemoncent)	<i>Ocimum americana</i>	Square	50cm
100.	Ram tulsi	<i>Ocimum gratissimum</i>	Square	50cm
101.	Rokto chita	<i>Plumbago zeylanica</i>	Square	1 m
102.	Ananta Mul	<i>Hemidesmus indicus</i>	Square	1 m
103.	Holud Basok	<i>Justicia adhatoda</i>	Square	1 m
104.	Nil shoor	<i>Stachytarpheta jamaicensis</i>	Square	1 m
105.	Kurchi	<i>Holerrhena pubesens</i>	Hexagonal	3 m
106.	Gulanha	<i>Tinospora cordifolia</i>	Square	1 m
107.	kathali chapa	<i>Artabotrys hexapetalus</i>	Hexagonal	3 m
108.	Rokto chondon	<i>Adenathera pavanina</i>	Hexagonal	3 m
109.	Daruchini	<i>Cinnamomum zeylanicum</i>	Hexagonal	2 m

**Table 1. Contd. ....**

SLNo.	local name	Scientific Name	Planting system	Spacing
110.	Udal	<i>Firmiana simplex</i>	Hexagonal	3 m
111.	Civit	<i>Swintonia floribanda</i>	Hexagonal	2m
112.	Burma shimul	<i>Ceiba pentandra</i>	Hexagonal	3 m
113.	Shetdron	<i>Leucas aspera</i>	Square	50 cm
114.	Babla	<i>Acacia nilotica</i>	Hexagonal	3 m
115.	Berela	<i>Sida cordifolia</i>	Hexagonal	1 m
116.	Titbegun	<i>Solanum indicum</i>	Hexagonal	3 m
117.	Apang	<i>Achyranthes aspera</i> Linn	Hexagonal	3 m
118.	Orhto shiphon	<i>Orthosiphon aristatus</i>	Square	50 cm
119.	Kunch	<i>Abrus precatorius</i>	Hexagonal	2m
120.	Bhui Amla	<i>Phyllanthus niruri</i>	Square	50 cm
121.	Dudh koruch	<i>Wrightia arborea</i>	Hexagonal	3 m

## Characterization of conserved medicinal plant germplasm at BAU-GPC

### Morphological characterization

Medicinal plants collected from selected five different geographical locations of Bangladesh and planted at BAU-GPC for characterization and conservation. To compare the morphology of the trees collected from the five selected study districts, plant height and diameter, number of the stems, length and width of the leaf, petiole length, and width were recorded. All traits were measured on an individual plant basis to obtain one measurement per plant. All measurements were averaged over plants collected from same location and averages for each location were used in subsequent analysis. Data of the above parameters were collected and reorded of other medicinal plants germplasm conserved at BAU-GPC.

### Molecular characterization

*Terminalia* genus are propagated by seed. The inter-as well as intra-specific variation in this genus might have resulted because of sexual recombination, segregation, together with mutations, acted on by natural selection. Srivastava *et al.* (1993) reported that out-crossing as the primary mode of reproduction in the genus *Terminalia*. Though *T. chebula* has diversity, there is still ambiguity regarding morphology, therefore, molecular markers can be an aid in assigning accurately the taxonomic status at species level. Molecular marker like RAPD markers have been successfully employed for determination of intra-specific genetic diversity. RAPD was used in many different applications involving the detection of DNA sequence polymorphisms (Hadrys *et al.*, 1992). RAPD technique is considered a useful tool due to its low cost and the good reliability as well as it is a relatively simple procedure. The study included the investigation of genetic variation of *T. Chibulla*, *T. bellerica* and *T. bellerica* collected from five districts and conserved at BAU-GPC. To our knowledge, nothing was reported on the evaluation of the species based on molecular markers. In this study, RAPD molecular markers were used to analyze genetic relationship among *Terminalia* species distributed in five different places of Bangladesh which could help in their genetic improvement and breeding programs. The research works were carried out at different laboratories by the Ph.D fellow (Fig. 19).

### Isolation of genomic DNA

Total genomic DNA was isolated from each medicinal plant germplasm, by using Wizard<sup>®</sup> Genomic DNA Purification Kit solution: pH 8.0 (Promega, Madison, WI,

USA). However, the following reagents, viz., nucleolysis solution, RNase A solution, protein precipitation solution, isopropanol, 70% ethanol and DNA rehydration solution were used.



**Fig. 19.** PhD. fellow working at the Laboratory

The work done at Invent technology Ltd. Banani, Dhaka and Plant Bacteriology and Biotechnology, Department of Plant Pathology and Department of Horticulture, BAU Mymensingh. Genomic DNA of Horitoki, Bohera and Arjun, was extracted by using aforesaid Kit. The detail procedure of DNA extraction is described below:

1. Processed leaf tissue by freezing with liquid nitrogen and grinding into a fine powder using a micro centrifuge tube pestle or a mortar and pestle. 40mg of this leaf powder was taken to a 15ml micro centrifuge tube.
2. 600 $\mu$ l of Nuclei Lysis Solution was added, and vortexed for 1-3 seconds to wet the tissue.
3. Then incubated at 65<sup>0</sup>C for 15 minutes.
4. 3 $\mu$ l Rnase Solution was added to the cell lysate, and the sample was mixed by inverting the tube 2-5 times. The mixture was incubated at 37<sup>0</sup>C for 15 minutes. Then the sample was allowed to cool at room temperature for five minutes.
5. 200 $\mu$ l of Protein Precipitation Solution was added and vortexed vigorously at high speed for 20 seconds.
6. Then centrifuged for 3 minutes at 13,000-16,000rpm. The precipitated proteins formed a tight pellet.
7. The supernatant containing the DNA (leaving the protein pellet behind) was carefully removed and transferred to a clean 1.5ml micro centrifuge tube containing 600 $\mu$ l room temperature isopropanol.
8. The solution was then gently mixed by inversion.
9. Then the solution was centrifuged at 13,000-16,000rpm for 1 minute.
10. The supernatant was carefully decanted. 600 $\mu$ l of room temperature 70% ethanol was added and the tube was gently inverted for several times to wash the DNA. After that centrifuged at 13,000-16,000rpm for 1 minute at room temperature.

11. The ethanol using either a drawn Pasteur pipette or a sequencing pipette tip was carefully aspirated. The DNA pellet was very loose at this point and care was taken to avoid aspirating the pellet into the pipette.
12. The tube was then inverted onto clean absorbent paper and the pellet was air-dried for 15 minutes.
13. The DNA pellet was rehydrated by adding 25µl of DNA Rehydration Solution and kept it over-night at 4°C.
14. Finally, the all the isolated genomic DNA samples were preserved at -20°C in deep freeze for further use.

### **Genomic DNA also extracted using following protocol**

Genomic DNA extraction from fresh tender leaf samples using CTAB (Cetyl trimethyl ammonium bromide) method.

- (1) 100 mg leaf tissues for each sample were weighed and used for grinding.
- (2) 1 ml of warm extraction buffer (2% (w/v) CTAB, 100 mM Tris-HCl (pH 8.0), 20 mM EDTA, 1.4 M NaCl) containing freshly added 2% (w/v) polyvinylpyrrolidone-40 (PVP-40) and 1% (w/v) sodium sulfite (Na<sub>2</sub>SO<sub>3</sub>) were added to a mortar.
- (3) The leaf materials were grinded by using mortar and pestle.
- (4) Crude extracts (700 µl) were transferred into a 1.5 ml microcentrifuge tube.
- (5) Vortexed and incubated in a water bath at 60°C for 30 min for cell lysis.
- (6) 700 µl phenol: chloroform: isoamylalcohol 25:24:1 (v/v/v) was added into the incubated extract, vortexed and centrifuged (15000 g, 10 min) in a microcentrifuge tube for first clarification.
- (7) About 700 µl of the aqueous layer was carefully transferred into a fresh microcentrifuge tube then 700 µl chloroform: isoamylalcohol 24:1 (v/v) was added, vortexed and centrifuged (15000 g, 10 min) in a microcentrifuge tube for second clarification.
- (8) About 700 µl of the aqueous layer was carefully transferred into a fresh microcentrifuge tube then added 75 µl of 5 M NaCl and 450 µl of cold isopropanol.
- (9) The mixture was inverted 4 to 5 times then incubated (-20°C, 1 h)
- (10) The mixture was centrifuged (4°C, 15000 g, 10 min) to pellet the nucleic acids.
- (11) Decanted the supernatant off carefully.
- (12) The pellet was washed by adding 500 µl of 70% (v/v) ethanol, and centrifuged (15000 g, 5 min).
- (13) The step 12 was repeated.
- (14) The pellet was dried and then re-suspended in 30 µl 1x TE buffer (10 mM Tris-HCl pH 8.0, 0.1 mM EDTA) and stored at -20°C.
- (15) The extracted DNA was diluted 1:10 (v/v) in nuclease-free sterile distilled water prior to PCR.

### **Confirmation of DNA**

DNA isolated following above protocol often contains a large amount of RNA and pigments which can usually cause spurious high estimation of DNA concentration on a spectrophotometer. For this ground, 0.8 % agarose gel was used for assessing both the quantity and the quality of isolated DNA to make sure the integrity.

### **Determination of DNA concentration**

For quantification of DNA concentration, the spectrophotometer wave length was set at 260 m after the spectrophotometer UV lamp was warmed up. A square cuvette (the zero or blank cuvette) was filled with 2 ml double distilled water and placed in the cuvette chamber then the absorbance reading was adjusted to zero for standardization. The test samples were prepared by taking 2  $\mu$ l of each DNA sample in the cuvette containing 2 ml sterile distilled water then mixed comprehensively by pipetting placed in spectrophotometer and absorbance reading was taken at 260 nm (Table 2). Then the cuvette was rinsed with sterile water, stamped out on a paper wipe, and absorbance reading for each sample was recorded in the same way.

Using the absorbance reading, the original sample concentrations were determined according the formula. DNA concentration ( $\eta$ g/ $\mu$ l) = Absorbance x Conversion factor (0.05) X 1000.

### **Preparation of working solution of DNA samples**

Before PCR, it is necessary to make uniform concentration of DNA for each species. Dilution was done simply by adding de-ionized water with the concentrated DNA samples. A concentration of about 100 ng/ $\mu$ l was maintained for working DNA samples. Working solution (100ng/  $\mu$ l) from different DNA samples was prepared using the following formula:  $S_1V_1 = S_2V_2$

Where,  $S_1$  = Initial strength (ng/ $\mu$ l),  $V_1$  = Initial volume of DNA solution ( $\mu$ l),  $S_2$  = Final strength (ng/ $\mu$ l),  $V_2$  = Final volume of DNA solution ( $\mu$ l)

For RAPD analysis a set of fifteen (15) decamer primers were initially employed in RAPD analysis, 5 primers produced reproducible and scorable RAPD profiles, the sequence of these 5 primers are illustrated in Table 3.

**Table 2.** Absorbance reading and concentration of DNA samples of *T. chebula*, *T. bellirica* and *T. arjuna*

Sl. No.	Accession ID	NucleicAcid Conc. ( $\eta\text{g}/\mu\text{l}$ )	A 260	A 280	260/280
<b><i>T. chebula</i></b>					
1	Tc-01	74.20	1.485	1.672	0.89
2	Tc-02	47.20	0.943	2.693	0.35
3	Tc-03	35.90	0.717	1.46	0.49
4	Tc-04	58.50	1.170	1.066	1.10
5	Tc-05	153.40	3.067	4.194	0.73
<b><i>T. bellirica</i></b>					
1	Tb-01	794.40	15.888	15.068	1.060
2	Tb-02	1034.80	20.695	19.498	1.040
3	Tb-03	995.80	19.917	19.022	1.050
4	Tb-04	1008.80	20.096	18.693	1.080
5	Tb-05	977.80	19.556	19.622	1.000
<b><i>T. arjuna</i></b>					
1	Ta-01	134.9	2.698	2.523	1.07
2	Ta-02	806.5	16.129	14.962	1.08
3	Ta-03	647.6	12.952	11.910	1.09
4	Ta-04	806.5	3.269	3.063	1.07
5	Ta-05	840.9	16.819	16.147	1.04

Tc-01= *Terminalia chebula* (Natore), Tc-02= *Terminalia chebula* (Tangail), Tc-03= *Terminalia chebula* (Sherpur), Tc-04= *Terminalia chebula* (Mymensingh), Tc-05= *Terminalia chebula* (Jamalpur)

Tb-01= *Terminalia bellirica* (Natore), Tb-02= *Terminalia bellirica* (Tangail), Tb-03= *Terminalia bellirica* (Sherpur), Tb-04= *Terminalia bellirica* (Mymensingh), Tb-05= *Terminalia bellirica* (Jamalpur)

Ta-01= *Terminalia arjuna* (Natore), Ta-02= *Terminalia arjuna* (Tangail), Ta-03= *Terminalia arjuna* (Sherpur), Ta-04= *Terminalia arjuna* (Mymensingh), Ta-05= *Terminalia arjuna* (Jamalpur)

### Polymerase Chain Reaction (PCR)

Polymerase Chain Reaction (PCR) mixture (20 $\mu\text{l}$ ) was prepared with following composition for RAPD analysis:

Name of item	Amount ( $\mu\text{l}$ )
Master Mix	10.00
Primer	1.50
Nuclease free H <sub>2</sub> O	7.50
DNA temFig.	1.00
Total volume	20

The amplification was performed using a DNA thermal cycler (Techno 512) using steps described in Table 4. The amplified products were separated 1% agarose gels and visualized after staining with ethidium bromide. The RAPD fragments were photographed using a UV transilluminator and analyzed with a gel documentation system (Bio-Rad, USA).

**Table 3.** Primer Code and sequences used for RAPD analysis

Name of Species	Primer Codes	Sequence (5' to 3')	(G+C)%
<i>T. chebula</i>	OPA02	5'-GAAAGGGGTG-3'	60%
	OPA18	5'-AGGTGACCGT-3'	60%
	OPB12	5'CCTTGACGCA-3'	60%
	OPB17	5'AGGGAACGAC-3'	60%
	OPC08	5'TGGACCGGTG-3'	70%
<i>T. bellirica</i>	MAP02	5'GTCCTACTCG-3'	60%
	MAP04	5'TGCGCGATCG-3'	70%
	MAP 10	5'GCGAATTCCG-3'	60%
	MAP 14	5'AGGATACGTG-3'	50%
	MAP 20	5'AGCCTGACGC-3'	70%
<i>T. arjuna</i>	OPJ20	5'AAGCGGCCTC-3'	70%
	OPP03	5'CTGATACGCC-3'	60%
	OPP08	5'ACATCGCCCA-3'	60%
	OPP10	5'TCCCGCCTAC-3'	70%
	OPT09	5'CACCCCTGAG-3'	70%

**Table 4.** Thermal profiles for RAPD markers

Step	Temperature °C	Time	No of cycle
Initial denaturation	94	5 minutes	1
Denaturation	94	1 minutes	
Annealing	36	1 minutes	35 cycles
Primer extension	72	1 minutes	
Final extension	72	7 minutes	

### Propagation of conserved medicinal plant germplasm at BAU-GPC

Three different experiments were conducted for propagation of Horitoki, Bohera and Arjun medicinal plant. Data on germination percentage, percent survivability, percent success, no. of leaves, plant height were recorded.

#### Expt. 1: Effects of soaking duration and soaking after days of fruit collection on germination and seedlings growth performance of Hortiki (*Terminalia chebula*)

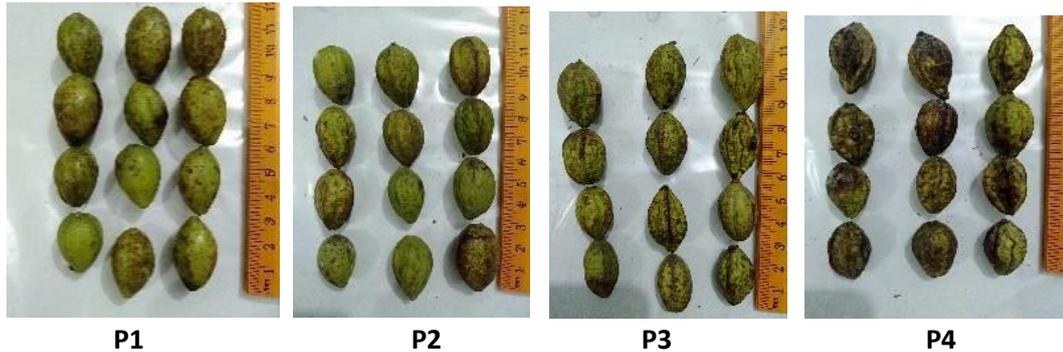
##### Experimental treatment and design

Two experiment was conducted at BAU-GPC from 2019 to 2021. First was five seed soaking durations viz., C<sub>1</sub> = Contol (No soaking); C<sub>2</sub> = Seeds soaked in normal water for two days, C<sub>3</sub> = Seeds soaked in normal water for four days; C<sub>4</sub> = Seeds soaked in normal water for six days; C<sub>5</sub> =Seeds soaked in normal cow dung slurry for six days. Another factor was after harvest four different storage period of seed viz., P<sub>1</sub> = Seeds sowing/soaking in collection date; P<sub>2</sub> = Seeds sown/soaked after 10 days of collection and then sown; P<sub>3</sub> = Seeds sown/soaked after 20 days of collection and then sown; P<sub>4</sub> = Seeds sown/soaked after 30 days of collection and then sown. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

##### Fruit collection

Optimum matured fruits of *Terminalia chebula* Retz were collected according to treatments from trees of BAU-GPC, Bangladesh Agricultural University, Mymensingh. In total 900

uniform sized fruits were sorted for the treatments (Fig. 20). Then collected fruits were depulped before soaking or sowing.



**Fig. 20.** Fruits of *Terminalia chebula* for depulping

Fruits were depulped at two ends with sharp knife in such a way that the embryo was not damaged. The depulped seeds were dried in the sun and stored in airtight containers until the seeds were subjected to treatments. One hundred eighty seeds were kept in water for two days, another 180 seeds were kept in normal water for four days, 180 seeds were kept in room temperature water for six days, 180 seeds were kept in cow dung slurry for six days and more 180 seeds for control. Total treatment combinations were 20 and each treatment composed 15 seeds.

### **Growing media and seed sowing**

Seeds were sown and grown in the top soils collected from the local areas of BAU-GPC, Bangladesh. The soil was sandy loamy and belong to Old Brahmaputra Flood Plain under the AEZ-9. The soils were well sieved (<3 mm) and mixed with decomposed cow dung at a ratio of 3:1 and finally filled in polybags of size 12.50 cm × 15.25 cm. To facilitate aeration and proper drainage, a number of perforations were made in the polybags before fillings them with soil-cow dung mixture. Only one seed was sown in each polybag. Seeds were dibbed in the germination media 0.5 cm from the surface and then covered with a thin layer of soil.

### **Protection and maintenance of sown seeds**

After sowing the seeds, protective measures were adopted against the hot sun, heavy rains, birds, rodents and pests. Insecticide (Chloropyrifos) and fungicide (Carbendazim) were also applied to protect the seeds and young seedlings from ants, termites and fungal infection. Initially the seeds were covered with thorny bushes to protect them from birds and rodents. Temporary sheds were used to protect the seeds from excessive sun and raindrops. Proper care was taken from sowing the seeds to harvesting the seedlings for assessment. Watering and weeding were done regularly to ensure maximum seedling growth. Loosening of topsoil was also done whenever necessary to disperse and mobilize nutrients and to prevent green mold growth on the surface.

### **Record keeping**

The cumulative germination was recorded in every third day from the day of sowing and it was continued for 90 days after sowing (DAS) the seeds. To assess seedling performance, 10 seedlings from each replication of treatments were randomly uprooted and measured for shoot length, root length, number of leaf, leaf area and collar dia. The seedlings were then separated into shoot, root and leaf components and dried in electric oven at 70°C for 48 h. Dry weight of root, shoot and leaves were then recorded.

**Germination percentage:** Seed germination percentage was calculated using the following formula:

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Number of Seeds sown}} \times 100$$

**Germination phases:** Imbibition period was determined by counting the number of days from sowing the seeds to the commencement of germination while germination period was recorded by counting the number of days from sowing to the completion of seed germination in each treatment.

**Germinating energy:** Germinating energy (GE) was calculated based on the percentage of the total number of seeds that had germinated when the germination reached its peak (Zazai *et al.*, 2018).

$$\text{Germinating energy (GE)} = \frac{\text{Number of seeds germinated upto time of peak germination}}{\text{Total Number of seeds sown}} \times 100$$

**Survival percentage:** The survival percentage of each treatment was recorded at 120 days after seed sowing. The survival percentage was calculated using formula (Zazai *et al.*, 2018) as below:

$$\text{Survival percentage of seedlings} = \frac{\text{Number of survived seedlings}}{\text{Total Number of seedlings}} \times 100$$

**Growth performance:**

At the end of the experiment, all seedlings were measured for total height and collar diameter. Total number of leaf in each seedling was also counted. Ten seedlings from each replication were randomly selected and uprooted carefully to estimate the seedling biomass. The uprooted seedlings were then separated into leaves, shoot and root components and dried in electric oven at 70°C until the constant weight was obtained for studying biomass productions in different pre sowing treatments.

**Vigor index**

Seedling vigor index (VI) was calculated according to Abdul Baki and Anderson (1973) as germination percentage  $\times$  (shoot length + root length).

**Statistical Analysis**

Data of the experiment were statistically analyzed using computer software Microsoft Excel and Statistix.10 to explore possible treatment variations. The Analysis of Variance (ANOVA) and LSD (Least Significant Difference) values were also used for the analysis.

## **Expt. No. 2: Effect of pulping of seed and sowing date on seedling emergence and growth performance of Bohera (*Terminalia bellirica*)**

The two factors experiment consisted of three types of pulping, *viz.*, B<sub>1</sub>= Pulped seed (whole fruit) direct sowing, B<sub>2</sub>= Depulped seeds then soaking and sowing, B<sub>3</sub>= Fruit soaking, depulped and sowing and five different sowing date, *viz.*, T<sub>1</sub>= sown in 20/04/2020, T<sub>2</sub>= sown in 05/05/2020, T<sub>3</sub>= sown in 20/05/2020, T<sub>4</sub>= sown in 05/06/2020, T<sub>5</sub>= sown in 20/06/2020. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

### **Fruit collection**

Optimum matured fruits of Bohera (*Terminalia bellirica*) were collected according to treatments from trees planted at BAU-GPC. In total 675 uniform sized fruits were sorted for the treatments to reduce the non-treatment variations. The collected seeds were dried in the sun and stored in airtight containers until the seeds were subjected to treatments and used according to treatments. Total treatment combinations were 15 and each treatment composed of 15 seeds. Thus including three replications each treatment consisted of 45 seeds and total seeds were 675 (3Ax5Bx3Rx15No.).

Growing media and seed sowing, protection and maintenance were the same as for experiment no. 1.

### **Data recorded and analysis**

Data recorded and analysis were conducted as in experiment no. 1

### **Exp. No. 3: Effects of fruit size and soaking duration on germination and seedling growth of Arjun (*Terminalia arjuna*)**

#### **Experimental treatment and design**

The experiment consisted four different soaking, viz., T<sub>1</sub>: Control or no treatment of fruits, T<sub>2</sub>: soaking fruits in water at room temperature for 36 hrs, T<sub>3</sub>: Soaking fruits in cow dung slurry for 36 hrs, T<sub>4</sub>: soaking fruits in hot water for 06 hrs and three fruit size viz., S<sub>1</sub>: small (Diameter; 1.6≥2.2cm), S<sub>2</sub>: medium (Diameter; 2.3≥3.0cm), and S<sub>3</sub>: large (Diameter; ≥ 3.1cm) size. For this experiment, a randomized complete block design (RCBD) was laid out with three replications.

#### **Fruit collection**

Optimum matured fruits of *Terminalia arjuna* were collected according to treatments from BAU-GPC trees. In 540 fruits with uniform size were sorted and used for treatments to reduce the non-treatment variations. The collected seeds were dried under sun and stored in airtight containers. one hundred eighty seeds were small (Diameter; 1.6≥2.2cm), one hundred eighty seeds were medium (Diameter; 2.3≥3.0cm), and another one hundred eighty seeds were large (Diameter ≥ 3.1cm) size fruits sown in polybag. Total treatment combinations were 12 and each treatment composed of 15 seeds. Alltogether therewere 540 (4Ax3Bx3Rx15No.) seeds were as there were 45 seed for each treatment. Growing media and seed sowing, protection and maintenance of sown seeds were same as the experiment no. 1.

**Data recorded and statistical analysis:** Data were recorded and analyzed as in experiment no. 1.

#### **Training on medicinal at BAU-GPC**

Two trainings (Day long) on medicinal plant including both theoreticals and practical were conducted at BAU-GPC during 2018-2019 and 2019-2020. The training purpose was to build awareness importance of medicinal plants, enhance practical knowledge on improved cultivation techniques, harvesting and handlings of raw materials, information on different aspects of economically important medicinal plants and to demonstrate the improved propagation and nursery raising techniques.



**Fig. 21.** Training on medicinal and certificate awarding at BAU-GPC, Mymensingh

Two different trainings for cultivators, gatherers, supply chain intermediaries, traders, local healers regarding importance and scope of medicinal plants, propagation, production technology medicinal management of garden, *etc.*, were conducted on 16 June 2019 and 27 June 2020 with 60 participants from Natore, Modhupur, Jamalpur, Sherpur and Mymensingh with 58 males and seven female participants (Fig. 21). All the participant visited the medicinal plant garden practically and have seen more than 120 medicinal germplasm in BAU-GPC. Practical classes on different propagation methods like cutting, layering, budding and grafting were carried.

### **Medicinal plant sapling distribution**

During the training program saplings of different medicinal plants were distributed among the trainees (Fig. 22). In total 150 saplings of Aoe Vera (60), Bashok (10), Tulsi (30), Horitoki (5), Bohera (5), Nishinda (5), Kalomegh (5), and Pathorkuchi (30). Trainees were happy to receive the medicinal plants (Table 5).



**Fig. 22.** Distribution of sapling of medicinal plants

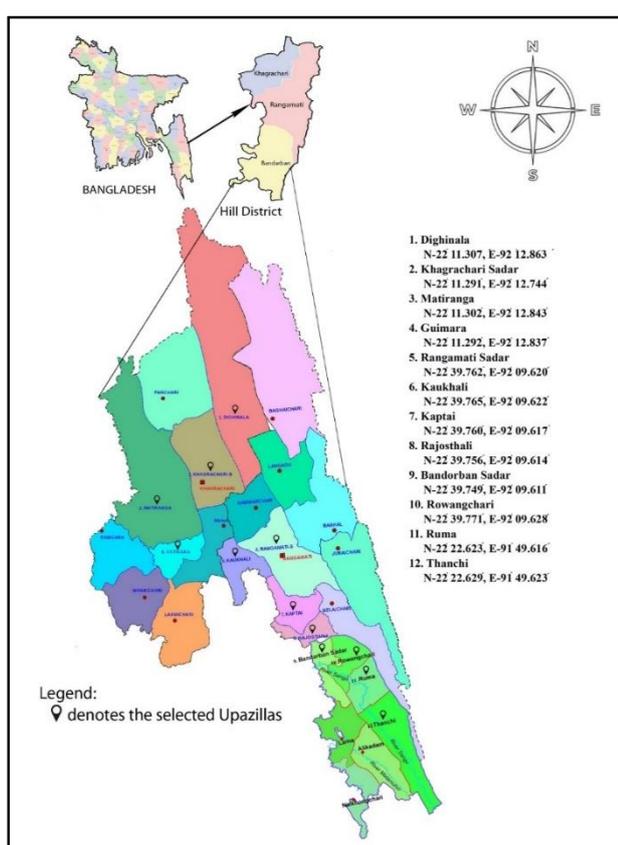
**Table 5.** Sapling distribution of medicinal plants

Sl. No	Local Name	Scientific Name	Quantity
1	Aoe Vera	<i>Aloe barbadensis</i>	60
2	Bashok	<i>Justicia adhatoda</i>	10
3	Tuls	<i>Ocimum tenuiflorum</i>	30
4	Horitoki	<i>Terminalia chebula</i>	05
5	Bohera	<i>Terminalia bellirica</i>	05
6	Nishinda	<i>Vitex negundo</i>	05
7	Kalomegh	<i>Andrographis paniculata</i>	05
8	Pathorkuchi	<i>Bryophyllum pinnatum</i>	30
<b>Total</b>	-	-	<b>150</b>

### 10.3 Component-2 (BFRI-Chattogram)

#### Study area selection

The Chattogram Hill Tracts (CHTs) is the South Eastern part of Bangladesh, covering 13,295 square kilometer. It comprises three hill districts namely Bandarban, Rangamati and Khagrachari, inhabitant of 11 tribal communities. There are 26 “Upazillas” in CHTs. However, considering the selection of tribe, communication, socio-political situation we have to select safer site from 12 Upazillas (four Upazillas from each district) were selected. The selected Upazillas were: Rangamati District (Rangamati sadar, Kawkhali, Kaptai and Rajasthali Upazilla); Bandarban District (Bandarban sadar, Rowangchhari, Ruma and Thanchi Upazilla) and Khagrachari District (Dighinala, Khagrachari sadar, Guimara and Matiranga Upazilla). Maps of the study area and geo-coordinates of the selected Upzilla are demonstrated in Fig. 23.



**Fig. 23.** Maps showing the study are with geo-coordinates of selected Upazillas

#### a. Exploration and mapping the status of Medicinal Plants in CHT's

An extensive field visits were conducted in the CHTs comprising the para/villages of the major tribal (Chakma, Marma, Tripura) and other communities during the sub-project period in the atudy areas. Before starting the survey, 60 *Boiddays* as respondents for information collections and 12 local tribal people as guide were selected from twelve Upazillas of CHT's. An orientation meeting was organized with selected *Boidday's* and guide and briefed about the aims of the project and also provide the training to the herbal practitioners or *Boiddays* how to collect the specimens of medicinal plants they use.

## **b. Informant's interview and ethno medicinal data collection**

Information on ethnomedicinal plants were collected through interview of selected *Boiddays*'s. Besides, individual interviews were also conducted with twelve group discussions in selected 12 Upazilla. In total 60 *Boiddays* participated in discussion meeting. Moreover, 10 experienced local people were also interviewed from the different selected Upazillas of CHT's. Documentation of ethnomedicinal information was done using the standard method of Martin (1995) and Cotton (1996). Relevant information, *i.e.*, useful parts, methods of formulation, diseases treated, mode of administration, local name of the plants, habit and habitat of the plants, conservation status, *etc.*, was collected and noted down during interviews and group discussions.

## **c. Plant collection, identification and preparation of permanent herbarium sheets**

Herbal practitioners were asked to bring plants or plant parts during interview. They gave the information about the medicinal uses of the plant along with its local name. Primary identification of the plants was done in the field; it was photographed, pressed for the preparation of herbarium sheet, and brought to BFRI herbarium. After processing permanent herbarium sheets were prepared following standard procedure (Alexeaus 1990 and KEW herbarium). The collected plants were identified with the help of the expert plant taxonomist, compared with the specimens in the Herbarium of BFRI and Bangladesh National Herbarium (BNH) and consulting Encyclopedia of Flora and Fauna of Bangladesh and Vascular Plants of Chattogram Hill Tracts (Uddin and Hassan, 2018a,b,c).

## **d. Collection of propagules and germplasm conservation of Ethnomedicinal plants.**

Based on the information of herbal practitioner propagules (seeds, seedlings, cuttings, rhizomes) of potential ethnomedicinal plants were collected. Initially the collected propagules were nursed in the rearing center. Then they were transferred to conservation plots of MFPD nursery, BFRI, Chattogram following the standard procedure of Plant Genetic Resources (PGR).

## **e. Restoration and Recolonization of the threatened medicinal plants in CHT's**

For restoration and re-colonization, a priority list of ethnomedicinal plant species prepared based on the desire of herbal practitioner. Accordingly, 10,000 seedlings of 13 species were raised in the MFPD nursery, BFRI, Chattogram. As per plans two ethnomedicinal plants gardens have been established in two hill districts of CHT with selected priority species and rest of the seedling distributed among the selected herbal practitioner in CHT's.

## **f. Data Analysis**

Analysis of collected information was carried out through Microsoft Excel Software. Use Value and Relative Frequency of Citation were determined using the following formula.

## **g. Use Value**

Use value (UV) is the evaluation of relative importance of each medicinal plant species based on its use among the informants (Vitalini *et al.* 2013). Use value was calculated using the following formula:

$$UV = \sum U/N$$

Where U is the number of uses mentioned by the informants for a given species and N is the total number of informants interviewed.

#### **h. Relative frequency of Citation**

Relative frequency of citation (RFC) is a quantitative index that gives us the local importance of the species in the ethno botanical investigation (Tardio and Pardo, 2008). According to the standard method of Vitalini *et al.* (2013), RFC is calculated as follows:

$$RFC = (o \leq RFC \leq 1).$$

Where FC is the number of informants who mentioned the importance of local species and *N* is the total number of informants who participated in interviews and group discussion.

### **10.4 Component-3 (IFESCU- Chattogram)**

- a. **Exploration and mapping the status of the Forest Genetic Resources (FGR):** Field visit in the natural forests of Tangail (Madhupur National Park), Chattogram (Hazarikhil Wildlife Sanctuary and Bariyadhala National Park), Ukhiya and Bamu Reserved Forest, Kaptai National Park (Rangamati) and Srimai forest of Chattogram South Forest Division was done for assessing the status of the Forest Genetic Resources (native and naturalized tree species).
- b. **Selection of FGR for recovery and restoration through multiplication:** Considering the density and abundance of the species, available forest genetic resources are identified for recovery and restoration of the species.
- c. **Collection of fruits and seeds:** Fruits and seeds of the following species were collected from Hazarikhil Wildlife Sanctuary, Bariyadhala National Park, Barshijura Seed Orchard Centre of Moulavi Bazar, Ukhiya Seed Orchard Center, Kalurghat Forest Depot, Madhupur National Park of Tangail; Kaptai National Park and Sri mai forest of Patiya Range, Chattogram South Forest Division, Chattogram.
- d. **Nursery techniques and raising planting materials:** Planting materials (seedlings and vegetative propagules) of all available tree species (86 species) were stored, cleaned and processed for seed pre-sowing treatments in the laboratory, propagator house and nursery bed. Care and maintenance of the nursery trays, polybags, seedbeds and propagator house beds were taken properly.
- e. **Morphological characterization:** Morpho-physiological parameters of the selected species were studied.
- f. **Experimental Design:** The seed pre-sowing treatments, growing media/ substrates and germination parameters are shown differently for each species. 2 MS in (Forestry) students were involved in field exploration, fruit/seed collection and layout of the experiments for studies of seed biology and nursery raising programs. Approximately 100 seedlings (excluding losses and damages) of each species were raised for establishing Conservation Stands in the University campus. Nursery experiment, site preparation and layout of the conservation stands were done following Randomized Complete Block Design. The seed pre-sowing treatments, growing in different media/ substrates and germination parameters were described separately for 25 species. The seedlings of the remaining species were raised in conventional polybags and transfers the seedlings to conservation stand when attain plantable sizes.

## 11. Results and discussion

### 11.1 Component-1 (BAU-Horticulture, Mymensingh)

During survey by FGD information obtained on medicinal plant germplasm at five selected locations are described as follows:

#### Natore

In all, 57 species of medicinal plants were listed during the field survey, having ethnobotanical value. These species belonged to 35 families. Among all families Fabaceae (8 species), Zingiberaceae (5 species) are the more dominant families followed by Combretaceae, Acanthaceae and Lamiaceae (3 species), Euphorbiaceae, Plumbaginaceae, Vitaceae and Apocynaceae (2 species) and 29 families like Liliaceae, Burseraceae, Sterculiaceae, Bombacaceae, Thymelaeaceae, Asparagaceae, Meliaceae, Nyctaginaceae, Convolvulaceae, Moringaceae, Apocynaceae, Verbenaceae, Solanaceae, Piperaceae, Lauraceae, Guttiferae, Lecythidaceae, Aristolochiaceae, Verbenaceae, Salicaceae, Boraginaceae, Smilacaceae, Bixaceae, Phyllanthaceae, Pandanaceae, Asteraceae were represented by single species (Table 6). The identified medicinal plants were herbs, trees, shrubs and climbers. The useful plant parts are leaves, leaves and roots, whole plants, only roots, bark, latex, and leaves and bark, seeds etc. These are administered mostly orally and a range of preparations such as decoction, paste and powder are adopted. Most of these preparations are made from the freshly collected plants just before the use; however, some are also used in dry form. All 39 families are found to contribute for various ethno botanical values used by the local people for the treatment of various diseases like diarrhoea, dysentery, cough, sore throat, fever, malaria, eczema, ulcers, headache, asthma, toothache, diuretic, diabetes, cholera, smallpox, jaundice, wounds, skin disease, piles and etc. Most of the species were used for curing more than one disease.

Commercial cultivation of some medicinal plants in field were also observed because farmers earned more income than rice or other crops. Out of 57 species, 8-10 species are commercially cultivating in the field. According to stake holders Aloe vera, Shimul alu and Ashogandha are cultivating in 150ha, 100ha and 20ha of lands respectively some others are cultivating in homestead. Bashok were planted both side of the road. Some medicinal plant species are currently used by local inhabitants for medicinal purposes to cure several diseases. Even though some respondents have good knowledge on uses of medicinal plants but they are practicing home remedies based on requirement only.

**Table 6.** Medicinal Plants recorded from Kathalbaria, Laxmipur union, Natore

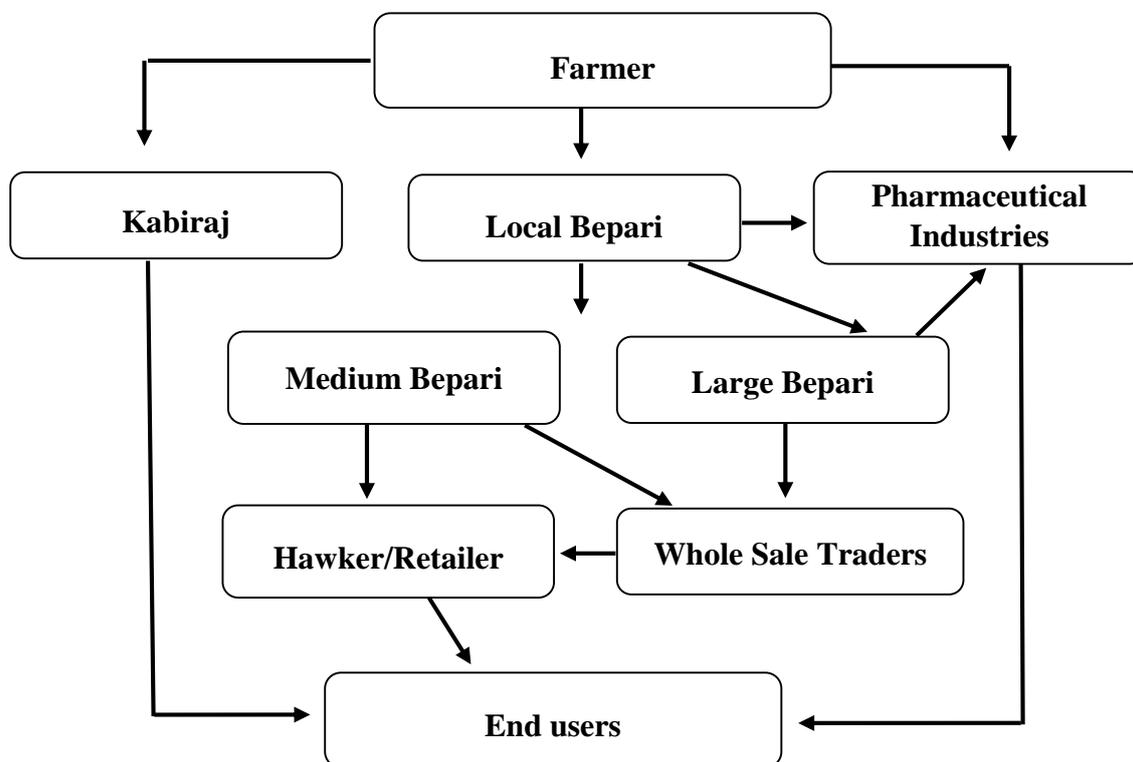
Sl No	Local name	English name	Scientific name	Family
1.	GritoKumari	Indian Aloe	<i>Aloe barbadensis</i>	Liliaceae
2.	Bashok	Malabar Nut	<i>Justicia adhatoda</i>	Acanthaceae
3.	Olotkombol	Devils Cotton	<i>Abroma augusta</i>	Sterculiaceae
4.	Shimul	Silk Cotton tree	<i>Bombax ceiba</i>	Bombacaceae
5.	Kalomegh	Creast	<i>Andrographis paniculata</i>	Acanthaceae
6.	Agor	Aloe wood	<i>Aquilaria malaccensis</i>	Thymelaeaceae
7.	Sotomuli	Asparagus	<i>Asparagus racemosus</i>	Asparagaceae
8.	Neem	Indian lilac	<i>Azadirachta indica</i>	Meliaceae
9.	Kanchon	Wild ebony	<i>Bauhinia acuminata</i>	Fabaceae
10.	Punornova	Pigweed	<i>Boerhavia diffusa</i>	Nyctaginaceae
11.	Polas	Bastard Teak	<i>Butea monosperma</i>	Fabaceae

**Table 6. Contd. ....**

Sl No	Local name	English name	Scientific name	Family
12.	Sonalu	Indian Laburnum	<i>Cassia fistula</i>	Fabaceae
13.	Harzora	Veldt Grape	<i>Cissus quadrangularis</i>	Vitaceae
14.	Vuikumra	Giant potato	<i>Ipomoea mauritiana</i>	Convolvulaceae
15.	Sojina	Drum stick	<i>Moringa Oleifera</i>	Moringaceae
16.	Sarpogandha	Snake Root	<i>Rauvolfia serpentina</i>	Apocynaceae
17.	Vharenda	Bellyach bush	<i>Jatropha gossygifolia</i>	Euphorbiaceae
18.	Torup chondal	Telegraph plant	<i>Codariocalyx motorius</i>	Fabaceae
19.	Ashok	Ashok	<i>Saraca asoca</i>	Fabaceae
20.	Arjun	Arjuna (Arjun)	<i>Terminalia arjuna</i>	Combretaceae
21.	Bohera	Beleric Myrobalan	<i>Terminalia bellirica</i>	Combretaceae
22.	Horitoki	ChebulicMyrobalan	<i>Terminalia chebula</i>	Combretaceae
23.	Nisinda	Chaste Tree	<i>Vitex negundo</i>	Verbenaceae
24.	Ashwagandha	Winter Cherry	<i>Withania somnifera</i>	Solanaceae
25.	Misridana	Peacock ginger	<i>Kaempferi rotunda</i>	Zingiberaceae
26.	Piple	Long pepper	<i>Piper longum</i>	Piperaceae
27.	Tejpata	Indian bay leaf	<i>Cinnamomum tamala</i>	Lauraceae
28.	Nageshwarchapa	Ceylon Irishwood	<i>Mesua nagassarium</i>	Guttiferae
29.	Naglingom	Cannonball tree	<i>Couropita guianensis</i>	Lecythidaceae
30.	kiamul	Costus	<i>Costus speciosus</i>	Zingiberaceae
31.	Ishermul	Indian birthwort	<i>Aristolochia indica</i>	Aristolochiaceae
32.	Goniori	Agnimantha	<i>Premna integrifolia</i>	Verbenaceae
33.	Boichi	Governor's plum	<i>Flacourtia indica</i>	Salicaceae
34.	Boula gota	Indian cherry	<i>Cordia dichotoma</i>	Boraginaceae
35.	Commifora	Indianbelliumtree	<i>Commiphora wightii</i>	Burseraceae
36.	kumari lota	Black creeper	<i>Smilax perfoliata</i>	Smilacaceae
37.	kharajora	Litsea	<i>Litsea monopetala</i>	Lauraceae
38.	Hatikarna	Hatikarna	<i>Leea macrophylla</i>	Vitaceae
39.	Nil chita	Blue Plumbago	<i>Plumbago capensis</i>	Plumbaginaceae
40.	Rongdana	Lipstick tree	<i>Bixa orellana</i>	Bixaceae
41.	Kalo nirbish	Curcuma	<i>Curcuma rubescens</i>	Zingiberaceae
42.	Sada nirbish	Curcuma sp	<i>Curcuma sp.</i>	Zingiberaceae
43.	Orboroi	Star Gooseberry	<i>Phyllanthus acidus</i>	Phyllanthaceae
44.	Polao pata	Pandan	<i>Pandanus amaryllifolius</i>	Pandanaceae
45.	Nagdana	Mugwort	<i>Artemisia vulguris</i>	Asteraceae
46.	Dad mordon	Candle bush	<i>Senna alata</i>	Fabaceae
47.	Kalo Tulsi	Holy basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
48.	Tulsi	Holy basil	<i>Ocimum americana</i>	Lamiaceae
49.	Rokto chita	Ceylon leadwort	<i>Plumbago zeylanica</i>	Plumbaginaceae
50.	Ananta Mul	Indian sarsparilla	<i>Hemidesmus indicus</i>	Apocynaceae
51.	Holud Basok	Malabar nut	<i>Justicia adhatoda</i>	Acanthaceae
52.	Kurchi	Big tiger milk	<i>Holarrhena pubesens</i>	Apocynaceae
53.	Daruchini	Cinnamon	<i>Cinnamomumzeylanicum</i>	Zingiberaceae
54.	Shetdron	Thumbai	<i>Leucas aspera</i>	Lamiaceae
55.	Babla	Gum arabic tree	<i>Acacia nilotica</i>	Fabaceae
56.	Kanch	Rosary pea	<i>Abrus precatorius</i>	Fabaceae
57.	Bhui Amla	Seed on the leaf	<i>Phyllanthus niruri</i>	Euphorbiaceae

## Supply chain of medicinal plants products at Natore

According to the opinion of participants during FGD the local raw materials of medicinal plants are mostly distributed as shown Fig. 24. From the figure it is observed that local processors like Bepari and Kabiraj collect medicinal plants from the farmers. Pharmaceutical companies also collect medicinal plants from the farmers to produce herbal products. Kabiraj and pharmaceutical companies process the medicinal plants and produce herbal products and they directly sell those to the end user/consumers. Local traders sell the medicinal plants to the whole sale traders, hawkers and consumers, both in raw and processed form.



**Fig. 24.** Supply chain of medicinal plants and plant products

## Modhupur, Tangail

In Modhupur, Tangail a wide diversity of the medicinal plants is recorded during the survey. In total 68 medicinal plants species were documented which belongs to 37 different families (Table 7). Among the recorded families Fabaceae consisted highest species (8) followed by Apocynaceae and Malvaceae (5 species), Solanaceae (4 species), Combretaceae, Acanthaceae, Lamiaceae and Euphorbiaceae (3 species), Vitaceae, Verbenaceae, Zingiberaceae, Piperaceae, Phyllanthaceae, Moraceae and Amaranthaceae (2 species). Rest 21 families like Thymelaeaceae, Pandanaceae, Passifloraceae, Apiaceae, Plumbaginaceae Asparagaceae, Rosaceae, Sterculiaceae Nyctaginaceae Mimosaceae Rubiaceae Asteraceae, Convolvulaceae, Meliaceae, Smilacaceae, Boraginaceae, Rutaceae, Liliaceae, Oxidaceae, Cucurbitaceae, Menispermaceae Anacardiaceae, Bombaceae were represented by single species. Kalomegh, Bashok, Tulshi, Aloe vera are cultivating in a small scale. During survey it is noticed that many of the medicinal plant species are about to exploited and will face extinction if they are not duly protected or cultivated. Some species of medicinal plants already lost. The most important direct causes of biodiversity loss include logging, the conversion of forested lands for agriculture and cattle-raising, urbanization, mining and oil exploitation, acid rain and fire. However, there has been a tendency of highlighting small-scale migratory farmers or “poverty” as the major cause of forest loss. Such farmers tend to settle along roads through the forest, to

clear a patch of land and to use it for growing subsistence or cash crops. The result is an entirely degraded piece of land which will be unable to recover its original biomass. Deforestation and degradation of species rich natural forest of Modhupur Tangail of Bangladesh is responsible for the loss of species. Many people living in Modhupur used herbal plants for the treatment of various ailments. It is worth mentioning that the usual complaints mainly deal with minor digestive disorders, colic, kidney stones, constipation, abdominal pain, cough and asthma. In certain circumstances, the herbal plants are used for treating more serious diseases such as diabetes and heart disease. The useful plant parts used to make herbal preparation are roots, fruits, leaves, sepals, bulbs and flowers.

**Table 7.** List of Medicinal plants at Modhupur, Tangail

SLNo	Local name	English name	Scientific name	Family
1.	Bohera	Beleric Myrobalan	<i>Terminalia bellirica</i>	Combretaceae
2.	Horitoki	Chebulic Myrobalan	<i>Terminalia chebula</i>	Combretaceae
3.	Agor	Aloe wood	<i>Aquilaria malaccensis</i>	Thymelaeaceae
4.	Rosy Periwinkle	Nayantara	<i>Catharanthus roseus</i>	Apocynaceae
5.	Sonalu	Indian Laburnum	<i>Cassia fistula</i>	Fabaceae
6.	Passion fruit	Tang fruit	<i>Passiflora edulis</i>	Passifloraceae
7.	Sarpogandha	Snake Root	<i>Rauwolfia serpentina</i>	Apocynaceae
8.	Thankuni/ Dholmanik	Indian Pennywort	<i>Centella asiatica</i>	Apiaceae
9.	Chita	Ceylon Leadwort	<i>Plumbago zeylancia</i>	Plumbaginaceae
10.	Bashok	Malabar Nut	<i>Justicia adhatoda</i>	Acanthaceae
11.	Sotomuli	Asparagus	<i>Asparagus densiflorus</i>	Asparagaceae
12.	Aparajita	Butterfly Pea	<i>Clitoria ternatea</i>	Fabaceae
13.	Harzora	Veldt Grape	<i>Cissus quadrangularis</i>	Vitaceae
14.	Ashogandha	Winter Cherry	<i>Withania somnifera</i>	Solanaceae
15.	Nisinda	Chaste Tree	<i>Vitex negundo</i>	Verbenaceae
16.	Alu Bokhara	Plums	<i>Prunus domestica</i>	Rosaceae
17.	Olotkombol	Devils Cotton	<i>Abroma augusta</i>	Stereuliaceae
18.	Ashok	Ashok	<i>Saraca asoca</i>	Fabaceae
19.	Punornova	Pigweed	<i>Boerhavia diffusa</i>	Nyctaginaceae
20.	Lojjaboti	Himalyan Mimosa	<i>Mimosa rubicaulis</i>	Mimosaceae
21.	Polas	Bastard Teak	<i>Butea monosperma</i>	Fabaceae
22.	Morinda	Indian Mulbery	<i>Morinda citrifolia</i>	Rubiaceae
23.	Stevia	Stevia	<i>Stevia rebaudiana</i>	Asteraceae
24.	Misridana	Peacock ginger	<i>Kaempferi rotunda</i>	Zingiberaceae
25.	Gritokumari	Indian Aloe	<i>Aloe barbadensis</i> Mill.	Liliaceae
26.	Tulsi	Holy Basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
27.	Piple	Long pepper	<i>Piper longum</i> L.	Piperaceae
28.	Akondo	Giant milk weed	<i>Calotropis gigantea</i>	Apocynaceae
29.	Kalomegh	Creat	<i>Andrographis paniculata</i>	Acanthaceae
30.	Vuikumra	Giant potato	<i>Ipomoea mauritiana</i>	Convolvulaceae
31.	TorupChondal	Telegraph plant	<i>Codariocalyx motorius</i>	Fabaceae
32.	Dhutura	Devils trumpet	<i>Datura metel</i>	Solanaceae
33.	Vherenda	Bellyach bush	<i>Jatropha gossypifolia</i>	Euphorbiaceae

**Table 7. Contd. ....**

SLNo	Local name	English name	Scientific name	Family
34.	Neem	Indian lilac	<i>Azadirachta indica</i>	Meliaceae
35.	Polao pata	Pandan	<i>Pandanus amaryllifolius</i>	Pandanaceae
36.	Amloki	Indian gooseberry	<i>Phyllanthus emblica</i>	Phyllanthaceae
37.	Alkushi	Velvet bean	<i>Mucuna pruriens</i>	Fabaceae
38.	Joypal	Purging croton	<i>Croton tiglium</i>	Euphorbiaceae
39.	Kumarilota	Kumarika	<i>Smilax perfoliata</i>	Smilacaceae
40.	Cat's tail	Chenille plant	<i>Acalypha hispida</i>	Euphorbiaceae
41.	Choi jhal	Choi jhal	<i>Piper chaba</i>	Piperaceae
42.	Alkananda	Allamanda	<i>Allamanda catharica</i>	Apocynaceae
43.	Hatir shoor	Heliotrope	<i>Heliotropium indicum</i>	Boraginaceae
44.	Bael	Wood apple	<i>Aegle marmelos</i>	Rutaceae
45.	Bilimbi	Bilimbi	<i>Averrhoa bilimbi</i>	Oxidaceae
46.	Amloki	emblic myrobalan	<i>Phyllanthus emblica</i>	Phyllanthaceae
47.	Kontikari	Red buffalo bur	<i>Solanum sisymbriifolium</i>	Solanaceae
48.	Petari	Indian Mallow	<i>Abutilon indicum</i>	Malvaceae
49.	Shalpani	Salparni	<i>Desmodium gangeticum</i>	Fabaceae
50.	Sugondbhala	Oregano	<i>Plectranthus amboinicus</i>	Lamiaceae
51.	Gonga Sagor	Cissus sp.	<i>Cissus sp.</i>	Vitaceae
52.	Arjun	Arjuna (Arjun)	<i>Terminalia arjuna</i>	Combretaceae
53.	Bot	Banyan Fig	<i>Ficus benghalensis</i>	Moraceae
54.	Telakucha	Ivy gourd	<i>Coccinia grandis</i>	Cucurbitaceae
55.	Kantati	Baleria	<i>Barleria prionitis</i>	Acanthaceae
56.	Punnagchampa	Shell zinger	<i>Alpinia zerumbet</i>	Zingiberaceae
57.	Roselle	Roselle	<i>Hibiscus sabdariffa</i>	Malvaceae
58.	Bisulla koroli	Ruby leaf	<i>Alternanthera brasiliiana</i>	Amaranthaceae
59.	Ram Tulsi	Holy basil	<i>Ocimum gratissicum</i>	Lamiaceae
60.	Nil shoor	Blue snake weed	<i>Stachytarpheta jamaicensis</i>	Verbenaceae
61.	Gulancha	Heartleaved moonseed	<i>Tinospora cordifolia</i>	Menispermaceae
62.	Rokto chondon	Red sandal wood	<i>Adenathera pavanina</i>	Fabaceae
63.	Udal	Chinese parasol	<i>Firmiana simplex</i>	Malvaceae
64.	Civit	Merpauh	<i>Swintonia floribanda</i>	Anacardiaceae
65.	Burma shimul	Kapok	<i>Ceiba pentandra</i>	Bombaceae
66.	Titbegun	Poison berry	<i>Solanum indicum</i>	Solanaceae
67.	Apang	Prickly chaff flower	<i>Achyranthes aspera</i> Linn.	Amaranthaceae
68.	Orhto shiphon	Orhto shiphon	<i>Orthosiphon aristatus</i>	Lamiaceae
69.	Dudh koruch	Woole dyeing Rosebay	<i>Wrightia arborea</i>	Apocynaceae
70.	Berela	Country Mallow	<i>Sida cordifolia</i>	Malvaceae
71.	Dumur	Fig	<i>Ficus rasemosa</i>	Moraceae

## Jamalpur

Less availability of medicinal plants is recorded after surveying Jamalpur. Only nine different medicinal plant species are noticed (Table 8). The recorded medicinal plants were Neem, Grito Kumari, Nisinda, Bashok, Arjun, Simul, Tulsi, Bohera and Horitoki. These medicinal plants belongs the families of Meliaceae, Liliaceae, Verbenaceae, Acanthaceae, Bombacaceae, Lamiaceae Combretaceae. Combretaceae was the dominant family which consisted of 3 species and other families consisted single species. In Jamalpur commercial cultivation of medicinal plants was not observed. All the medicinal plants were found in the homestead area or road side and other places.

**Table 8.** List of Medicinal plants recorded in Jamalpur

SLNo	Local name	English name	Scientific name	Family
1.	Neem	Indian lilac	<i>Azadirachta indica</i>	Meliaceae
2.	GritoKumari	Indian Aloe	<i>Aloe barbadensis</i>	Liliaceae
3.	Nisinda	Chaste Tree	<i>Vitex negundo</i>	Verbenaceae
4.	Bashok	Malabar Nut	<i>Justicia adhatoda</i>	Acanthaceae
5.	Arjun	Arjuna (Arjun)	<i>Terminalia arjuna</i>	Combretaceae
6.	Simul	Silk Cotton tree	<i>Bombax ceiba</i>	Bombacaceae
7.	Tulsi	Holy Basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
8.	Bohera	Beleric Myrobalan	<i>Terminalia bellirica</i>	Combretaceae
9.	Horitoki	Chebulic Myrobalan	<i>Terminalia chebula</i>	Combretaceae

## Sherpur

To collect information on medicinal plant FGD were conducted at Zhinaigati and Shribordi. In total 17 different medicinal plants species of 13 different families are found in Sherpur (Table 9). The families were Liliaceae, Asparagaceae, Acanthaceae, Fabaceae, Vitaceae, Lamiaceae, Verbenaceae, Apocynaceae, Euphorbiaceae, Nyctaginaceae, Solanaceae, Zingiberaceae and Combretaceae. In the homestead of Mst. Shefali Begum at Nawkuchi, Bakakura, Zhinaigati several medicinal plants like Bashok, Grito Kumari, Sotomuli, Kalomegh, Tulshi, Harzora, Sarpogandha, Ashogandha, Ekangi and Mishridana were seen. She developed at small nursery of medicinal plant at her homestead. Which she inharited from her late husband. Now she is maintaining the nursery with difficulties. At Hariakona village of Shingaboruna union of Shribordi Upazila Mr. Pranjol M. Samgma is cultivating Aloe vera and Sotomuli in the hilly areas. In the hill and homestead some medicinal plants are also growing naturally. A good number of medicinal plants found at Nawkuchi, Bakakura, and Zhinaigati than Shribordi.

## Mymensingh

The relative prevalence of medicinal plants in Mymensingh has been shown in (Table 10). In total 23 medicinal plant species are listed in Mymensingh. Twenty families consisted the 23 medicinal plant species. The families were Acanthaceae, Combretaceae, Apocynaceae, Lamiaceae, Verbenaceae, Liliaceae, Asparagaceae, Bombacaceae, Meliaceae, Zingiberaceae, Moringaceae, Apocynaceae, Fabaceae, Poaceae, Mackinlayaceae, Cucurbitaceae, Fabaceae, Moraceae, Solanaceae and Crassulaceae. The most prevalent species in the study area were Bashok, Arjun, Bohera, Hortoki, GritoKumari, Thankuni, Nayantara, Tulsi, Nisinda, Shimul, Akonda, Sajina and Patharkuchi etc. All these species were found in almost in the homestead area.

**Table 9.** List of Medicinal plants, Sherpur

SL No	Local name	English Name	Scientific Name	Family
1	GritoKumari	Indian Aloe	<i>Aloe barbadensis</i> Mill.	Liliaceae
2	Sotomuli	Asparagus	<i>Asparagus racemosus</i>	Asparagaceae
3	Kalomegh,	Creast	<i>Andrographis paniculata</i>	Acanthaceae
4	TorupChondal	Telegraph plant	<i>Codariocalyxmotorius</i>	Fabaceae
5	Harzora	Veldt Grape	<i>Cissusquadrangularis</i> L.	Vitaceae
6	Tulsi	Holy Basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
7	Bashok	Malabar Nut	<i>Justicia adhatoda</i> L.	Acanthaceae
8	Sarpogandha	Snake Root	<i>Rauwolfia serpentina</i>	Apocynaceae
9	Vherenda	Bellyach bush	<i>Jatropha gossypifolia</i>	Euphorbiaceae
10	Punornova	Pigweed	<i>Boerhavia diffusa</i> L.	Nyctaginaceae
11	Nisinda	Chaste Tree	<i>Vitex negundo</i> L.	Verbenaceae
12	Ashogandha	Winter Cherry	<i>Withania somnifera</i> L.	Solanaceae
13	Ekangi	Aromatic zinger	<i>Zingiber zerumbet</i>	Zingiberaceae
14	Misridana	Peacock ginger	<i>Kaempferia rotunda</i>	Zingiberaceae
15	Bohera	Beleric Myrobalan	<i>Terminalia bellirica</i>	Combretaceae
16	Horitoki	Chebulic Myrobalan	<i>Terminalia chebula</i>	Combretaceae
17	Arjun	Arjuna (Arjun)	<i>Terminalia arjuna</i>	Combretaceae

**Table 10.** List of Medicinal plants, Mymensingh

SL No	Local name	English Name	Scientific Name	Family
1.	Bashok	Malabar Nut	<i>Justicia adhatoda</i> L.	Acanthaceae
2.	Arjun	Arjuna	<i>Terminalia arjuna</i> L.	Combretaceae
3.	Bohera	BelericMyrobalan	<i>Terminalia bellirica</i>	Combretaceae
4.	Horitoki	ChebulicMyrobalan	<i>Terminalia chebula</i>	Combretaceae
5.	Nayantara	Rosy Periwinkle	<i>Catharanthus roseus</i> L.	Apocynaceae
6.	Tulsi	Holy Basil	<i>Ocimumteniflorum.</i>	Lamiaceae
7.	Nisinda	Chaste Tree	<i>Vitex negundo</i> L.	Verbenaceae
8.	GritoKumari	Indian Aloe	<i>Aloe barbadensis</i> Mill.	Liliaceae
9.	Sotomuli	Asparagus	<i>Asparagus densiflorus</i>	Asparagaceae
10.	Simul	Silk Cotton tree	<i>Bombax ceiba</i> L.	Bombacaceae
11.	Neem	Indian lilac	<i>Azadirachta indica</i>	Maliaceae
12.	Cardamom	Cardamom	<i>Ellettaria cardamomum</i>	Zingiberaceae
13.	Sojina	Drum stick	<i>Moringa Oleifera</i>	Moringaceae
14.	Akando	Giant milk weed	<i>Calotropis gigantea</i>	Apocynaceae
15.	Arhor	Pigeon pea	<i>Cajanus cajan</i>	Fabaceae
16.	Ekangi	Aromatic zinger	<i>Kaempferia galanga</i>	Zingiberaceae
17.	Lemongrass	Lemongrass	<i>Cymbopogon citratus</i>	Poaceae
18.	Thankuni	Indian pennywort	<i>Centella asiatica</i>	Mackinlayaceae
19.	Telakucha	Ivygourd	<i>Coccinia grandis</i>	Cucurbitaceae
20.	Sonalu	Sonalu	<i>Cassia fistula</i>	Fabaceae
21.	Dumur	Fig	<i>Ficus racemosa</i>	Moraceae
22.	Datura	Thornapples	<i>Datura metel</i>	Solanaceae
23.	Pathorkuchi	Cathedral bells	<i>Bryophyllum pinnatum</i>	Crassulaceae

## Collection of medicinal plant species from selected locations

Several visits were done during the project period at Natore, Tangail (Modhupur), Jamalpur, Sherpur and Mymensingh to collect medicinal plant germplasm. In total 126 medicinal plants were collected (Table 11). Most of the medicinal plants were collected from Modhupur and Natore due to availability of medicinal plant germplasm there. Only few medicinal plants were collected from Jamalpur, Sherpur and Mymensingh.

### *Ex-situ* conservation of collected medicinal plant at BAU GPC

The goal of conservation is to support sustainable development by protecting and using biological resources in ways that do not diminish the world's variety of genes and species or destroy important habitats and ecosystems. In general, it involves activities such as collection, propagation, characterization, evaluation, disease indexing and elimination, storage and distribution. The conservation of plant genetic resources has long been realized as an integral part of biodiversity conservation. One of the approaches of medicinal plants conservations is *Ex-situ* conservation. *Ex-situ* conservation involves conservation outside the native habitat and is generally used to safeguard populations in danger of destruction, replacement or deterioration. In total 126 medicinal plant species were collected and planted at BAU-GPC during project period (Table 11 & Fig 25).

**Table 11.** Medicinal plants conserved at BAU-GPC

Sl No.	Local name	English name	Scientific name	Family
<b>Planted from July 2018 to June 2019</b>				
1	Bashok	Malabar Nut	<i>Justicia adhatoda</i>	Acanthaceae
2	Olotkombol	Devils Cotton	<i>Abroma augusta</i>	Stereuliaceae
3	Grito Kumari	Indian Aloe	<i>Aloe barbadensis</i>	Liliaceae
4	Morinda	Indian Malbery	<i>Morinda Citrifolia</i>	Rubiaceae
5	Kalomegh	Creast	<i>Andrographis paniculata</i>	Acanthaceae
6	Agor	Aloe wood	<i>Aquilaria malaccensis</i>	Thymelaeaceae
7	Sotomuli	Asparagus	<i>Asparagus racemosus</i>	Asparagaceae
8	Neem	Indian lilac	<i>Azadiracht aindica</i>	Meliaceae
9	Kanchon	Wild ebony	<i>Bauhinia acuminata</i>	Cesalpiniaceae
10	Punarnava	Pigweed	<i>Boerhavia diffusa</i>	Nyctaginaceae
11	Polas	Bastard Teak	<i>Butea monosperma</i>	Fabaceae
12	Mahua	Butter tree	<i>Madhuca indica</i>	Sapotaceae
13	Sonalu	Indian Laburnum	<i>Cassia fistula</i>	Fabaceae
14	Korpur	Camphor	<i>Cinnamomum camphora</i>	Lauraceae
15	Harzora	Veldt Grape	<i>Cissus quadrangularis</i>	Vitaceae
16	Vuikumra	Giant potato	<i>Ipomoea mauritiana</i>	Convolvulaceae
17	Tulsi	Holy Basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
18	Sarpogandha	Snake Root	<i>Rauwolfia serpentina</i>	Apocynaceae
19	Lal bherenda	Bellyache bush	<i>Jatropha gossypifolia</i>	Euphorbiaceae
20	Simul	Silk Cotton tree	<i>Bombax ceiba</i>	Bombacaceae
21	Ashok	Ashok	<i>Saraca asoca</i>	Fabaceae
22	Arjun	Arjuna	<i>Terminalia arjuna</i>	Combretaceae
23	Bohera	Beleric Myrobalan	<i>Terminalia bellirica</i>	Combretaceae

**Table 11. Contd. ....**

SI No.	Local name	English name	Scientific name	Family
24	Horitoki	ChebulicMyrobalan	<i>Terminalia chebula</i>	Combretaceae
25	Nisinda	Chaste Tree	<i>Vitex negundo</i>	Verbenaceae
26	Ashawagandha	Winter Cherry	<i>Withania somnifera</i>	Solanaceae
27	Misridana	Peacock ginger	<i>Kaempferi rotunda</i>	Zingiberaceae
28	Piple	Long pepper	<i>Piper longum</i>	Piperaceae
29	Tejpata	Indian bay leaf	<i>Cinnamomum tamala</i>	Lauraceae
30	Torupchondal	Telegraph plant	<i>Codariocalyx motorius</i>	Fabaceae
31	Joba	China rose	<i>Hibiscus rosa-sinensis</i>	Malvaceae
32	Lojjaboti	Himalyan Mimosa	<i>Mimosa rubicaulis</i>	Mimosaceae
33	Akondo	Giant milk weed	<i>Calotropis gigantea</i>	Apocynaceae
34	Aporajita	Butterfly Pea	<i>Clitoria ternatea</i>	Fabaceae
35	Elaichi	Cardamom	<i>Ellettaria cardamomum</i>	Zingiberaceae
36	Hijol	Barringtonia	<i>Barringtonia acutangula</i>	Lecythidaceae
37	Tomal	Mottled ebony	<i>Diospyros montana</i>	Ebenaceae
38	Pathorkuchi	Cathedral bells	<i>Bryophyllum pinnatum</i>	Crassulaceae
39	Dholsomudro	Elephant ear tree	<i>Leea machrophylla</i>	Leaceae
40	Nayantara	Rosy Periwinkle	<i>Catharanthus roseus</i>	Apocynaceae
41	Stevia	Stevia	<i>Stevia rebaudiana</i>	Asteraceae
42	Jog dumur	Cluster fig	<i>Ficus racemosa</i>	Moraceae
43	Hazari Bely	Glory bower	<i>Clerodendrum fragrans</i>	Verbenaceae
44	Anti-diabetic plant	Gynura	<i>Gynura procumbens</i>	Asteraceae
45	Arhar	Pigeon pea	<i>Cajanus cajan</i>	Fabaceae
46	Ekangi	Aromatic zinger	<i>Kaempferia galanga</i>	Zingiberaceae
47	Pudina	Spear mint	<i>Mentha spicata</i>	Lamiaceae
48	Sajina	Moringa	<i>Moringa oleifera</i>	Moringaceae
49	Lemon grass	Lemon grass	<i>Cymbopogon citratus</i>	Poaceae
50	Gada	Marigold	<i>Tagetes spp.</i>	Asteraceae
<b>Planted from July 2019 to June 2020</b>				
01	Kontikari	Red buffalobur	<i>Solanum sisymbriifolium</i>	Solanaceae
02	Nageshwar chapa	Ceylon Irishwood	<i>Mesua nagassarium</i>	Guttiferae
03	Naglingom	Cannonball tree	<i>Couroupita guianensis</i>	Lecythidaceae
04	kiamul	Costus	<i>Costus speciosus</i>	Zingiberaceae
05	Ishermul	Indian birthwort	<i>Aristolochia indica</i>	Aristolochiaceae
06	Goniori	Agnimantha	<i>Premna integrifolia</i>	Verbenaceae
07	Euphorbia	Euphorbia	<i>Euphorbia milii</i>	Euphorbiaceae
08	Boichi	Governor's plum	<i>Flacourtia indica</i>	Salicaceae
09	Ritha	Soapnut tree	<i>Sapindus trifoliatus</i>	Sapindaceae
10	Alkananda	Allamanda	<i>Allamanda catharica</i>	Apocynaceae
11	Cat's tail	Chenille plant	<i>Acalypha hispida</i>	Euphorbiaceae
12	Choi jhal	Choi jhal	<i>Piper chaba</i>	Piperaceae
13	Joypal/Jamalgota	Purging croton	<i>Croton tiglium</i>	Euphorbiaceae
14	Golap	Rose	<i>Rosa rubiginosa</i>	Rosaceae

**Table 11. Contd. ....**

Sl No.	Local name	English name	Scientific name	Family
15	Hatirshoor	Heliotrope	<i>Heliotropium indicum</i>	Boraginaceae
16	Bael	Wood apple	<i>Aegle marmelos</i>	Rutaceae
17	Bilimbi	Bilimbi	<i>Averrhoa bilimbi</i>	Oxidaceae
18	Dudraj	Euphorbia	<i>Euphorbia tirucalli</i>	Euphorbiaceae
19	Amloki	Emblic myrobalan	<i>Phyllanthus emblica</i>	Phyllanthaceae
20	Boula	Indian cherry	<i>Cordia dichotoma</i>	Boraginaceae
21	Commifora	Indianbellium-tree	<i>Commiphora wightii</i>	Burseraceae
22	kumari lota	Black creeper	<i>Smilax perfoliata</i>	Smilacaceae
23	Petari	Indian Mallow	<i>Abutilon indicum</i>	Malvaceae
24	Kanaidinga	Midnight horror	<i>Oroxylum indicum</i>	Bignoniaceae
25	Nil chita	Blue Plumbago	<i>Plumbago capensis</i>	Plumbaginaceae
26	Pasanbedi	Ghost plant	<i>Graptopatalum paraguayenac</i>	Crassulaceae
27	Rongdana	Lipstick tree	<i>Bixa orellana</i>	Bixaceae
28	Shalpani	Salparni	<i>Desmodium gangeticum</i>	Fabaceae
29	Coleus	Indina borage	<i>Coleus amboinicus</i>	Lamiaceae
30	Ashoth	Ashoth	<i>Ficus religiosa</i>	Moraceae
31	Bot	Banyan Fig	<i>Ficus benghalensis</i>	Moraceae
32	Dudhsor	Indian spurge tree	<i>Euphorbia neriifolia</i>	Euphorbiaceae
33	Telakucha	Ivy gourd	<i>Coccinia grandis</i>	Cucurbitaceae
34	Amada	Mangozinger	<i>Curcuma amada</i>	Zingiberaceae
35	Mehedi	Henna	<i>Lawsonia inermis</i>	Lythraceae
36	Ararot	Arrow root	<i>Maranta arudinacea</i>	Marantaceae
37	Kodbel	Wood apple	<i>Limonia acidissima</i>	Rutaceae
38	Shoty	Zedoary	<i>Curcuma zedoaria</i>	Zigiberaceae
39	Orboroi	Star Gooseberry	<i>Phyllunthus acidus</i>	Phyllanthaceae
40	Polao pata	Pandan	<i>Pandanus odoratissimus</i>	Pandanaceae
41	Gonga Sagor	Gonga Sagor	<i>Cissus sp.</i>	Vitaceae
42	Kalo nirbish	Canna sp	<i>Canna sp.</i>	Zingiberaceae
43	Sada nirbish	Curcuma sp	<i>Curcuma sp.</i>	Zingiberaceae
44	kantati	Barleria	<i>Berlaria prionitis</i>	Acanthaceae
<b>Planted from July 2020 to June 2021</b>				
1	Nagdana	Mug wort	<i>Artemisia vulguris</i>	Asteraceae
2	Dad mordon	Candle bush	<i>Senna alata</i>	Fabaceae
3	Punnag champa	Shell zinger	<i>Alpinia zerumbet</i>	Zingiberaceae
4	Roselle	Roselle	<i>Hibiscus sabdariffa</i>	Malvaceae
5	Gurboch	Sweet flag	<i>Acorus calamus</i>	Acoraceae
6	Bisulla koroli	Ruby leaf	<i>Alternanthera brasiliiana</i>	Amaranthaceae
7	Petari	Indian mallow	<i>Abutilon indicum</i>	Mulvaceae
8	Ram Tulsi	Holy basil	<i>Ocimum gratissicum</i>	Lamiaceae
9	Kalo Tulsi	Holy basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
10	Tulsi	Holy basil	<i>Ocimum americana</i>	Lamiaceae
11	Pashan Bedi	Pashan Bedi	<i>Bergenia ligulata</i>	Saxifragaceae
12	Rokto chita	Ceylon leadwort	<i>Plumbago zeylanica</i>	Plumbaginaceae

**Table 11. Contd. ....**

Sl No.	Local name	English name	Scientific name	Family
13	Ananta Mul	Indian sarsparilla	<i>Hemidesmus indicus</i>	Apocynaceae
14	Holud Basok	Malabar nut	<i>Justicia adhatoda</i>	Acanthaceae
15	Nil shoor	Blue snake weed	<i>Stachytarpheta jamaicensis</i>	Verbenaceae
16	Kurchi	Big tiger milk	<i>Holerrhena pubesens</i>	Apocynaceae
17	Gulanchar	Amruthaballi	<i>Tinospora cordifolia</i>	Menispermaceae
18	kathali chapa	Tail grape	<i>Artabotrys hexapetalus</i>	Annonaceae
19	Rokto chondon	Red sandal wood	<i>Adenathera pavanina</i>	Fabaceae
20	Daruchini	Cinnamon	<i>Cinnamomum zeylanicum</i>	Zingiberaceae
21	Udal	Chinese parasol	<i>Firmiana simplex</i>	Malvaceae
22	Civit	Merpauh	<i>Swintonia floribanda</i>	Anacardiaceae
23	Burma shimul	Kapok	<i>Ceiba pentandra</i>	Bombaceae
24	Shetdron	Thumbai	<i>Leucas aspera</i>	Lamiaceae
25	Babla	Gum arabic tree	<i>Acacia nilotica</i>	Fabaceae
26	Berela	Country-Mallow	<i>Sida cordifolia</i>	Malvaceae
27	Titbegun	Poison berry	<i>Solanum indicum</i>	Solanaceae
28	Apang	Prickly chaff flower	<i>Achyranthes aspera</i> L	Amaranthaceae
29	Orhto shiphon	Orhto shiphon	<i>Orthosiphon aristatus</i>	Lamiaceae
30	Kunch	Rosary pea	<i>Abrus precatorius</i>	Fabaceae
31	Bhui Amla	Seed on the leaf	<i>Phyllanthus niruri</i>	Euphorbiaceae
32	Dudh koruch	Woollydyeing rosebay	<i>Wrightia arborea</i>	Apocynaceae

**Fig 25: Conserved Medicinal Plants at BAU-GPC, Mymensingh**



LN: Bashok  
EN: Malabar nut  
SN: *Justicia adhatoda*



LN: Ulot kombol  
EN: Devils cotton  
SN: *Abroma augusta*



LN: Ghratokumari  
EN: Aloe vera  
SN: *Aloe barbadensis*

**Fig. 25: Contd.....**



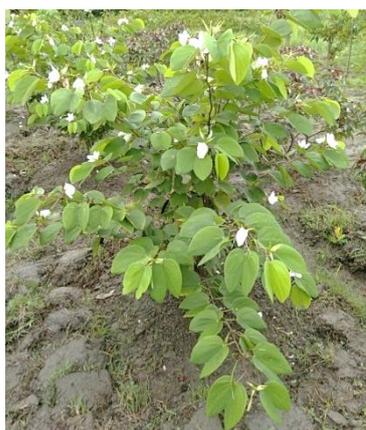
LN: Noni  
EN: Morinda  
SN: *Morinda citrifolia*



LN: Kalomegh  
EN: Creat  
SN: *Andrographis paniculata*



LN: Agor  
EN: Aloe wood  
SN: *Aquilaria malaccensis*



LN: Kanchon  
EN: Camel's foot tree  
SN: *Bauhinia acuminata*



LN: Neem  
EN: Indian lilac  
SN: *Azadirachta indica*



LN: Shotomuli  
EN: Asparagus  
SN: *Asparagus racemosus*



LN: Mahua  
EN: Butter tree  
SN: *Madhuca indica*



LN: Polash  
EN: Bastard teak  
SN: *Butea monosperma*



LN: Punarnova  
EN: Spreading hog- weed  
SN: *Boerhavia diffusa*

**Fig. 25: Contd.....**



LN: Sonalu  
EN: Indian laburnum  
SN: *Cassia fistula*



LN: Korpur,  
EN: Camphor  
SN: *Cinnamomum camphora*



LN: Harzora  
EN: Veldt grape  
SN: *Cissus quadrangularis*



LN: Bhui kumra  
EN: Giant potato  
SN: *Ipomoea mauritiana*



LN: Bherenda  
EN: Bellayche bush  
SN: *Jatropha gossypifolia*



LN: Sarpogandha  
EN: Snake root plant  
SN: *Rauwolfia serpentina*



LN: Shimul  
EN: Silk cotton tree  
SN: *Bombax ceiba*



LN: Ashok  
EN: Ashok  
SN: *Saraca asoca*



LN: Arjun  
EN: Arjun  
SN: *Terminalia arjuna*

**Fig. 25: Contd.....**



LN: Bohera  
 EN: Belliric myrobalan  
 SN: *Terminalia bellirica*



LN: Horitoki  
 EN: Chebulic myrobalan  
 SN: *Terminalia chebula*



LN: Nisinda  
 EN: Chaste tree  
 SN: *Vitex negundo*



LN: Misridana  
 EN: Peacock zinger  
 SN: *Kaempferia rotunda*



LN: Piple  
 EN: long pepper  
 SN: *Piper longum*



LN: Ashwagandha  
 EN: Winter cherry  
 SN: *Withania somnifera*



LN: Tejpata  
 EN: Indian bay leaf  
 SN: *Cinnamomum tamala*



LN: Torup chondal  
 EN: Dancing plant  
 SN: *Codariocalyx motorius*



LN: Akondo  
 EN: Giant milk weed  
 SN: *Calotropis gigantea*

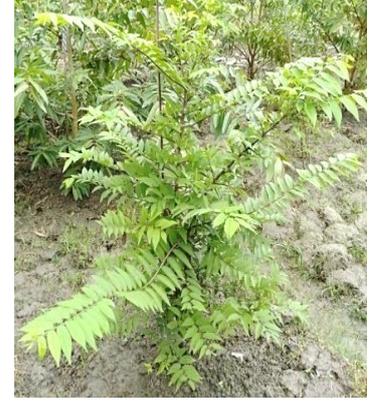
**Fig. 25: Contd.....**



LN: Aparajita  
 EN: Butterfly pea  
 SN: *Clitoria ternatea*



LN: Hijol  
 EN: Itchy tree  
 SN: *Barringtonia acutangula*



LN: Tomal  
 EN: Mottled ebony  
 SN: *Diospyros montana*



LN: Pathorkuchi  
 EN: Cathedral bells  
 SN: *Bryophyllum pinnatum*



LN: Hosti korno Polash  
 EN: Elephant ear plant  
 SN: *Leea machrophylla*



LN: Nayantara  
 EN: Periwinkle  
 SN: *Catharanthus roseus*



LN: Jog Dumur  
 EN: Cluster fig  
 SN: *Ficus racemosa*



LN: Gynura/ Akar  
 EN: Gynura  
 SN: *Gynura procumbens*



LN: Hajari Belly  
 EN: Glory bower  
 SN: *Clerodendrum fragrans*

**Fig. 25: Contd.....**



LN: Pudina  
EN: Spear mint  
SN: *Mentha spicata*



LN: Sajna  
EN: Moringa  
SN: *Moringa oleifera*



LN: Lemon grass  
EN: Lemon grass  
SN: *Cymbopogon citratus*



LN: Kontikari  
EN: Red buffalo bur  
SN: *Solanum sisymbriifolium*



LN: Nageswar chapa  
EN: Ceylon Irishwood  
SN: *Mesua nagassarum*



LN: Kiamul  
EN: Costus  
SN: *Costus speciosus*



LN: Nag lingom  
EN: Cannonball tree  
SN: *Couroupita guianensis*



LN: Ishwar mul  
EN: Indian birthwort  
SN: *Aristolochia indica*



LN: Goniiori  
EN: Agnimantha  
SN: *Premna integrifolia*

**Fig. 25: Contd.....**



LN: Ritha  
EN: Soapnut tree  
SN: *Sapindus trifoliatus*



LN: Alkananda  
EN: Allamanda  
SN: *Allamanda cathartica*



LN: Joypal  
EN: Purging croton  
SN: *Croton triglium*



LN: Hatir shoor  
EN: Heliotrope  
SN: *Heliotropium indicum*



LN: Kumari lota  
EN: Kumarika  
SN: *Smilax spp*



LN: Amloki  
EN: Emblic myrobalan  
SN: *Phyllanthus emblica*



LN: Boula gota  
EN: Indian cherry  
SN: *Cordia dichotoma*



LN: Nil chita  
EN: Blue plumbago  
SN: *Plumbago capensis*



LN: Commiphora  
EN: Indian bdellium tree  
SN: *Commiphora wightii*

**Fig. 25: Contd.....**



LN: Rong dana  
EN: Lipstick tree  
SN: *Bixa orellana*



LN: Nag dana  
EN: Mug wort  
SN: *Artemisia annua*



LN: Salparni  
EN: Salparni  
SN: *Desmodium gangeticum*



LN: Sugondhi Bala  
EN: Indian borage  
SN: *Plectranthus*



LN: Ashoth  
EN: Ashoth  
SN: *Ficus religiosa*



LN: Kodbel  
EN: Wood apple  
SN: *Limonia acidissima*



LN: Orboroi  
EN: Star Gooseberry  
SN: *Phyllanthus acidus*  
Family: *Phyllanthaceae*



LN: Polao Pata  
EN: Pandan  
SN: *Pandanus amaryllifolius*



LN: Gonga Sagor  
EN: Cissus  
SN: *Cissus sp*

Fig. 25: Contd.....



LN: Kalo nirbish  
 EN: Ruby  
 SN: *Curcuma rubescens*



LN: Sada nirbish  
 EN: Curcuma  
 SN: *Curcuma sp*



LN: Kantati  
 EN: Barleria  
 SN: *Barleria prionitis*



LN: Dad mordon  
 EN: Candle bush  
 SN: *Senna alata*



LN: Punnag champa  
 EN: Shell Ginger  
 SN: *Alpinia zerumbet*



LN: Roselle  
 EN: Roselle  
 SN: *Hibiscus sabdariffa*



LN: Gurbach  
 EN: Sweet flag  
 SN: *Acorus calamus*



LN: Bishulla koroli  
 EN: Ruby leaf  
 SN: *Alternanthera brasiliana*



LN: Tulsi  
 EN: Holy basil  
 SN: *Ocimum tenuiflorum*

**Fig. 25: Contd.....**



LN: Kalo Tulsi  
 EN: Red holy basil  
 SN: *Ocimum tenuiflorum*



LN: Tulsi  
 EN: Lime basil  
 SN: *Ocimum americana*



LN: Ram Tulsi  
 EN: Clove basil  
 SN: *Ocimum gratissimum*



LN: Rokto chita  
 EN: Ceylon leadwort  
 SN: *Plumbago zeylanica*



LN: Ananta mul  
 EN: Indian sarsaparilla  
 SN: *Hemidesmus indicus*



LN: Holud Basok  
 EN: Malabar nut  
 SN: *Justicia adhatoda*



LN: Nil shoor  
 EN: Blue snake weed  
 SN: *Stachytarpheta jamaicensis*



LN: Kurchi  
 EN: Big tiger milk  
 SN: *Holarrhena pubescens*



LN: Gulancha  
 EN: Heat-leaved moon seed  
 SN: *Tinospora cordifolia*

**Fig. 25: Contd.....**



LN: Rokto chondon  
 EN: Red Sandalwood  
 SN: *Adenathera pavinana*



LN: Daruchini  
 EN: Cinnamon  
 SN: *Cinnamomum zeylanicum*



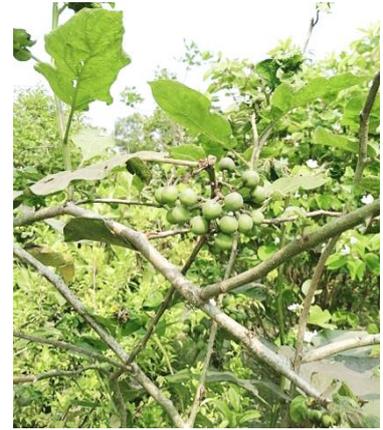
LN: Udal  
 EN: Chinese parasol  
 SN: *Firmiana simplex*



LN: Babla  
 EN: Gum arabic tree  
 SN: *Acacia nilotica*



LN: Berela  
 EN: Common wireweed  
 SN: *Sida acuta*



LN: Brihoti  
 EN: Poison berry  
 SN: *Solanum indicum*



LN: Apang  
 EN: Prickly chaff flower  
 SN: *Achyranthes aspera*



LN: Ortho siphon  
 EN: Ortho shiphon  
 SN: *Orthosiphon aristatus*



LN: Kunch  
 EN: Rosary pea  
 SN: *Abrus precatorius*

**Fig. 25: Contd.....**



LN: Ekangi  
 EN: Aromatic zinger  
 SN: *Kaempferia galanga*



LN: Heem sagor  
 EN: Palm beachbells  
 SN: *Kalanchoe gastonis-bonnieri*



LN: Ban Dhane  
 EN: Sweet broom  
 SN: *Scoparia dulcis*



LN: Jarul  
 EN: Queens crape myrtle  
 SN: *Lagerstroemia speciosa*



LN: Patagota  
 EN: Bonfire tree  
 SN: *Firmiana colorata*



LN: Ghetu/ Bamunhati  
 EN: Turk's turban  
 SN: *Clerodendrum indicum*



LN: Satipata  
 EN: Palm grass  
 SN: *Molinieria capitulata*



LN: Bhat  
 EN: Hill glory bower  
 SN: *Clerodendrum viscosum*



LN: Ayapan  
 EN: Ayapan  
 SN: *Ayapana triplinervis*

**Fig. 25: Contd.....**



LN: Dondo kolos  
 EN: Thumbai  
 SN: *Leucas aspera*



LN: Dudh koruch  
 EN: Woole Dyeing Roosebay  
 SN: *Wrightia arborea*



LN: Burmese shimul  
 EN: Kapok  
 SN: *Ceiba pentandra*



LN: Khara jora  
 EN: Litsea  
 SN: *Litsea monopetala*



LN: Khona  
 EN: Indian trumpet tree  
 SN: *Oroxylum indicum*



LN: Bhui Amla  
 EN: Seed on the leaf  
 SN: *Phyllanthus niruri*



LN: Dudh shor  
 EN: Indian spurge tree  
 SN: *Euphorbia neriifolia*



LN: Euphorbia  
 EN: Crown of thorns  
 SN: *Euphorbia milii*



LN: Euphorbia  
 EN: Crown of thorns  
 SN: *Euphorbia Sp*

**Fig. 25: Contd.....**



LN: Dudh raz  
EN: Milk bush  
SN: *Euphorbia tirucalli*



LN: Pashan bedi  
EN: Ghost plant  
SN: *Graptopetalum paraguayense*



LN: Mehedi  
EN: Henna  
SN: *Lawsonia inermis*



LN: Aam ada  
EN: Mango zinger  
SN: *Curcuma amada*



LN: Ararut  
EN: Arrow root  
SN: *Maranta arudinacea*



LN: Shoty  
EN: Zedoary  
SN: *Curcuma zedoaria*

**Fig. 25:** Conserved Medicinal Plants at BAU-GPC

### Morphological characterization

Morphological visual traits were recorded of the medicinal plants collected from five districts of Bangladesh and conserved at BAU-GPC. At BAU-GPC more than 127 medicinal plants have been conserved. All medicinal plants conserved at BAU-GPC were morphologically characterized from July 2018 to June 2021 (Table 12). Morphological variability is often restricted however, traits may not express at all the stages of the plant development and appearance may be affected by environmental conditions.

The following parameters observed and recorded of the conserved medicinal plants.

**Growth habit of the plant:** Growth habit of the plant was recorded as tree, herb, shrub, creeper/climber etc

**Plant height:** Plant height refers to the length of the plant from ground level up to shoot apex of plant.

Canopy spreading (N-S): It was at from North side to South side of the plant canopy.

Canopy spreading (E-W): It was at from East side to West side of the plant canopy.

Leaf blade length: Leaf blade length was measured from base to tip.

Leaf blade width: The width was measured from one margin to another margin

Petiole length: It was measured from the attach of the petiole to joining of the blade

Leaf shape: It was catgorized according to the IPGRI descriptors of leaf shape.

Leaf apex shape: Leaf apex shape was catgorized according to the IPGRI descriptors

Leaf base shape: Followed by IPGRI descriptors of other plants

Leaf margin: Followed by IPGRI descriptors of other plants

Color of young leaf: Colour was measured using color chart

Color of fully developed leaf: Colour was measured using color chart

With mophological characters, comparison among the *T. chebula* germplasm collected from selected five district swere done but significant difference was not observed. More or less similar observation of growth habit, plant height, canopy spreading (North-South and East - West), leaf shape, leaf blade length (cm), leaf blade width, petiole length , leaf apex shape, leaf base shape, leaf margin, color of young leaf, color of fully developed leaf of the plant were recorded. Similar observation were also recoreded in case of *T. bellerica* and *T. aurjuna*.

**Table 12.** Morphological characteristics of Medicinal Plants

Parameters	Units	Photo
<b>1. Nisinda (Chaste tree) --<i>Vitex negundo</i></b>		
Age of Plant	30 months	
Height	565 cm	
Canopy Spreading(N-S)	355 cm	
Canopy Spreading(E-W)	580 cm	
Leaf Blade Shape	Pedate	
Leaflet Blade Length	16 cm	
Leaf Blade width	2.6 cm	
Petiole Length	06 cm	
Leaf Apex shape	Acute	
Leaf Base shape	Acute	
Leaf Margin	Entire	
Colour of young leaf	Green	
Colour of fully developed leaf	Green	
<b>2. Bashok (Malabar nut)--<i>Justicia adhatoda</i></b>		
Age of Plant	08 months	
Height	67.66 cm	
Canopy Spreading(N-S)	85.33 cm	
Canopy Spreading(E-W)	92.66 cm	
Leaf Blade Shape	Lanceolate	
Leaf Blade Length	18.7 cm	
Leaf Blade width	6.4 cm	
Petiole Length	1.93	
Leaf Apex shape	Acuminate	
Leaf Base shape	Acuminate	
Leaf Margin	Entire	
Colour of young leaf	Green	
Colour of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>3. Shimul (Silk cotton tree)--<i>Bombax ceiba</i></b>		
Age of Plant	30 months	
Height	590 cm	
Canopy Spreading(N-S)	540 cm	
Canopy Spreading(E-W)	560 cm	
Leaf Blade Shape	Digitate	
Leaflet Blade Length	26 cm	
Leaflet Blade width	08 cm	
Petiole Length	29.93 cm	
Leaf Apex shape	Acuminate	
Leaf Base shape	Acuminate	
Leaf Margin	Entire	
Colour of young leaf	Green	
Colour of fully developed leaf	Green	
<b>4. Tulsi (Holy basil)--<i>Ocimum tenuiflorum</i></b>		
Age of Plant	06 months	
Height	73 cm	
Canopy Spreading(N-S)	37 cm	
Canopy Spreading(E-W)	32 cm	
Leaf Blade Shape	Ovate	
Leaf Blade Length	4.5 cm	
Leaf Blade width	8.4 cm	
Petiole Length	1.3 cm	
Leaf Apex shape	Acute	
Leaf Base shape	Obtuse	
Leaf Margin	Seerrate	
Colour of young leaf	green	
Colour of fully developed leaf	green	
<b>5. Arjun (Arjun)--<i>Terminalia arjuna</i></b>		
Age of Plant	30 months	
Height	595 cm	
Canopy Spreading(N-S)	519 cm	
Canopy Spreading(E-W)	557 cm	
Leaf Blade Shape	Linear	
Leaf Blade Length	14.6	
Leaf Blade width	3.5	
Petiole Length	0.5 cm	
Leaf Apex shape	Acute	
Leaf Base shape	Obtuse	
Leaf Margin	Denticulate	
Colour of young leaf	Dark green	
Colour of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo	
<b>6. Tomal (Mottled ebony)-- <i>Diospyros montana</i></b>			
Age of Plant	30 months	 	
Height	330 cm		
Canopy Spreading(N-S)	310 cm		
Canopy Spreading(E-W)	195 cm		
Leaf Blade Shape	Lanceolate		
Leaf Blade Length	5.1 cm		
Leaf Blade width	1.1 cm		
Petiole Length	0.3 cm		
Leaf Apex shape	Acuminate		
Leaf Base shape	Cordate		
Leaf Margin	Entire		
Colour of young leaf	Green		
Colour of fully developed leaf	Green		
<b>7. Sonalu (Indian Laburnum)--<i>Cassia fistula</i></b>			
Age of Plant	30 months	 	
Height	254 cm		
Canopy Spreading(N-S)	150 cm		
Canopy Spreading(E-W)	203 cm		
Leaf Blade Shape	Even Pinnate		
Leaflet Blade Length	9.1 cm		
Leaflet Blade width	4.4 cm		
Petiole Length	5.3 cm		
Leaflet Apex shape	Acute		
Leaflet Base shape	Obtuse		
Leaf Margin	Entire		
Colour of young leaf	Light green		
Colour of fully developed leaf	Green		
<b>8. Polash (Bastard teak)--<i>Butea monosperma</i></b>			
Age of Plant	30 months	 	
Height	390 cm		
Canopy Spreading(N-S)	320 cm		
Canopy Spreading(E-W)	290 cm		
Leaf Blade Shape	Trifoliate		
Leaf Blade Length	16 cm		
Leaf Blade width	14.5 cm		
Petiole Length	15.5 cm		
Leaf Apex shape	Obtuse		
Leaf Base shape	Round		
Leaf Margin	Entire		
Colour of young leaf	Green		
Colour of fully developed leaf	Green		

**Table 12. contd...**

Parameters	Units	Photo	
<b>9. Neem (Indian lilac)--<i>Azadirachta indica</i></b>			
Age of Plant	24 months	 	
Height	180 cm		
Canopy Spreading(N-S)	86 cm		
Canopy Spreading(E-W)	100 cm		
Leaf Blade Shape	Odd pinnate		
Leaflet Blade Length	8.0 cm		
Leaflet Blade width	1.8 cm		
Petiole Length	5.5 cm		
Leaflet Apex shape	Accuminate		
Leaflet Base shape	Inequilatera		
Leaflet Margin	Dentate		
Colour of young leaf			
Colour of fully developed leaf	Green		
<b>10. Kanchon (Camel's foot tree)--<i>Bauhinia acuminata</i></b>			
Age of Plant	30 months	 	
Height	235 cm		
Canopy Spreading(N-S)	171 cm		
Canopy Spreading(E-W)	235 cm		
Leaf Blade Shape	Obcordate		
Leaf Blade Length	9.2 cm		
Leaf Blade width	10.0		
Petiole Length	3.5		
Leaf Apex shape	Obcordate		
Leaf Base shape	Cordate		
Leaf Margin	Entire		
Colour of young leaf	Green		
Colour of fully developed leaf	Green		
<b>11. Ulot kombol (Devil's cotton) --<i>Abroma augusta</i></b>			
Age of Plant	18 months	 	
Height	295 cm		
Canopy Spreading(N-S)	140 cm		
Canopy Spreading(E-W)	195 cm		
Leaf shape	Heterophylly		
Leaf blade length	19.5/12 cm		
Leaf blade width	11/5.8 cm		
Petiole length	08/06 cm		
Leaf apex shape	Acuminate		
Leaf base shape	Cordate		
Leaf margin	Serrate		
Colour of young leaf	Green		
Colour of fully developed leaf	Green		

**Table 12. contd...**

Parameters	Units	Photo	
<b>12. Bherenda (Bellayche bush) --<i>Jatropha gossypifolia</i></b>			
Age of Plant	30 months	 	
Height	170 cm		
Canopy spreading(N-S)	150 cm		
Canopy spreading(E-W)	165 cm		
Leaf shape	Palmate		
Leaf blade length	08 cm		
Leaf blade width	11 cm		
Petiole length	08 cm		
Leaf apex shape	Acute		
Leaf base shape	Cordate		
Leaf margin	Ciliate		
Colour of young leaf	Purple		
Colour of fully developed leaf	Bright Green		
<b>13. Horitoki (Chebolic myrobalan)-- <i>Terminalia chebula</i></b>			
Age of Plant	30 months	 	
Height	190 cm		
Canopy spreading(N-S)	100 cm		
Canopy spreading(E-W)	107 cm		
Leaf shape	oval		
Leaf length	15 cm		
Leaf blade width	5.5 cm		
Petiole length	0.9 cm		
Leaf apex shape	Acute		
Leaf base shape	Cordate		
Leaf margin	Entire		
Colour of young leaf	Light red		
Colour of fully developed leaf	Green		
<b>14. Akondo (Giant milk weed)-- <i>Calotropis gigantea</i></b>			
Age of Plant	10 months	 	
Height	190 cm		
Canopy spreading(N-S)	100 cm		
Canopy spreading(E-W)	107 cm		
Leaf shape	Cuneate		
Leaf length	18.5 cm		
Leaf blade width	19.5 cm		
Petiole length	0.5 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Cordate		
Leaf margin	Entire		
Colour of young leaf	Light green		
Colour of fully developed leaf	Light green		

**Table 12. contd...**

Parameters	Units	Photo
<b>15. Bohera (Belliric myrobalan)-- <i>Terminalia bellirica</i></b>		
Age of Plant	11 months	
Height	145 cm	
Canopy spreading(N-S)	105 cm	
Canopy spreading(E-W)	86 cm	
Leaf shape	Ovate-Lanceolate	
Leaf blade length	25.5 cm	
Leaf blade width	09 cm	
Petiole length	03 cm	
Leaf apex shape	Apiculate	
Leaf base shape	Iequilateral	
Leaf margin	Entire	
Colour of young leaf	Green	
Colour of fully developed leaf	Green	
<b>16. Mahua (Butter tree)-- <i>Madhuca indica</i></b>		
Age of Plant	30 months	
Height	365 cm	
Canopy spreading(N-S)	180 cm	
Canopy spreading(E-W)	185 cm	
Leaf shape	Lanceolet	
Leaf blade Length	30 cm	
Leaf blade width	8.6 cm	
Petiole length	2.7 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Dark green	
Color of fully developed leaf	Dark green	
<b>17. Agor (Aloe wood)-- <i>Aquilaria malaccensis</i></b>		
Age of Plant	30 months	
Height	155 cm	
Canopy spreading(N-S)	49 cm	
Canopy spreading(E-W)	51 cm	
Leaf shape	Lanceolet	
Leaf blade Length	8.7 cm	
Leaf blade width	2.3 cm	
Petiole length	0.4 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo	
<b>18. Kalomegh (Creat)--<i>Andrographis paniculata</i></b>			
Age of Plant	02 months	 	
Height	39 cm		
Canopy spreading(N-S)	18 cm		
Canopy spreading(E-W)	20 cm		
Leaf shape	Lanceolet		
Leaf blade Length	5.2 cm		
Leaf blade width	1.8 cm		
Petiole length	0.3 cm		
Leaf apex shape	Acuminate		
Leaf base shape	Acute		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Black and green		
<b>19. Korpur (Camphor)--<i>Cinnamomum camphora</i></b>			
Age of Plant	30 months	 	
Height	360 cm		
Canopy spreading(N-S)	305 cm		
Canopy spreading(E-W)	292 cm		
Leaf shape	Ovoid		
Leaf blade Length	7.8 cm		
Leaf blade width	3.2 cm		
Petiole length	1.9 cm		
Leaf apex shape	Acuminate		
Leaf base shape	Acute		
Leaf margin	Entire		
Color of young leaf	Light red		
Color of fully developed leaf	Green		
<b>20. Ashok (Ashok)—<i>Saraca asoca</i></b>			
Age of Plant	30 months	 	
Height	270 cm		
Canopy spreading(N-S)	150 cm		
Canopy spreading(E-W)	154 cm		
Leaf shape	Oblong		
Leaf blade Length	33.2 cm		
Leaf blade width	4.6 cm		
Petiole length	Sessile		
Leaf apex shape	Rounded		
Leaf base shape	Acuminate		
Leaf margin	Entire		
Color of young leaf	Reddish		
Color of fully developed leaf	Green		

**Table 12. contd...**

Parameters	Units	Photo	
<b>21. Tejpata (Indian bay leaf)– <i>Cinnamomum tamala</i></b>			
Age of Plant	24 months	 	
Height	130 cm		
Canopy spreading(N-S)	53 cm		
Canopy spreading(E-W)	35cm		
Leaf shape	Lanceolate		
Leaf blade Length	12cm		
Leaf blade width	05cm		
Petiole length	01cm		
Leaf apex shape	Acuminate		
Leaf base shape	Acuminate		
Leaf margin	Entire		
Color of young leaf	green		
Color of fully developed leaf	Dark green		
<b>22. Hijol (<i>Baringtonia</i>)--<i>Baringtonia acutangula</i></b>			
Age of Plant	30 months	 	
Height	292 cm		
Canopy spreading(N-S)	212 cm		
Canopy spreading(E-W)	263 cm		
Leaf shape	Oblanceolate		
Leaf blade Length	26.5 cm		
Leaf blade width	9.5 cm		
Petiole length	0.4 cm		
Leaf apex shape	Acute		
Leaf base shape	Acute		
Leaf margin	Dentate		
Color of young leaf	Light green		
Color of fully developed leaf	Green		
<b>23. Hosti korno Polash (<i>Elephant ear tree</i>)--<i>Leea macrophylla</i></b>			
Age of Plant	09months	 	
Height	50 cm		
Canopy spreading(N-S)	40 cm		
Canopy spreading(E-W)	40 cm		
Leaf shape	Lilac		
Leaf blade Length	30 cm		
Leaf blade width	30 cm		
Petiole length	5.5 cm		
Leaf apex shape	Acute		
Leaf base shape	Cordate heart shaped		
Leaf margin	Crenate		
Color of young leaf	Green		
Color of fully developed leaf	Green		

**Table 12. contd...**

Parameters	Units	Photo
<b>24. Jog Dumur (Cluster fig)-- <i>Ficus racemose</i></b>		
Age of Plant	24 months	
Height	175 cm	
Canopy spreading(N-S)	240 cm	
Canopy spreading(E-W)	260 cm	
Leaf shape	Ovate	
Leaf blade Length	60 cm	
Leaf blade width	65 cm	
Petiole length	5.5 cm	
Leaf apex shape	Aristulate	
Leaf base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Light green	
<b>25. Nagessar chapa (Ceylon Irishwood)-- <i>Mesua nagassarium</i></b>		
Age of Plant	30 months	
Height	100 cm	
Canopy spreading(N-S)	78 cm	
Canopy spreading(E-W)	95 cm	
Leaf shape	Lanceolate	
Leaf blade Length	08 cm	
Leaf blade width	1.8 cm	
Petiole length	0.5 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Red	
Color of fully developed leaf	Green	
<b>26. Nag lingom (Cannonball tree)- <i>Couroupita guianensis</i></b>		
Age of Plant	22 months	
Height	74cm	
Canopy spreading(N-S)	45cm	
Canopy spreading(E-W)	53cm	
Leaf shape	Lanceolate	
Leaf blade Length	08 cm	
Leaf blade width	1.8 cm	
Petiole length	0.5 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Crenate	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>27. Ishwar mul (<i>Indian birthwort</i>) -- <i>Aristolochia indica</i></b>		
Age of Plant	04 months	 
Height	20 cm	
Canopy spreading(N-S)	30 cm	
Canopy spreading(E-W)	30 cm	
Leaf shape	Obtuse	
Leaf blade Length	07 cm	
Leaf blade width	04 cm	
Petiole length	01 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Tumcate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>28. Goniore (<i>Agnimantha</i>)-- <i>Prema integrifolia</i></b>		
Age of Plant	06 months	 
Height	25cm	
Canopy spreading(N-S)	20 cm	
Canopy spreading(E-W)	20 cm	
Leaf shape	Poplar	
Leaf blade Length	7.5 cm	
Leaf blade width	03 cm	
Petiole length	01 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Rounded	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>29. Boula gota (<i>Indian cherry</i>) -- <i>Cordia dichotoma</i></b>		
Age of Plant	17 months	 
Height	410 cm	
Canopy spreading(N-S)	620 cm	
Canopy spreading(E-W)	480 cm	
Leaf shape	Obdulate	
Leaf blade Length	10cm	
Leaf blade width	05cm	
Petiole length	03cm	
Leaf apex shape	Cuspidate	
Leaf base shape	Rounded	
Leaf margin	Undulate	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>30. Commiphora (Bdellium tree) - <i>Commifora wightii</i></b>		
Age of Plant	30 months	
Height	74 cm	
Canopy spreading(N-S)	90cm	
Canopy spreading(E-W)	98 cm	
Leaf shape	Lanceolate	
Leaf blade Length	6.2cm	
Leaf blade width	2.9 cm	
Petiole length	01cm	
Leaf apex shape	Acute	
Leaf base shape	Cuneate	
Leaf margin	Crenate	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>31. Nil chita (Blue plumbago)-- <i>Plumbago capensis</i></b>		
Age of Plant	15 months	
Height	88 cm	
Canopy spreading(N-S)	105 cm	
Canopy spreading(E-W)	116 cm	
Leaf shape	Lanceolate	
Leaf blade Length	23.2 cm	
Leaf blade width	06cm	
Petiole length	0.4 cm/Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Crenate	
Color of young leaf	Green with blue	
Color of fully developed leaf	Green with blue	
<b>32. Bhat (Hill glory bower), -- <i>Clerodendrum viscosum</i></b>		
Age of Plant	03 months	
Height	134 cm	
Canopy spreading(N-S)	43 cm	
Canopy spreading(E-W)	54 cm	
Leaf shape	Ovate	
Leaf blade Length	17 cm	
Leaf blade width	13 cm	
Petiole length	08 cm	
Leaf apex shape	Acute	
Leaf base shape	Cordate	
Leaf margin	Crenate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>33. Jarul (Queens crepe myrtle) -- <i>Lagerstroemia speciosa</i></b>		
Age of Plant	30 months	
Height	425 cm	
Canopy spreading(N-S)	335 cm	
Canopy spreading(E-W)	340 cm	
Leaf shape	Laurel	
Leaf blade Length	32cm	
Leaf blade width	11cm	
Petiole length	0.5cm	
Leaf apex shape	Cuspidate	
Leaf base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>34. Kumarilota (Kumarika)-- <i>Smilax</i> spp.</b>		
Age of Plant	15months	
Height	400cm	
Canopy spreading(N-S)	-----	
Canopy spreading(E-W)	-----	
Leaf shape	Obtuse	
Leaf blade Length	13cm	
Leaf blade width	10.5cm	
Petiole length	04cm	
Leaf apex shape	Cuspidate	
Leaf base shape	Roundate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>35. Alkananda (Allamanda), -- <i>Allamanda cathartica</i></b>		
Age of Plant	05months	
Height	70cm	
Canopy spreading(N-S)	50cm	
Canopy spreading(E-W)	60cm	
Leaf shape	Lanceolate	
Leaf blade Length	13cm	
Leaf blade width	3.5cm	
Petiole length	Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Cuneate	
Leaf margin	Entire	
Color of young leaf	Light Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>36. Satipata (Palm grass), -- <i>Monileria capitulata</i></b>		
Age of Plant	04months	
Height	24 cm	
spreading(N-S)	60 cm	
spreading(E-W)	56 cm	
Leaf shape	Parallet	
Leaf blade Length	41cm	
Leaf blade width	10cm	
Leaf sheath length	22cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>37. Arhar (Pigeon pea)--<i>Cajanus cajan</i></b>		
Age of Plant	08months	
Height	360 cm	
Canopy spreading(N-S)	210 cm	
Canopy spreading(E-W)	170 cm	
Leaf shape	Tripartite	
Leaf blade Length	7.5 cm	
Leaf blade width	03 cm	
Petiole length	2.5 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>38. Kath Badam (Indian almond)-- <i>Terminalia catappa</i></b>		
Age of Plant	08 months	
Height	93 cm	
Canopy spreading(N-S)	70 cm	
Canopy spreading(E-W)	73 cm	
Leaf shape	Spathulate	
Leaf blade Length		
Leaf blade width		
Petiole length		
Leaf apex shape	Rounded and shortly acute	
Leaf base shape	Cuneate	
Leaf margin	Crenate	
Color of young leaf	Green	
Color of fully developed leaf	Pinkish-reddish	

**Table 12. contd...**

Parameters	Units	Photo
<b>39. Pathorkuchi (Cathedral bells)--<i>Bryophyllum pinnatum</i></b>		
Age of Plant	06 months	 
Height	68 cm	
spreading(N-S)	70 cm	
spreading(E-W)	76 cm	
Leaf shape	Phylloclades (Elliptical)	
Leaflet /Lobe Length	08 cm	
Leaflet /Lobe width	6.1 cm	
Petiole length	5.1 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Rounded	
Leaf margin	Crenate/Serrate	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>40. Polao pata ( Pandan)--<i>Pandanus amarylofolius</i></b>		
Age of Plant	06 months	 
Height	27 cm	
spreading(N-S)	55 cm	
spreading(E-W)	61 cm	
Leaf shape	Linear	
Leaf blade Length	30 cm	
Leaf blade width	02 cm	
Petiole length	---	
Leaf apex shape	Attenuate	
Leaf base shape	Parallel	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>41. Hajari belly (Glory bower)--<i>Clerodendrum fragrans</i></b>		
Age of Plant	12 months	 
Height	107 cm	
Spreading(N-S)	45 cm	
Spreading(E-W)	55 cm	
Leaf shape	Cordate	
Leaf blade Length	18.3 cm	
Leaf blade width	17 cm	
Petiole length	8.1 cm	
Leaf apex shape	Acute	
Leaf base shape	Cordate	
Leaf margin	Serrate	
Color of young leaf	Light green	
Color of fully developed leaf	Light green	

**Table 12. contd...**

Parameters	Units	Photo
<b>42. Ekangi (Aromatic zinger)--<i>Kaempferia galanga</i></b>		
Age of Plant	03 months	
Height	12 cm	
Spreading(N-S)	29 cm	
Spreading(E-W)	42 cm	
Leaf shape	Elliptical-lanceolate	
Leaf blade Length	18 cm	
Leaf blade width	11 cm	
Leaf sheath length	07 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>43. Joypal ( Purging croton) ---<i>Croton tiglium</i></b>		
Age of Plant	03 months	
Height	39 cm	
Canopy spreading(N-S)	18 cm	
Canopy spreading(E-W)	15 cm	
Leaf shape	Ovate	
Leaf blade Length	6.5 cm	
Leaf blade width	3.9 cm	
Petiole length	2.2 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Reddish	
Color of fully developed leaf	Green	
<b>44. Misridana (Peacock zinger)--<i>Kaempferi rotunda</i></b>		
Age of Plant	03 months	
Height	31 cm	
Canopy spreading(N-S)	62 cm	
Canopy spreading(E-W)	52 cm	
Leaf shape	Oblanceolate	
Leaf blade Length	33 cm	
Leaf blade width	06 cm	
Leaf sheath length	20 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Undulate	
Color of young leaf	Reddish and green	
Color of fully developed leaf	Reddish and green	

**Table 12. contd...**

Parameters	Units	Photo
<b>45. Am ada (Mango zinger )—<i>Curcuma amada</i></b>		
Age of Plant	04 months	 
Height	63 cm	
Spreading(N-S)	52 cm	
Spreading(E-W)	55 cm	
Leaf shape	Lanceolate	
Leaf blade Length	33 cm	
Leaf blade width	14 cm	
Petiole length	30 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>46. Rongdana (Lipstick tree)--<i>Bixa orellana</i></b>		
Age of Plant	08 months	 
Height	90 cm	
Canopy spreading(N-S)	70 cm	
Canopy spreading(E-W)	68 cm	
Leaf shape	Cordate	
Leaf blade Length	21 cm	
Leaf blade width	12.2 cm	
Petiole length	09	
Leaf apex shape	Acuminate	
Leaf base shape	Cordate	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Light green	
<b>47. Ayapan ()--<i>Ayapana triplinervis</i></b>		
Age of Plant	04 months	 
Height	16 cm	
Spreading(N-S)	18 cm	
Spreading(E-W)	16 cm	
Leaf shape	Lanceolate	
Leaf blade Length	6.1 cm	
Leaf blade width	2.2 cm	
Petiole length	Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Reddish and green	
Color of fully developed leaf	Reddish and green	

**Table 12. contd...**

Parameters	Units	Photo	
<b>48. Gynura (<i>Gynura procumbens</i>)</b>			
Age of Plant	11 months		
Height	64 cm		
Canopy spreading(N-S)	130 cm		
Canopy spreading(E-W)	300 cm		
Leaf shape	Lanceolate		
Leaf blade Length	11 cm		
Leaf blade width	4.5 cm		
Petiole length	02 cm		
Leaf apex shape	Acute		
Leaf base shape	Acute		
Leaf margin	Serrate		
Color of young leaf	Green		
Color of fully developed leaf	Green		
<b>49. Lemon grass (Lemon grass)--<i>Cymbopogon citratus</i></b>			
Age of Plant	24 months		
Height	28 cm		
Spreading(N-S)	100 cm		
Spreading(E-W)	102 cm		
Leaf shape	Linear		
Leaf blade Length	76 cm		
Leaf blade width	01 cm		
Leaf sheath length	21 cm		
Leaf apex shape	Parallel		
Leaf base shape	Parallel		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Green		
<b>50. Kiamul (<i>Costus</i>)--<i>Costus speciosus</i></b>			
Age of Plant	11 months		
Height	160 cm		
Spreading(N-S)	32 cm		
Spreading(E-W)	30 cm		
Leaf shape	Elliptical		
Leaf blade Length	32 cm		
Leaf blade width	10.5 cm		
Petiole length	Sessile		
Leaf apex shape	Acuminate		
Leaf base shape	Cuneate		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Green		

**Table 12. contd...**

Parameters	Units	Photo	
<b>51. Harzora (Veldt Grape) --<i>Cissus quadrangularis</i></b>			
Age of Plant	24 months		
Length	172 cm		
Canopy spreading(N-S)	-----		
Canopy spreading(E-W)	----		
Leaf shape	Cordate		
Leaf blade Length	5.5 cm		
Leaf blade width	05 cm		
Petiole length	01 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Cordate		
Leaf margin	Undulate		
Color of young leaf	Green		
Color of fully developed leaf	Dark green		
<b>52. Ritha (Soapnut tree) --<i>Sapindus trifoliatus</i></b>			
Age of Plant	20 months		
Height	150 cm		
Canopy spreading(N-S)	44 cm		
Canopy spreading(E-W)	52 cm		
Leaf shape	Ovate		
Leaf blade Length	10 cm		
Leaf blade width	4.5 cm		
Petiole length	0.4 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Obtuse		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Dark green		
<b>53. Shotomuli (Asparagus)--<i>Asparagus racemosus</i></b>			
Age of Plant	24 months		
Length	202 cm		
Spreading(N-S)			
Spreading(E-W)			
Leaf shape	Pine needles like leaves		
Leaf blade Length	1.2 cm		
Leaf blade width	1 mm		
Petiole length	----		
Leaf apex shape	----		
Leaf base shape	-----		
Leaf margin	Entire		
Color of young leaf	Light green		
Color of fully developed leaf	Light green		

**Table 12. contd...**

Parameters	Units	Photo
<b>54. Morinda (Indian Mulberry)-- <i>Morinda citrifolia</i></b>		
Age of Plant	16 months	
Height	117 cm	
Canopy spreading(N-S)	120 cm	
Canopy spreading(E-W)	110 cm	
Leaf shape	Lanceolate	
Leaf blade Length	21 cm	
Leaf blade width	7.5 cm	
Petiole length	1.0 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>55. Ghitokumari (Aloe vera)-- <i>Aloe barbadensis</i></b>		
Age of Plant	18 months	
Height	60 cm	
Canopy spreading(N-S)	48 cm	
Canopy spreading(E-W)	50 cm	
Leaf shape	lance-shaped	
Leaf blade Length	40 cm	
Leaf blade width	4.5 cm	
Petiole length	Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Wide base	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>56. Sarpagandha (Snake root plant)--<i>Rauvolfia serpentina</i></b>		
Age of Plant	24 months	
Height	83 cm	
Spreading(N-S)	60 cm	
Spreading(E-W)	30 cm	
Leaf shape	Lanceolate	
Leaf blade Length	12.5 cm	
Leaf blade width	3.0 cm	
Petiole length	01 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo	
<b>57. Punarnava ( Pigweed)- <i>Boerhavia diffusa</i></b>			
Age of Plant	24 months	 	
Height/ Length	14 meter		
Canopy spreading(N-S)	----		
Canopy spreading(E-W)	----		
Leaf shape	Ovate		
Leaf blade Length	1.6 cm		
Leaf blade width	1.1 cm		
Petiole length	1.7 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Round		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Green		
<b>58. Dudh shor ( Indian spurge tree)- <i>Euphorbia nerifolia</i></b>			
Age of Plant	36 months	 	
Height/ length	165 cm		
Canopy spreading(N-S)	92 cm		
Canopy spreading(E-W)	63 cm		
Leaf shape	Obovate		
Leaflet blade Length	15.5 cm		
Leaflet blade width	3.6 cm		
Petiole length	Sessile		
Leaf apex shape	Obtuse		
Leaf base shape	Attenuate		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Green		
<b>59. Piper longum (Piple)-<i>Piper longum</i></b>			
Age of Plant	08 months	 	
Height/Length	1.2 meter		
Canopy spreading(N-S)	----		
Canopy spreading(E-W)	----		
Leaf shape	Cordate		
Leaf blade Length	07 cm		
Leaf blade width	7.1cm		
Petiole length	3.2 cm		
Leaf apex shape	Acute		
Leaf base shape	Cordate		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Dark green		

**Table 12. contd...**

Parameters	Units	Photo	
<b>60. Torup chondal (Telegraph plant)-<i>Codariocalyx motorius</i></b>			
Age of Plant	18 months	 	
Height	275 cm		
Canopy spreading(N-S)	182 cm		
Canopy spreading(E-W)	190 cm		
Leaf shape	Hastate/ trifoliolate		
Leaf blade Length	07 cm		
Leaf blade width	1.6 cm		
Petiole length	1.5 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Obtuse		
Leaf margin	Entire		
Color of young leaf	Light green		
Color of fully developed leaf	Light green		
<b>61. Aporajita (Butterfly pea)- <i>Clitoria ternatea</i></b>			
Age of Plant	18 months	 	
Height	about 20 meter		
Canopy spreading(N-S)	----		
Canopy spreading(E-W)	----		
Leaf shape	Palmaisect		
Leaflet blade Length	2.8 cm		
Leaflet blade width	2.1 cm		
Petiole length	Sessile		
Leaf apex shape	Obtuse		
Leaf base shape	Round		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Dark green		
<b>62. Nayan tara ( Rosy periwinkle)—<i>Catharanthus roseus</i></b>			
Age of Plant	12 months	 	
Height	98 cm		
Canopy spreading(N-S)	86 cm		
Canopy spreading(E-W)	72 cm		
Leaf shape	Obovate		
Leaf blade Length	4.1 cm		
Leaf blade width	2.2 cm		
Petiole length	0.6 cm		
Leaf apex shape	Obtuse		
Leaf base shape	Acute		
Leaf margin	Entire		
Color of young leaf	Green		
Color of fully developed leaf	Dark green		

**Table 12. contd...**

Parameters	Units	Photo
<b>63. Pudina (Spear mint)—<i>Mentha spicata</i></b>		
Age of Plant	04 months	
Height	47 cm	
Spreading(N-S)	30 cm	
Spreading(E-W)	32 cm	
Leaf shape	Elliptic	
Leaf blade Length	5.9 cm	
Leaf blade width	2.3 cm	
Petiole length	0.4 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Light green	
<b>64. Sajna (Moringa)—<i>Moringa oleifera</i></b>		
Age of Plant	11 months	
Height	115 cm	
Canopy spreading(N-S)	80 cm	
Canopy spreading(E-W)	65 cm	
Leaflet shape	Oblong	
Leaflet blade Length	1.0 cm	
Leaflet blade width	0.8 cm	
Petiole length	2.0 cm	
Leaflet apex shape	Obtuse	
Leaflet base shape	Round	
Leaf margin	Tripinatisect	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>65. Kontikari (Red Buffalo Bur)—<i>Solanum sisymbriifolium</i></b>		
Age of Plant	12 months	
Height	90 cm	
Canopy spreading(N-S)	45 cm	
Canopy spreading(E-W)	62 cm	
Leaf shape		
Leaf blade Length	8.2 cm	
Leaf blade width	7.0 cm	
Petiole length	2.4 cm	
Leaf apex shape	Acute	
Leaf base shape	Truncate	
Leaf margin	Lobate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>66. Choi Jhal (Choi Jhal)—<i>Piper chaba</i></b>		
Age of Plant	08 months	
Height/ Length	61 cm	
Canopy spreading(N-S)	----	
Canopy spreading(E-W)	----	
Leaf shape	Cordate	
Leaf blade Length	4.5 cm	
Leaf blade width	4.1 cm	
Petiole length	2.0 cm	
Leaf apex shape	Acute	
Leaf base shape	Cordate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>67. Hatir shoor (Heliotrope) ---<i>Heliotropium indicum</i></b>		
Age of Plant	03 months	
Height	40 cm	
Canopy spreading(N-S)	21 cm	
Canopy spreading(E-W)	13 cm	
Leaf shape	Ovate	
Leaf blade Length	6.8	
Leaf blade width	4.1 cm	
Petiole length	1.2	
Leaf apex shape	Acute	
Leaf base shape	obtuse	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>68. Amloki (Emblic myrobalan)---<i>Phyllanthus emblica</i></b>		
Age of Plant	12 months	
Height	132 cm	
Canopy spreading(N-S)	130	
Canopy spreading(E-W)	235 cm	
Leaf shape	Pinnate	
Leaf blade Length	10.5 cm	
Leaf blade width	3.2 cm	
Petiole length	0.5 cm	
Leaflet apex shape	Truncate	
Leaflet base shape	Truncate	
Leaflet margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>69. Kharajora (Litsea)—<i>Litsea monopetela</i></b>		
Age of Plant	36 months	
Height	240 cm	
Canopy spreading(N-S)	120 cm	
Canopy spreading(E-W)	90 cm	
Leaf shape	Elliptic	
Leaf blade Length	23 cm	
Leaf blade width	9.8 cm	
Petiole length	2.3 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>70. Ashoth (Ashoth)—<i>Ficus religiosa</i></b>		
Age of Plant	16 months	
Height	144 cm	
Canopy spreading(N-S)	121 cm	
Canopy spreading(E-W)	113 cm	
Leaf shape	Deltoid	
Leaf blade Length	10.10 cm	
Leaf blade width	6.5 cm	
Petiole length	4.0 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Cordate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>71. Kodbel (Wood apple)—<i>Limonia acidissima</i></b>		
Age of Plant	26 months	
Height	220 cm	
Canopy spreading(N-S)	244 cm	
Canopy spreading(E-W)	197 cm	
Leaf shape	Imparipinnate	
Leaflet blade Length	2.1 cm	
Leaflet blade width	1.8 cm	
Petiole length	3.2 cm	
Leaflet apex shape	Obtuse	
Leaflet base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>72. Orboroi (Star gooseberry)—<i>Phyllanthus acidus</i></b>		
Age of Plant	12 months	
Height	81 cm	
Canopy spreading(N-S)	60 cm	
Canopy spreading(E-W)	70 cm	
Leaf shape	Unipinnate	
Leaflet blade Length	2.6 cm	
Leaflet blade width	1.9 cm	
Petiole length	3.1 cm	
Leaflet apex shape	Acute	
Leaflet base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>73. Kanaidinag/ Khona (Indian trumpet tree)—<i>Oroxylum indicum</i></b>		
Age of Plant	18 months	
Height	174 cm	
Canopy spreading(N-S)	169 cm	
Canopy spreading(E-W)	173 cm	
Leaf shape	Bipinnatisect	
Leaflet blade Length	4.5 cm	
Leaf blade width	4.2 cm	
Petiole length	1.5 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Sinuate-undulate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>74. Gonga Sagor---<i>Cissus</i> sp.</b>		
Age of Plant	18 months	
Height	535 cm	
Canopy spreading(N-S)	----	
Canopy spreading(E-W)	----	
Leaf shape	Digitate	
Leaflet blade Length	09 cm	
Leaflet blade width	05 cm	
Petiole length	16 cm	
Leaflet apex shape	Acute	
Leaflet base shape	Acute	
Leaflet margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>75. Kalo nirbish ( Ruby)—<i>Curcuma rubescens</i></b>		
Age of Plant	03 months	
Height	60 cm	
Canopy spreading(N-S)	----	
Canopy spreading(E-W)	----	
Leaf shape	Lanceolet	
Leaf blade Length	38 cm	
Leaf blade width	13.4 cm	
Leaf sheath length	24 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Light green with reddish margin	
Color of fully developed leaf	Green with reddish margin	
<b>76. Sada nirbish ---<i>Curcuma</i> sp.</b>		
Age of Plant	03 months	
Height	71 cm	
spreading(N-S)	75 cm	
spreading(E-W)	77 cm	
Leaf shape	Lanceolet	
Leaf blade Length	48 cm	
Leaf blade width	13 cm	
Petiole length	15 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>77. Nagdana (Mug wort)—<i>Artemisia vulgaris</i></b>		
Age of Plant	12 months	
Height	160 cm	
Canopy spreading(N-S)	180 cm	
Canopy spreading(E-W)	210 cm	
Leaf shape	Lobed	
Leaf blade Length	9.1 cm	
Leaf blade width	7.5 cm	
Petiole length	1.0 cm	
Leaf apex shape	Acute	
Leaf base shape	Cuneate	
Leaf margin	Lobate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>78. Shalpani (Salparni)—<i>Desmodium gangeticum</i></b>		
Age of Plant	14 months	
Height	120 cm	
Canopy spreading(N-S)	60 cm	
Canopy spreading(E-W)	90 cm	
Leaf shape	Obtuse	
Leaf blade Length	4.8 cm	
Leaf blade width	3.7 cm	
Petiole length	2.0 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>79. Sugondhibala (Oregano) —<i>Plectranthus amboinicus</i></b>		
Age of Plant	12 months	
Height	70 cm	
Branch spreading(N-S)	245 cm	
Branch spreading(E-W)	240 cm	
Leaf shape	Deltoid	
Leaf blade Length	4.0 cm	
Leaf blade width	3.8 cm	
Petiole length	1.8 cm	
Leaf apex shape	Acute	
Leaf base shape	Truncate	
Leaf margin	Pinnatifid	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>80. Kantati (Swarna Jhinti) —<i>Barleria prionitis</i></b>		
Age of Plant	12 months	
Height	135 cm	
Canopy spreading(N-S)	175 cm	
Canopy spreading(E-W)	160 cm	
Leaf shape	Lanceolet	
Leaf blade Length	6.2 cm	
Leaf blade width	1.9 cm	
Petiole length	Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>81. Dad mordon (Candle bush)---<i>Senna alata</i></b>		
Age of Plant	18 months	
Height	192 cm	
Canopy spreading(N-S)	205 cm	
Canopy spreading(E-W)	215 cm	
Leaf shape	Even pinnate	
Leaflet blade Length	5.8 cm	
Leaf blade width	2.7 cm	
Petiole length	2.6 cm	
Leaflet apex shape	Truncate	
Leaflet base shape	Rounded	
Leaf margin	Pinnatisect	
Color of young leaf	Light green	
Color of fully developed leaf	Dark green	
<b>82. Joypal (Pruging croton)—<i>Croton triglium</i></b>		
Age of Plant	18 months	
Height	70 cm	
Canopy spreading(N-S)	30 cm	
Canopy spreading(E-W)	21 cm	
Leaf shape	Ovate	
Leaf blade Length	9.6 cm	
Leaf blade width	4.2 cm	
Petiole length	4.1 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Obtuse	
Leaf margin	Undulate	
Color of young leaf	Reddish	
Color of fully developed leaf	Green	
<b>83. Punnag champa ( Shell zinger)—<i>Alpinia zerumbet</i></b>		
Age of Plant	30 months	
Height	117 cm	
Branch spreading(N-S)	190 cm	
Branch spreading(E-W)	237 cm	
Leaf shape	Linear	
Leaf blade Length	22 cm	
Leaf blade width	7.4 cm	
Leaf sheath length	26 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>84. Roselle (Roselle)---<i>Hibiscus sabdariffa</i></b>		
Age of Plant	07 months	
Height	90 cm	
Canopy spreading(N-S)	90 cm	
Canopy spreading(E-W)	80 cm	
Leaf shape	Trifoliate	
Leaf blade Length	9.2 cm	
Leaf blade width	9.6 cm	
Petiole length	6.0 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>85. Gurbosch (Common sweet flag)—<i>Acorus calamus</i></b>		
Age of Plant	30 months	
Height	34 cm	
Canopy spreading(N-S)	48 cm	
Canopy spreading(E-W)	45 cm	
Leaf shape	Linear	
Leaf blade Length	34 cm	
Leaf blade width	2.0 cm	
Petiole length	----	
Leaf apex shape	Acute	
Leaf base shape	----	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>86. Bishulla koroli (Ruby leaf)—<i>Alternanthera brasiliana</i></b>		
Age of Plant	08 months	
Height	90 cm	
Canopy spreading(N-S)	150 cm	
Canopy spreading(E-W)	180 cm	
Leaf shape	Ovate	
Leaf blade Length	14 cm	
Leaf blade width	08 cm	
Petiole length	0.5 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Inequilateral	
Leaf margin	Entire	
Color of young leaf	Dark Red	
Color of fully developed leaf	Dark Red	

**Table 12. contd...**

Parameters	Units	Photo
<b>87. Chalta (Wood apple)—<i>Dillenia indica</i></b>		
Age of Plant	20 months	
Height	160 cm	
Canopy spreading(N-S)	75 cm	
Canopy spreading(E-W)	90 cm	
Leaf shape	Lanceolet	
Leaf blade Length	34 cm	
Leaf blade width	7.4 cm	
Petiole length	05 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>88. Ram Tulsi —<i>Ocimum gratssicum</i></b>		
Age of Plant	06 months	
Height	120 cm	
Canopy spreading(N-S)	90 cm	
Canopy spreading(E-W)	105 cm	
Leaf shape	6.9 cm	
Leaf blade Length	4.7 cm	
Leaf blade width	3.5 cm	
Petiole length	Acuminate	
Leaf apex shape	Acuminate	
Leaf base shape	Serrate	
Leaf margin	Green	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>89. Tulsi (Black tulsi)—<i>Ocimum tenuiflofum</i></b>		
Age of Plant	06 months	
Height	105 cm	
Canopy spreading(N-S)	20 cm	
Canopy spreading(E-W)	50 cm	
Leaf shape	Ovate	
Leaf blade Length	1.9 cn	
Leaf blade width	1.3 cm	
Petiole length	1.2 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Obtuse	
Leaf margin	Dentate	
Color of young leaf	Reddish	
Color of fully developed leaf	Reddish	

**Table 12. contd...**

Parameters	Units	Photo
<b>90. Tulsi—<i>Ocimum Americana</i></b>		
Age of Plant	06 months	
Height	60 cm	
Canopy spreading(N-S)	45 cm	
Canopy spreading(E-W)	51 cm	
Leaf shape	Ovate	
Leaf blade Length	2.5 cm	
Leaf blade width	2.2 cm	
Petiole length	1.0 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Reddish	
Color of fully developed leaf	Reddish	
<b>91. Pashan bedi (Ghost plant) – <i>Graptopetalum paraguayense</i></b>		
Age of Plant	14 months	
Height	17 cm	
Canopy spreading(N-S)	13 cm	
Canopy spreading(E-W)	14 cm	
Leaf shape	Subulate	
Leaf blade Length	8.2 cm	
Leaf blade width	2.8 cm	
Petiole length	Sessile	
Leaf apex shape	Acute	
Leaf base shape	----	
Leaf margin	Entire	
Color of young leaf	Reddish green	
Color of fully developed leaf	Reddish green	
<b>92. Rokto chita (Ceylon leadwort) – <i>Plumbago zeylanica</i></b>		
Age of Plant	12 months	
Height	30 cm	
Canopy spreading(N-S)	30 cm	
Canopy spreading(E-W)	38 cm	
Leaf shape	Ovate	
Leaf blade Length	8.8 cm	
Leaf blade width	3.3 cm	
Petiole length	0.2 cm	
Leaf apex shape	Acute	
Leaf base shape	Rounded	
Leaf margin	Undulate	
Color of young leaf	Reddish green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>93. Ananta mul (Indian sarsparilla)—<i>Hemidesmus indicus</i></b>		
Age of Plant	12 months	
Height	55 cm	
Canopy spreading(N-S)	135 cm	
Canopy spreading(E-W)	105 cm	
Leaf shape	Linear	
Leaf blade Length	6.5 cm	
Leaf blade width	1.0 cm	
Petiole length	Sessile	
Leaf apex shape	Acute	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>94. Holud Basok (Malabar nut)—<i>Justicia adhatoda</i></b>		
Age of Plant	12 months	
Height	40 cm	
Canopy spreading(N-S)	35 cm	
Canopy spreading(E-W)	30 cm	
Leaf shape	Lanceolet	
Leaf blade Length	13 cm	
Leaf blade width	3.4 cm	
Petiole length	1.4 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Acute	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>95. Nil shoor (Blue snake weed)—<i>Stachytarpheta jamaicensis</i></b>		
Age of Plant	18 months	
Height	135 cm	
Canopy spreading(N-S)	105 cm	
Canopy spreading(E-W)	100 cm	
Leaf shape	Lanceolet	
Leaf blade Length	08 cm	
Leaf blade width	3.3 cm	
Petiole length	Sessile	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Serrulate	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	

**Table 12. contd...**

Parameters	Units	Photo
<b>96. Kurchi (Big tiger milk)—<i>Holarrhena pubesens</i></b>		
Age of Plant	10 months	
Height	96 cm	
Canopy spreading(N-S)	74 cm	
Canopy spreading(E-W)	57 cm	
Leaf shape	Ovate	
Leaf blade Length	14 cm	
Leaf blade width	09 cm	
Petiole length	Sessile	
Leaf apex shape	Acuminate	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>97. Padma kurchi/ Guloncho (Heart leaf moon seed)-- <i>Tinospora cordifolia</i></b>		
Age of Plant	10 months	
Height/ Length	255 cm	
Spreading(N-S)	35 cm	
Spreading(E-W)	40 cm	
Leaf shape	Cordate	
Leaf blade Length	13 cm	
Leaf blade width	10.5 cm	
Petiole length	9 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Cordate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>98. Kathali chapa (Tail grape)—<i>Artabotrys hexapetalus</i></b>		
Age of Plant	12 months	
Height	118 cm	
Canopy spreading(N-S)	60 cm	
Canopy spreading(E-W)	60 cm	
Leaf shape	Elliptic	
Leaf blade Length	25 cm	
Leaf blade width	11.5 cm	
Petiole length	02 cm	
Leaf apex shape	Acuminate	
Leaf base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>99. Rokto chondon (Red sandal wood)—<i>Adenathera pavanina</i></b>		
Age of Plant	08 months	
Height	60 cm	
Canopy spreading(N-S)	30 cm	
Canopy spreading(E-W)	47 cm	
Leaf shape	Bipinnate	
Leaf blade Length	1.4 cm	
Leaf blade width	0.9 cm	
Petiole length	Sessile	
Leaflet apex shape	Obtuse	
Leaflet base shape	Rounded	
Leaf margin	Bipinnatisect	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>100. Daruchini (Cinnamon)—<i>Cinnamomum zeylanicum</i></b>		
Age of Plant	24 months	
Height	82 cm	
Canopy spreading(N-S)	90 cm	
Canopy spreading(E-W)	53 cm	
Leaf shape	Ovate	
Leaf blade Length	08 cm	
Leaf blade width	04 cm	
Petiole length	01 cm	
Leaf apex shape	Acute	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	
<b>101. Udal (Chinese parasol tree)—<i>Firmiana simplex</i></b>		
Age of Plant	30 months	
Height	287 cm	
Canopy spreading(N-S)	155 cm	
Canopy spreading(E-W)	155 cm	
Leaf shape	Palmitifid	
Leaf blade Length	40 cm	
Leaf blade width	64 cm	
Petiole length	64.5 cm	
Leaf apex shape	Aristate	
Leaf base shape	Obtuse	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

Parameters	Units	Photo
<b>102. Cevit (Merpauh) -- <i>Swintonia floribunda</i></b>		
Age of Plant	03 months	
Height	45 cm	
Canopy spreading(N-S)	23 cm	
Canopy spreading(E-W)	25 cm	
Leaf shape	Linear	
Leaf blade Length	13 cm	
Leaf blade width	4.2 cm	
Petiole length	02 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Rounded	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Light green	
<b>103. Burmese shimul (Kapok)-- <i>Ceiba pentandra</i></b>		
Age of Plant	04 months	
Height	50 cm	
Canopy spreading(N-S)	35 cm	
Canopy spreading(E-W)	40 cm	
Leaf shape	Digitate	
Leaflet blade Length	13 cm	
Leaf blade width	03 cm	
Petiole length	02 cm	
Leaflet apex shape	Acuminate	
Leaf base shape	Acuminate	
Leaf margin	Entire	
Color of young leaf	Green	
Color of fully developed leaf	Dark green	
<b>104. Dondo Kolos-(Thumbai)—<i>Leucas aspera</i></b>		
Age of Plant	03 months	
Height	45 cm	
Canopy spreading(N-S)	42 cm	
Canopy spreading(E-W)	37 cm	
Leaf shape	Linear	
Leaf blade Length	6.2 cm	
Leaf blade width	1.1 cm	
Petiole length	Sessile	
Leaf apex shape	Acute	
Leaf base shape	Acuminate	
Leaf margin	Sinuate-undulate	
Color of young leaf	Green	
Color of fully developed leaf	Green	

**Table 12. contd...**

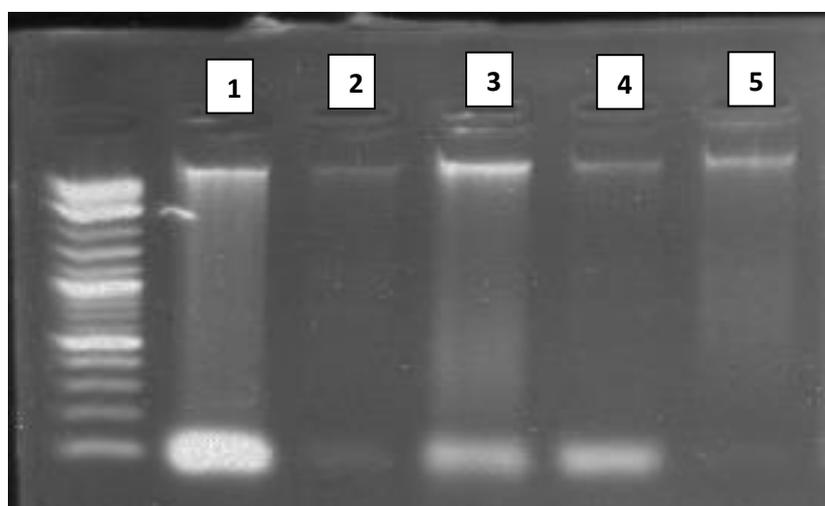
Parameters	Units	Photo
<b>105. Babla (Gum Arabic tree)—<i>Acacia nilotica</i></b>		
Age of Plant	06 months	
Height	65 cm	
Canopy spreading(N-S)	55 cm	
Canopy spreading(E-W)	68 cm	
Leaf shape	Bipinnate	
Leaflet blade Length	0.9 cm	
Leaflet blade width	0.5 cm	
Petiole length	1.5 cm	
Leaflet apex shape	Obtuse	
Leaflet base shape	Rounded	
Leaf margin	Bipinnatisect	
Color of young leaf	Light green	
Color of fully developed leaf	Green	
<b>106. Berela (Country mallow)—<i>Sida cordifolia</i></b>		
Age of Plant	08 months	
Height	35 cm	
Canopy spreading(N-S)	85 cm	
Canopy spreading(E-W)	92 cm	
Leaf shape	Lanceolet	
Leaf blade Length	3.1 cm	
Leaf blade width	1.0 cm	
Petiole length	0.3 cm	
Leaf apex shape	Acute	
Leaf base shape	Acute	
Leaf margin	Serrate	
Color of young leaf	Dark green	
Color of fully developed leaf	Dark green	
<b>107. Brihoti/ Teet Begun-- <i>Solanum indicum</i></b>		
Age of Plant	20 months	
Height	190 cm	
Canopy spreading(N-S)	145 cm	
Canopy spreading(E-W)	155 cm	
Leaf shape	Ovate	
Leaf blade Length	11.5 cm	
Leaf blade width	7.0 cm	
Petiole length	2.9 cm	
Leaf apex shape	Obtuse	
Leaf base shape	Truncate	
Leaf margin	Undulate	
Color of young leaf	Light green	
Color of fully developed leaf	Green	

Table 12. contd...

Parameters	Units	Photo
<b>108. Apang (Prickly chaff flower)-- <i>Achyranthes aspera</i> Linn.</b>		
Age of Plant	06 cm	
Height	09 cm	
Spreading(N-S)	105 cm	
Spreading(E-W)	90 cm	
Leaf shape	Elliptic	
Leaf blade Length	4.2 cm	
Leaf blade width	1.8 cm	
Petiole length	Sessile	
Leaf apex shape	Acute	
Leaf base shape	Cuneate	
Leaf margin	Entire	
Color of young leaf	Light green	
Color of fully developed leaf	Green	

### Molecular Characterization of medicinal plants

Variation in morphological features, alone are not enough to discriminate germplasm collected from five different districts as morphological characters are influenced by environmental conditions. Currently, DNA markers technology is preferred over traditional approaches to assess genetic variability as a complementary strategy to effectively manage genetic resources. Molecular tools provide valuable data on diversity through their ability to detect variation at the DNA level. Due to COVID 19 pandemic, Universities and other molecular laboratories were closed since March 2020. Besides, chemical availability were also a big problem. Due to these unavoidable situation, sufficient laboratory research work could not carried out. Only very limited works were done but this work need repetition for confirmation. With the limited data it was very difficult to summarize the result. For authentic conclusion more research work for findings is needed. However, five *T. arjuna* and *T. chebula* germplasm were collected from five districts and DNA were extracted (Fig. 26).



**Fig. 26:** Integrating of genomic DNA of *Terminalia arjuna* isolated from fresh leaves (0.8% agarose gel). From left to right; Lane 1-Natore, Lane 2-Tangail, Lane 3- Sherpur, Lane 4-Mymensingh, Lane 5- Jamalpur

Only two primers were used for RAPD analysis of *T. chebula*. *Terminalia* germplasm collected from five districts were differentiated from each other based on polymorphic fragments that were obtained after RAPD amplification. Both the primers produced clear and reproducible polymorphic fragments in all five germplasm collected from five districts of *T. Chebula*. In total 11 amplified bands with 6 (six) monomorphic and 5 (five) polymorphic bands were scored (Table 13). Primer OPA02 detected the highest polymorphism (66.67%), whereas Primer OPA18 displayed minimum (37.50%). The size of the amplified products ranged from 110 to 700 bp. The maximum number of RAPD bands (8) was detected using the OPA18 primer, whereas the minimum number (3) was amplified with OPA02.

**Table 13:** Monomorphic, polymorphic and total amplified bands, % polymorphism of *T. chebula*

RAPD Primer	Monomorphic bands	Polymorphic bands	Total bands	% Polymorphism
OPA02	1	2	3	66.67
OPA18	5	3	8	37.50
<b>Total</b>	<b>6</b>	<b>5</b>	<b>11</b>	<b>45.45</b>

The result demonstrated that different primers generated various fragment numbers and lengths. The size of the amplified products ranged from 110 to 700 bp. The maximum number of RAPD bands (8) was detected using the OPA18 primer, whereas the minimum number (3) was amplified with OPA02.

### Multiplication of medicinal plants conserved at BAU-GPC

**Expt. 1:** Effects of soaking duration and soaking after days of fruit collection on germination and seedlings growth performance of Hortiki (*Terminalia chebula*)

Soaking duration of seed significantly affected the germination period of *Terminalia chebula* and it started from 32 days and completed within 59 days. The fastest germination (the lowest imbibition period, 32 days) was observed where seeds were soaked in cowdung slurry for 6 days (C<sub>5</sub>) followed by C<sub>4</sub> (35 days) and delayed germination (the highest imbibition period, 59 days) was observed in C<sub>1</sub> (Table 14). Similar result also found in germination ending days where early (52 days) germination completed in C<sub>5</sub> (seed soaked in cowdung slurry for 6 days) than other treatment. Seeds soaked in cowdung slurry for 6 days significantly increased the germination percentage (85.25%), germination energy (43.41), survival percentage (85.21%) than other treatments and the lowest was recorded in control (C<sub>1</sub>). The seeds hard seed coats show enhanced germination when various pre-sowing treatments are conducted (Ajiboye *et al.*, 2009). Soaking seeds in water for 48h improved germination (Jackson, 1994). Luna, 1996 mentioned that fermentation of seed for three weeks by removing fruits' pulp and placing the seeds in between layers of straw in a tray having perforations at the bottom gives about 60% germination of *Terminalia chebula Retz.* seeds. Rashid *et al.*, 1990 showed that the whole fruits of *Terminalia chebula Retz.* and *Terminalia belerica* pre-treated by soaking in water for 48h had enhance germination. Similar findings also observed in the present study where, germination speed, germination percentage, and seedling growth of *Terminalia chebula Retz.* significantly increased when fleshy fruits are depulped and seeds are soaked in cold water compared to control.

Results had shown that, seed soaking after days of fruit collection significantly affected germination. Seed germination started on 31 days after sowing and continued up to 61 days. The fastest germination (the lowest imbibition period, 31 days) was observed in P<sub>2</sub> (seeds sowing/soaking after 10 days of collection) followed by P<sub>1</sub> and delayed germination (the

highest imbibition period, 59 days) was observed in P<sub>4</sub> (Table 15). Significantly highest germination percentage (79.20%), germination energy (39.59%), survival percentage (79.81%) were recorded in P<sub>2</sub> treatment (Seeds sowing after 10 days of collection) and the lowest was in P<sub>1</sub> (72.00%, 33.69, 65.83%) respectively.

**Table 14.** Effect of soaking duration on seed germination of *Terminalia chebula*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
C <sub>1</sub>	39.00	59.00	63.00	28.33	47.50
C <sub>2</sub>	36.00	55.75	67.75	37.71	59.13
C <sub>3</sub>	35.83	52.75	75.75	39.99	82.13
C <sub>4</sub>	35.25	57.75	78.00	32.83	84.21
C <sub>5</sub>	32.25	52.75	85.25	43.41	85.21
LSD <sub>0.05</sub>	0.87	0.98	1.23	0.81	1.08
LSD <sub>0.01</sub>	1.17	1.31	1.64	1.08	1.45
Level of significance	**	**	**	**	**

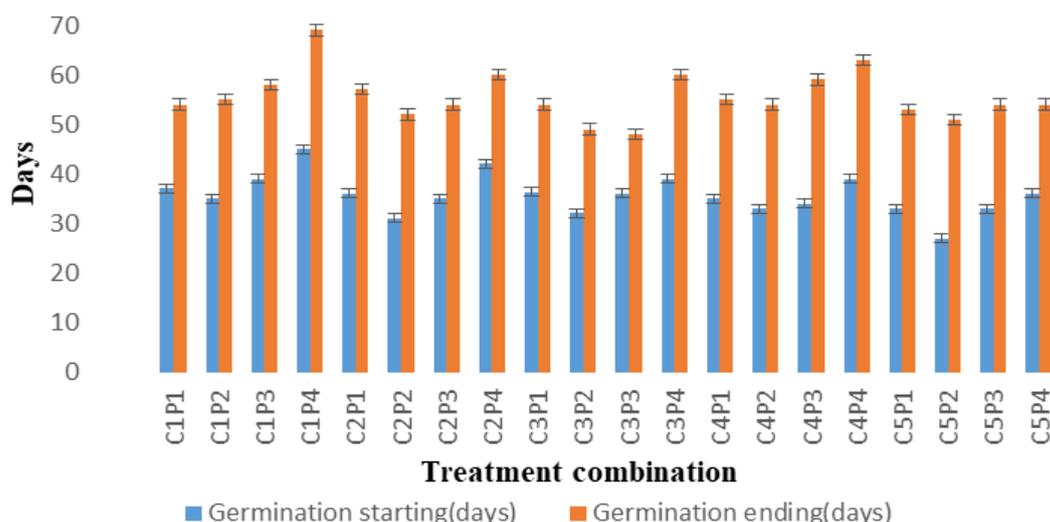
\*\* = Significant at 1% level of probability, C<sub>1</sub>=Without soaking seeds; C<sub>2</sub>=Seeds soaking in normal water for 2days, C<sub>3</sub>=Seeds soaking in normal water 4 days; C<sub>4</sub> = Seeds soaking in normal water for 6 days; C<sub>5</sub> =Seeds soaking in normal cow dung slurry for 6 days.

For combined effect of soaking duration and seed soaking after days of collection significantly affect germination. The fastest germination (the lowest imbibition period, 27 days) was observed in C<sub>5</sub>P<sub>2</sub> and delayed germination (the highest imbibition period, 69 days) was observed in C<sub>1</sub>P<sub>4</sub> (Fig. 27). The highest germination percentage (93.00%), germination energy (53.67) were found in C<sub>5</sub>P<sub>4</sub> and lowest was in C<sub>1</sub>P<sub>4</sub> (Fig. 26). The highest survival percentage (92.86%) was recorded in C<sub>5</sub>P<sub>4</sub> and the lowest (40.00%) was in C<sub>1</sub>P<sub>1</sub> (Fig. 27).

**Table 15.** Effect of soaking after days of collection on germination and survival percentage % of *Terminalia chebula*.

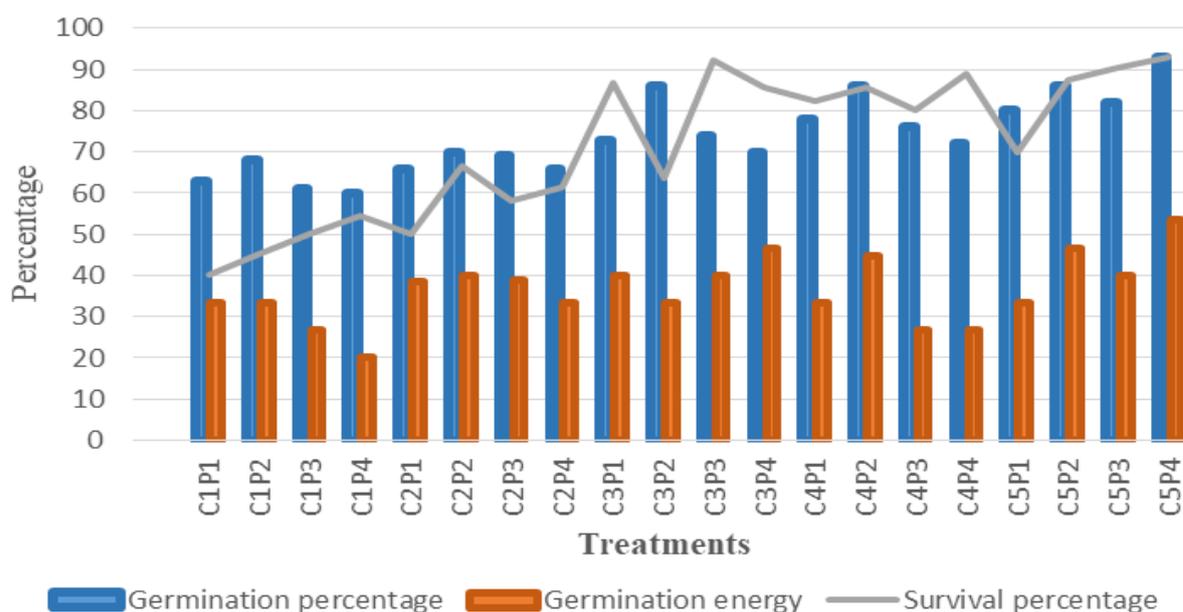
Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
P <sub>1</sub>	35.47	54.60	72.00	33.69	65.83
P <sub>2</sub>	31.60	52.20	79.20	39.59	79.81
P <sub>3</sub>	35.48	53.60	72.40	34.46	74.18
P <sub>4</sub>	40.20	61.20	72.20	36.06	76.71
LSD <sub>0.05</sub>	0.77	0.87	1.09	0.72	0.96
LSD <sub>0.01</sub>	1.04	1.17	1.47	0.96	1.29
Level of significance	**	**	**	**	**

\*\* Significant at 1% level of probability, P<sub>1</sub> = Seeds sowing/soaking in collection date; P<sub>2</sub> = Seeds sowing/soaking after 10 days of collection; P<sub>3</sub> = Seeds sowing/soaking after 20 days of collection; P<sub>4</sub> = Seeds sowing/soaking after 30 days of collection



**Fig. 27.** Combined effect of soaking duration and soaking after days of collection on germination starting and ending of *Terminalia chebula*

C<sub>1</sub>=Without soaking; C<sub>2</sub>= Soaking in normal water for 2days, C<sub>3</sub>= Soaking in normal water 4 days; C<sub>4</sub>=Soaking in normal water for 6 days; C<sub>5</sub> =Soaking in normal cow dung slurry for 6 days:P<sub>1</sub>=Sowing/soaking in collection date; P<sub>2</sub>=Sowing/soaking after 10 days of collection; P<sub>3</sub>=Sowing/soaking after 20 days of collection; P<sub>4</sub> = Sowing/soaking after 30 days of collection



**Fig. 28.** Combined effect of soaking duration and soaking after days of collection on germination percentage, germination energy and survival percentage

C<sub>1</sub>=Without soaking; C<sub>2</sub>=Soaking in normal water 2days, C<sub>3</sub>=Soaking in normal water 4 days; C<sub>4</sub>=Soaking in normal water for 6 days; C<sub>5</sub> =Soaking in normal cow dung slurry 6 days:P<sub>1</sub>=Sowing/soaking in collection date; P<sub>2</sub>= Sowing/soaking after 10 days of collection; P<sub>3</sub>=Sowing/soaking after 20 days of collection; P<sub>4</sub> = Sowing/soaking after 30 days of collection

### Growth performance of *Terminalia chebula* seedling

Soaking duration of seed significantly affected different growth parameters like leaf number, leaf area, shoot height, root length, vigor index and collar diameter of seedling of *T. chebula*

(Table 16). The highest leaf number (51.38) was observed in C<sub>5</sub> followed by C<sub>4</sub> (43.65) and the lowest was in C<sub>1</sub> (36.00). The leaf area was the highest in C<sub>5</sub> (34.99 cm<sup>2</sup>) and the lowest leaf area was in C<sub>1</sub> (19.51). Shoot height of the seedlings was the highest (24.75 cm) in C<sub>5</sub> and the lowest C<sub>1</sub> (15.04 cm). Root length of the seedlings was highest (28.00 cm) and the lowest was recorded in C<sub>1</sub> (22.25 cm). Total length of the seedlings was found the highest (52.33 cm) in C<sub>5</sub> and the lowest in C<sub>1</sub>. The highest vigor index was recorded in C<sub>5</sub> (4507.0) and the lowest in C<sub>1</sub> (2352.7). The highest collar diameter was found in C<sub>5</sub> (0.53 cm) and the lowest in C<sub>1</sub> (0.39 cm).

Soaking after days of collection of fruit significantly affected the leaf number, leaf area, shoot height, root length, total seedling length, vigor index and collar diameter of *T. chebula* seedlings (Table 17). The highest leaf number (47.51), leaf area (28.02 cm<sup>2</sup>), shoot height (23.80 cm), root length (24.45 cm), highest total length (48.25 cm), vigor index (3657.1), collar diameter (0.48 cm) were observed in P<sub>2</sub> and the lowest in P<sub>3</sub>. (Table 17).

**Table 16.** Effect of soaking duration of seed on vegetative growth of *Terminalia chebula*

Treatment	Leaf Number	Leaf Area (cm <sup>2</sup> )	Shoot Height (cm)	Root length (cm)	Total length (cm)	Vigor Index	Collar Diameter (cm)
C <sub>1</sub>	36.00	19.51	15.04	22.25	37.29	2352.7	0.39
C <sub>2</sub>	42.21	25.03	20.06	23.44	43.50	2951.5	0.48
C <sub>3</sub>	41.59	26.16	24.00	26.00	50.00	3782.0	0.47
C <sub>4</sub>	43.65	28.96	23.00	25.00	48.00	3752.7	0.44
C <sub>5</sub>	51.38	34.99	24.75	28.00	52.33	4507.0	0.53
LSD <sub>0.05</sub>	1.15	0.98	1.07	1.24	1.49	134.20	0.021
LSD <sub>0.01</sub>	1.45	1.32	1.43	1.66	1.99	179.75	0.03
Level of significance	**	**	**	**	**	**	**

\*\* Significant at 1% level of probability, C<sub>1</sub>=Without soaking seeds; C<sub>2</sub>=Seeds soaking in normal water for 2 days, C<sub>3</sub>=Seeds soaking in normal water 4 days; C<sub>4</sub> = Seeds soaking in normal water for 6 days; C<sub>5</sub> =Seeds soaking in normal cow dung slurry for 6 days:

**Table 17.** Effect of soaking after days of collection of *Terminalia chebula* fruit on seedling vegetative growth

Treatment	Leaf Number	Leaf Area (cm <sup>2</sup> )	Shoot Height (cm)	Root length (cm)	Total length (cm)	Vigor Index	Collar Diameter (cm)
P <sub>1</sub>	38.70	22.78	18.60	21.65	40.25	3004.0	0.46
P <sub>2</sub>	47.51	28.02	23.80	24.45	48.25	3845.1	0.48
P <sub>3</sub>	42.75	24.11	22.18	23.05	45.23	3370.6	0.43
P <sub>4</sub>	40.90	23.79	20.70	21.80	42.50	3657.1	0.46
LSD <sub>0.05</sub>	1.03	0.8829	0.95	1.11	1.33	120.03	0.0190
LSD <sub>0.01</sub>	1.38	1.1826	1.28	1.48	1.78	160.77	0.0255
Level of significance	**	**	**	**	**	**	**

\*\* Significant at 1% level of probability, P<sub>1</sub> = Seeds sowing/soaking in collection date; P<sub>2</sub> = Seeds sowing/soaking after 10 days of collection; P<sub>3</sub> = Seeds sowing/soaking after 20 days of collection; P<sub>4</sub> = Seeds sowing/soaking after 30 days of collection

Vegetative growth of *Terminalia chebula* seedlings was significantly affected by soaking duration and soaking after days of collection. The highest leaf number (60.00) was observed in C<sub>5</sub>P<sub>4</sub> and the lowest (32.50 cm) in C<sub>1</sub>P<sub>4</sub>. The highest leaf area (48.03 cm<sup>2</sup>) was recorded in C<sub>5</sub>P<sub>4</sub> and the lowest (18.41 cm<sup>2</sup>) from C<sub>1</sub>P<sub>2</sub>. The highest collar diameter (0.62 cm<sup>2</sup>) was observed in C<sub>5</sub>P<sub>4</sub> and the lowest (0.37 cm<sup>2</sup>) from C<sub>1</sub>P<sub>3</sub>. The highest vigor index (6217) was observed in C<sub>5</sub>P<sub>4</sub> and the lowest vigor index of seedlings was recorded (1890) from C<sub>1</sub>P<sub>1</sub> (Table 18).

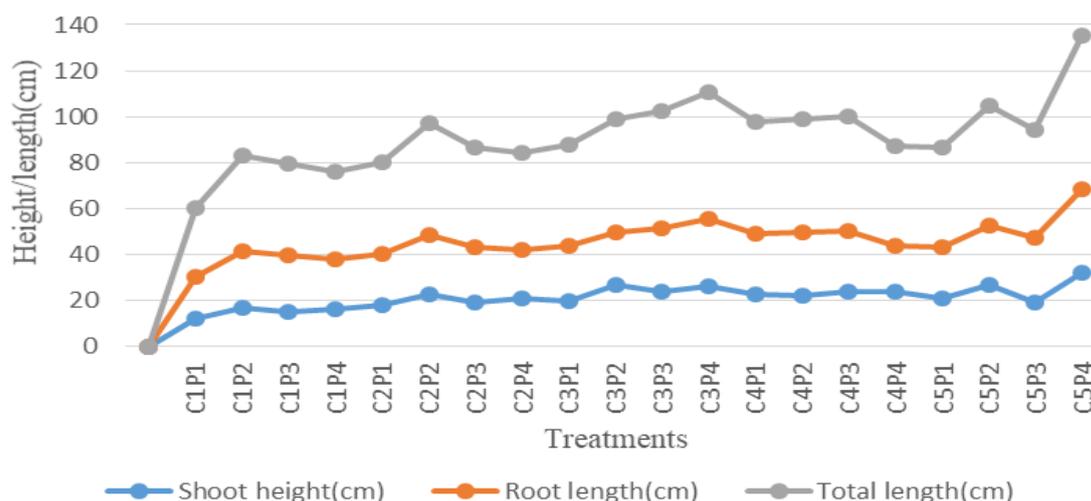
**Table 18.** Combined effect of soaking duration and soaking after days of collection fruit on seedling leaf number, leaf area, vigor index and collar diameter

Treatment	Leaf Number	Leaf Area(cm <sup>2</sup> )	Vigor Index	Collar diameter(cm)
C <sub>1</sub> P <sub>1</sub>	33.50	20.24	1890.00	0.40
C <sub>1</sub> P <sub>2</sub>	41.00	18.41	2821.33	0.42
C <sub>1</sub> P <sub>3</sub>	37.00	20.63	2419.50	0.37
C <sub>1</sub> P <sub>4</sub>	32.50	18.77	2280.00	0.39
C <sub>2</sub> P <sub>1</sub>	42.50	21.53	2638.00	0.50
C <sub>2</sub> P <sub>2</sub>	44.33	32.44	3394.70	0.51
C <sub>2</sub> P <sub>3</sub>	43.00	21.40	2983.60	0.44
C <sub>2</sub> P <sub>4</sub>	39.00	24.73	2789.80	0.49
C <sub>3</sub> P <sub>1</sub>	40.00	26.72	3210.00	0.52
C <sub>3</sub> P <sub>2</sub>	45.22	27.55	4257.33	0.48
C <sub>3</sub> P <sub>3</sub>	42.17	24.20	3793.42	0.44
C <sub>3</sub> P <sub>4</sub>	39.00	26.15	3867.25	0.44
C <sub>4</sub> P <sub>1</sub>	40.00	29.41	3822.50	0.44
C <sub>4</sub> P <sub>2</sub>	52.00	27.08	4256.67	0.49
C <sub>4</sub> P <sub>3</sub>	38.60	28.06	3800.33	0.43
C <sub>4</sub> P <sub>4</sub>	44.00	31.29	3131.40	0.40
C <sub>5</sub> P <sub>1</sub>	37.50	31.02	3459.67	0.47
C <sub>5</sub> P <sub>2</sub>	55.00	34.63	4495.50	0.53
C <sub>5</sub> P <sub>3</sub>	53.00	26.27	3856.00	0.49
C <sub>5</sub> P <sub>4</sub>	60.00	48.03	6217.00	0.62
LSD <sub>0.05</sub>	2.30	1.97	268.39	0.043
LSD <sub>0.01</sub>	3.08	2.64	359.50	0.057
Level of significance	**	**	**	**

\*\* Significant at 1% level of probability, C<sub>1</sub>=without soaking seeds; C<sub>2</sub>=Seeds soaking in normal water for 2days, C<sub>3</sub>=Seeds soaking in normal water 4 days; C<sub>4</sub> = Seeds soaking in normal water for 6 days; C<sub>5</sub> =Seeds soaking in normal cow dung slurry for 6 days:

P<sub>1</sub> = Seeds sowing/soaking in collection date; P<sub>2</sub> = Seeds sowing/soaking after 10 days of collection; P<sub>3</sub> = Seeds sowing/soaking after 20 days of collection; P<sub>4</sub> = Seeds sowing/soaking after 30 days of collection

The highest shoot height (32.00 cm) was observed in C<sub>5</sub>P<sub>4</sub> and the lowest (12.00 cm) from C<sub>1</sub>P<sub>1</sub>. The highest root length (68.50cm) was observed in C<sub>5</sub>P<sub>4</sub> and the lowest (30.00 cm) from C<sub>1</sub>P<sub>1</sub>. The highest total length (138.83cm) was observed in C<sub>5</sub>P<sub>4</sub> the lowest (60.00 cm) from C<sub>1</sub>P<sub>1</sub> (Fig. 29 and Fig. 31.)



**Fig. 29.** Combined effect of soaking duration and soaking after days of collection of *Terminalia chebula Retz.* fruit on shoot, root and total length of seedling

### Biomass production

After four months of seed sowing, a significantly higher leaf, shoot, root and total dry weight of *Terminalia chebula Retz.* seedlings were achieved (2.04, 3.37, 1.13, and 6.53 g, respectively) from seedling grown after seeds soaked in normal cow dung slurry for 6 days (C<sub>5</sub>) and the lowest (4.37 g) in control (C<sub>1</sub>) (Table 19). The higher leaves, shoot, root and total dry weight is due to more number of leaves, higher shoot length, roots and root length in seedling where seeds were soaked in normal cow dung slurry for 6 days and lower number of roots and small length of roots resulted in lower biomass in control (C<sub>1</sub>). The results resembled with Hossain *et al.*, 2005 who mentioned that the leaf dry weight, shoot dry weight and total dry weight of *Terminalia chebula Retz.* seedlings were significantly enhanced by depulping and soaking of seeds in water.

**Table 19.** Effect of soaking duration on leaf dry weight, shoot dry weight, root dry weight and total dry weight of *T. chebula* seedlings

Treatment	Leaf dry weight (g)	shoot dry weight (g)	Root dry weight (g)	Total dry weight (g)
C <sub>1</sub>	1.41	2.12	0.84	4.37
C <sub>2</sub>	1.96	2.96	1.02	5.95
C <sub>3</sub>	1.81	2.86	1.02	5.68
C <sub>4</sub>	1.84	2.90	1.12	5.86
C <sub>5</sub>	2.04	3.37	1.13	6.53
LSD <sub>0.05</sub>	0.07	0.06	0.03	0.11
LSD <sub>0.01</sub>	0.09	0.09	0.04	0.15
Level of significance	**	**	**	**

\*\* Significant at 1% level of probability

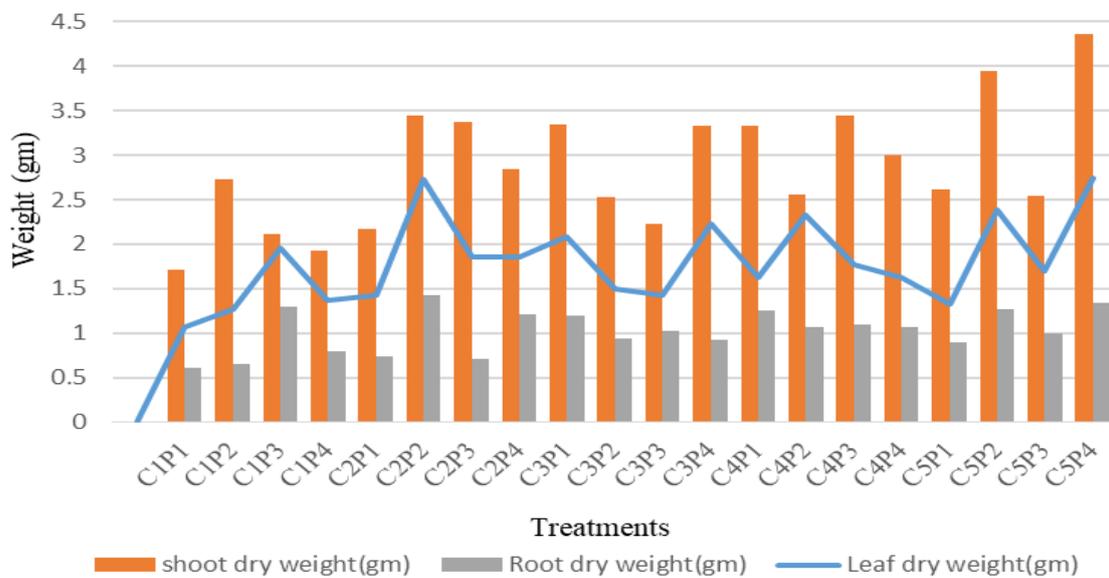
Average dry weight of leaves, shoot, root and total dry weight of *Terminalia chebula Retz.* seedlings were found the highest (2.04, 3.22, 1.07, and 6.33 g, respectively, after four months sowing seeds in treatment P<sub>2</sub> (seeds sowing after 10 days of collection) and the lowest in P<sub>1</sub> (Table 20).

**Table 20.** Effect of seed soaking after days of collection fruit on leaf dry weight, shoot dry weight, root dry weight and total dry weight of *T. chebula* seedlings

Treatment	Leaf dry weight (g)	shoot dry weight (g)	Root dry weight (g)	Total dry weight (g)
P <sub>1</sub>	1.51	2.48	0.94	4.92
P <sub>2</sub>	2.04	3.22	1.07	6.33
P <sub>3</sub>	1.74	2.65	1.02	5.41
P <sub>4</sub>	1.96	3.01	1.07	6.04
LSD <sub>0.05</sub>	0.06	0.05	0.03	0.10
LSD <sub>0.01</sub>	0.08	0.07	0.04	0.14
Level of significance	**	**	**	**

\*\* Significant at 1% level of probability

Combined effect of seed soaking duration and soaking after days of collection of fruit on the leaves, shoot, root and total dry weight of *Terminalia chebula* Retz. has been shown in (Fig. 30). After four months of sowing the seeds, the significantly highest weight of the above parameters were recorded (2.74, 4.36, 1.34 and 8.44 g, respectively) in the treatment C<sub>5</sub>P<sub>4</sub> and the lowest in C<sub>1</sub>P<sub>1</sub>.



**Fig. 30:** Combined effect of seed soaking duration and soaking after days of collection of fruit on shoot, root and leaf dry weight of *T. chebula* seedlings



**Fig. 31.** Seed and seedlings of *T. chebula*

**Expt. No. 2: Effect of pulping of seed and sowing date on seedling emergence and growth performance of Bohera (*Terminalia bellirica*)**

Germination was significantly influenced by pulping of *Terminalia bellirica* seeds. The fastest germination (the lowest imbibition period, 14.60 days) was observed in depulped seed before soaking (B<sub>2</sub>) and delayed (23.73 days) in Pulped seeds (B<sub>1</sub>). The lowest days required to complete germination was noticed in B<sub>2</sub> (21.23 days) and the highest in B<sub>1</sub> (40.50 days). Germination percentage was significantly affected by pulping of seed. The maximum Germination percentage (69.33%) was recorded when the fruits were depulped seed before soaking (B<sub>2</sub>) and the minimum in pulped seed (B<sub>1</sub>) (Table 21). Germination energy also noticed the maximum in (B<sub>2</sub>). Pulping of seed had significant effect on survival percentage of *T. bellirica* seedlings. The highest survival percentage (82.40%) was observed in depulped seed before soaking (B<sub>2</sub>) and the minimum in pulped seed (B<sub>1</sub>) (Table 22).

**Table 21.** Effect of pulp on seed germination and survival percentage of *T. bellirica*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage	Germination energy	Survival percentage
B <sub>1</sub>	23.73	40.50	40.74	15.42	71.96
B <sub>2</sub>	14.60	21.23	69.33	26.66	82.40
B <sub>3</sub>	19.80	30.83	54.01	16.96	76.98
LSD <sub>0.05</sub>	1.31	1.26	0.72	0.91	0.96
LSD <sub>0.01</sub>	1.76	1.71	0.97	1.23	1.30
Level of significance	**	**	**	**	**

\*\* Significant at 1% level of probability

B<sub>1</sub>= Pulped seeds, B<sub>2</sub>= Depulped seed before soaking, B<sub>3</sub>= Depulped seeds *after soaking*

Seed sowing date had significant affect on germination (Table 21). Seed germination started on 16 days after sowing the *T.bellirica* seeds and continued up to the 21 days. The fastest germination (the lowest imbibitions period, 16 days) was observed in T<sub>4</sub> (05.06.2020) and delayed germination (germination ending 36 days) was observed in T<sub>1</sub>. Germination percentage, germination energy and survival percentage were significantly affected in different sowing dates. The highest germination percentage, germination energy and survival percentage were 64.45 %, 24.15, 86.61%, respectively) when seeds sown on 05.06.2020 (Table 21).

**Table 22.** Effect of seed sowing date on germination and survival percentage of *T. bellirica*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage	Germination energy	Survival percentage
T <sub>1</sub>	21.33	36.00	45.78	16.11	69.54
T <sub>2</sub>	21.33	32.00	52.22	19.18	73.12
T <sub>3</sub>	19.22	29.61	56.77	19.56	73.52
T <sub>4</sub>	16.67	27.56	64.45	24.15	86.61
T <sub>5</sub>	18.33	29.11	54.25	19.42	82.77
LSD <sub>0.05</sub>	1.69	1.63	0.93	1.18	1.24
LSD <sub>0.01</sub>	2.27	2.20	1.26	1.59	1.67
Level of significance	**	**	**	**	**

\*\* Significant at 1% level of probability

T<sub>1</sub>= 20.04.2020, T<sub>2</sub>= 05.05.2020, T<sub>3</sub>= 20.05.2020, T<sub>4</sub>= 05.06.2020, T<sub>5</sub>= 20.06.2020

The combined effects of seed pulping and sowing dates significantly influenced seed germination of *T. bellirica* (Table 23). The highest germination percentage (83.00%) and survival percentage (81.25%) was noticed from B<sub>2</sub>T<sub>4</sub> combination (depulped seed before soaking and sown on 05.06.2020) (Table 23).

**Table 23.** Combined effect of seed pulping and sowing dates on germination and survival percentage of *T. bellirica*

Treatment	Germination starting(days)	Germination ending(days)	Germination percentage	Germination energy	Survival percentage
B <sub>1</sub> T <sub>1</sub>	27.00	45.00	32.33	10.67	66.74
B <sub>1</sub> T <sub>2</sub>	25.00	41.00	60.00	24.33	72.34
B <sub>1</sub> T <sub>3</sub>	22.67	39.50	45.00	13.33	69.55
B <sub>1</sub> T <sub>4</sub>	21.00	38.00	36.67	16.54	71.55
B <sub>1</sub> T <sub>5</sub>	23.00	39.00	73.33	25.66	74.66
B <sub>2</sub> T <sub>1</sub>	15.00	27.00	46.67	15.33	73.15
B <sub>2</sub> T <sub>2</sub>	17.00	22.00	43.33	17.48	72.55
B <sub>2</sub> T <sub>3</sub>	15.00	21.33	73.33	23.33	75.00
B <sub>2</sub> T <sub>4</sub>	12.00	20.67	83.00	27.87	81.25
B <sub>2</sub> T <sub>5</sub>	14.00	23.17	46.67	19.11	75.55
B <sub>3</sub> T <sub>1</sub>	22.00	36.00	70.00	33.33	77.66
B <sub>3</sub> T <sub>2</sub>	22.00	33.00	66.67	20.00	76.63
B <sub>3</sub> T <sub>3</sub>	20.00	30.00	44.67	13.33	73.42
B <sub>3</sub> T <sub>4</sub>	17.00	27.00	60.00	26.67	72.33
B <sub>3</sub> T <sub>5</sub>	18.00	28.17	58.07	18.26	72.55
LSD <sub>0.05</sub>	2.92	2.83	1.61	2.0378	2.15
LSD <sub>0.01</sub>	3.94	3.81	2.17	2.75	2.90
Level of significance	**	**	**	**	**

\*\* Significant at 1% level of probability

Number of leaf, leaf area (cm<sup>2</sup>), shoot height (cm), root length (cm), total length (cm) and vigor index showed significant variation due to the effect of pulp on seed germination in *T. bellirica* (Table 24.) After 120 days of seed sowing the leaf number, leaf area (cm<sup>2</sup>), shoot height (cm), root length (cm), total length (cm) and vigor index were found maximum (15.42, 49.60, 33.90, 39.58, 73.48 and 5118.8), respectively.

**Table 24.** Effect of seed pulp on vegetative growth of *T. bellirica*

Treatment	Leaf Number	Leaf Area (cm <sup>2</sup> )	Shoot Height (cm)	Root length (cm)	Total length (cm)	Vigor Index
B <sub>1</sub>	12.85	35.70	26.78	34.05	60.83	2510.2
B <sub>2</sub>	15.42	49.60	33.90	39.58	73.48	5118.8
B <sub>3</sub>	13.93	43.11	29.30	33.76	63.06	3461.4
LSD <sub>0.05</sub>	0.59	0.59	0.69	0.79	1.29	87.49
LSD <sub>0.01</sub>	0.79	0.81	0.94	1.07	1.74	118.02
Level of significance	**	**	**	**	**	**

\*\* Significant at 1% level of probability: B<sub>1</sub>= Pulped seeds, B<sub>2</sub>= Depulped seed before soaking, B<sub>3</sub>= Depulped seeds after soaking

In case of the effect of sowing dates, the number of leaf, leaf area (cm<sup>2</sup>), shoot height (cm), root length (cm), total length (cm) and vigor Index showed variation significantly of *T. bellirica* seedlings. The parameters were observed maximum 15.50cm, 46.01 cm, 35.47 cm, 37.00 cm, 72.47 cm and 4751.1 respectively when seeds were sown on 05.06.2020 (Table 25 and Fig. 32).

**Table 25.** Effects of sowing dates on the vegetative growth of *T. bellirica* seedlings

Treatment	Leaf Number	Leaf Area (cm <sup>2</sup> )	Shoot Height (cm)	Root length (cm)	Total length (cm)	Vigor Index
T <sub>1</sub>	13.96	37.73	19.33	33.78	53.11	2492.3
T <sub>2</sub>	14.41	41.73	28.83	33.88	62.71	3339.3
T <sub>3</sub>	13.86	43.72	34.00	34.80	68.80	3968.1
T <sub>4</sub>	15.50	46.01	35.47	37.00	72.47	4751.1
T <sub>5</sub>	13.60	44.83	32.33	35.54	67.87	3933.2
LSD <sub>0.05</sub>	0.76	0.77	0.90	1.023	1.67	112.95
LSD <sub>0.01</sub>	1.028	1.04	1.22	1.07	2.25	152.37
Level of significance	**	**	**	**	**	**

T<sub>1</sub>= sown in 20.04.2020, T<sub>2</sub>= sown in 05.05.2020, T<sub>3</sub>= sown in 20.05.2020, T<sub>4</sub>= sown in 05.06.2020, T<sub>5</sub>= sown in 20.06.2020



**Fig. 32.** Seed and seedlings growth of *T. Bellirica*

**Exp. No. 3: Effect of fruit size and soaking on germination and seedling growth of *Terminalia arjuna***

Germination was found significantly influenced by soaking fruits of *T. Aurjuna* (Table 26). The fastest germination (the lowest imbibition period, 8.33 days and ending germination, 14.33days) was observed soaking fruits in cow dung slurry for 36 hrs (T<sub>3</sub>) and delayed (ending germination, 28.22days) while fruits were not soaked (T<sub>1</sub>). Germination percentage, germination energy and survival percentage were also significantly affected by soaking. The maximum germination percentage (68.44%), germination energy (39.26) and survival percentage (76.33%) were recorded when the fruits were soaked in cow dung slurry for 36 hrs soaking (T<sub>3</sub>) and the minimum in control (T<sub>1</sub>).

Germination was found affected by fruit size (Table 27). Large fruits enhanced fast germination (start, 10 and end 17 days. The highest germination percentage (83.33%), germination energy (41.75) and survival percentage (72.75%) was recorded in large size fruit whereas minimum in small fruit.

**Table 26.** Effect of soaking of fruits on germination of *T. arjuna*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
T <sub>1</sub>	11.60	28.22	53.33	26.67	52.97
T <sub>2</sub>	10.71	21.44	57.78	34.11	64.89
T <sub>3</sub>	8.33	14.33	68.44	39.26	76.33
T <sub>4</sub>	9.00	14.67	64.22	39.00	71.16
LSD <sub>0.05</sub>	1.19	1.076	0.85	0.82	1.38
LSD <sub>0.01</sub>	1.38	1.46	1.15	1.11	1.88
Level of significance	**	**	**	**	**

\*\* = Significant at 1% level of probability: T1: No soaking of fruits, T2: Soaking fruits in water at room temp.for 36 hrs, T3: Soaking fruits in Cow dung slurry for 36 hrs, T4: Soaking fruits in hot water for 06 hrs.

The combined effects of fruit soaking and size significantly influenced seed germination (Table 28). The highest germination percentage (85.33%) and survival percentage (83.00%) was from T<sub>3</sub>S<sub>3</sub> combination (large fruit soaked in cow dung slurry for 36 hrs).

**Table 27.** Effect of seed size on seed germination and survival percentage of *T. arjuna*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
S <sub>1</sub>	7.80	22.50	40.92	26.58	60.98
S <sub>2</sub>	9.18	19.50	58.58	35.95	65.29
S <sub>3</sub>	10.50	17.00	83.33	41.75	72.75
LSD <sub>0.05</sub>	0.88	0.93	0.74	0.71	1.19
LSD <sub>0.01</sub>	1.19	1.27	0.99	0.96	1.63
Level of significance	**	**	**	**	**

\*\* Significant at 1% level of probability

S<sub>1</sub>: Small (Diameter; ≤2.2cm), S<sub>2</sub>: Medium (2.3≥3.0cm), S<sub>3</sub>: Large (≥ 3.1cm)

**Table 28.** Combined effect of several treatment and seed size on seed germination and survival percentage of *Terminalia arjuna*

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
T <sub>1</sub> S <sub>1</sub>	10.33	30.33	33.33	20.00	51.25
T <sub>1</sub> S <sub>2</sub>	11.46	27.33	53.33	26.67	53.66
T <sub>1</sub> S <sub>3</sub>	13.00	27.00	73.33	33.33	54.00
T <sub>2</sub> S <sub>1</sub>	9.21	27.00	39.33	26.67	62.85
T <sub>2</sub> S <sub>2</sub>	10.92	21.00	54.00	35.33	64.50
T <sub>2</sub> S <sub>3</sub>	12.00	16.33	80.00	40.33	67.33
T <sub>3</sub> S <sub>1</sub>	7.66	15.67	44.33	29.33	65.33
T <sub>3</sub> S <sub>2</sub>	8.33	14.67	67.67	41.78	72.66
T <sub>3</sub> S <sub>3</sub>	9.00	12.67	85.33	46.67	83.00

Table 28 Continued...

Treatment	Germination starting (days)	Germination ending (days)	Germination percentage (%)	Germination energy	Survival percentage (%)
T <sub>4</sub> S <sub>1</sub>	4.00	17.00	46.67	30.33	64.50
T <sub>4</sub> S <sub>2</sub>	6.00	15.00	59.33	40.00	70.33
T <sub>4</sub> S <sub>3</sub>	8.00	12.00	81.67	43.67	78.66
LSD <sub>0.05</sub>	1.7625	1.8628	1.4714	1.4166	2.3961
LSD <sub>0.01</sub>	2.3955	2.5319	1.9999	1.9255	3.2567
Level of significance	**	**	**	**	**

Soaking fruits in cow dung slurry for 36 hrs showed significant effects on the growth parameters of *T.arjuna* seedling (Table 29). The highest leaf number, leaf area, shoot and root length, vigor index of seedlings was found in soaking of fruits in cow dung slurry for 36 hrs and the lowest in control.

Seedling growth was significantly affected by fruits size. Leaf production ability, leaf area, shoot and root length, vigor index of seedlings were increased due to fruits size of (Table 30). Large fruit produced maximum number of leaf, leaf area, total length of seedling and vigor index.

**Table 29.** Effect fruit soaking on vegetative growth parameters of *T. arjuna*

Treatment	Leaf number	Leaf area(cm <sup>2</sup> )	Shoot height(cm)	Root length(cm)	Total length(cm)	Vigor Index
T <sub>1</sub>	27.00	14.80	27.83	43.67	71.50	4002.8
T <sub>2</sub>	27.83	15.22	32.67	39.50	72.17	4416.3
T <sub>3</sub>	38.00	20.25	39.50	48.67	88.17	6589.4
T <sub>4</sub>	28.50	17.72	34.83	46.83	81.66	6115.6
LSD <sub>0.05</sub>	0.99	0.23	0.96	1.01	1.45	115.25
LSD <sub>0.01</sub>	1.35	0.31	1.30	1.37	1.97	156.64
Level of significance	**	**	**	**	**	**

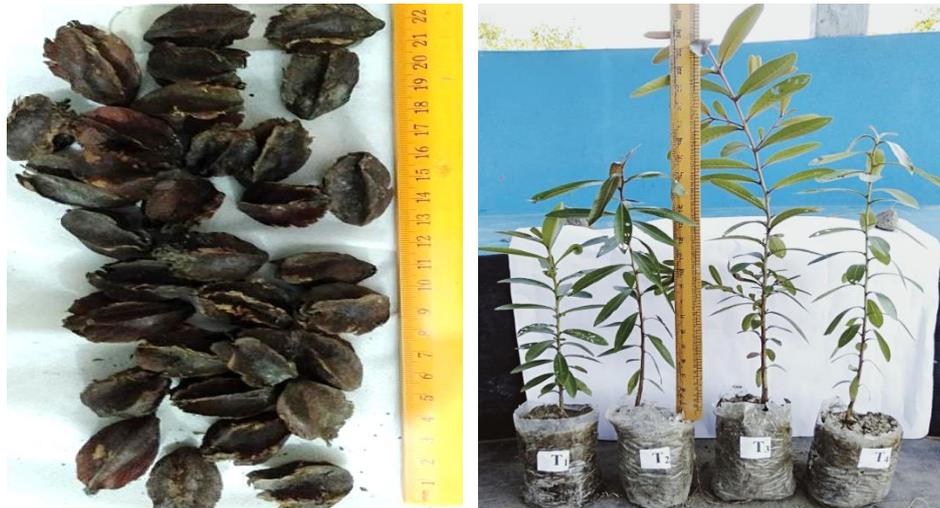
T<sub>1</sub>: No soaking of fruits, T<sub>2</sub>: Soaking fruits in water at room temp. for 36 hrs, T<sub>3</sub>: Soaking fruits in Cow dung slurry for 36 hrs, T<sub>4</sub>: Soaking fruits in hot water for 06 hrs.

**Table 30.** Effect of fruit size on vegetative growth parameters of *T. arjuna*

Treatment	Leaf number	Leaf area(cm <sup>2</sup> )	Shoot height(cm)	Root length(cm)	Total length(cm)	Vigor Index
S <sub>1</sub>	21.75	14.38	24.63	36.88	61.50	2537.7
S <sub>2</sub>	23.75	16.03	30.63	47.88	78.50	4650.7
S <sub>3</sub>	45.50	20.59	43.63	59.00	102.62	8654.8
LSD <sub>0.05</sub>	0.86	0.19	0.83	0.87	1.26	99.81
LSD <sub>0.01</sub>	1.17	0.27	1.13	1.19	1.71	135.66
Level of significance	**	**	**	**	**	**

S<sub>1</sub>: Small (Diameter; 1.6≥2.2cm), S<sub>2</sub>: Medium (2.3≥3.0cm), S<sub>3</sub>: Large (≥ 3.1cm)

Combined effects of fruit soaking and size were significant for leaf number, leaf area, shoot and root length and vigor index (Fig. 31). The highest leaf number, leaf area, shoot and root length and vigor index was recorded in T<sub>3</sub>S<sub>3</sub> (Table 33). For propagation of *T. arjuna* larger fruit soaking in cowdung slurry for 36 hrs found most suitable.



**Fig. 33.** Fruit (a) and (b) seedlings of *T. arjuna*

**Table 31.** Combined effect of fruit soaking and size on vegetative growth of *T. arjuna*.

Treatment	Leaf number	Leaf area(cm <sup>2</sup> )	Shoot height(cm)	Root length(cm)	Total length(cm)	Vigor Index
T <sub>1</sub> S <sub>1</sub>	23.00	13.33	24.50	33.00	57.50	1915.81
T <sub>1</sub> S <sub>2</sub>	22.50	13.67	26.50	44.50	71.00	3785.68
T <sub>1</sub> S <sub>3</sub>	35.50	17.41	32.50	53.50	86.00	6307.05
T <sub>2</sub> S <sub>1</sub>	23.50	13.68	27.00	32.50	59.50	2340.33
T <sub>2</sub> S <sub>2</sub>	23.00	15.01	31.50	32.00	63.50	3429.50
T <sub>2</sub> S <sub>3</sub>	37.00	16.97	39.50	54.00	93.50	7479.17
T <sub>3</sub> S <sub>1</sub>	18.00	13.8	24.50	29.50	54.00	2394.17
T <sub>3</sub> S <sub>2</sub>	26.50	18.64	37.00	51.50	88.50	5988.33
T <sub>3</sub> S <sub>3</sub>	69.50	28.31	57.00	65.00	122.00	11385.76
T <sub>4</sub> S <sub>1</sub>	22.50	16.71	22.50	52.50	75.00	3500.42
T <sub>4</sub> S <sub>2</sub>	23.00	16.78	27.50	63.50	91.00	5399.33
T <sub>4</sub> S <sub>3</sub>	40.00	19.68	45.50	63.50	109.00	9447.20
LSD <sub>0.05</sub>	0.02	0.39	1.66	1.74	2.51	199.62
LSD <sub>0.01</sub>	2.34	0.54	2.25	2.37	3.41	271.31
Level of significance	**	**	**	**	**	**

T<sub>1</sub>: No soaking of fruits, T<sub>2</sub>: Soaking fruits in water at room temp. for 36 hrs, T<sub>3</sub>: Soaking fruits in Cow dung slurry for 36 hrs, T<sub>4</sub>: Soaking fruits in hot water for 06 hrs.

S<sub>1</sub>: Small (Diameter; ≤2.2cm), S<sub>2</sub>: Medium (2.3≥3.0cm), S<sub>3</sub>: Large (≥ 3.1cm)

Some medicinal plants were also multiplied by different vegetative propagation (Fig. 34)

a) Air-layering: About 90% air layering were succeeded to chaste tree.

b) Cuttings: The propagation of Veldt grape, Malabar nut, Arjun, Chaste tree, gynura were propagated through cutting. All cutting saplings are conserved in BAU-GPC.

c) Sucker: *Aloe barbadensis* produced sucker for propagation

d) Seeding: Ashwagandha, Holy basil, Telegraph plant, Indian ginseng, Creat, Glory bower were propagated by seeding. Optimum number of seedlings are conserved in BAU-GPC.



**Fig. 34.** Propagation of medicinal plants by layering, cutting and seed

### Medicinal plant trial plot at Natore

A trial plot of medicinal plants were developed in the land of Mr. Md. Shahidul Islam, a farmer who cultivates medicinal plant at Kathabaria, Laxmipur, Natore. In total 37 Medicinal plant species under different genera of 25 families were collected from surrounding areas of Laxmipur, Natore and planted in the farmers trail plot. Medicinal plants planted in the farmer's trial plot are shown in table 32. Among the planted families Fabaceae (5 species) and Zingiberaceae (4 species) are the more dominant families followed by Combretaceae (3 species), Nyctaginaceae Vitaceae, Acanthaceae and Verbenaceae (2 species) and 20 families like, Liliaceae, Asparagaceae, Bombacaceae, Convolvulaceae, Lamiaceae, Apocynaceae, Solanaceae, Euphorbiaceae, Piperaceae, Crassulaceae, Aristolochiaceae, Smilacaceae, Hypoxidaceae, Stereculiaceae, Thymelaeaceae, Meliaceae, Ceasalpiniaceae, Moringaceae were represented by single species (Table 32). All the Medicinal plants were planted following during the first year of the project. Planting system, spacing and all other activities were performed same as BAU-GPC. The planted medicinal plants were tree, shrub, herb and creeper/climber and their growth and spreading are shown in table 33. Tree medicinal plants were Ashok, hortoki, bohera, arjun, shimul, nishinda, polas, agor, neem etc. The shrub, herb and creeper/climber medicinal plants were gritokumari, Bashok, sotomuli, harzora, vuikumra, tulsi, sarpogandha, dadmordon, ashogandha, lalbherenda, piple, pathorkuchi, hatikana, ekangi, kiamul, ishermul, goniori, kumarilota, kalomegh, talmuli, aamada, alkushi, punarnava, olotkombol, kanchon, and torup chondal. Useful parts of the medicinal plants are given in table 35.

Growth performance of the medicinal plants were recorded. All the planted medicinal plants were survived and growth perofrmances were observed. Performance of medicinal plants are shown in Fig. 35. Tree medicinal plants demonstrated excellant vegetative growth, branching and canopy spreading. Other medicinal shrub, herb, climber's also performed well in good growth.



**Fig. 35.** Medicinal plant Trial plot at Natore

**Table 32.** Medicinal plants at farmer's trial plot, Kathalbaria, Laxmipur, Natore

Sl No.	Local Name	English Name	Scientific Name	Family
01	GritoKumari	Indian Aloe	<i>Aloe barbadensis</i>	Liliaceae
02	Bashok	Malabar Nut	<i>Justicia adhatoda</i>	Acanthaceae
03	Sotomuli	Asparagus	<i>Asparagus racemosus</i>	Asparagaceae
04	Shimul	Silk Cotton tree	<i>Bombax ceiba</i>	Bombacaceae
05	Harzora	Veldt Grape	<i>Cissus quadrangularis</i>	Vitaceae
06	Vuikumra	Giant potato	<i>Ipomoea mauritiana</i>	Convolvulaceae
07	Tulsi	Holy Basil	<i>Ocimum tenuiflorum</i>	Lamiaceae
08	Sarpogandha	Snake Root	<i>Rauvolfia serpentina</i>	Apocynaceae
09	Dad mordon	Candle bush	<i>Senna alata</i>	Fabaceae
10	Misridana	Peacock ginger	<i>Kaempferia rotunda</i>	Zingiberaceae
11	Ashok	Ashok	<i>Saraca asoca</i>	Fabaceae
12	Arjun	Arjuna	<i>Terminalia arjuna</i>	Combretaceae
13	Bohera	BelericMyrobalan	<i>Terminalia bellirica</i>	Combretaceae
14	Horitoki	Chebolicmyrobalan	<i>Terminalia chebula</i>	Combretaceae
15	Nisinda	Chaste Tree	<i>Vitex negundo</i>	Verbenaceae
16	Ashawagandha	Winter Cherry	<i>Withania somnifera</i>	Solanaceae
17	Lal bherenda	Bellyache bush	<i>Jatropha gossypifolia</i>	Euphorbiaceae
18	Piple	Long pepper	<i>Piper longum</i>	Piperaceae
19	Pathorkuchi	Cathedral bells	<i>Bryophyllum pinnatum</i>	Crassulaceae
20	Hatikana	Elephant ear plant	<i>Leea macrophylla</i>	Vitaceae
21	Ekangi	Aromatic zinger	<i>Kaempferia galanga</i>	Zingiberaceae
22	kiamul	Costus	<i>Costus speciosus</i>	Zingiberaceae
23	Ishwar mul/Langoli	Indian birthwort	<i>Aristolochia indica</i>	Aristolochiaceae
24	Goniori	Agnimantha	<i>Premna integrifolia</i>	Verbenaceae
25	Kumarilota	Black creeper	<i>Smilax perfoliata</i>	Smilacaceae
26	Kalomegh	Creat	<i>Andrographispaniculata</i>	Acanthaceae
27	Talmuli/ kalimusli	Weevil wort	<i>Curculigo orchiodes</i>	Hypoxidaceae
28	Amrul/Aamada	Mango ginger	<i>Curcuma amada</i>	Zingiberaceae
29	Alkushi	Velvet bean	<i>Mucuna pruriens</i>	Fabaceae
30	Punarnava	Pigweed	<i>Boerhavia diffusa</i>	Nyctaginaceae
31	Olotkombol	Devils Cotton	<i>Abroma augusta</i>	Stereuliaceae
32	Agor	Aloe wood	<i>Aquilaria malaccensis</i>	Thymelaeaceae
33	Neem	Indian lilac	<i>Azadirachta indica</i>	Meliaceae
34	Kanchon	Wild ebony	<i>Bauhinia acuminata</i>	Fabaceae
35	Torupchondal	Telegraph plant	<i>Codariocalyx motorius</i>	Fabaceae
36	Polas	Bastard Teak	<i>Butea monosperma</i>	Fabaceae
37	Sajina	Moringa	<i>Moringa oleifera</i>	Moringaceae

**Table 33.** Medicinal plants at farmer's trial plot, Kathalbaria, Laxmipur, Natore

SI No.	Local Name	Plant height	Spread	Growth habit
01	GritoKumari	50cm	50cm	Herb
02	Bashok	1.5m	1.0m	Woody Shrub
03	Sotomuli	1m	40cm	Climber
04	Simul	2.5m	2.5m	Tree
05	Harzora	Vine	Vine	Climber
06	Vuikumra	Vine	Vine	Climber herb
07	Tulsi	2m	1m	Shrub
08	Sarpogandha	80m	80m	Shrub
09	Dad mordon	2m	2m	Tree
10	Misridana	80cm	80cm	Herb
11	Ashok	1.5m	1.0m	Tree
12	Arjun	3m	1.5m	Tree
13	Bohera	2m	1m	Tree
14	Horitoki	2	1m	Tree
15	Nisinda	3m	2m	Tree
16	Ashogandha	1m	50cm	Shrub
17	Lal bherenda	1.5m	1.0m	Shrub
18	Piple	Vine	Vine	Vine
19	Pathorkuchi	1m	30χμ	Herb
20	Hatikana	1m	60cm	Herb
21	Ekangi	20cm	30cm	Herb
22	kiamul	1.0m	50cm	Creeper
23	Ishermul	40cm	80cm	Creeper
24	Goniori	1.3m	70cm	
25	Kumarilota	Vine	Vine	Vine
26	Kalomegh	70cm	50cm	Shrub
27	Talmuli	40cm	40cm	Herb
28	Amrul/Aamada	40cm	40cm	Herb
29	Alkushi	-	-	creeper
30	Punarnava	Vine	Vine	Vine
31	Olotkombol	2.5m	1.5m	Shrub
32	Agor	2.0m	50cm	Tree
33	Neem	2.5m	50cm	Tree
34	Kanchon	2.0m	1.0m	Shrub
35	Torup chondal	1.5m	1.0μ	Shrub
36	Polas	2.0m	1.0m	Tree
37	Sajina	2m	1.0m	Tree

**Table 34.** Medicinal plants and their usable parts

SI No	Local Name/ English Name	Scientific Name	Use parts
01	GritoKumari/ Indian Aloe	<i>Aloe barbadensis</i>	Leaves
02	Bashok/ Malabar Nut	<i>Justicia adhatoda</i>	Leaves, root
03	Sotomuli/ Asparagus	<i>Asparagus racemosus</i>	Tuber, whole plant,
04	Shimul/Silk Cotton tree	<i>Bombax ceiba</i>	Root, bark, leaves, seed
05	Harzora/ Veldt Grape	<i>Cissus quadrangularis</i>	Leaf, stem, roots
06	Vuikumra/ Giant potato	<i>Ipomoea mauritiana</i>	Root, leaves, seed
07	Tulsi/ Holy Basil	<i>Ocimum tenuiflorum</i>	Root, leaves, seed
08	Sarpogandha/ Snake Root	<i>Rauwolfia serpentina</i>	Root, leaves
09	Dad mordon/ Candle bush	<i>Senna alata</i>	Flowerroot, leaf, seed, bark
10	Misridana/ Peacock ginger	<i>Kaempferia laotica</i>	Rhizome
11	Ashok/ Ashok	<i>Saraca asoca</i>	Wholeplant, flower, seed
12	Arjun/Arjuna	<i>Terminalia arjuna</i>	Bark
13	Bohera/ BelericMyrobalan	<i>Terminalia bellirica</i>	Bark, fruit, seed
14	Horitoki/ Chebulicmyrobalan	<i>Terminalia chebula</i>	Fruit
15	Nisinda/ Chaste Tree	<i>Vitex negundo</i>	Whole plant
16	Ashawgandha/ Winter Cherry	<i>Withania somnifera</i>	Roots
17	Vharenda/ Bellyache bush	<i>Jatropha gossypifolia</i>	Leaves, stem, roots, seed, latex
18	Piple/ Piper longan	<i>Piper longum</i>	Roots and fruits
19	Pathorkuch/ Cathedral bells	<i>Bryophyllum pinnatum</i>	Leaves
20	Hatikana/ Hatikana	<i>Leea macrophylla</i>	Root, Leaves, fruit
21	Ekangi/aromatic zinger	<i>Kaempferia galanga</i>	Rhizome
22	Kiamul/Costus	<i>Costus speciosus</i>	Rhizome
23	Ishwar mul/ Indian birthwort	<i>Aristolochia indica</i>	Root and Rhizome
24	Goniori/ Agnimantha	<i>Premna integrifolia</i>	Root
25	Kumarilota/catbriers	<i>Smilax proliferata</i>	Root, young shoot
26	Kalomegh/ Creat	<i>Andrographis paniculata</i>	Leaves, stem roots
27	Talmuli (kalimusli	<i>Curculigo orchoides</i>	Tuberous roots
28	Amrul (Aamada)	<i>Curcuma amada</i>	Rhizom
29	Alkushi/ Velvet bean	<i>Mucuna pruriens</i>	Seed
30	Punarnava/ Pigweed	<i>Boerhavia diffusa</i>	Wholeplant, root, leaves
31	Olotkombol/ Devils Cotton	<i>Abroma augusta</i>	Seed
32	Agor/ Aloe wood	<i>Aquilaria malaccensis</i>	Leaf, wood.
33	Neem/ Indian lilac	<i>Azadirachta indica</i>	Stem & root bark, leaves, flower, fruits
34	Kanchon/ Wild ebony	<i>Bauhinia acuminata</i>	Flower, bark, roots
35	Torupchondal/Telegraph plant	<i>Codariocalyx motorius</i>	Leaves, stem & roots
36	Polas/ Bastard Teak	<i>Butea monosperma</i>	Bark, leaves, flower, seed
37	Sajina/Moringa	<i>Moringa oleifera</i>	Leaves, flower, fruit, bark of stem & root

## 11.2 Component-2 (BFRI)

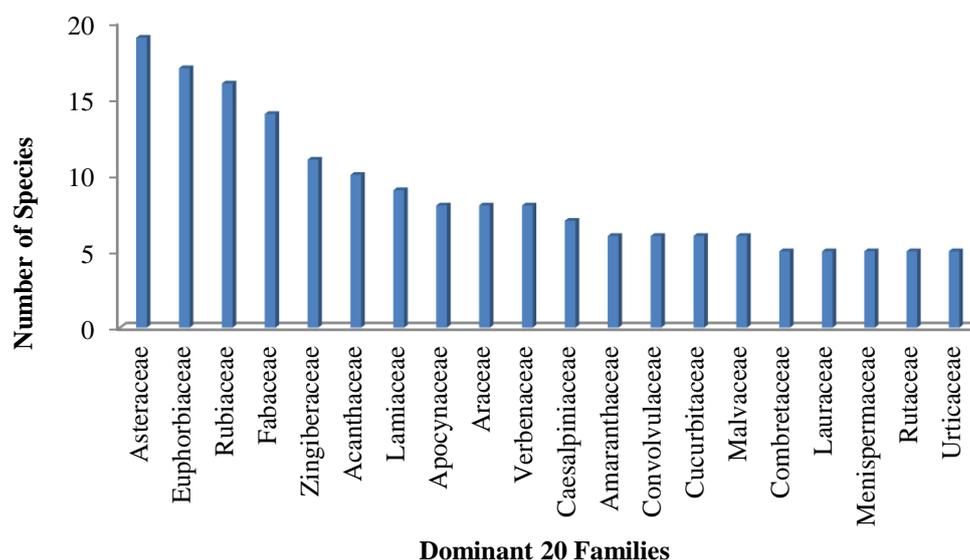
### *Demographic information of Informants*

Information of ethnomedicinal plants were collected from 60 herbal practitioners of the study area. Out of them 46 (77%) are men and 14 (23%) are women. Furthermore, most of the informants have no formal educations except one or two have got the opportunity for elementary education. Among the informants or herbal practitioners 22 belongs to Chakma tribe, followed by Marma 19, Tripura 10, Tonchongya 7 and Khumi 2.

### *Plants identified by family and growth forms*

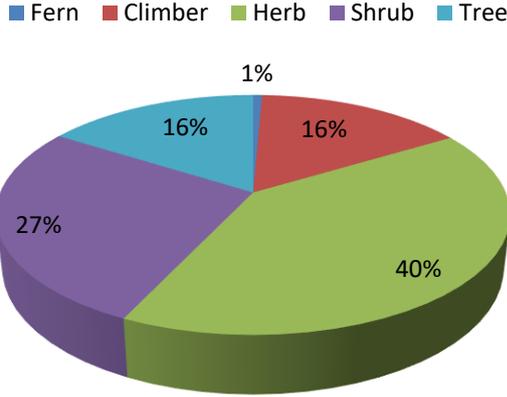
During the study 566 plant were documented, among them 266 plants found common, it means 47.42% plant are used by different herbal practitioners is common. The study reveals that a total of 300 plant species under 228 genera, belongs to 97 botanical families described by the tribal herbal practitioners of CHT's used for different ailments (Appendix 1). List of the described species are presented alphabetically stating scientific name, family, local names, habit, useful parts and ailments and relevant information. A list of 50 dominant species based on the use value provided in the Table 35.

The family Asteraceae is represented by highest number of 19 species, followed by Euphorbiaceae 17, Rubiaceae 16, Fabaceae 14, Zingiberaceae 11, Acanthaceae 10, Lamiaceae 9, Apocynaceae, Verbenaceae and Araceae 8, Caesalpiniaceae 7, Malvaceae, Amaranthaceae, Convolvulaceae and Cucurbitaceae 6 and 45 families represented by 1 species only (Appendix 2) and dominant 20 families were presented in Fig. 36.



**Fig. 36.** Distribution of ethnomedicinal plant species among dominant 20 families

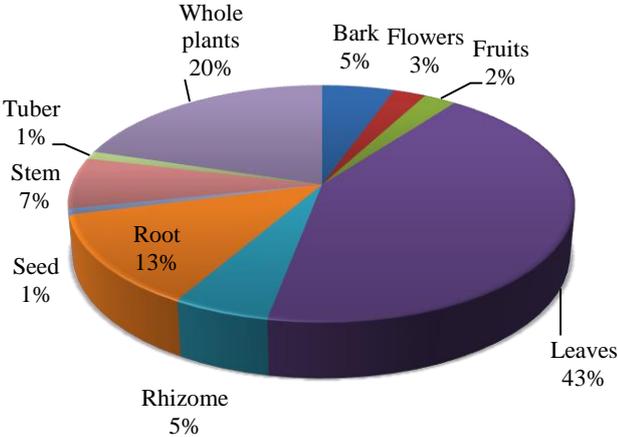
In life form, herbs (40%) were found most used plant followed by shrubs (27%), climber and trees (16%) and Fern (1%) (Fig. 37). According to Baydoun *et al.* (2015) herbs were used dominantly in the herbal preparation due to their medicinal properties and serving various primary human ailments and therapeutic indicators.



**Fig. 37.** Use of different life forms by the herbal practitioner in CHTs

***Different plant parts used for the preparation of ethnomedicine***

The study reveals that the herbal practitioners of Chattogram Hill Tracts use 10 different parts of the plants for treating different ailments. Leaves are the most dominant plant parts (43%), followed by whole plants (20%), roots (13%), stems (7%), rhizome and bark (5%) tuber and seeds (1%) (Fig. 38). Easy collection of leaves compared to other parts of the plants makes it favorite for the herbal preparation Giday *et al.* (2003). Moreover, leaves are the most active part of the plants in terms of production of metabolites and photosynthesis.

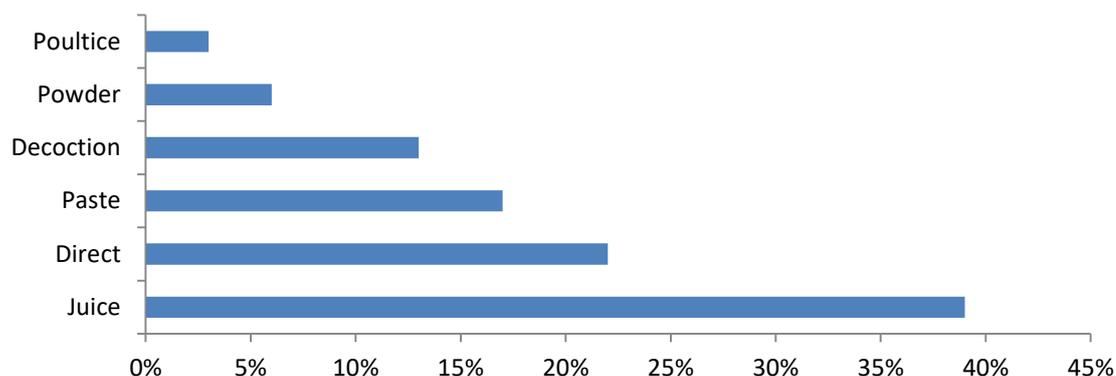


**Fig. 38.** Different plant parts used for the preparation of ethnomedicine by Boidday's in CHT

Furthermore, easy collection and availability makes the leaves and flowering parts common for herbal practitioners (Baydoun *et al.* 2015). The study further exposes the fact that almost 90% of the plants described by the herbal practitioners were wild, and the remaining is being cultivated.

***Herbal formulation and administration***

Herbal practitioners informed that almost 65% of ethnomedicines are administered orally and they use drugs in 7 different forms to treat different diseases. The most common form was found juice, followed by chewing raw, paste, decoction, powder and poultice (Fig. 39).



**Fig. 39.** Preparation method of herbal medicine in the management of various human ailments

According to the Nadembega *et al.* (2011) in traditional herbal drug, decoction can be considered one of the common forms of herbal formulations because it is very easy to prepare ethnomedicine simply by mixing plants parts with boiling water. However, in CHT's most common forms herbal formulation is juice. It is done by grinding the plant parts in stone and squeezing to extract juice. It may be due to their local adaptation with the harsh situation of Chattogram Hill Tracts and tradition they inherited from their predecessor.

**Table 35.** List of dominant 50 ethno-medicinal plants species on the basis of use values (UV)

Scientific name/ Family	Tribal name	Habit	Status*	Parts used**	Form of drug	UV	RFC	Ailment	Mode of use
<b>Acanthaceae</b>									
<i>Thunbergia grandiflora</i> (Roxb. ex Rottler) Roxb.	Del ludi (Chakma)	C	W	S	Juice	0.73	0.27	Conjunctivitis (eye problem), eczema and constipation	External
<i>Justicia adhatoda</i> L.	Shin mang gree (Marma)	S	C, W	L	Juice	0.60	0.12	Cough, blood pressure, general weakness and fever disease	Oral
<b>Anacardiaceae</b>									
<i>Mangifera indica</i> L.	Aam gach (Chakma)	T	W	L, BK and FR	Juice	0.70	0.10	Jaundice, fever, toothache, dysentery, urinary discharge, vomiting and diarrhea	Oral
<b>Apiaceae</b>									
<i>Centella asiatica</i> L.	Minmini (Chakma)	H	C, W	WP	Direct/ intact leaf	0.67	0.08	Vomiting, diarrhea of children, blood dysentery, insomnia, digestion problem and conjunctivitis	Oral
<b>Apocynaceae</b>									
<i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem & Schult.	Tashuru (Marma)	S	W	WP	Juice	0.75	0.07	Hooping cough, chicken pox, healing wounds and asthma	Oral
<i>Holarrhena antidysenterica</i> (L.) R.Br.	Lakthu (Marma)	T	C, W	BK	Juice	0.73	0.10	Diarrhea, hookworm, abdominal pain, threadworm, mouth sore, gastric ulcer and hyperacidity	Oral

Table 35 continued...

Scientific name/ Family	Tribal name	Habit	Status*	Parts used**	Form of drug	UV	RFC	Ailment	Mode of use
<i>Plumeria rubra</i> L.	Anggara gach (Chakma)	T	W	BK	Juice	0.73	0.10	Anemia, burning sensation of body, facial paralysis, bone fracture, jaundice, piles and asthma	Oral
<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz.	Gach pitta (Chakma)	S	C, W	R, L and FL	Decoction	0.70	0.08	Hypertension, insanity, constipation, cough and hysteria	Oral
<b>Araliaceae</b>									
<i>Schefflera elliptica</i> (Blume) Harms.	Amuki- khai (Marma)	S	W	L	Direct	0.73	0.10	Swelling problem, diabetic, dysentery, asthma and cancer	External
<b>Asclepiadaceae</b>									
<i>Calotropis gigantea</i> (L.) R. Br.	Aur gach (Chakma)	S	W	WP	Decoction	0.65	0.07	Pain, cough in children	Oral
<b>Asteraceae</b>									
<i>Gynura pseudo- china</i> (L.) DC.	Mring seba (Marma)	H	C, W	L	Juice	0.67	0.08	Snake bite, stop vomiting, intestinal worms and gastric problem	Oral
<i>Blumea virens</i> Wall ex DC.	Kalo ambush (Chakma)	H	W	L	Juice	0.60	0.10	Headache, body-pain and eye-problems	External
<b>Begoniaceae</b>									
<i>Begonia roxburghii</i> (Miq.) A.DC.	Khor tetui (Chakma)	H	W	WP	Paste	0.63	0.15	Throat pain and tongue infections of infants	External
<i>Heliotropium indicum</i> L.	Saimagri (Marma)	H	W	L	Direct	0.72	0.15	Injured muscle, dropsy, dyspepsia and abdominal pain	External
<b>Clusiaceae</b>									
<i>Mesua ferrea</i> L.	Sipran (Marma)	T	C	FL	Juice	0.70	0.07	Irregular menstruation, abdominal pain, boils and itching	Oral
<b>Combretaceae</b>									
<i>Terminalia chebula</i> Retz.Obs.	Ajubang (Marma)	T	W	FR	Powder	0.87	0.38	Jaundice, anorexia, eye diseases, hysteria and weakness	Oral
<b>Crassulaceae</b>									
<i>Kalanchoe lecininata</i> (L.) Pers.	Roah- kapanghey (Chakma)	H	C, W	L	Juice	0.67	0.10	Kidney problem, male infertility, cough, burn problem, headache and asthma	Oral
<b>Equisetaceae</b>									
<i>Equisetum diffusum</i> D. Don	Pinlacha (Marma)	H	W	S	Paste	0.62	0.08	Stiff muscle, bleeding from vein cutting	External
<i>Equisetum ramosissimum</i> Desf.	Rossa crassa (Marma)	H	W	S and TU	Direct	0.60	0.05	Fractured bone, abdominal tumour	External
<b>Euphorbiaceae</b>									
<i>Euphorbia nerifolia</i> L.	Shib gach (Chakma)	S	W	L, S and R	Juice	0.70	0.10	Snake bite, bronchitis, tumour, piles, anal fistula, cough	External
<i>Ricinus communis</i> L.	Bedul gach (Chakma)	S	W	L	Decoction	0.62	0.08	Piles, anal fistula, rheumatic pain	External
<b>Fabaceae</b>									
<i>Desmodium triquetrum</i> (L.) DC.	Kingmring (Marma)	S	C, W	WP	Direct	0.68	0.20	Fistula/ piles, blood pressure and general weakness	Oral

Table 35 continued...

Scientific name/ Family	Tribal name	Habit	Status*	Parts used**	Form of drug	UV	RFC	Ailment	Mode of use
<i>Cajanus cajan</i> (L.) Millsp.	Domorsum i gach (Chakma)	S	C	L	Juice	0.62	0.05	Asthma, stop vomiting, intestinal worms, gastric problem and cough	Oral
<i>Canavalia ensiformis</i> (L.) DC.	Pithanang (Marma)	C	W	SE	Direct	0.60	0.08	Body burning, breast pain, gallstone and pain	Oral
<b>Hypoxidaceae</b>									
<i>Molineria recurvata</i> (Dryand.) H.	Oilay (Marma)	H	W	R	Juice	0.63	0.07	Bleeding, insomnia, tumour and bone dislocation	External
<b>Lamiaceae</b>									
<i>Leucas zeylanica</i> (L.) R. Br.	Gassa dagor (Chakma)	H	W	L and FL	Juice	0.67	0.25	Mental disease, black fever, headache	External
<b>Lauraceae</b>									
<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	Menda bukur (Tripura)	T	C, W	BK	Juice	0.60	0.10	Diarrhea, gastric, wound healing and liver diseases	Oral
<b>Liliaceae</b>									
<i>Crinum latifolium</i> L.	Tongkrasui (Marma)	H	W	R	Juice	0.62	0.05	Abdominal pain, rheumatic pain	Oral
<b>Lygodiaceae</b>									
<i>Lygodium flexuosum</i> (L.) Sw.	Banolata (Tanchang ya)	H	W	L	Juice	0.65	0.05	Measles, chicken pox, chest pain and mental disorder	External
<b>Malvaceae</b>									
<i>Sida rhombifolia</i> L.	Prodolulan g (Chakma)	H	W	WP	Direct	0.63	0.05	Remittent fever, sores, abscess, general weekness and large boils	Oral
<b>Melastomaceae</b>									
<i>Melastoma melabathricum</i> L.	Kongkoine (Marma)	S	W	L and R	Paste	0.68	0.27	Boils, gynecological problem, snake bite, dysentery, sore problem, toothache, epilepsy, small pox	External
<b>Meliaceae</b>									
<i>Azadirachta indica</i> A. Juss.	Tamakha (Marma)	T	C	L and BK	Juice	0.88	0.37	Gastric ulcer, skin problem and liver disorder	Oral
<b>Menispermaceae</b>									
<i>Stephania japonica</i> (Thumb.) Miers.	Khumi (Marma)	C	W	R	Paste	0.67	0.08	Irregular menstruation of women, constipation and anal fistula	External
<b>Moringaceae</b>									
<i>Moringa oleifera</i> Lamk.	Sejnashak (Chakma)	T	W	L and BK	Juice	0.68	0.10	High blood pressure, Rheumatic pain, cold, cough, headache	Oral
<b>Myrsinaceae</b>									
<i>Maesa ramentacea</i> (Roxb.) A. DC.	Laccha sibeng gach (Chakma)	T	W	L	Direct	0.67	0.05	Pneumonia, tetanus, evil spirit, hysteria and satanophobia	External
<i>Maesa indica</i> Wall.	Ludi salak sara (Chakma)	S	W	WP	Juice	0.63	0.08	Fever, headache and dizziness of mother	Oral
<b>Oleaceae</b>									
<i>Jasminum sambac</i> (L.) Ait.	Kyaklung pai (Marma)	S	C	L and S	Decoction	0.67	0.05	Fever, fracture, abdominal pain	Oral

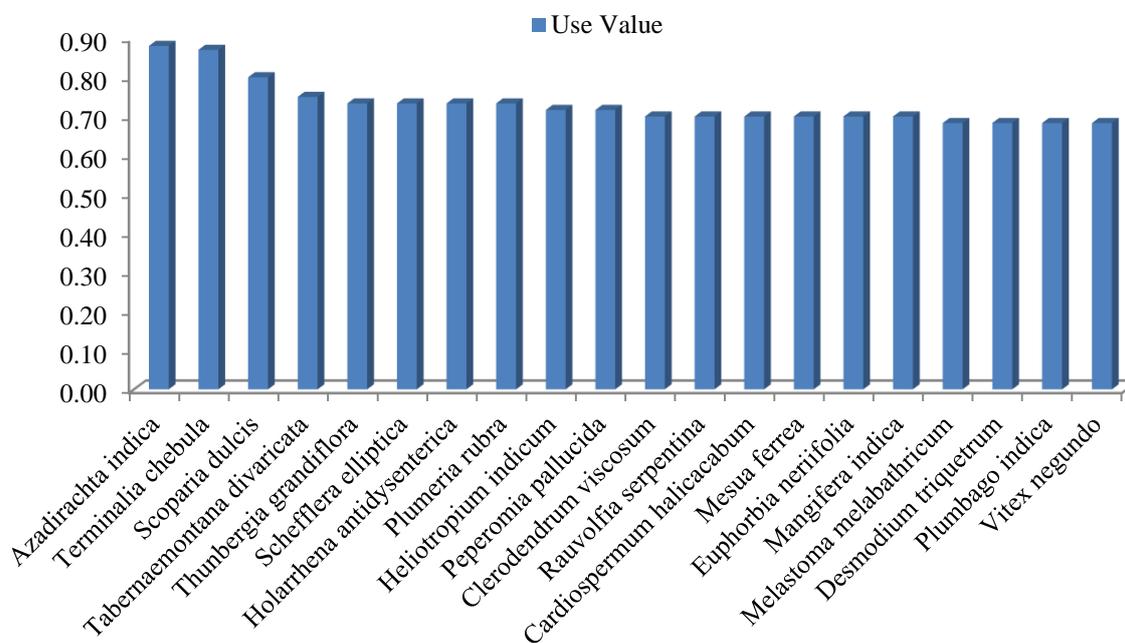
Table 35 continued...

Scientific name/ Family	Tribal name	Habit	Status*	Parts used**	Form of drug	UV	RFC	Ailment	Mode of use
<b>Piperaceae</b>									
<i>Peperomia pallucida</i> (L.) H. B. & K.	Hangara giluk shak (Chakma)	H	W	L and S	Paste	0.72	0.10	Snake bite, allergy, urinary infection, abscess, headache, eczema, eye inflammation	External
<b>Plumbaginaceae</b>									
<i>Plumbago indica</i> L.	Aguni tita (Chakma)	H	W	BK and L	Decoction	0.68	0.07	Hidden fever, cough, acidity and paralysis	Oral
<b>Rubiaceae</b>									
<i>Morinda angustifolia</i> Roxb.	Chak show (Marma)	T	W	BK	Paste	0.67	0.05	Fractured bone, breast pain, gallstone and earache	External
<b>Sapindaceae</b>									
<i>Cardiospermum halicacabum</i> L.	Kheta foxa ludi (Chakma)	C	W	WP	Decoction	0.70	0.07	Chicken pox, blood dysentery, indigestion, conjunctivitis and insomnia	Oral
<b>Scrophulariaceae</b>									
<i>Scoparia dulcis</i> L.	Mosala kher, Fuji kher (Chakma)	H	W	L and R	Paste	0.80	0.30	Haemorrhage, diarrhea, dysentery, fever, cough, bronchitis, toothache, breast pain, abdominal pain, earache	External
<b>Solanaceae</b>									
<i>Solanum lasiocarpum</i> Dunal	Chanka du (Marma)	H	W	R	Juice	0.63	0.05	Irregular menstruation, stop vomiting, intestinal worms and gastric problem	Oral
<b>Verbenaceae</b>									
<i>Clerodendrum viscosum</i> Vent.	Khumchhe (Marma)	S	W	L	Juice	0.70	0.18	Abdominal pain, cancer, fever, hysteria and mental disorder	Oral
<i>Vitex negundo</i> L.	Nirganda (Chakma)	T	C, W	L, FL and R	Paste	0.68	0.05	Abdominal pain, disinfecting wounds and ulcers, black fever, dysentery and liver problem	External
<i>Premna esculenta</i> Roxb.	Lelom pada (Chakma)	S	W	L and BK	Paste	0.67	0.10	Fever, headache, abdominal pain, scorpion stings, blister, high blood pressure, respiratory problems	External
<i>Clerodendrum indicum</i> (L.) O. Kuntze.	Nuli gach, Bheg gach (Chakma)	S	W	L, R and S	Powder	0.65	0.07	Fever, cough, rheumatic pain, nose bleeding	Oral
<i>Vitex penduncularis</i> Wall. ex Schuer.	Ashmul gach (Chakma)	T	W	L, BK and R	Decoction	0.63	0.08	Burning urination, menorrhagia, anal fissure	Oral
<b>Vitaceae</b>									
<i>Cissus javana</i> DC.	Lal hoilla (Chakma)	C	W	WP	Juice	0.60	0.07	Sexual infertility, constipation and ulcer	Oral
<b>Zingiberaceae</b>									
<i>Curcuma longa</i> (L.)	Nahnu (Marma)	H	C	RH	Direct	0.60	0.08	Diarrhea, dysentery, skin disease	Oral

\*W: Wild, C: Cultivated; \*\*R: Root, RH: Rhizome, L: Leaf, SE: Seed, FR: Fruit, FL: Flower, BK: Bark, WP: Whole plant, TU: Tuber; UV: Use Value; RFC = Relative frequency of Citation.

### Use value and relative frequenc of citation

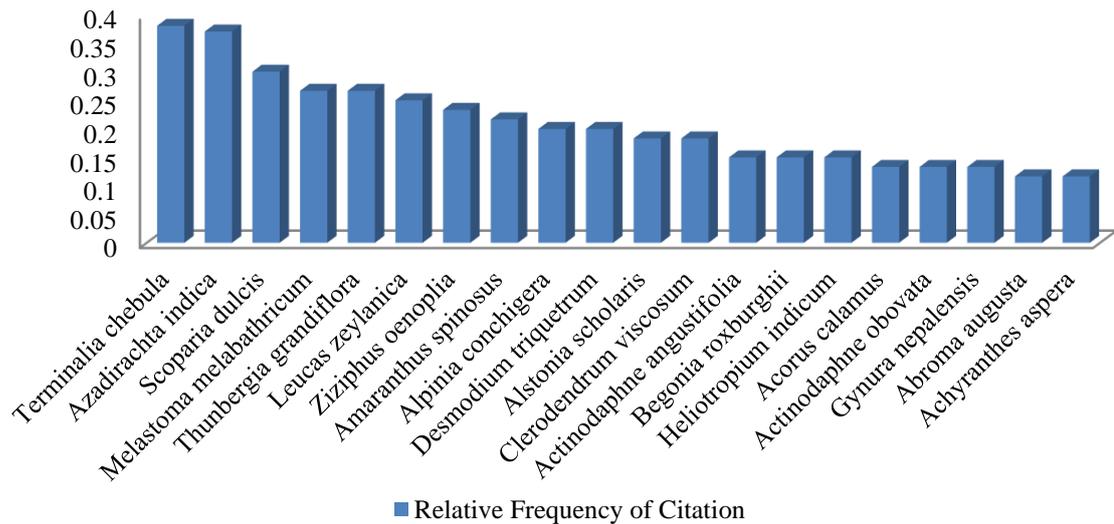
Using the ethnobotanical indices like *UV* and *RFC*, the traditional knowledge of 50 dominant ethnomedicinal plants used in treating of various human ailments were analyzed (Table 35). The study reveals that *UV* ranged from 0.18- 0.88. Out of 300 reported ethnomedicinal plant species, 33 plants were identified with *UV* greater than 0.65 (Fig. 40). The species are *Azadirachta indica*, *Terminalia chebula*, *Scoparia dulcis*, *Tabernaemontana divaricata*, *Thaunbergia grandiflora*, *Schefflera elliptica*, *Holarrhena antidysenterica*, *Plumeria rubra*, *Heliotropium indicum*, *Reperomia pallucida*, *Clerodendrum viscosum*, *Rauvolfia serpentina*, *Cardiospermum halicacabum*, *Mesua ferrea*, *Euphorbia neriifolia*, *Mangifera indica*, *Melastoma melabathricum*, *Desmodium triquetrum*, *Plumbago indica*, *Vitex negunda*, *Moringa oleifera*, *Leucas zeylanica*, *Centrala asiatica*, *Gynura pseudo-china*, *Stephania japonica*, *Jasminum sambac*, *Maesa ramentacea*, *Morinda angustifolia*, *Kalanchoe lecinata*, *Premna esculanta*, *Calotropis gigantea*, *Clerodendrum indicum*, *Lygodium flexuosum*. The medicinal plant species with low *UV* are also very important and might not be ignored. Care should be taken to keep the knowledge alive for future generations and proper management for their conservation. Plant species having high *UV* value should be further screened in ethnopharmacological studies for active compounds.



**Fig. 40.** Use value of 20 dominant medicinal plants of CHTs.

*RFC* is used to find out the most frequently used plant species for treating of various ailments in the study area. It is found that *RFC* is ranged from 0.02- 0.38. Twenty plant species reported in this study are showed the high values. The species are *Terminalia chebula*, *Azadirachta indica*, *Scoparia dulcis*, *Melastoma melabathricum*, *Thunbergia grandiflora*, *Leucas zeylanica*, *Ziziphus oenoplia*, *Amaranthus spinosa*, *Alpinia conchighera*, *Desmodium triquetrum*, *Alstonia scholaris*, *Clerodendrum viscosum*, *Actinodaphne angustifolia*, *Begonia roxburghii*, *Heliotropium indicum*, *Acorus calamus*, *Actinodaphne obovata*, *Gynura nepalensis*, *Abroma angusta*, *Achyranthes aspera*, *Adenia trilobata* and *Justicia adhatoda* (Fig. 41). The ethnomedicinal plant species with higher *RFC* value indicate that, these plant species are well known to most of the herbal practitioner in the study area. Therefore, the medicinal plants having high *RFC* must be further assessed for phytochemical analysis to

identify their active constituents for any potential drug extraction.



**Fig. 41.** Relative Frequency Citation (RFC) of 20 dominant medicinal plants of Chattogram Hill Tracts

### *Germplasm conservation of Ethnomedicinal plants*

During survey and documentation of ethnomedicinal information from different project sites propagules of 64 rare and potential species were collected for conservation. The collected species belongs to 57 genera under 27 families. Asteraceae and Zingiberaceae each contain maximum 8 species followed by Araceae (7), Asparagaceae and Euphorbiaceae (5) Acanthaceae and Apocynaceae (3), Amaranthaceae and Dioscoriaceae (2) and rest 19 families contains only one species each.



**Fig. 42.a.** Germplasm of ethnomedicinal plants at conservation plot of BFRI, Chattogram

List of the collected germplasm of ethnomedicinal plant species from CHT is presented in Table 36 with tribal and English name and family. Photographs of some collected propagules and germplasm of ethnomedicinal plants conserved at conservation plots of BFRI provided in Fig. 42.a and Fig. 42.b.



*Sansevieria kirkii*



*Solanum torvum*



*Celosia cristata*



*Clerodendrum indicum*



*Pedilanthus tithymaloides*



*Dracaena spicata*



*Lepidagathis incurva*



*Hymenocallis littoralis*



*Sonchus arvensis*

**Fig. 42.b.** Medicinal plants raised from collected propagules

**Table 36.** Collected germplasm of ethnomedicinal plants species conserved at Germplasm center of BFRI, Chattogram

Sl. No.	Species name	Tribal name	Family	English/Common Name
1.	<i>Achyranthes aspera</i> L.	Uktalang garang (Tripura)	Acanthaceae	Red chaff tree
2.	<i>Acmella oleracea</i> (L.) R.K.Jansen	Ozon shak (Chakma)	Asteraceae	Acmella
3.	<i>Acorus calamus</i> L.	Langyoo,Bospata (Chakma)	Acoraceae	Sweet flag
4.	<i>Aglaonema hookerianum</i> Schoot	Gach petik (Chakma)	Araceae	Nimahook
5.	<i>Aglaonema modestum</i> Schott ex Engl.	Shikkachal (Chakma)	Araceae	Spotted evergreen
6.	<i>Alocasia cucullata</i> (Lour.) G. Don	Bis kachu (Chakma)	Araceae	Chinese Taro
7.	<i>Alpinia conchigera</i> Griff.	Khetranga (Marma)	Zingiberaceae	Alpinia
8.	<i>Alpinia nigra</i> (Gaertn.) B. L. Burt	Krenga (Chakma)	Zingiberaceae	Alpinia
9.	<i>Amaranthus spinosus</i> L.	Hada maresh (Marma)	Amaranthaceae	Spiny amaranth
10.	<i>Amomum aromaticum</i> Roxb.	Kaching (Marma)	Zingiberaceae	Bengal cardamom
11.	<i>Ampelgynonum salarkhanii</i> M. A. Hassan	Koccha komra (Tripura)	Polygonaceae	Hilly smartweed
12.	<i>Asparagus racemosus</i> Willd.	Boma raja (Marma)	Asparagaceae	Asparagus
13.	<i>Begonia roxburghii</i> (Mic.) DC	Khara tetai (Chakma)	Begoniaceae.	Free flowering begonia
14.	<i>Blumea virens</i> DC.	Kalo ambush (Chakma)	Asteraceae	Blumea
15.	<i>Calotropis gigantea</i> (L.) Ait.f.	Khachkufu (Tripura)	Apocynaceae	Gigantic swallow wort
16.	<i>Celosia cristata</i> L.	Cram pang gach (Marma)	Amaranthaceae	Cock's comb
17.	<i>Centella asiatica</i> (L.) Urban	Minmini (Chakma)	Apiaceae	Indian pennywort
18.	<i>Cissus assamica</i> (M.A. Lawson) Craib	Murmuija amila (Chakma)	Vitaceae	Amasha lata
19.	<i>Cissus javana</i> DC.	Pipe ranga (Tanchangya)	Vitaceae	Begonia vine
20.	<i>Clerodendrum indicum</i> (L.) Kuntze	Nuli gach, Bheg gach (Chakma)	Verbenaceae	Clerodendrum
21.	<i>Cnesmone javanica</i> Blume	Chotra pata (Chakma)	Euphorbiaceae	Agni bichuti
22.	<i>Crotalaria acicularis</i> Buch.-Ham ex Benth & Hook. F.	Son Phul (Chakma)	Fabaceae	Crotalaria
23.	<i>Curculigo orchiodes</i> Gaertn.	Charabindu (Tanchongya)	Hypoxidaceae	Black musale
24.	<i>Curcuma amada</i> Roxb.	Kala hilla (Chakma)	Zingiberaceae	Mango ginger
25.	<i>Curcuma longa</i> L.	Nahnu (Marma)	Zingiberaceae	Turmeric
26.	<i>Dendrocnide sinuata</i> (Blume) Chew	Mainjain (Marma)	Urticaceae	Bangla dandi
27.	<i>Diplazium esculentum</i> (Retz.) Sw.		Ethyriaceae	
28.	<i>Dracaena spicata</i> Roxb.	Sanai pata gach (Chakma)	Asparagaceae	Dracaena
29.	<i>Dracaena trifasciata</i> (Prain)	Kasabang	Asparagaceae	Kado drakan
30.	<i>Elephantopus spicatus</i> B. Juss. ex Aubl.	Abang khey (Tanchangya)	Asteraceae	Elephantopus
31.	<i>Euphorbia hirta</i> L.	Dutta kher (Tripura)	Euphorbiaceae	Snake weed
32.	<i>Euphorbia neriifolia</i> L.	Manasa(Chakma)	Euphorbiaceae	Indian spurge tree
33.	<i>Euphorbia tithymaloides</i> L.	Moronak (Marma)	Euphorbiaceae	Slipper plant

**Table 36 Contunied...**

Sl. No.	Species name	Tribal name	Family	English/Common Name
34.	<i>Gynura nepalensis</i> A. DC.	Dhulbei sak (Chakma)	Asteraceae	Gynura
35.	<i>Gynura pseudochina</i> DC.	Sidra boisak (Tanchnagya)	Asteraceae	
36.	<i>Hedychium coronarium</i> J. Konig	Nai shan bowna (Chakma)	Zingiberaceae	White ginger
37.	<i>Heliotropium indicum</i> L.	Halisora (Chakma)	Boraginaceae	Indian heliotrope
38.	<i>Hitchenia careyana</i> Benth.		Gingiberaceae	
39.	<i>Homalomena aromatica</i> (Roxb. ex Sim) Scott	Shigon shag	Araceae	
40.	<i>Hoya parasitica</i> (Roxb.) Wall. ex Wight	Fessya gach (Chakma)	Apocynaceae	Hoya
41.	<i>Hymenocallis littoralis</i> (Jacq.) Salisb.	Upakhallis (Chakma)	Amaryllidaceae	Pancratium
42.	<i>Ichnocarpus frutescens</i> (L.) R.	Langibkhe nuyee (Marma)	Apocynaceae	Black creeper
43.	<i>Jatropha curcas</i> L.	Tachiapan (Marma)	Euphorbiaceae	Barbados nut
44.	<i>Justicia gendarussa</i> Burm.f.	Mohajam (Tanchangya)	Acanthaceae	Gendarussa
45.	<i>Laportea crenulata</i> Gaud.		Urticaceae	
46.	<i>Lasia spinosa</i> (L.) Thwaites	Gandagi (Chakma)	Araceae	Lasia
47.	<i>Lepidagathis incurva</i> Buch.-Ham. ex D. Don	Kargogathis (Chakma)	Acanthaceae	Lepidagathis
48.	<i>Monstera obliqua</i> Miq.		Araceae	Mexican breadfruit
49.	<i>Peliosanthes teta</i> Andrews	Deo keret (Chakma)	Asparagaceae	Peliosanthes
50.	<i>Pothos scandens</i> L.	Kansiripata (Marma)	Araceae	Rock vine
51.	<i>Pseuderanthemum sinuatum</i> Redlk.		Acanthaceae	
52.	<i>Sansevieria kirkii</i> Baker	Rockla gach (Marma)	Asparagaceae	
53.	<i>Senna occidentalis</i> (L.) Link	Dangor dattlong (Chakma)	Fabaceae	Stinking weed
54.	<i>Solanum torvum</i> L.	Mida begun bichi	Solanaceae	Fig. brush
55.	<i>Sonchus arvensis</i> L.	Tougmula (Marma)	Asteraceae	Sonchus
56.	<i>Stemona tuberosa</i> Lour.	Ukunadura (Chakma)	Stemonaceae	Stemona
57.	<i>Stephania japonica</i> (Thumb.) Miers	Thya nuya (Marma)	Menispermaceae	Snake vine
58.	<i>Sterculia foetida</i> L.	Yaa-hea (Chakma)	Malvaceae	Wild almond
59.	<i>Tacca Integrifolia</i>	Ketikucchan (Tanchnagya)	Dioscoreaceae	White bat flower
60.	<i>Tectaria chattagramica</i> (Clarke) Ching.		Tectariaceae	
61.	<i>Typhonium trilobatum</i> (L.) Scott.	Kharbas (Chakma)	Araceae	
62.	<i>Uraria crinita</i> (L.) DC.	Bilai lengur (Chakma)	Leguminosae	Uraria
63.	<i>Vernonia cinerea</i> (L.) Less.	Jatrabon (Tanchangya)	Asteraceae	Vernonia
64.	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm.	Murada (Chakma)	Zingiberaceae	Zingiber

### ***Recolonization of ethnomedicinal plants in CHTs***

A number of group discussions were organized with herbal practitioners to prepare a priority medicinal plant lists for re-colonization and restoration of the species in CHT's. Accordingly, a priority lists of 13 ethnomedicinal plants were prepared based on the desire of herbal practitioner. Ten thousand seedlings of 13 species have been raised in MFPD nursery, BFRI, Chattogram. The species are, Amloki (*Phyllanthus embelica*), Arjun (*Terminalia arjuna*), Bohera (*Terminalia bellerica*), Haritaki (*Terminalia chebula*), Ashok (*Saraca asoca*), Gritakumari (*Aloe vera*), Basak (*Justicia adhatoda*), Neem (*Azadirachta indica*), Satamuli (*Asparagus racemosus*), Raktakambal (*Adenantha pavonina*), Ritha (*Sapindus mukrossi*), Sinduri (*Bixa orellana*) and Ashwagandha (*Withania somnifera*). As per plans of the project

activity two ethnomedicinal plants gardens have been established in two hill districts of CHTs and rest of the seedling distributed among the selected herbal practitioner in CHT's. Some photographs of medicinal plants seedlings raising at BFRI for distribution presented in Fig. 43.



**Ritha (*Sapindus mukorossi*)**



**Haritaki (*Terminalia chebula*)**



**Arjun (*Terminalia arjuna*)**



**Bahera (*Terminalia belerica*)**



**Ashok (*Saraca asoca*)**



**Basak (*Justicia adhatoda*)**



**Shindur (*Bixa orellana*)**



**Gritokumari (*Aloe vera*)**

**Fig. 43.** Seedlings of medicinal plants raised for distribution at BFRI

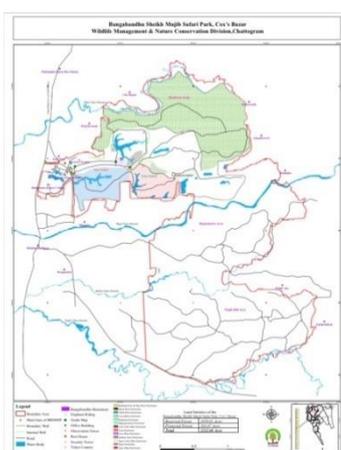
### 11.3 Component-3 (IFESCU)

#### Exploration and identification of Endangered Forest Genetic Resources

The endangered native forest tree species including medicinal plants were explored from different Protected Areas (PAs) and natural forests of Bangladesh. Baroiyadhala National Park (BDNP), Hazarikhil Wildlife Sanctuary (HWS), Madhupur National Park (MNP), Kaptai National Park (KNP), Himchari National Park (HNP), Bangabhandu Sheikh Mujib Safari Park at Dulhazara, and Srimai Natural Forest of Patiya through several visits during the study period in order to take a few measures to protect medicinal plants from extinction.

#### 11.a. Exploration the status of Forest Genetic Resources in the Bangabandhu Safari Park, Dulhazara, Cox's Bazar

**Bangabandhu Sheikh Mujib Safari Park Cox's Bazar** was developed on an undulating landscape of around 2,224 acres (0.09 km<sup>2</sup>) at Chakaria Upazila, Cox's Bazar, Bangladesh, some 107 km away from the port city, Chattogram. The objective of the park is to create facilities for eco-tourism, research work and entertainment as well as from conserving wild plants and animals in a natural environment. Seed trees of Bangabandhu Safari Park, Dulahazara, Chakaria, Cox's Bazar are *Anisoptera scaphula* (Boilam), *Artocarpus chama* (Chapalish), *Bombax ceiba* (Shimul), *Castanopsis tribuloides* (Sil Batna), *Cinnamomum iners* (Tej bahal), *Dehassia kurzii* (Modan musta), *Dipterocarpus alatus* (Dhullya Garjan), *Dipterocarpus costatus* (Baittya Garjan), *Dipterocarpus gracilis* (Sil Garjan), *Dipterocarpus turbinatus* (Tella Garjan), *Gardenia coronaria* (Konnari), *Grewia nervoa* (Asar), *Lithocarpus acuminata* (Dholi batna), *Mangifera sylvatica* (Uriam), *Pterospermum semisagittatum* (Lana Asar), *Swintonia floribunda* (Civit), *Syzygium firmum* (Dhakijam), *Terminalia chebula* (Horitoki), *Terminalia citrina* (Ban Hoital), *Vitex peduncularis* (Horina), etc.



**Fig. 44.** Seed trees of Bangabandhu Safari Park, Dulahazara, Chakaria, Cox's Bazar

#### 11.b. Exploration the status of Forest Genetic Resources in the Srimai Forest beat, Patiya Range, Chattogram South Forest Division

**Srimai beat** is situated in Patiya Upazilla, Chattogram. This beat is composed of 2 unions and 6 mouza. Its area is 3497.589 ha. In the area, 3388.66 ha are under reserved forest and 108.92 ha are under protected forest. The sites are under the Patiya Range of Chattogram South Forest Division. It is approximately South-East to the Chattogram city. The area

lies between 22°19'51.61" and 22°15'53.02" north latitude and between 92° 2'39.23" and 92° 5'38.29" east longitude. The western part of Srimai beat is Haidgaon, the northern part is Kelishohor beat, North-east part of Srimai beat is known as Kokhorosia beat, South-East part of Srimai beat is Dopachori beat, the eastern part is Komlachori beat and the south part of Srimai beat is known as Borguni beat (Patiya Reserved Forest, Chattogram, Bangladesh, 2018).

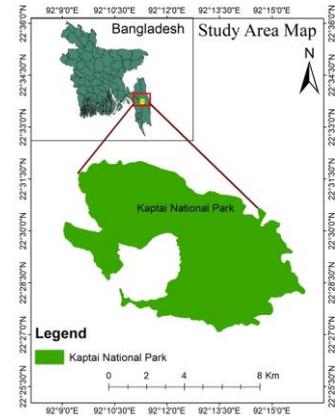


**Fig. 45.** Srimai Forest Beat, Patiya Range, Chattogram South Forest Division

Seed trees of Srimai Forest beat, Patiya Range, Chattogram South Forest Division, Chattogram are *Albizia odoratissima* (Tetuya Koroi), *Alstonia scholaris* (Chatian), *Anisoptera scaphula* (Boilam), *Aphanamixis polystachya* (Pitraj), *Aporosa dioca* (Khorola), *Artocarpus chama* (Chapalish), *Artocarpur lachucha* (Borta), *Bombax ceiba* (Shimul), *Brownlowia elata* (Moos), *Callicarpa arborea* (Bormala), *Castanopsis indica* (Sada Batna), *Chukrasia tabularis* (Chickrassi), *Cordia dichotoma* (Bahal gach), *Derris robusta* (Juijja), *Dillenia indica* (Chalta), *Diospyros bengalensis* (Lohamori), *Dipterocarpus turbinatus* (Teli Garjan), *Duabanga grandiflora* (Bandarhola), *Ficus benghalensis* (Bot), *Ficus hispida* (Dumur), *Ficus semicordata* (Chorkigola), *Flacourtia jangomas* (Lukluki), *Glochidion multiloculare* (Painna tori), *Haldina cordifolia* (Haldu), *Holigarna longifoila* (Barela), *Hopea odorata* (Telsur), *Lagerstroemia parviflora* (Shida Jarul), *Lapisanthes tetraphylla* (Harina), *Macaranga denticulata* (Bura), *Macaranga peltata* (Path Bura), *Mallotus roxburghinaus* (Nuniakuchi), *Mangifera sylvatica* (Uri am), *Phyllanthus emblica* (Amloki), *Protium serratum* (Gutgutya), *Stercuila villosa* (Udal), *Sterculia foetida* (Box – badam), *Sterospermum colais* (Dharmara), *Streblus asper* (Sheora), *Swintonia floribunda* (Civit), *Terminalia bellerica* (Bohera), etc.

### 11.c. Exploration the status of Forest Genetic Resources in the Rampahar forest beat, Kaptai National Park, Rangamati South Forest Division

**Kaptai National Park** is a major national park of Bangladesh situated in Rangamati district. It was established in 1999 and its area is 5,464.78 ha (13,498.0 acres). Prior to declaration of the national park, it was Sitapahar Reserve. The original Sitapahar Reserve area was 14,448.0 acres. Out of this an area of 100 acres has been dereserved for the establishment of the industrial estate at Kaptai. It is about 57 kilometre from Chattogram city. It comprises with two Ranges namely Kaptai Range and Karnaphuli Range. Kaptai National park is being managed under CHT South Forest Division. It is historically important because of first time teak (*Tectona grandis*) plantation in Bangladesh was started from this area. Its forest type is mixed evergreen forest.

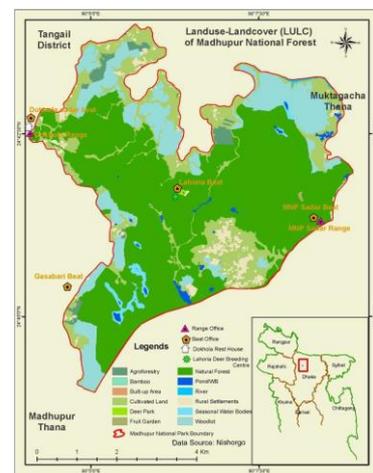
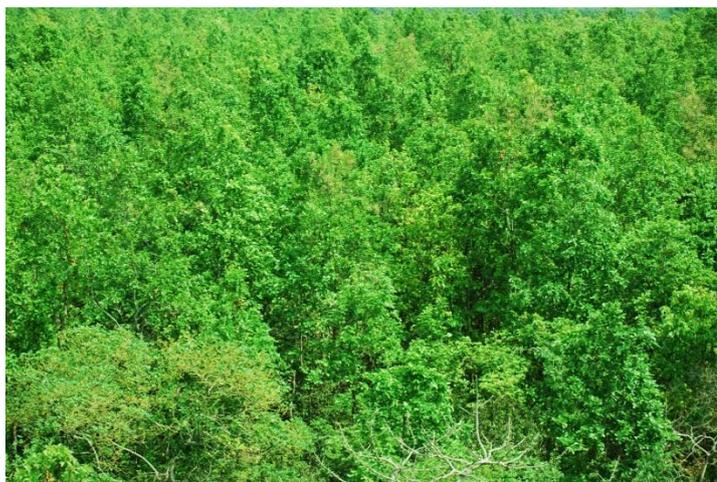


**Fig. 46.** Part of Kaptai National Park, Kaptai, Rangamati

Seed trees of Kaptai National Park, Rangamati are *Cassia nodosa* (Bon Sonalu), *Duabanga grandiflora* (Bandarhola), *Ficus lamponga* (Dumur), *Tetrameles nudiflora* (Chandul), *Zanthoxylum rhetsa* (Bazna), etc.

#### 11.d. Exploration the status of Forest Genetic Resources in the Madhupur National Park (MNP), Tangail

**Madhupur National Park** covers an area of 8,436 ha (20,850 acres). The Forest was established as a national park by the Bangladesh government in 1962 but, was officially declared as National park in 1982 under the Bangladesh Wildlife (Preservation) Amendment Act of 1947. The Park is located at Madhupur upazila, Tangail district in the central region of the country. It is about 125 km (78 mi) away from Dhaka. The local topography mainly consists of flat topped ridges (*Chalas*) intersected by numerous depressions (*Baids*). The park is easily accessible by the road throughout the year. The park is a famous tourist spot due to the natural and scenic beauty.



**Fig. 47.** Tree species recorded for seed collection from Madhupur National Park (MNP), Tangail

Tree species recorded for seed collection from Madhupur National Park (MNP), Tangail are *Barringtonia acutangula* (Hijol), *Carea arborea* (Kumbi), *Croton tiglina* (Jamal gota), *Carea arborea* (Kumbi), *Dillenia pentagyna* (Ajuli), *Ficus racemosa* (Jogya dumur), *Gardenia coronaria* (Konayari), *Grevillea rubasta* (Silver Oak), *Grewia nervosa* (Datoi guta), *Haldina cordiflora* (Haldu), *Hymenodictyon orixensis* (Bhutum), *lagestromia parviflora* (Sida jarul), *Litsea glutinosa* (Kharajura), *Maducha longitolia* (Mohua), *Milium velutina* (Gandi gojari), *Schleichera oleosa* (Joyna, Kusum), *Spondias*

*pinnata* (Bon amra), *Stereospermum colais* (Darmara), *Terminalia bellerica* (Bohera), *Terminalia chebula* (Hortoki), *Zanthoxylum rhetsa* (Bajna), etc.

#### 11.e. Exploration the status of Forest Genetic Resources in the Hazarikhil Wildlife Sanctuary

Hazarikhil Wildlife Sanctuary (HWS), located in the Fatikchari upazila of Chattogram district, Bangladesh with a land area of 2,908.5 acres, is a Protected Area IUCN Category II. Once the forest was very rich in flora and fauna but apparently it seems that some valuable timber species may have been disappeared from the area due to changes in overall conditions because of the habitat destruction, over-exploitation, unsustainable harvesting and habitat fragmentation. A total of 162 tree species (having  $\geq 5$  cm diameter at breast height (dbh)) belonging to 85 species were assessed very recently.



**Fig. 48.** Forest trees recorded from Hazarikhil Wildlife Sanctuary for seed collection

Forest trees recorded from Hazarikhil Wildlife Sanctuary for seed collection are *Albizia chinensis* (Chakua koroi), *Anisoptera scaphula* (Boilam), *Anogeissus acuminata* (Itchri, hiori), *Aquilaria agallocha* (Agar), *Bischofia javanica* (Kanjai bhadi), *Callicarpa arborea* (Bormala), *Canarium resiniferum* (Dhup), *Chaetocarpus castanocarpus* (Atailla), *Cryptocarya amygdalina* (Bhuiya gachh), *Dillenia indica* (Chalta), *Engelhardtia spicata* (Kechra bhadi), *Flacourtia jangomas* (Painnagola), *Gardenia coronaria* (Konnayari), *Haldina cordifolia* (Haldu), *Hydnocarpus wightianus* (Chalmugra), *Lepisanthes rubiginosa* (Harinagola), *Lithocarpus polystachya* (Batna), *Litsea glutinosa* (Meda or Menda), *Lophopetalum wightianum* (Rakton), *Neonauclea sessilifolia* (Kom), *Palaquium polyanthum* (Tali), *Podocarpus neriifolia* (Banspata), *Spondias pinnata* (Bon Amra), *Stereospermum colais* (Dharmara), *Taxodium distichum* (Taxodium), *Terminalia bellerica* (Bohera), *Terminalia chebula* (Horitaki), *Tetrameles nudiflora* (Chandul), etc.

#### 11. f. Exploration the status of Forest Genetic Resources in the Cox's Bazar South Forest Division/ Himchari National Park

The Cox's Bazar Forest Division was first created on 1<sup>st</sup> April, 1920 by splitting of the Chattogram Division and the addition of Matamuhuri reserve. In 1933 both the divisions were merging together as Chattogram Forest Division. In 1951 Chattogram Division again divided in to Chattogram and Cox's Bazar Forest Divisions. Finally in 2001, Cox's Bazar Forest division was divided in to Cox's Bazar North and Cox's Bazar South Forest

Divisions. The original forests of Cox's Bazar South Forest Divisions were so mixed in character that it can be classified as i) evergreen, ii) deciduous, iii) bamboo jungle and iv) savannah. Some native threatened tree species are recorded from the Teknaf Wildlife Sanctuary, Himchari National Park, Sheikh Jamal National Park (Inani Protected Forest) and Rajarkul Botanical Garden.



**Fig. 49.** Seed trees at Silkhali garjan Forest, Teknaf Wildlife Sanctuary

Seed trees recorded from Cox's Bazar South Forest Division including Himchari National Park are *Alstonia scholaris* (Chatian), *Anisoptera schapula* (Boilam), *Aphanamixis polystachya* (Pitraj), *Artocarpus chama* (Chapalish), *Artocarpus lacucha* (Borta), *Bischofia javanica* (Kanjai Bhadi), *Bombax ceiba* (Shimul), *Bombax insigne* (Pahari Tula), *Brownlowia elata* (Moss), *Butea monosperma* (Polash), *Cinnamomum iners* (Tezbahul), *Dillenia pentagyna* (Hargaza), *Diospyros malabarica* (Deshi gab), *Dipterocarpus alatus* (Baitya Garjan), *Dipterocarpus costatus* (Dholi Garjan), *Dipterocarpus turbinatus* (Tellya Garjan), *Elaeocarpus floribundus* (Jalpai), *Ficus racemosa* (Dumur), *Hopea odorata* (Telsur), *Mangifera sylvatica* (Uriam), *Ormosia robusta* (Ghora Chokha Shim), *Pterospermum semisagittatum* (Lana assar), *Stereospermum tetragonum* (Dharmara), *Swintonia floribunda* (Civit), *Syzygium firmum* (Dhakijam), *Terminalia bellirica* (Bahera), *Terminalia chebula* (Haritaki), *Vitex glabrata* (Arshol), etc.

### 11.g. Phenology of the threatened tree species from different forest ecosystems

The phenology of the threatened tree species under study in the sub-project is shown in the Table 37.

**Table 37.** Phenology of the threatened tree species

No	Botanical name	Local name	Type	Flowering	Fruiting
1	<i>Adenanthera pavonina</i> L.	Raktakambal	Deciduous	March-April	May-August
2	<i>Albizia chinensis</i> (Osb.) Merr.	Chakua koroi	Deciduous	April-June	December-January
3	<i>Anisoptera scaphula</i> (Roxb.) Pierre	Boilam	Evergreen	December to January	March-April
4	<i>Antidesma ghaesembilla</i> Gaertn.	Khudi-jam	Deciduous	March-September	June-December
5	<i>Aphanamixis polystachya</i> (Wall.) R.N. Parker	Pitraj, Roina	Evergreen	February-March	March-April
6	<i>Aquilaria malaccensis</i> Lam.	Agar	Evergreen	March-April	June-July
7	<i>Artocarpus lacucha</i> Buch.-Ham.	Dewa	Deciduous	March-April	May-June
8	<i>Baccaurea ramiflora</i> Lour.	Latkan	Evergreen	March	August-September
9	<i>Bauhinia acuminata</i> L.	Shet Kanchan	Semi-evergreen	March-June	May to July

**Table 37 continued....**

No	Botanical name	Local name	Type	Flowering	Fruiting
10	<i>Bischofia javanica</i> Blume	Kanjai bhadi	Evergreen	February-April	April-July
11	<i>Bombax ceiba</i> L.	Simul	Deciduous	February-March	April-May
12	<i>Bouea oppositifolia</i> (Roxb.) Meissn.	<b>Mailam</b>	Evergreen	December-January	February- April
13	<i>Brownlowia elata</i> Roxb.	<b>Moos</b>	Evergreen	June - July	August-September
14	<i>Calophyllum inophyllum</i> L.	<b>Puinal</b>	Evergreen	April-May	June- October
15	<i>Calophyllum polyanthum</i> Wall. ex Choisy	<b>Kamdeb</b>	Evergreen	April – June	October-November
16	<i>Carallia brachiata</i> (Lour.) Merr.	Kiabong, Roskao	Evergreen	December-March	May-June
17	<i>Careya arborea</i> Roxb.	Kumbhi	Deciduous	March-May	June-July
18	<i>Caryota urens</i> L.	Chau-Gota	Evergreen	January-March	March-May
19	<i>Cassia fistula</i> L.	Sonalu	Deciduous	March-May	May-September
20	<i>Chukrassia tabularis</i> A. Juss.	Chikrassi	Deciduous	May-June	July to November
21	<i>Cinnamomum iners</i> Reinw.	Tezbahul	Evergreen	February-March	April-August
22	<i>Crateva magna</i> (Lour.) DC.	Barun	Deciduous	March-April	July-September
23	<i>Croton tiglium</i> L.	Jamalgota	Evergreen	January-July	November-December
24	<i>Cryptocarya amygdalina</i> Nees in Wall.	Bhuiya Gachh	Evergreen	February- July or sometimes October	March-November
25	<i>Dehaasia kurzii</i> King ex Hook.f.	Modon Mosto	Evergreen	August-October	October- December
26	<i>Dillenia pentagyna</i> Roxb.	Hargoza	Deciduous	April-May	June-July
27	<i>Diospyros malabarica</i> (Desr.) Kostel	Deshi gab	Evergreen	May-June	June-August
28	<i>Dipterocarpus alatus</i> Roxb. ex G. Don	Dholi-garjan	Semi-evergreen	December-February	February- May
29	<i>Dipterocarpus costatus</i> Gaertn.	Baittya Garjan	Evergreen	December-January	February-May
30	<i>Dipterocarpus turbinatus</i> Gaertn.	Teli-garjan	Semi-Evergreen	Feb.- March	May – June
31	<i>Dysoxylum binectariferum</i> (Roxb.) Hook. f. ex Bedd.	Rongi-rata, Barata	Evergreen	March- July	May- November
32	<i>Ehretia serrata</i> Roxb.	Kala-huja	Deciduous	March-April	November-December
33	<i>Elaeocarpus floribundus</i> Blume	Belphoi, Jalpai	Evergreen	July-August	December-January
34	<i>Elaeocarpus tectorius</i> (Lour.) Poir.	Titpai, Chekio, Bamunpai	Evergreen	May-June	July to October
35	<i>Engelhardtia spicata</i> Leschen ex Bl.	Jhumka Bhadi	Deciduous	February-March	March-April
36	<i>Fernandoa adenophylla</i> (Wall. ex G. Don) Van Steenis	Barapatta	Deciduous	May-June	July to November
37	<i>Ficus hispida</i> L.f.	Khosaka, Kuksa	Deciduous	April- June	Aug-September
38	<i>Firmiana colorata</i> (Roxb.) R. Br.	Udal, Pata-gota	Deciduous	March	April-May
39	<i>Flacourtia jangomas</i> (Lour.) Raeusch.	Lukluki , Painnagula	Evergreen	December-March	March-July
40	<i>Gardenia coronaria</i> Buch.-Ham.	Kannyari	Deciduous	March-April	May-December
41	<i>Garuga pinnata</i> Roxb.	Sil bhadi			
42	<i>Grewia nervosa</i> (Lour.) Panigr.	Assar, Patka	Evergreen or semi-deciduous	March-May	September-November
43	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Haldu, Kaika	Deciduous	April-May	May- December
44	<i>Hymenodictyon orixensis</i> (Roxb.) Mabb.	Bhutum	Deciduous	July-August	September-November

Table 37 continued....

No	Botanical name	Local name	Type	Flowering	Fruiting
45	<i>Lagerstroemia parviflora</i> Roxb. var. <i>benghalensis</i> Clarke in Hook. f.	Sidha-Jarul	Deciduous	May-June	May-December
46	<i>Lepisanthes rubiginosa</i> (Roxb.) Leenh.	Rubiharina	Evergreen	March- April	May- August
47	<i>Lithocarpus acuminata</i> (Roxb.) Rehd.	Kala batna	Evergreen	January-February	March to September
48	<i>Litsea monopetala</i> (Roxb.) Pers.	Kat meda, Sukurja	Evergreen	March-April	May-July
49	<i>Lophopetalum wightianum</i> Arn.	Raktan	Evergreen	November-December	January-June
50	<i>Macaranga denticulata</i> (Blume) Muell.-Arg. in DC.	Bura	Evergreen	March-April	July
51	<i>Madhuca longifolia</i> (Koenig) Macbr.	Mahua	Deciduous	February-April	June-July
52	<i>Mallotus philippensis</i> (Lam.) Muell.-Arg.	Sinduri, Kamela	Evergreen	January-February	February-March
53	<i>Michelia champaca</i> L.	Champa	Evergreen to semi-deciduous	April-September	August-September
54	<i>Milium longiflora</i> (Hook.f. & Thom.) Finet & Gagnep.	Kuchukao, Lombatasbi	Deciduous	January-February	March- May
55	<i>Milium velutina</i> (Dunal) Hook. f. & Thorn.	Gandhi-gazari	Deciduous	March-April	May-June
56	<i>Ormosia robusta</i> (Roxb.) Baker	Ghorachokha shim, Hokka Nali	Evergreen	April-May	June-July
57	<i>Oroxylum indicum</i> (L.) Kurz	Thona, Kanaidinda	Deciduous	June-August	September- March
58	<i>Palaquium polyanthum</i> (Wall. ex DC.) Engler.	Tali, Dudhi	Evergreen	March-April	July-August
59	<i>Phyllanthus emblica</i> L.	Amloki	Deciduous	March-May	July-September
60	<i>Podocarpus neriifolius</i> D. Don	Banspata	Evergreen	June-July	November-December
61	<i>Protium serratum</i> (Wall. ex Colebr.) Engl. in DC.	Gutguttya, Neur	Evergreen or semi-deciduous	March-April	April-June
62	<i>Pterocarpus indicus</i> Willd.	Padok, Padauk	Deciduous	March-April	April-May
63	<i>Pterospermum acerifolium</i> (L.) Willd.)	Muskanda			
64	<i>Pterygota alata</i> (Roxb.) R. Br.	Buddha-narikel	Deciduous	February-March	April-May
65	<i>Putranjiva roxburghii</i> Wall.	Jiaputa	Evergreen	March-May	December-January
66	<i>Quercus gomeziana</i> A. Camus	Goorja Batna	Deciduous	March-April	July-August
67	<i>Sapium indicum</i> Wild.	Mel	Deciduous	July-August	December-January
68	<i>Saraca asoca</i> (Roxb.) de Willd.	Ashok	Evergreen	February-April	March- August
69	<i>Schima wallichii</i> (DC.) Korth.	Kanak	Evergreen	April-May	June- September
70	<i>Schleichera oleosa</i> (Lour.) Oken	Kusum, Joyna	Semi-evergreen to deciduous	March-April	May- September
71	<i>Semecarpus anacardium</i> L.f.	Bela, Bhela	Deciduous	May-September	December-March
72	<i>Spondias pinnata</i> (L.f.) Kurz.	Bon-amra	Deciduous	February-March	April to August
73	<i>Sterculia foetida</i> L.	Udal, Box-badam	Deciduous	February-March	April-June
74	<i>Sterculia villosa</i> Roxb. ex Smith	Udal	Deciduous	March-April	April-May
75	<i>Stereospermum colais</i> (Buch.-Ham. ex Dillw.) Mabblerley	Dharmara	Deciduous	April-May	June to November
76	<i>Suregada multiflora</i> (A. Juss.) Baill.	Ban-naranga	Evergreen	May-September	June- November

Table 37 continued....

No	Botanical name	Local name	Type	Flowering	Fruiting
77	<i>Swintonia floribunda</i> Griff.	Civit	Semi-evergreen	February-March	March to May
78	<i>Syzygium firmum</i> Thw.	Dhaki Jam	Evergreen	December-February	June- August
80	<i>Syzygium formosum</i> (Wall.) Masamune	Phul jam	Evergreen	December-Mar	June-July
81	<i>Syzygium fruticosum</i> DC.	Puti jam	Evergreen	March-April	May-June
82	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun	Deciduous	April-July	February-May
83	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bahera	Deciduous	March-April	November-January
84	<i>Terminalia chebula</i> Retz.	Haritaki	Deciduous	April-June	January-March
85	<i>Terminalia citrina</i> (Gaertn.) Roxb. ex Fleming	Hatiyal	Deciduous	February-March	March-April
86	<i>Tetrameles nudiflora</i> R. Br.	Chandul	Deciduous	February-April	April-May
87	<i>Trewia nudiflora</i> L.	Pitali	Deciduous	March-April	July-September
88	<i>Uvaria cordata</i> (Dunal.) Alston	Bagh-runga	Evergreen	May- June	September-December
89	<i>Vitex glabrata</i> R. Br.	Arsol, Goda, Horina	Deciduous	April-May	May-August
90	<i>Vitex peduncularis</i> Wall.	Goda, Arsol	Deciduous	April-May	June- September
91	<i>Walsura robusta</i> Roxb.	Bonlichu	Evergreen	March-May	December-March
92	<i>Wrightia tomentosa</i> (Roxb.) Roem. & Schult.	Dudh-kurus	Deciduous	April-June	January-March
93	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	Bajna	Deciduous	March-April	April- September

Studies on seed biology and growth and development of seedlings providing seed pre-sowing treatments and growing media are shown as follows:



**Fig. 50.** Nursery raising activities of BARC-IFESCU implementing NATP Phase 2 sub-project PID # 074

#### 11.h. Germination and initial seedlings growth response of *Cryptocarya amygdalina* under different pre-sowing treatments

*Cryptocarya amygdalina* (local name is Bhuiya gachh) belonging to Lauraceae family, is a native threatened tree species of Bangladesh. Trees up to 20 m tall, leaves broadly are oblong, elliptic-lanceolate or oblanceolate. Flowering and fruiting happens during March-November. Conservation status considered as rare (Uddin and Hassan 2018b). The selection of appropriate pre-sowing treatment is essential for quick and maximum seed germination (Thapa and Gautam 2006). Proper pre-treatments of seeds can stimulate germination time and germination process (Azad *et al.* 2006, Azad *et al.* 2011, Azad *et al.* 2012). The effect of pre-sowing treatments on seed germination of few tropical forest tree species has been informed by several authors (Khan *et al.* 2001, Alamgir and Hossain 2005, Nandi *et al.* 2019, Haider *et al.* 2014 and Dey *et al.* 2020). Therefore, an endeavor has been made to study the effect of pre-sowing treatments on seed germination to identify appropriate pre-sowing treatments for *Cryptocarya amygdalina* species.

## Methodology

### Study site

The study was carried out in the nursery of the Institute of Forestry and Environmental Sciences, University of Chittagong, Chattogram (lies between 91°50'E longitude and 22°30'N latitude) (Hossain *et al.* 2017). The climate is a tropical monsoon with an average monthly highest temperature of 29.75°C and a monthly lowest of 21.24 °C. The maximum temperature usually occurs in May at 32.60 °C and the minimum in January at 14.10 °C.

### Seed collection

*Cryptocarya amygdalina* fruits were collected from Hazarikhil Wildlife Sanctuary, Chattogram, Bangladesh during December, 2018. Phenotypic characteristics of fruits were recorded. Fruits were dried under open sun for three days. Randomly selected fruits' information was recorded.

### Experimental design

The soil used for filling polybags were collected from the forest floor, dried and sieved well (<3mm) and mixed with decomposed cow dung in a ratio of 3:1. 15×10 cm size polybags were used for the experiment. The media used in the propagator house were fine Sylhet sand. Forest topsoil was used in the open nursery bed. Collected seeds were sown in respectively prepared polybag, open nursery bed and propagator house. The study was made up of 8 treatments with 4 replications (10 seed per replication) in a Randomized Complete Block Design. Forty (40) healthy seeds were chosen randomly for each treatment. Daily germination progress was recorded as soon as the seeds start germination. Seedlings raised in open nursery bed and propagator house were transferred to polybag after 1 month of the last germination of seeds. The pricked-out seedlings were kept in shade for 2 weeks and then transferred to sunlight. Proper care and maintenance were done regularly. Five seedlings were selected randomly from each treatment and shoot height and leaf number of the seedlings was recorded. The pre-sowing treatments are as:

T<sub>0</sub>- Seeds sown in soil filled polybags (control)

T<sub>1</sub>- Seeds soaking in normal water for 48 hours and sown in polybags

T<sub>2</sub>- Seeds soaking in normal water for 24 hours and sown in polybags

T<sub>3</sub>- Seeds soaking in normal water for 12 hours and sown in polybags

T<sub>4</sub>- Seeds sown in seedbed (permanent shade)

T<sub>5</sub>- Seeds soaking in hot water for 30 seconds and sown in propagator house

T<sub>6</sub>- Seeds sown in propagator house

T<sub>7</sub>- Seeds soaking in normal water for 24 hours & sown in propagator house



**Fig. 51.** Fruits of Bhuiya gachh



**Fig. 52.** Seedlings of Bhuiya gachh



**Fig. 53.** Experiment plot of Bhuiya gachh

## Data collection and analysis

**Germination percentage:** The number of seeds out of 100 seeds from the starting of germination to the termination of germination (Kumar, 1999).

$$\text{Germination \% (GP)} = \frac{\text{No of seed germinated}}{\text{No. of seed sown}} \times 100$$

**Cumulative germination % (CGP):** It assessed at the end of seed germination by summed up daily germination (Hasnat *et al.* 2019).

$$\text{CGP} = \frac{\text{Cumulative number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

**Germination energy (GE):** It is measured by computing daily germination percentage of its peak time (Dwivedi, 1993).

**Germination index (GI):** According to AOSA (1983) GI was calculated using this formula:

$$\text{Germination index (GI)} = \frac{\text{No.of germinated seeds}}{\text{Days of first count}} + \dots + \frac{\text{No.of germinated seeds}}{\text{Days of first count}}$$

**Mean germination time (MGT):** It calculates the rate and the time-spread of germination (Bewley *et al.* 2013, Soltani *et al.* 2015) and it should determine the time to half of the germination. The formula:

$$\text{MGT} = \frac{\sum Dn}{\sum n}$$

Where, D = the number of days counted from the starting of germination, n = the number of seeds that were germinated on day D (Ellis and Roberts 1981, Afzal *et al.* 2005).

**Germination Uniformity (GU):** It was calculated by using the formula:

$$\text{GU} = \frac{\sum n}{(\sum (Fn-t)^2 \times n)}$$

Where, t is the time in days, beginning from day 0, the day of germination, and n is the number of seeds germinated at t and F are alike to MGT (Abdolahi *et al.* 2012).

**Germination value (GV):** It was calculated by multiplication of the peak value of germination and mean daily germination (Hasnat *et al.* 2019).

$$\text{GV} = \text{Peak value of germination} \times \text{mean daily germination}$$

**Germination capacity:** It is the percentage of seeds germinated in an experiment from the starting to end. It was classified as follows: a) 90-100%-very good, b)70-90%-good, c)50-70%-average, d) 30-50%-poor, e)20-30%-very poor, and f) (<) less than 10% extremely poor (Kumar 1999).

## Statistical analysis

All the recorded data were analyzed statistically by using computer package software SPSS ver. 23. Duncan's Multiple Range Test (DMRT) was employed to define the statistical significance and it shown by different letters.

## Results

### Morphological features of seeds

The average length and width of fruits were  $1.694 \pm 0.058$  cm and  $1.068 \pm 0.046$  cm respectively. About 909 fruits were found per kg. (Table 38).

**Table 38.** Seed length, width and number of *C. amygdalina* seeds per kg

	Length (cm)	Width (cm)	Weight/seed (g)	Number/ kg
Fruit	$1.694 \pm 0.058$	$1.068 \pm 0.046$	$1.1 \pm 0.055$	909

± indicates the standard error of mean

### Germination performance

The germination performance of *C. amygdalina* seeds was affected by different pre-sowing treatments in this study. Seed germination starts first in T<sub>1</sub> (50th day) after the seed was sown and T<sub>0</sub> required maximum time (70th day) to initiate germination. Maximum germination percentage (84.62%) was recorded in T<sub>4</sub> (seeds sown in seedbed) followed by 69.23 % in T<sub>3</sub> (seeds soaking in normal water for 12 hours and sown in polybags), 35.89 % in T<sub>0</sub> (control). Germination percentage was lowest (15.38 %) in T<sub>7</sub> and significantly ( $p < 0.05$ ) different from other treatments. The minimum germination period (55.67 days) was found in T<sub>4</sub> and maximum (76 days) in T<sub>0</sub> (Table 39).

**Table 39.** Germination response of *C. amygdalina* seeds in different pre-sowing treatments

Treatments	Germination starts after (days)	Germination on end after (days)	Germination energy period (days)	Germination (%)	Germination capacity
T <sub>0</sub>	70	79	76.00 a*	35.89 cd	Poor
T <sub>1</sub>	50	87	63.00 bc	48.72 c	Average
T <sub>2</sub>	60	76	63.67 bc	20.51 de	Very poor
T <sub>3</sub>	52	78	58.33 bc	69.23 b	Average
T <sub>4</sub>	52	76	55.67 c	84.62 a	Good
T <sub>5</sub>	60	98	69.67 ab	23.08 de	Extremely poor
T <sub>6</sub>	60	91	67.00 abc	20.51 de	Extremely poor
T <sub>7</sub>	64	76	68.33 ab	15.38 e	Extremely poor

\* Means followed by the same letter (s) in the same column do not vary significantly at  $P < 0.05$ , according to Duncan's Multiple Range Test (DMRT).

The maximum germination index (0.1832) was recorded in T<sub>4</sub> and significantly ( $p < 0.05$ ) different from other treatments. Highest germination energy (30.77 %) found in T<sub>4</sub> and lowest (10.26 %) in T<sub>2</sub>, T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub>. The germination uniformity revealed significant difference among the treatments. Maximum germination value (1.7554) was recorded in T<sub>4</sub> which is significantly ( $p < 0.05$ ) different from other treatments and minimum in T<sub>7</sub> (0.0556). Mean germination time was maximum (75.97) in T<sub>0</sub> and minimum in T<sub>4</sub> (60.51) (Table 40).

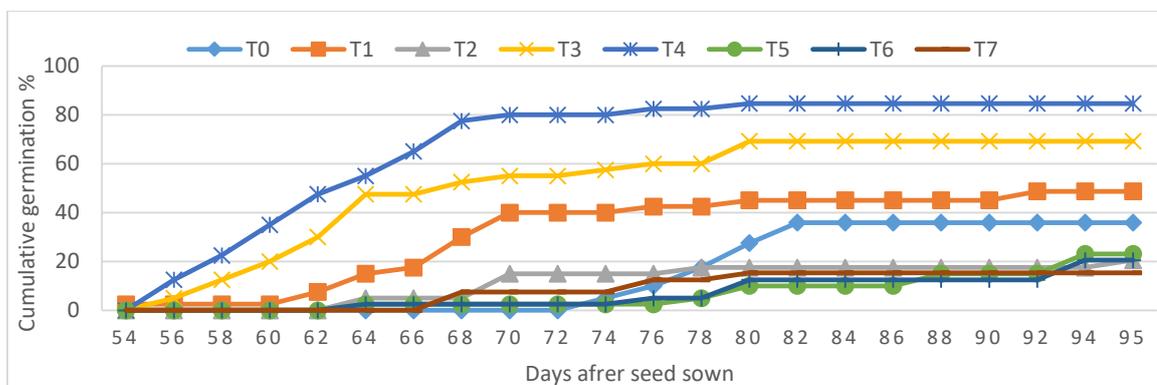
**Table 40.** Germination response of *C. amygdalina* seeds in different pre-sowing treatments

Treatment	Germination Energy (%)	Germination Index (GI)	Mean Germination Time (MGT)	Germination Uniformity (GU)	Germination value
T <sub>0</sub>	17.95 bc	0.0613 ab	75.97 a	0.0003 c	0.2868 cd
T <sub>1</sub>	17.95 bc	0.0920 ab	67.45 cd	0.0007 ab	0.4792 c
T <sub>2</sub>	10.26 c	0.0351 b	69.39 bc	0.0004 c	0.0923 d
T <sub>3</sub>	25.64 ab	0.1450 ab	62.76 de	0.0007 a	1.0479 b
T <sub>4</sub>	30.77 a	0.1832 a	60.51 e	0.0005 bc	1.7554 a
T <sub>5</sub>	10.26 c	0.1016 ab	74.64 ab	0.0004 c	0.1123 d
T <sub>6</sub>	10.26 c	0.1275 ab	72.67 abc	0.0004 c	0.0883 d
T <sub>7</sub>	10.26 c	0.0286 b	70.33 abc	0.0003 c	0.0556 d

\* Means followed by the same letter (s) in the same column do not vary significantly at P<0.05, according to Duncan's Multiple Range Test (DMRT).

### Mean cumulative germination percentage

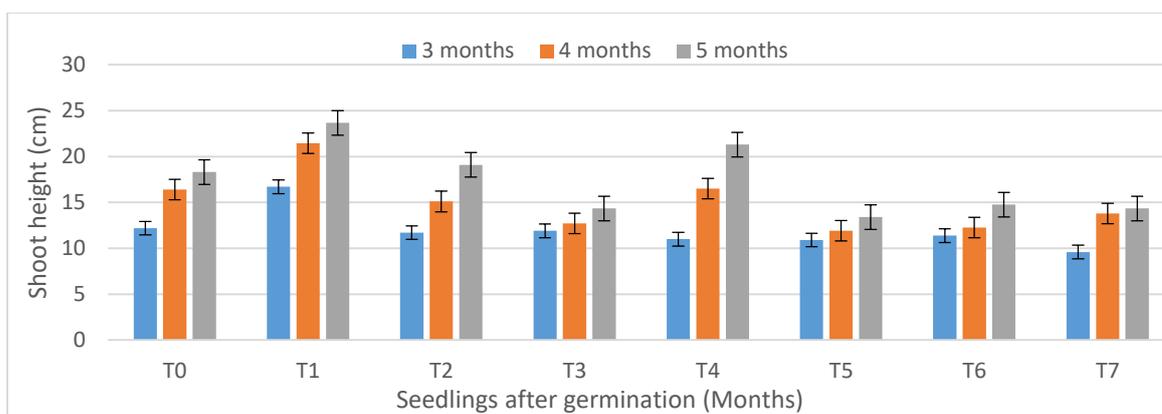
To reveal cumulative germination percentage for each treatment, daily germination percentages are summed. The cumulative germination of T<sub>1</sub> treatment started from 50 days of seed sown and rose slowly and continued germination up to 48.72 % within 30 days. In T<sub>0</sub> treatment, germination started at 70<sup>th</sup> days and reached 35.89 % gradually. T<sub>4</sub> showed highest cumulative germination percentage (84.62 %), germination started 52<sup>th</sup> days after sowing and continued up to 80<sup>th</sup> days (Fig. 54).



**Fig. 54.** Cumulative germination percentage of *C. amygdalina* seedlings in different pre-sowing treatments

### Growth performance of the seedlings

Different treatments affected the vegetative growth of *C. amygdalina* seedlings. After 5 months of seed germination, the highest mean shoot height (23.67 cm) was recorded in T<sub>1</sub> (seeds soaking in normal water for 48 hours and sown in polybags) and the lowest (13.4 cm) was observed in T<sub>5</sub> (seeds soaking in hot water for 30 seconds and sown in propagator house). Plants grown with T<sub>4</sub> treatment attained 21.3 cm shoot height (Fig. 55).



**Fig. 55.** Growth of *C. amygdalina* seedlings in response to different pre-sowing treatments

Leaf number was recorded at four months old seedlings. The highest number of leaf (10.2) produced in T<sub>4</sub> treatment (seeds sown in seedbed) and lowest (3.2) in T<sub>7</sub> treatment (seeds soaking in normal water for 24 hours and sown in propagator house) (Table 41).

**Table 41.** Leaf number of *C. amygdalina* seedlings in different pre-sowing treatments

Treatments	Leaf number (4 months old seedlings)
T <sub>0</sub>	7 ± 0.32
T <sub>1</sub>	8.4 ± 1.44
T <sub>2</sub>	6.8 ± 1.24
T <sub>3</sub>	9.6 ± 0.40
T <sub>4</sub>	10.2 ± 0.37
T <sub>5</sub>	7.6 ± 0.87
T <sub>6</sub>	3.4 ± 0.51
T <sub>7</sub>	3.2 ± 0.71

## Discussion

The science of seed biology encompasses development and physiology of seeds until they finally germinate or fail to do so (Schmidt, 2000). Germination and seedling establishment are critical stages which affected both quality and quantity of crop yields (Subedi and Ma, 2005).

The present findings of the study on *C. amygdalina* found out that seeds sown in seedbed provided highest germination percentage 84.62 %. Maximum shoot height (23.67 cm) was recorded in T<sub>1</sub> (seeds soaking in normal water for 48 hours and sown in polybags). Highest germination energy (30.77 %), germination index (0.1832), germination value (1.7554) and leaf number (10.2) recorded in T<sub>4</sub> (seeds sown in seedbed). Seed sown in propagator house and control treatment revealed 20.51% and 35.89% germination percentage, respectively. Forest topsoil was used in the open nursery bed which provides sufficient nutrient to increase germination. Nursery bed was made under shade of other tree species which also influence germination and growth. More temperature in propagator house and nutrient deficient sand media reduced this species germination and growth performance. de Kok, (2015) reported that *C. amygdalina* grows sometimes along rivers, at 50–1525 m altitude. That indicates the species is shade and moisture loving species and full sunlight and moisture deficiency is not favorable for initial development. Seedling raised in seedbed gets more nutrient and grow fast. But not suitable for plantation because survival rate of bare rooted seedling is low in field (Dey and Hossain 2019). So, after attaining certain

height (10 cm) seedlings need to transfer to polybag and keep in partial shade. So, from the study for *C. amygdalina* species, nursery bed with permanent shade is recommended to get maximum germination and vigor seedlings.

## **Conclusion**

Pre-sowing seeds significantly affected the germination of *Cryptocarya amygdalina*. Seeds sown in nursery bed with permanent shade showed maximum germination and initial growth performance. After attaining certain height (10 cm) seedlings need to be transferred to polybag with soil and cow dung media for afforestation and reforestation. The result of the present study recommends the nursery owners or other seedling producer organizations to sown *Cryptocarya amygdalina* seeds in nursery bed with permanent shade for maximum germination and vigor seedlings production.

## **11. i. Germination and Initial Growth Performance of *Aphanamixis polystachya* (wall) parker -A Threatened Medicinal Tree Species in Bangladesh**

*Aphanamixis polystachya* (Wall) Parker, belonging to Meliaceae family, a valuable medicinal plant of Bangladesh. It is large evergreen tree, with a dense spreading crown and a straight cylindrical bole up to 15m in height and 1.5-1.8m in width (Fabricant and Farnsworth, 2001). This species has huge medicinal, economic and ecological value but due to degradation of forest and insufficient natural regeneration the species is becoming rare in Bangladesh.

## **Materials and methods**

### **Study site**

The study was carried out in the nursery of the Institute of Forestry and Environmental Sciences, University of Chittagong, Chattogram (lies between 91°50'E longitude and 22°30'N latitude) (Hossain *et al.* 2005). The climate is tropical monsoon with an average monthly highest temperature of 29.75°C and a monthly lowest of 21.24 °C. The maximum temperature usually occurs in May at 32.60 °C and the minimum in January at 14.10 °C.

### **Seed collection**

*Aphanamixis polystachya* fruits were collected from University of Chittagong, Chattogram during March 2019. Phenotypic characteristics of fruits and seeds were measured. Seeds were extracted from fruits, dried in the open sun for three days. Randomly selected seeds were used for characterization.

### **Experimental design**

The soil used for filling polybags were collected from the forest floor, dried and sieved well (<3mm) and mixed with decomposed cow dung in a ratio of 3:1. 15×10 cm size polybags were used for the experiment. The media used in the propagator house were fine Sylhet sand. Forest topsoil was used in the open nursery bed. Collected seeds were sown in respectively prepared polybag, open nursery bed and propagator house. The study was made up of 6 treatments with 3 replications (15 seed per replication) in a Randomized Complete Block Design. Forty-five (45) healthy seeds were chosen randomly for each treatment. Daily germination progress was recorded as soon as the seeds start germination. Seedlings raised in open nursery bed and propagator house were transferred to polybag after 1 months of the last germination of seeds. The pricked-out seedlings were kept in shade for 2 weeks and then transferred to sunlight. Proper care and maintenance were done

regularly. Shoot height and leaf number of the seedlings were recorded after 2<sup>nd</sup> and 3<sup>rd</sup> month of last germination. The pre-sowing treatments are as:

- T<sub>0</sub>- Seeds sown in soil filled polybags without treatment (control)
- T<sub>1</sub>- Seeds soaking in normal water for 48 hours and sown in polybags (room temperature 24°C)
- T<sub>2</sub>- Seeds soaking in normal water for 24 hours and sown in polybags (room temperature 24°C)
- T<sub>3</sub>- Seeds soaking in hot water for 1 minute and sown in polybags (boiled water)
- T<sub>4</sub>- Seeds sown in propagator house, and
- T<sub>5</sub>- Seeds sown in an open nursery bed

### Data collection and analysis

**Germination percentage:** The number of seeds out of 100 seeds from the starting of germination to the termination of germination (Kumar, 1999)

$$\text{Germination \% (GP)} = \frac{\text{No of seed germinated}}{\text{No. of seed sown}} \times 100$$

**Cumulative germination % (CGP):** It assessed at the end of seed germination by summed up daily germination (Hasnat *et al.*, 2019).

$$\text{CGP} = \frac{\text{Cumulative number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

**Germination energy (GE):** It is measured by computing the daily germination percentage of its peak time (Dwivedi, 1993).

**Germination index (GI):** According to AOSA (1983) GI was calculated using this formula:

$$\text{Germination index (GI)} = \frac{\text{No.of germinated seeds}}{\text{Days of first count}} + \dots + \frac{\text{No.of germinated seeds}}{\text{Days of first count}}$$

**Mean germination time (MGT):** It calculates the rate and the time-spread of germination (Bewley *et al.* 2013, Soltani *et al.* 2015) and it should determine the time to half of the germination. The formula:

$$12 \quad \text{MGT} = \frac{\sum Dn}{\sum n}$$

Where, D = the number of days counted from the starting of germination, n = the number of seeds that were germinated on day D (Ellis and Roberts 1981, Afzal *et al.* 2005).

**Germination Uniformity (GU):** It was calculated by using the formula:

$$\text{GU} = \frac{\sum n}{(\sum (Fn-t)^2 \times n)}$$

Where, t is the time in days, beginning from day 0, the day of germination, and n is the number of seeds germinated at t and F are alike to MGT (Abdolahi *et al.*, 2012).

**Germination value (GV):** It was calculated by multiplication of the peak value of germination and mean daily germination (Hasnat *et al.*, 2019).

$$\text{GV} = \text{Peak value of germination} \times \text{mean daily germination}$$

**Germination capacity:** It is the percentage of seeds germinated in an experiment from the starting to end. It was classified as follows: a) 90-100%-very good, b)70-90%-good, c)50-70%-average, d) 30-50%-poor e)20-30%-very poor, and f) (<) less than 10% extremely poor (Kumar, 1999).

### Statistical analysis

All the recorded data were analysed statistically by using computer package software SPSS ver. 23. Duncan's Multiple Range Test (DMRT) was employed to define the statistical significance and it was shown by different letters in different tables.

## Results

### Morphological features of seeds

The average seeds length and width was found  $1.612 \pm 0.04$  cm and  $1.506 \pm 0.03$  cm respectively. About 629 seeds were found per kg (Table 42).

**Table 42.** Seed length, width and number of seeds per kg of *A. polystachya* seeds

	Length (cm)	Width (cm)	Weight/seed (g)	Seeds/kg
Average	$1.612 \pm 0.04$	$1.506 \pm 0.03$	$1.59 \pm 0.08$	629

± indicates the standard error of mean.

Date of germination starts and ends varied among different treatments. Germination starts after 16 days in T<sub>4</sub> treatment and T<sub>0</sub> required maximum time (22 days) to initiate germination. Highest germination percentage (85.71 %) was found in T<sub>4</sub> and lowest 57.14% in T<sub>1</sub> and T<sub>5</sub>. T<sub>4</sub> was significantly ( $p < 0.05$ ) different from other treatments. Lowest germination period (20.33 days) recorded in T<sub>4</sub> treatment followed by 21.67 days in T<sub>2</sub> but there was no significant difference among treatments (Table 43).

**Table 43.** Effect on germination behavior of *A. polystachya* seeds with different pre-sowing treatments

Treatments	Germination starts after (days)	Germination end after (days)	Germination period (days)	Germination (%)	Germination Capacity
T <sub>0</sub>	22	35	25.33 a*	61.90 b	Average
T <sub>1</sub>	21	31	26.33 a	57.14 b	Average
T <sub>2</sub>	20	31	21.67 a	71.43 b	Good
T <sub>3</sub>	18	30	23.00 a	66.66 b	Average
T <sub>4</sub>	16	31	20.33 a	85.71 a	Very good
T <sub>5</sub>	18	32	23.00 a	57.14 b	Average

\* Means followed by the same letter (s) in the same column do not vary significantly at  $P < 0.05$ , according to Duncan's Multiple Range Test (DMRT).

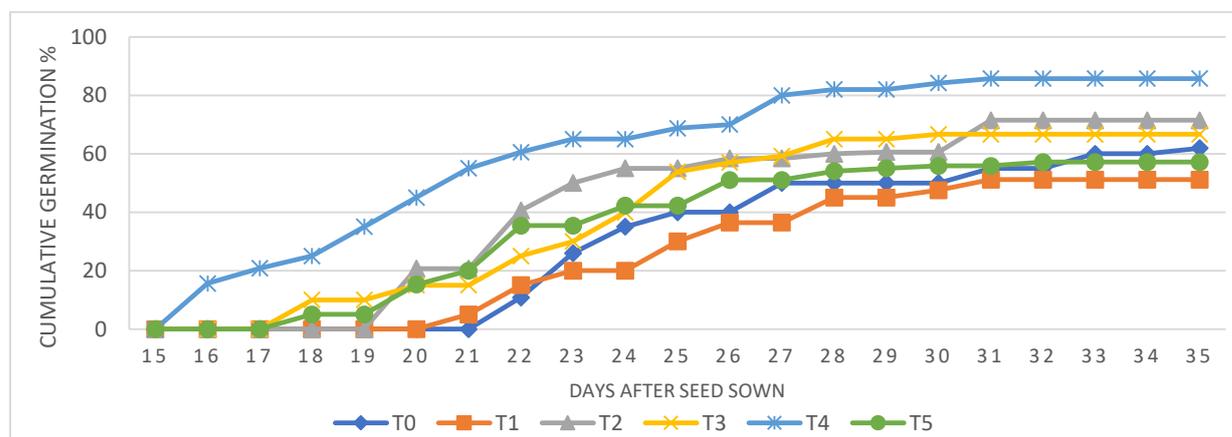
Maximum germination energy (33.33 %) was revealed in T<sub>4</sub> and T<sub>2</sub> and minimum germination energy (23.81%) in T<sub>0</sub> and T<sub>3</sub>. Highest germination index (0.2690) was found in T<sub>4</sub> and there was no significant difference among treatments. Highest germination value (1.188) was recorded in T<sub>4</sub> treatment and significantly ( $P < 0.05$ ) different from other treatments. Mean germination time found minimum in T<sub>4</sub> (23.16), slightly vary from T<sub>2</sub> and T<sub>5</sub> and maximum in T<sub>1</sub> (28.27) (Table 44).

**Table 44.** Effect on germination behavior of *A. polystachya* seeds in different pre-sowing treatments

Treatments	Germination Energy (%)	Germination Index (GI)	Mean Germination Time (MGT)	Germination Uniformity (GU)	Germination Value
T <sub>0</sub>	23.81 a*	0.1619 a	27.53 ab	0.0040 b	0.5661 b
T <sub>1</sub>	28.57 a	0.1449 a	28.27 a	0.0029 b	0.5303 b
T <sub>2</sub>	33.33 a	0.2048 a	24.83 bc	0.0049 b	0.8213 ab
T <sub>3</sub>	23.81 a	0.1854 a	25.81 ab	0.0054 b	0.7444 ab
T <sub>4</sub>	33.33 a	0.2690 a	23.16 c	0.0113 b	1.188 a
T <sub>5</sub>	28.57 a	0.2061 a	24.50 bc	0.0055 b	0.5794 b

\*Means followed by the same letter (s) in the same column do not vary significantly at P<0.05, according to Duncan's Multiple Range Test (DMRT).

To obtain cumulative germination percentage for each treatment, daily germination percentages were summed. Cumulative germination of T<sub>4</sub> starts after 16 days of seed sown and rose rapidly and continued up to 85.71% within 31 days. After 22 days of seed sown, T<sub>0</sub> treated seeds starts germinated and achieved 61.90% germination percentage (Fig. 56).



**Fig. 56.** Cumulative germination percentage of *A. polystachya* under different pre-sowing treatments

Shoot height was recorded at two and three months old seedlings. The highest mean shoot height (21.94 cm) attained in T<sub>2</sub> treatment (soaking in cold water for 24 hours and sown in polybags) and lowest (17.84 cm) in T<sub>5</sub> treatment (Seeds sown in seedbed). Mean maximum number of leaf (8.2) produced in T<sub>2</sub> and minimum (5.8) in T<sub>4</sub> treatment (Table 45).

**Table 45.** Mean shoot height and leaf number of *A. polystachya* seeds in different pre-sowing treatments

Treatments	Mean shoot height (cm)		Leaf number	
	2 months	3 months	2 months	3 months
T <sub>0</sub>	15.2±1.15	18.46±0.99	5.6±0.6	6.2±0.97
T <sub>1</sub>	15.7±0.44	19.5±0.71	7±1.30	7.6±0.51
T <sub>2</sub>	19.1±0.87	21.94±0.59	7.6±0.244	8.2±0.58
T <sub>3</sub>	18±1.44	21.76±1.19	6.6±0.4	7±0.45
T <sub>4</sub>	16.9±0.23	18.1±0.26	4.8±0.26	5.8±0.26
T <sub>5</sub>	14±0.67	17.84±0.62	6±0.55	7.4±0.68



**Fig. 57.** Pitraj Seed



**Fig. 58.** Pitraj seed propagator house



**Fig. 59.** seedlings in propagator



**Fig. 60.** Seedlings in polybag

## **Discussion**

The study on *Aphanamixis polystachya* found that seed sown in propagator house provided highest germination percentage (85.71%). Seed pre-sowing treatments significantly affect the germination of *Aphanamixis polystachya*. Seeds sown in propagator house in controlled environment and sand media showed maximum germination behaviors followed by seed treated with normal water at room temperature for 24 hours. After attaining certain height (10 cm) seedlings need to transfer from propagator to polybag with soil and cow dung media to get vigor and maximum seedlings for afforestation and reforestation.

## **11.j. Ex-situ Conservation of Threatened Tree Species at University Campus**

### **Study area**

The study conducted in the University of Chittagong (nursery, seed research laboratory and conservation stand).

### **Seedling raising**

Seeds of the selected species underwent pre-sowing treatments (if needed) before sowing in the nursery bed, propagator house and indoor condition of laboratory. The pre-sowing treatments varied with species to suit it with the type of seeds and nature of seed coats of different species. Seeds are generally sown in the polybags and propagator house beds but very small seeds were sown in the germination trays. Sandy loam soil was used in the polybags and nursery trays, whereas propagator house beds were composed of coarse sands. Decomposed cow-dung was added with the sandy loam soil at 1:3 proportion.

### **Care and maintenance of the seedlings**

Seedlings raised in propagator and seedbed transferred to polybag within 1-2 months of germination. The polybags, nursery trays and propagator house beds were regularly watered and cleaned off weeds. Partial shade was provided to protect the seedlings from strong sunlight.

### **Conservation stand establishment**

The one-year-old seedlings were planted in the conservation site prepared on the hills located at the south of Faculty of Science Building and adjacent to the hill bottom colony of the University of Chattogram campus. The site was cleared off bushes and weeds. A total of 25-36 seedlings for each species were planted in the sufficiently sized pits filled with soil and cow dung. A uniform spacing, 2m × 2m, was maintained in the plantations between the seedlings. The conservation plots were surrounded by biodegradable fence material to protect them from grazing. Weeding was conducted regularly with a frequency of three times a year.

### **Seedling data collection**

Average height of the seedlings (cm) from ground at 6- and 18-months old age seedlings is

collected for each of the species to assess the growth performance. From each of the species and age range, a total of 25 seedlings were measured for total height with a centimeter scaled ranging rod.

### Data analysis

Height of the seedlings from the conservation plots was analyzed per species to estimate the survival percentage and growth performance in the nursery. Conservation status of the species is available from Encyclopedia of Flora and Fauna of Bangladesh (Ahmed *et al.*, 2009a, 2009b, 2009c, 2008a, 2008b, 2008c; Siddiqui *et al.*, 2007a, 2007b). Since, the IUCN red list status for the selected tree species is not available in Bangladesh, that's why status from Encyclopedia of Flora and Fauna of Bangladesh is compared with the selected species that seemed to be rare in the natural forests of Bangladesh.

### Status of the selected rare species

The study selected 90 endangered indigenous tree species from different parts of Bangladesh for experimentation, multiplication and conservation (Table 46). Taxonomically the species belong to 65 genera and 39 families. Highest four species from *Terminalia* genus followed by *Dipterocarpus*, *Mallotus*, *Miliusa*, *Sterculia* and *Vitex* genera with two species each. Among the family's representation, Euphorbiaceae was highest with nine species followed by Anacardiaceae, Combretaceae, Meliaceae, and Sterculiaceae each with four species.

**Table 46.** Composition of the endangered tree species selected for experimentation, multiplication and conservation at Chittagong University campus

No.	Botanical Name	Vernacular name	English name	Family	Conservation status
1	<i>Adenanthera pavonina</i> L.	<b>Raktakambal</b> , Raktakanchan, Ranjan	Red bead tree	Mimosaceae	LC*
2	<i>Albizia chinensis</i> (Osbeck) Merr.	<b>Chakua koroi</b>	Chinese Albizia	Mimosaceae	LC
3	<i>Anisoptera scaphula</i> (Roxb.) Pierre	<b>Boilam</b> , Boilshora, <b>Boilsur</b> , Sada boilam	Mascal-wood	Dipterocarpaceae	CD
4	<i>Antidesma ghaesambilla</i> Gaertn.	<b>Chutkigota</b> , <b>Elena</b> , Khudijam, Tendera	-----	Euphorbiaceae	LC
5	<i>Aphanamixis polystachya</i> (Wall.) Parker	Boddiraj, Berirata, <b>Pitraj</b> , Rata, Rohina, <b>Roina</b>	Amoora	Meliaceae	LC
6	<i>Aquilaria malaccensis</i> Lamk.	Agar, Agaru	Agar tree	Thymelaeaceae	LC
7	<i>Artocarpus lacucha</i> Buch.-Ham.	Ban Kanthal, <b>Barta</b> , Deophal, <b>Dewa</b> , Dewa Cham	Monkey jack	Moraceae	LC
8	<i>Baccaurea ramiflora</i> Lour.	<b>Bhubi</b> , Harfata, Kangra gula, Latka, <b>Latkon</b>	Burmese grape	Euphorbiaceae	LC
9	<i>Bauhinia acuminata</i> L.	Sada kanchan, <b>Swet-kanchan</b>	Mountain ebony, White bahunia	Caesalpiniaceae	LC
10	<i>Bischofia javanica</i> Bl.	<b>Kanjai badhi</b> , Kehura bhadi, laubhadi,	Java cedar, West Indian cedar	Euphorbiaceae	LC
11	<i>Bombax ceiba</i> L.	Simul	Red silk cotton tree	Bombacaceae	LC
12	<i>Bouea oppositifolia</i> (Roxb.) Meissn.	Ban aam, Maila, <b>Miriam</b> , Moyam, Uriam	Burmese plum, Marian plum	Anacardiaceae	NE but seems rare
13	<i>Brownlowia elata</i> Roxb.	Moos, Masjat	Not known	Tiliaceae	VU
14	<i>Calophyllum inophyllum</i> L.	Ponnal, sultan champa	Alexdrian Laurel	Clusiaceae	LC
15	<i>Calophyllum polyanthum</i> Wall. ex Choisy.	Kamdev	The Poonspar Tree	Clusiaceae	NE
16	<i>Carallia brachiata</i> (Lour.) Merr.	Raskao, Lotkao, <b>Kiabong</b> , Kemal gach	Not Known	Rhizophoraceae	LC

Table 46 Continued...

No.	Botanical Name	Vernacular name	English name	Family	Conservation status
17	<i>Careya arborea</i> Roxb.	Bidipata, <b>Gadila, Kumbi</b> , Tendu pata	Slow-match tree	Lecythidaceae	VU
18	<i>Caryota urens</i> L.	<b>Chau supari</b> , Gol sago, Chau-gota,	Hill palm, Indian sago-palm	Arecaceae	LC
19	<i>Cassia fistula</i> L.	<b>Bandar lathi</b> , Honalu, <b>Sonalu</b>	Golden Shower	Caesalpinaceae	LC
20	<i>Chukrasia tabularis</i> A. Juss.	<b>Chikrassi</b> , Chabarassy, <b>Haithra-poma</b> , Paba	Chattogram wood, Indian mahogany	Meliaceae	LC
21	<i>Crateva magna</i> (Lour.) DC.	<b>Barun</b> , Banya, Gota burna, <b>Pitagola</b>	Three-leaved caper	Capparaceae,	LC
22	<i>Croton tiglium</i> L.	<b>Jaypal</b> , Jamalgota, Bish khagor	Purging croton	Euphorbiaceae	CD
23	<i>Cryptocarya amygdalina</i> Nees	Bhuia gach, <b>Sutrong</b>	----	Lauraceae	NE but seems rare
24	<i>Dehaasia kurzii</i> King	Bograj, <b>Modon mosta</b>	---	Lauraceae	NE but seems rare
25	<i>Dillenia pentagyna</i> <b>Roxb.</b>	Hargeza			
26	<i>Diospyros malabarica</i> ( <b>Desr.</b> ) <b>Kostel.</b>	Deshi gab	Indian persimmon	Ebenaceae	LC
27	<i>Dipterocarpus alatus</i> Roxb. Ex G. Don	Dahlia garjan, <b>Dhullya garjan</b> , <b>Sada Garjan</b> , Mashkhaliya garjan, Sil garjan	Garjan tree	Dipterocarpaceae	LC
28	<i>Dipterocarpus costatus</i> Gaertn.	<b>Baittya garjan</b> , Gutti garjan, Kessho garjan,	Garjan tree	Dipterocarpaceae	CD
29	<i>Dipterocarpus turbinatus</i> Gaertn.	<b>Teli-garjan</b>	Garjan Tree	Dipterocarpaceae	LC
30	<i>Dysoxylum binectariferum</i> (Roxb.) Hook. F. et. Bedd.	Bandar ratal, <b>Bara rata</b> , Hota rata	---	Meliaceae	CD
31	<i>Ehretia serrata</i> Roxb.	Kalahuja, <b>Kalauja</b> , Kat goa, Paban	Heliotrope tree	Boraginaceae	LC
32	<i>Elaeocarpus floribundus</i> Bl.	<b>Belphoi</b> , Ban belphoi, Jalpai	Indian olive, Rugged oil-fruit	Elaeocarpaceae	LC
33	<i>Elaeocarpus tectorius</i> (Lour.) Poir.	Belfoi, <b>Jalpai</b>	Indian Olive	Elaeocarpaceae	LC
34	<i>Engelhardtia spicata</i> <b>Leschen</b> ex Bl.	Chorkata lej, Dhala rata, <b>Jhumka bhadi</b> , Kichra-bhadi, Loha bhadi	Great Malay Beam	Juglandaceae	NE
35	<i>Fernandoa adenophylla</i> (Wall. Ex G. Don) vn Steenis	<b>Bar patta</b> , Bon sal, Bon segun, Chilana, Koira aswal, Pahari hijal, Sil parul	Karen wood	Bignoniaceae	LC
36	<i>Ficus hispida</i> L. f.	Dumur, <b>Kak dumur</b> , Khosaka, <b>Khuksa</b> , Kudura	Opposite leaved fig, Rough leaved fig	Moraceae	LC
37	<i>Firmiana colorata</i> (Roxb.) R. Br.	<b>Faisa udal</b> , Mula, Pata gota, Udal, Ujal	The coloured sterculia	Sterculiaceae	LC
38	<i>Flacourtia jangomas</i> (Lour.) Raensch	<b>Lok luki</b> , Paniala, <b>Paina gola</b> , Peala gota, <b>Pela gota</b>	Indian cherry	Flacourtiaceae	LC
39	<i>Garcinia cowa</i> Roxb. ex DC.	<b>Kao</b> , Kao gula	The Cowa fruit	Clusiaceae	LC
40	<i>Gardenia coronaria</i> Buch.-Ham.	Connari, <b>Kannyari</b>	Golden Gardenia	Rubiaceae	VU
41	<i>Garuga pinnata</i> <b>Roxb.</b>	Sil bhadi , Bhadi	Grey Downy Balsam	Burseraceae	LC
42	<i>Grewia nervoa</i> (Lour.) Panigr.	<b>Achar gulla</b> , Assar, <b>Datoi</b> , Patka, Sitki	Phalsa	Tiliaceae	LC
43	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Dakrum, <b>Haldu, Kaika</b> , Kali kadam,	Yellow Teak	Rubiaceae	CD
44	<i>Hymenodictyon orixensis</i> (Roxb.) Mabblerley	<b>Bhutum, Buikadam</b> , Puti kadam, Kali kadam, Srikadam	Bridal Couch Tree	Rubiaceae	VU
45	<i>Lagerstroemia parviflora</i> Roxb.	<b>Sidha jarul</b> , tilla-jarul		Lythraceae	LC but seems rare
46	<i>Lepisanthes rubiginosa</i> (Roxb.) Leenhouts	Bara harina, <b>Chagal guti</b> , <b>Chagaler bori</b> , Chagaler leda, Harina gula	Rusty sapindus	Sapindaceae	LC
47	<i>Lithocarpus acuminata</i> (Roxb.) Rehder	<b>Dholi batna</b> , Gola batna, Kali batna, Kanta batna, Lota batna	Indian Chestnut	Fagaceae	EN

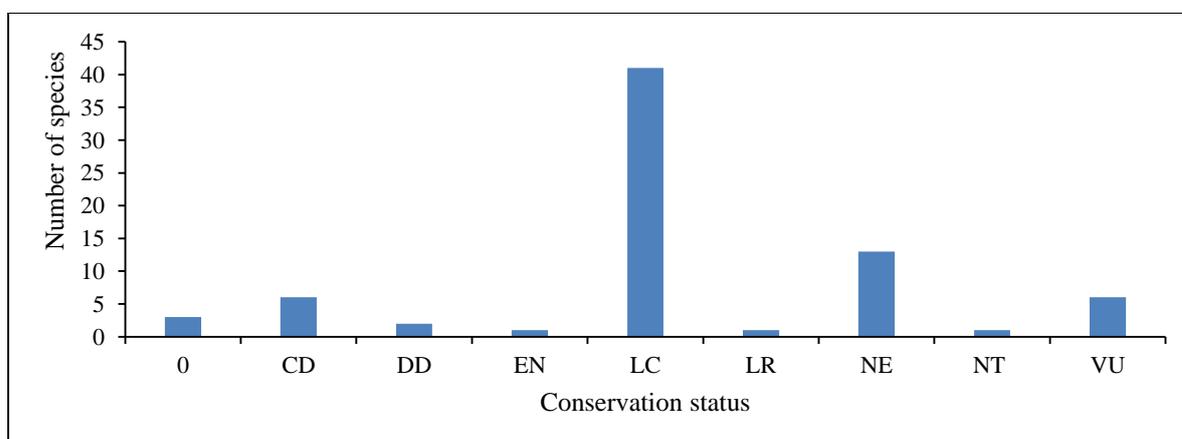
Table 46 Continued...

No.	Botanical Name	Vernacular name	English name	Family	Conservation status
48	<i>Litsea monopetala</i> (Roxb.) Pers.	<b>Lalkhori, Manda</b> , Meda, Pipul gach, <b>Sukurja</b>	Common Grey Mango Laurel	Lauraceae	NE
49	<i>Lophopetalum wightianum</i> Arn.	<b>Raktan</b> , Rattan, Sutrong	Wight's lophopetalum	Celastraceae	NT
50	<i>Macaranga denticulata</i> (Bl.) Muell.-Arg.	<b>Bura, Bura kochi</b> , Burna, Rata bura	Blistery Macaranga	Euphorbiaceae	LC
51	<i>Madhuca longifolia</i> (Koenig) MacBride	Mahua, Mohwa	Butter tree, The mohua tree	Sapotaceae	NE
52	<i>Mallotus philippensis</i> (Lamk.) Muell.-Arg.	<b>Kamela</b> , Sindur, <b>Sinduri</b> , Singara,	Red berry, Monkey face tree	Euphorbiaceae	LC
53	<i>Milium longiflora</i> (Hook. F. & Thom.) Finet & Gagnep.	Phesikau, Kuchu kao	----	Annonaceae	CD
54	<i>Milium velutinum</i> (Dunal) Hook.f. et Thoms.	Bal gozari, Gandhi-gazari, Gobra sal, Pora sal, Senia sal	----	Annonaceae	LC but seems rare
55	<i>Ormosia robusta</i> (Roxb.) Baker	Ormosi, <b>Hokkanali</b>	Horse-eye-bean	Fabaceae	DD but seems rare
56	<i>Oroxylum indicum</i> (L.) Benth. Ex Kurz	Hona, <b>Kanadinga, Khona</b> , Thona	Indian trumpet flower	Bignoniaceae	LC
57	<i>Palaquium polyanthum</i> (Wall. ex DC.) Engler.	<b>Tali</b> , Dudhi	Palaquium	Sapotaceae	NE but seems rare
58	<i>Phyllanthus emblica</i> L.	Amloki, Amla	Emblic Myrobalan	Euphorbiaceae	LC
59	<i>Protium serratum</i> (Wall. Ex Colebr.)	<b>Gutguya</b> , Hiliabhadi, Lohabhadi, Neur, Niyar	Indian red pear	Burseraceae	LC
60	<i>Pterocarpus indicus</i> Willd.	Andaman padauk, <b>Padak</b> , Paduak, Rakta Chandan	Andaman red wood	Fabaceae	NE
61	<i>Pterospermum acerifolium</i> (L.) Willd.	Muskanda, Kanak champa	Mapple-leaved Bayur	Sterculiaceae	LC
62	<i>Pterygota alata</i> (Roxb.) R. Br.	<b>Buddha narikel</b> , Jangli badam,	The Buddha's coconut tree	Sterculiaceae	LC
63	<i>Putranjiva roxburghii</i> Wall.	<b>Jiaputa</b> , Putranjib		Euphorbiaceae	LC
64	<i>Quercus gomeziana</i> A. Camus	<b>Dhoilla batna</b> , Goorja batna, Khooisa batna, <b>Tal batna</b>	Oak tree	Fagaceae	DD
65	<i>Sapium indicum</i> Willd.	<b>Mel</b> , Kala be;	Not known	Euphorbiaceae	LC
66	<i>Saraca asoca</i> (Roxb.) de Wilde	<b>Asok</b> , Monea, Owsad tree	Asoka tree	Caesalpiniaceae	LC
67	<i>Schima wallichii</i> (DC.) Korth.	<b>Banak</b> , Bon champa, <b>Kanak</b> , Makra	Schima	Theaceae	LC
68	<i>Schleichera oleosa</i> (Lour.) Oken.	<b>Kusum, Joyna</b> , Lakkha	Ceylon oak, Gum tree, Honey tree	Sapindaceae	NE
69	<i>Semecarpus anacardium</i>	<b>Behula</b>		Anacardiaceae	NE
70	<i>Spondias pinnata</i> (L.f.) Kurz.	Amra, <b>Deshi-amra, Bon-amra</b> , Pial	Hog plum	Anacardiaceae	LC
71	<i>Sterculia foetida</i> L.	Jangli badam, <b>Box-badam</b> , Udal badam	Wild Almond Tree	Sterculiaceae	NE
72	<i>Sterculia villosa</i> Roxb. Ex. Smith.	Bara ujal, <b>Fashya udal</b> , Udal, Ujal	Elephant rope tree	Sterculiaceae	LC
73	<i>Stereospermum colais</i> (Buch.-Ham. ex Dillw.) Mabberley	<b>Dharmara</b> , Pahari awal	Yellow Snake Tree	Bignoniaceae	LC
74	<i>Suregada multiflora</i> (A. Juss.) Bail.	<b>Ban naranga</b> , Chagal ladha, Maricha	False lime	Euphorbiaceae	NE
75	<i>Swintonia floribunda</i> Griff.	<b>Am-chandul</b> , Bailsur, <b>Civit</b>	Civit	Anacardiaceae	VU
76	<i>Syzygium firmum</i>	<b>Dhakai jam</b>	Sea apple	Myrtaceae	LC
77	<i>Syzygium formosum</i> (Wall.) Masamune	<b>Paniya jam</b> , Phul jam	Not known	Myrtaceae	LC
78	<i>Syzygium fruticosum</i> DC.	<b>Puti jam</b> , Bon jam	Not known	Myrtaceae	LC
79	<i>Terminalia arjuna</i> (Roxb. Ex DC.) Wt. et Arn.	<b>Arjun</b> , Arjuna	The arjuna myrobalan, White murdah	Combretaceae	VU

Table 46 Continued...

No.	Botanical Name	Vernacular name	English name	Family	Conservation status
80	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bahera, Bayra, Boira, Bora gach	Basterd myrobalan, Bellaric myrabolan	Combretaceae	LC
81	<i>Terminalia chebula</i> Retz.	Haritaki, Horttal, Hartoki	Black myrobalan, Chebulic myrabolan	Combretaceae	VU
82	<i>Terminalia citrina</i> (Gaertn) Roxb. Ex. Fleming	Hartiki, <b>Hatiyal</b> , Hartaki	Citrina myrobalan	Combretaceae	LC
83	<i>Tetrameles nudiflora</i> R. Br.	<b>Chandul</b> , Mainakat, Tirol, <b>Toirol</b> , Taru	Tetrameles	Datiaceae	NE
84	<i>Trewia nudiflora</i> L.	Batul, <b>Pitali</b> , lattoo, gotagamar, Mera gota, pitagola	False white teak	Euphorbiaceae	NE
85	<i>Uvaria cordata</i> (Dunal) Alston	<b>Bagh-runga</b> , Gagh-ranga	Calabao	Annonaceae	LC
86	<i>Vitex glabrata</i> R.Br.	Arsal, Asphal, <b>Harina</b> , Tokra gach	Smooth chaster tree	Verbenaceae	LC
87	<i>Vitex peduncularis</i> Wall. Ex Schauer	Awal, <b>Arsol</b> , <b>Goda</b> , <b>Horina</b> , Aswal	Longspike Chaste tree	Verbenaceae	NE but seems rare
88	<i>Walsura robusta</i> Roxb.	<b>Ataligula</b> , <b>Ban lichi</b> , Lal batta	-----	Meliaceae	LC
89	<i>Wrightia arborea</i> (Dennst.) Mabberley	<b>Dudh-kurus</b> , Dudh-koraiya	Not known	Apocynaceae	NT
90	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	Badrang, <b>Bajna</b> , <b>Basbarana</b>	-----	Rutaceae	LC

IUCN red list of threatened species is the world's most comprehensive source of information about the conservation status of plants, animals and fungi. The first red listing of species was done in 2000 for selected animals of Bangladesh which was repeated with more species in 2016. IUCN red listing of the plant species is yet to be updated in Bangladesh. However, conservation status of the plants of Bangladesh is provided in Encyclopedia of Flora and Fauna of Bangladesh by Ahmed *et al.* 2009a, 2009b, 2009c, 2008a, 2008b, 2008c; Siddiqui *et al.*, 2007a, 2007b. The 12-year-old status indicated that as much as 41 species were Least Concern, followed by 10 Not Evaluated and six species under Conservation Dependent and Vulnerable each. Moreover, there are two Data Deficient, one Lower Risk, one Near Threatened and one Endangered species (Fig. 61). In this discussion, we want to focus on the Least Concern plants that became rare now-a-days in the natural forests of Bangladesh. *Adenanthera pavonina*, *Antidesma ghaesembilla*, *Aphanamixis polystachya*, *Aquilaria malaccensis*, *Artocarpus lacucha*, *Baccaurea ramiflora*, *Bauhinia 142rachiata*, *Bischofia javanica*, *Carallia brachiata*, *Caryota urens* are some of the then Least Concern species that seemed to become rare at present and conserved in the University of Chittagong campus.



**Fig. 61.** Number of species under different conservation status [here, CD = Conservation Dependent, DD = Data Deficient, EN = Endangered, LC = Least Concern, LR = Lower Risk, NE = Not Evaluated, NT = Near Threatened, VU = Vulnerable]

## Growth performance

Survival percentage and height (cm) measurement was taken when the plantations are 30 months (43 species), 18 months old (35 species) and 6 months old (12 species). A total of 3,169 seedlings were planted in 2019 (1586 seedlings), in 2020 (1288 seedlings) and 295 seedlings were planted in 2021.

Survival percentage of 30 months old seedlings (1586 seedlings of 43 tree species) vary from 83-100%. The 18 months old seedlings show the same 83-100% survival percentage except the species *Caryota urens* which showed only 10% survival percentage. Wild bore eats the rhizome of the species in the plantations. The seedlings planted in 2021 (295 seedlings of 12 species) revealed the 100% survival of the seedlings.

At the age of 30 months, *Trewia nudiflora* (Pitali) attained the maximum height (591 cm) followed by Paduk (540 cm), Chikrasi (482 cm), Jamal gota (451 cm). Ten species attained height (cm) more than 400 cm, 7 species more than 300 cm. The lowest height was found for Mirian (28 cm), followed by Modonmosta (72 cm), Bhuiya gach (73 cm), and Bon naranga (78 cm). Chundul attained maximum height (418 cm) at the age of 18 months followed by Kainjal bhadi (390 cm), Dumur (369 cm) and Bon litchi (320 cm). the lowest height was found for Chaogota (23 cm) followed by Lomba tasbi (32 cm), Dewa (35 cm) and Barpata (44 cm). Seedlings of 12 species at the age of 6 months old showed that Chesra koroi attained maximum height (109 cm) followed by Puti jam (75 cm), whereas the lowest height was found in Hargeza (25 cm), Moos (34 cm) and Guti jam (38 cm) (Table 47). The growth performance may be influenced by the slow growing nature of species along with the edaphic and climatic variations attributed to the sites.

**Table 47.** Scientific name, source of the fruits/seeds, survival percentage and height growth of the tree species in the conservation plot

No.	Botanical Name	Fruits/ seeds source	Seedlings planted (no.)	Survival %	Age (months)	Average ht. (cm)
<b>Plantations Established in May-June 2019</b>						
1	<i>Adenanthera pavonina</i> L.	BTRI	36	100	30	395
2	<i>Anisoptera scaphula</i> (Roxb.) Pierre	HWS	36	100	30	116
3	<i>Antidesma ghaesambilla</i> Gaertn.	HNP	36	100	30	273
4	<i>Aphanamixis polystachya</i> (Wall.) Parker	HWS	36	100	30	344
5	<i>Baccaurea ramiflora</i> Lour.	KNP	36	94	30	189
6	<i>Bauhinia acuminata</i> L.	BDNP	36	100	30	305
7	<i>Bouea oppositifolia</i> (Roxb.) Meissn.	Boalkhali	36	83	30	28
8	<i>Carallia brachiata</i> (Lour.) Merr.	CWS	36	100	30	159
9	<i>Cassia fistula</i> L.	CWS	36	100	30	411
10	<i>Chukrasia tabularis</i> A. Juss.	HWS	36	100	30	482
11	<i>Crateva magna</i> (Lour.) DC.	Hathazari	48	100	30	148
12	<i>Croton tiglium</i> L.	MNP	36	100	30	451
13	<i>Cryptocarya amygdalina</i> Nees	HWS	36	100	30	73
14	<i>Dehaasia kurzii</i> King	HWS	36	100	30	72

Table 47 Continued...

No.	Botanical Name	Fruits/ seeds source	Seedlings planted (no.)	Survival %	Age (months)	Average ht. (cm)
15	<i>Diospyros malabarica</i> (Desr.) Kostel.	BDNP	30	93	30	161
16	<i>Dipterocarpus alatus</i> Roxb. ex G. Don	Silkhali Forest Range	36	100	30	280
17	<i>Dysoxylum binecteriferum</i> (Roxb.) Hook. f. et. Bedd.	HWS	36	100	30	162
18	<i>Ehretia serrata</i> Roxb.	Bahaddarhat, Chattogram	36	100	30	214
19	<i>Elaeocarpus floribundus</i> Bl.	HWS	36	100	30	410
20	<i>Elaeocarpus tectorius</i> (Lour.) Poir.	HWS	36	100	30	414
21	<i>Engelhardtia spicata</i> Leschen ex Bl.	BFRI campus	36	86	30	189
22	<i>Firmiana colorata</i> (Roxb.) R. Br.	HWS	36	100	30	314
23	<i>Flacourtia jangomas</i> (Lour.) Raeusch	KNP	25	100	30	158
24	<i>Gardenia coronaria</i> Buch. -Ham.	HWS	36	100	30	107
25	<i>Hymenodictyon orixensis</i> (Roxb.) Mabberley	MNP	36	83	30	238
26	<i>Lagerstroemia parviflora</i> Roxb.	MNP	36	100	30	198
27	<i>Lepisanthes rubiginosa</i> (Roxb.) Leenhouts	HWS	50	98	30	412
28	<i>Lithocarpus acuminata</i> (Roxb.) Rehder	CWS	36	100	30	351
29	<i>Ormosia robusta</i> (Roxb.) Baker	HWS	36	100	30	208
30	<i>Oroxylum indicum</i> (L.) Benth. ex Kurz	HWS	36	100	30	439
31	<i>Pterocarpus indicus</i> Willd.	CU ampus	36	100	30	540
32	<i>Putranjiva roxburghii</i> Wall.	CU campus	36	100	30	206
33	<i>Saraca asoca</i> (Roxb.) de Wilde	MNP	36	94	30	114
34	<i>Schleichera oleosa</i> (Lour.) Oken.	HWS	36	100	30	140
35	<i>Semecarpus anacardium</i>	KNP	60	100	30	223
36	<i>Spondias pinnata</i> (L.f.) Kurz.	HWS	30	100	30	428
37	<i>Stereospermum colais</i> (Buch. - Ham. ex Dillw.) Mabberley	TWS	36	97	30	254
38	<i>Suregada multiflora</i> (A. Juss.) Bail.	BDNP	25	92	30	78
39	<i>Swintonia floribunda</i> Griff.	HWS	50	100	30	356
40	<i>Terminalia chebula</i> Retz.	Hathazari	50	100	30	389
41	<i>Trewia nudiflora</i> L.	Hathazari	36	100	30	591
42	<i>Uvaria cordata</i> (Dunal) Alston	BSPD	36	94	30	267
43	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	KNP	30	100	30	204

Table 47 Continued.....

No.	Botanical Name	Fruits/ seeds source	Seedlings planted (no.)	Survival %	Age (months)	Average ht. (cm)
<b>Plantations Established in May-June 2020</b>						
1	<i>Aquilaria malaccensis</i> Lamk.	LNP	36	100	18	176
2	<i>Artocarpus lacucha</i> Buch. - Ham.	HWS	30	93	18	35
3	<i>Bischofia javanica</i> Bl.	KNP	60	100	18	390
4	<i>Careya arborea</i> Roxb.	MNP	36	100	18	60
5	<i>Caryota urens</i> L.	CU campus	35	10	18	23
6	<i>Dipterocarpus costatus</i> Gaertn.	Silkhali Forest Range	40	85	18	53
7	<i>Fernandoa adenophylla</i> (Wall. ex G. Don) vn Steenis	HNP	50	100	18	44
8	<i>Ficus hispida</i> L. f.	HWS	36	94	18	369
9	<i>Garcinia cowa</i> Roxb. ex DC	HWS	30	100	18	82
10	<i>Grewia nervoa</i> (Lour.) Panigr.	KNP	36	100	18	88
11	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	KNP	30	100	18	183
12	<i>Litsea monopetala</i> (Roxb.) Pers.	KNP	30	100	18	73
13	<i>Lophopetalum wightianum</i> Arn.	HWS	30	100	18	77
14	<i>Macaranga denticulata</i> (Bl.) Muell.-Arg.	HWS	30	100	18	234
15	<i>Madhuca longifolia</i> (Koenig) MacBride	HWS	50	96	18	162
16	<i>Mallotus philippensis</i> (Lamk.) Muell.-Arg.	BDNP	50	93	18	136
17	<i>Miliusa longiflora</i> (Hook. f. & Thom.) Finet & Gagnep.	BDNP	50	98	18	32
18	<i>Miliusa velutina</i> (Dunal) Hook.f. et Thoms.	MNP	36	93	18	137
19	<i>Palaquium polyanthum</i> (Wall. ex DC.) Engler. Tali	HWS	15	100	18	141
20	<i>Phyllanthus emblica</i> L.	HWS	30	100	18	288
21	<i>Protium serratum</i> (Wall. ex Colebr.)	Mirpur Botanical Garden	50	100	18	128
22	<i>Pterygota alata</i> (Roxb.) R. Br.	Mirpur Botanical Garden	36	100	18	176
23	<i>Quercus gomeziana</i> A. Camus	KNP	25	100	18	166
24	<i>Sapium indicum</i> Willd. Mel	Hathazari	30	100	18	145
25	<i>Schima wallichii</i> (DC.) Korth.	MNP	25	94	18	76
26	<i>Sterculia foetida</i> L.	HWS	36	100	18	166

Table 47 Continued.....

No.	Botanical Name	Fruits/ seeds source	Seedlings planted (no.)	Survival %	Age (months)	Average ht. (cm)
27	<i>Sterculia villosa</i> Roxb. ex. Smith.	HWS	36	100	18	66
28	<i>Syzygium firmum</i>	FWS	36	100	18	175
29	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wt. et Arn.	Banskhali Eco-Park	36	65	18	88
30	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	KNP	50	100	18	235
31	<i>Terminalia citrina</i> (Gaertn.) Roxb. ex. Fleming	Banskhali	36	100	18	65
32	<i>Tetrameles nudiflora</i> R. Br.	KNP	36	100	18	418
33	<i>Vitex glabrata</i> R.Br.	FWS	30	100	18	240
34	<i>Vitex peduncularis</i> Wall. ex Schauer	HWS	50	98	18	139
35	<i>Walsura robusta</i> Roxb.	KNP	36	100	18	320
<b>Plantations Established in May-June 2021</b>						
1	<i>Albizia chinensis</i> (Osbeck) Merr.	HWS	5	100	6	109
2	<i>Bombax ceiba</i> L.	HNP	30	90	6	44
3	<i>Brownlowia elata</i> Roxb.	HNP	30	100	6	34
4	<i>Calophyllum inophyllum</i> L.	BNP	30	100	6	52
5	<i>Calophyllum polyanthum</i> Wall. ex Choisy	HWS	5	100	6	41
6	<i>Dillenia pentagyna</i> Roxb. Hargeza	MNP	30	100	6	25
7	<i>Dipterocarpus turbinatus</i> Gaertn.	HWS	30	100	6	59
8	<i>Garuga pinnata</i> Roxb. Sil bhadi	HWS	30	100	6	57
9	<i>Pterospermum acerifolium</i> (L.) Willd.	HNP	30	100	6	59
10	<i>Syzygium formosum</i> (Wall.) Masamune	HNP	30	100	6	38
11	<i>Syzygium fruticosum</i> DC.	HNP	30	100	6	75
12	<i>Wrightia arborea</i> (Dennst.) Mabberley	BNP	15	100	6	41

[\*BDNP- Baraiyadhala National Park, BTRI- Bangladesh Tea Research Institute, CWS- Chunati Wildlife Sanctuary, FWS- Fasiakhali Wildlife Sanctuary, HWS- Hazarikhil Wildlife Sanctuary, KNP- Kaptai National Park, MNP- Madhupur National Park, BSPD- Bangabandhu Safari Park, Dulhazara]

## Conclusion

Human-induced disturbance to natural habitats, overexploitation of wild resources, invasive species and climate change are causing loss of biodiversity unprecedentedly. Threats to biodiversity continue to increase worldwide and the conservation of biodiversity through *In situ* and complementary *Ex situ* measures is more important than ever. *Ex-situ* conservation refers to conservation of components of biodiversity outside their natural habitats, e.g. zoos, museums, gene banks, botanical gardens/arboretums, used for threatened and endangered species to avoid their extinction. Biodiversity is the life support system of our planet- we depend on it for the air we breathe, the food we eat, and the water we drink. Medicines originating from wild species, including penicillin, aspirin, taxol, and quinine, have saved millions of lives and relived tremendous sufferings. It has been observed that native species richness is linked to the health of ecosystems.

Ecosystem restoration is of increasing global interest as part of broader strategies to tackle climate change, loss of biodiversity and desertification, major environmental problems of our times. This emerging interest was formalized with the adoption of the revised and updated Strategic Plan of the UN Convention on Biological Diversity (CBD) for 2011–2020, which aims for the restoration of at least 15% of degraded ecosystems by 2020 (Aichi Target 15). As approximately 2 billion hectares of land are estimated to have potential to benefit from restoration, achieving Target 15 would imply the restoration of 300 million hectares, in this time frame. Afforestation is one of the key tools for forest landscape restoration. But, due to rapid loss of the mature individuals and mother trees of many native tree species the seed sources of rare trees are becoming scarcer day by day. Moreover, though there are scattered plantation programs across Bangladesh but very little is known about the conservation programs dedicated for rare native tree species except Hossain *et al.*, (2017). The present program explored, multiplied and established conservation plots for 74 tree species which can also be considered as potential stand for future seed source of these rare native tree species.

Establishment of tree plantation on degraded lands and clear-felled or barren forests favored some fast growing exotics, e.g. *Gmelina arborea*, *Acacia*, and *Eucalyptus*. High productivity, less harvesting time, and deeper silvicultural knowledge are the beneficial factor for choosing those pioneer, colonizing exotics. However, the use of a wide variety of native tree species becomes more significantly important in reforestation projects due to the greater biodiversity benefits and wider environmental services. In contrast to widely believed that some native tree species, perform poorly when planted in open and degraded lands. Whereas, the initial results of a number of natives, e.g. Pitali, Barun, Dhaki Jam be a promising alternative to those of exotic species to be used for reforestation projects.

Forest Landscape Restoration is one of the mostly talked programs now-a-days for wildlife protection, biodiversity conservation, maintaining the environmental balance and sustainable management of the forest ecosystems. Afforestation is one of the key tools for forest landscape restoration. But, due to rapid loss of the mature individuals and mother trees of many native tree species the seed sources of the threatened trees are becoming rare day by day. Moreover, though there are scattered plantation programs across Bangladesh but very little is known about the conservation programs dedicated for rare native tree species except Hossain *et al.*, (2017). The present program explored, multiply and established conservation plots for 74 tree species which can also be considered as potential stand for future seed source of these rare native tree species for hill and sal forest regions.

## 12. Research highlight (title, background, objectives, methodology, key findings, and key words)

### 12.1 Component-1 (BAU-Horticulture, Mymensingh)

#### **Enhance seed germination and seedlings growth of Chebulic myrobalan (*Terminalia chebula* Retz.) by soaking in cowdung slurry**

**Background:** Low germination percentage of Chebulic myrobalan in bengali horitoki (*Terminalia chebula* Retz.) as well as long time requirement is believed due to the hard seed coat and thick fleshy pulp of fruits. Nevertheless, delayed and irregular germination of seeds in the nursery is a serious constraint of efficient nursery management and plantation establishment. Thus a new method to enhance seed germination and growth performance of *T. chebula* Retz. is developed where seeds are soaked in cowdung slurry for six days before sowing.

**Objectives:** to enhance seed germination and growth performance of *Terminalia chebula* Retz. before sowing

**Methodology:** Optimum matured, uniform and disinfected fruits of *Terminalia chebula* Retz is collected from trees of BAU-GPC, Bangladesh Agricultural University, Mymensingh. Fruits is depulped at two ends and soaked in normal cow dung slurry for six (06) days. The sandy loamy soils are collected, sieved ( $\leq 3$  mm) and mixed with decomposed cow dung at a ratio of 3:1, after that filled in polybags (12.5 cm  $\times$  15.25 cm). One depulped and soaked seed is sown in each polybags by dibbling method in the germination media with depth of 0.5 cm and then covered with a thin layer of soil. Germination percentage is calculated, growth performance and survival percentage are recorded at 120 days after sowing.

**Key findings:** Enhance seedling germination percentage (85.25%) and survival percentage (85.21%) is observed after soaked in cowdung slurry for six days than control 63% and 47.50%, respectively, before sowing.

**Key words:** Medicinal plants, germination percentage, survival percentage.

### 12.2 Component-2 (BFRI)

#### **12.2.1 Collection, identification, characterization, multiplication, conservation and documentation of available medicinal plants in Chattogram and CHT**

Bangladesh is an immense reservoir of medicinal plant resources. Such resources constitute a very important component of plant diversity particularly the biodiversity rich areas in the Chattogram Hill Tracts (CHTs) comprising three hill districts namely Bandarban, Rangamati and Khagrachari. Herbal medicine has been widely and effectively used for the remedy of various diseases in the region by the tribal people over generations. But this valuable knowledge of tribal medicine is under threat due to availability of modern drugs. So, it is urgently needed to document those traditional knowledges before it is being lost and therefore survey, collection, identification and conservation of those plants is very important in this regard during 2018-2021. Thus this valuable indigenous wealth of the plant species for medicinal values including knowledge of their uses in the CHTs to explore, identify and measures to be taken for their conservation. Considering the fact BFRI component of the sub project initiated the following objectives:

- Collection, identification and characterization of available medicinal plants in Chattogram and CHT (Khagrachari, Rangamati and Bandarban hill districts).

- Conservation of the specimen/fruits/seeds/vegetative propagules, multiplication and germplasm at BFRI campus by suitable field stations.
- Documentation of ethnomedicinal plants practiced by the herbal healers.

The study was conducted in three hill districts namely Bandarban, Khagrachari and Rangamati. Out of 26 Upazilla in CHT's 12 Upazilla were selected (four Upazilla in each district). Exploring of ethnomedicinal plant species, 60 herbal practitioners (locally called *Boiddays*) were selected (five *Boiddays* from each Upazilla) from the study areas. Documentation of ethnomedicinal information's with relevant information were done using the standard method through group discussion and individual interviews of Martin (1995) and Cotton (1996). The collected plants were identified with the help of the expert plant taxonomist, compared with the specimens in the Herbarium of BFRI and Bangladesh National Herbarium (BNH) and pertinent literature. Propagules (cutting and rhizomes, *etc.*) of potential ethnomedicinal plants were collected during field visits and conserved at Germplasm center of BFRI following standard procedure of PGR. Reclonization of threatened ethnomedicinal plant species were done by establishing two medicinal plants garden in Bandarban and Rangamati with the medicinal plant species desired by *Boiddays*. Analysis of collected information was carried out through Microsoft Excel Software. User Value (*UV*) and Relative Frequency of Citation (*RFC*) were determined according to Vitalini *et al.*, (2013).

The uses information of ethnomedicinal plants were collected from 60 herbal practitioners of the study area. Out of them 46 (77%) were men and 14 (23%) were women. Furthermore, most of the informants have no formal educations except one or two have got the opportunity to go to the elementary school. Among the informants or herbal practitioners 22 belongs to Ckama tribe, followed by Marma 19, Tripura 10, Tonchongya 7 and Khumi 2.

During the study period a total of 566 plants were identified. Out of them, 266 plants were found common, it means 47.42% plants are used by different herbal practitioner is common. The study 64 species are conserved at BFRI and 300 plant species documented under 228 genera, belongs to 97 families used for the treatment of 139 ailments by tribal practitioners. The family Asteraceae is represented by highest number of 19 species, followed by Euphorbiaceae 17, Rubiaceae 16, Fabaceae 14, Zingiberaceae 11, Acanthaceae 10, Lamiaceae 9, Apocynaceae, Verbenaceae and Araceae 8, Caesalpiniaceae 7, Malvaceae, Amaranthaceae, Convolvulaceae and Cucurbitaceae 6 and 45 families represented by 1 species only. In life form, herbs (40%) were found most used plant followed by shrubs (27%), climber and trees (16%) and fern (1%) each.

The herbal practitioners of CHT's described 10 different parts of the plants use for the treatment of different ailments. Leaves were the most dominant plant parts (43%) used, followed by whole plants (20%), roots (13%), stems (7%), rhizome and bark (5%) tuber and seeds (1%). Almost 65% of ethnomedicines are administered orally, and during study local informants described that they use drugs in 7 different forms to treat different diseases. The most common form was found juice, followed by eating raw, paste, decoction, powder and poultice.

The study reveals that ethnobotanical indices, Use Value (*UV*) ranged from 0.18-0.88 for collected plant species. Out of 300 reported ethnomedicinal plant species, 33 plants were identified with *UV* greater than 0.65.

*RFC* is used to find out the most frequently used plant species for the treatment of various human ailments in the study area and the *RFC* of the collected medicinal plants is ranged from 0.02- 0.38. Twenty plant species reported in this study showed the high values.

## 12.3 Component-3 (IFESCU)

### 12.3.1 Germination and initial seedlings growth response of *Cryptocarya amygdalina* under different pre-sowing treatments

**Background:** *Cryptocarya amygdalina* (local name is Bhuiya gachh) belonging to Lauraceae family, is a native threatened tree species of Bangladesh. Trees up to 20 m tall, leaves broadly oblong, elliptic-lanceolate or oblanceolate. Flowering and fruiting happens in March-November. Conservation status considered as rare (Uddin and Hassan, 2018b).

**Objectives:** Study the effect of pre-sowing treatments on seed germination to identify appropriate pre-sowing treatments for *Cryptocarya amygdalina* species.

**Methodology:** *Cryptocarya amygdalina* fruits were collected from Hazarikhil Wildlife Sanctuary, Chattogram, Bangladesh during December, 2018. Randomly selected fruits information was recorded. The soil used for filling polybags were collected from the forest floor, dried and sieved well (<3mm) and mixed with decomposed cow dung in a ratio of 3:1. The size of polybags used for the experiment were 15×10 cm. Forest topsoil was used in the open nursery bed. Collected seeds were sown in respectively prepared polybag, open nursery bed and propagator house. The study was made up of 8 treatments with 4 replications (10 seed per replication) in a Randomized Complete Block Design. Forty (40) healthy seeds were chosen randomly for each treatment. Daily germination progress was recorded. Five seedlings were selected randomly from each treatment and shoot height and leaf number of the seedlings was recorded. The pre-sowing treatments are as:

- T<sub>0</sub>- Seeds sown in soil filled polybags (control)
- T<sub>1</sub>- Seeds soaking in normal water for 48 hours and sown in polybags
- T<sub>2</sub>- Seeds soaking in normal water for 24 hours and sown in polybags
- T<sub>3</sub>- Seeds soaking in normal water for 12 hours and sown in polybags
- T<sub>4</sub>- Seeds sown in seedbed (permanent shade)
- T<sub>5</sub>- Seeds soaking in hot water for 30 seconds and sown in propagator house
- T<sub>6</sub>- Seeds sown in propagator house
- T<sub>7</sub>- Seeds soaking in normal water for 24 hours & sown in propagator house

**Data analysis:** Germination percentage by Kumar, 1999, Cumulative germination percentage (CGP) by Hasnat *et al.*, 2019, Germination energy (GE) by Dwivedi, 1993, Germination index (GI) by AOSA, 1983, Mean germination time (MGT) by Bewley *et al.*, 2013, Soltani *et al.*, 2015, Ellis and Roberts 1981, and Afzal *et al.*, 2005, Germination Uniformity (GU) by Abdolahi *et al.* 2012, Germination value (GV) by Hasnat *et al.* 2019, and Germination capacity by Kumar 1999 were measured. All the recorded data were analyzed statistically by using computer package software SPSS ver. 23. Duncan's Multiple Range Test (DMRT) was employed to define the statistical significance and it was shown by different letters in different the different tables.

**Key Findings:** Seed's pre-sowing treatments significantly affects the germination of *Cryptocarya amygdalina*. Seeds sown in nursery bed with permanent shade showed maximum germination and initial growth performance. After attaining certain height (10 cm) seedlings need to transfer to polybag with soil and cow dung media for afforestation and reforestation. The result of the present study recommends the nursery owners or other seedling producer organizations to sow *Cryptocarya amygdalina* seeds in nursery bed with permanent shade for maximum germination and vigorous seedlings production in order to expand *C. amygdalina* stand in the forest.

**Key words:** *Cryptocarya amygdalina*, pre-sowing treatments, Germination, and initial seedlings growth response.

### 12.3.2 Germination and Initial Growth Performance of *Aphanamixis polystachya* (wall) parker -A Threatened Medicinal Tree Species in Bangladesh

**Background:** *Aphanamixis polystachya* (Wall) Parker, belonging to Meliaceae family, a valuable medicinal plant of Bangladesh. It is large evergreen tree, with a dense spreading crown and a straight cylindrical bole up to 15m in height and 1.5-1.8m in width (Fabricant and Farnsworth, 2001). This species has huge medicinal, economic and ecological value but due to degradation of forest and insufficient natural regeneration the species is becoming rare in Bangladesh.

**Objective(s):** Revaluing suitable pre-sowing treatments for maximum germination rates and initial seedling growth to improve nursery techniques and conserve rare native species.

**Methodology:** The study was carried out in the nursery of the IFESCU, Chattogram during March 2019. Collected *Aphanamixis polystachya* fruits were extracted, dried in the open sun for three days. Randomly selected seeds were used for characterization. The soil used for filling polybags were collected from the forest floor, dried and sieved well (<3mm) and mixed with decomposed cow dung in a ratio of 3:1. Polybags size were 15×10 cm used for the experiment. Forest topsoil was used in the open nursery bed. The study was made up of six treatments with three replications (15 seed per replication) in a Randomized Complete Block Design. Forty-five healthy seeds were chosen randomly for each treatment. Daily germination progress was recorded as soon as the seeds start germination. Seedlings raised in open nursery bed and propagator house were transferred to polybag after 1 months of the last germination of seeds. The pricked-out seedlings were kept in shade for 2 weeks and then transferred to sunlight. Proper care and maintenance were done regularly. Shoot height and leaf number of the seedlings were recorded after 2<sup>nd</sup> and 3<sup>rd</sup> month of last germination. The pre-sowing treatments are as:

- T<sub>0</sub>- Seeds sown in soil filled polybags without treatment (control).
- T<sub>1</sub>- Seeds soaking in normal water for 48 hours and sown in polybags (room temp. 24°C)
- T<sub>2</sub>- Seeds soaking in normal water for 24 hours and sown in polybags (room temp. 24°C)
- T<sub>3</sub>- Seeds soaking in hot water for 1 minute and sown in polybags (boiled water)
- T<sub>4</sub>- Seeds sown in propagator house, and
- T<sub>5</sub>- Seeds sown in an open nursery bed

**Data analysis:** Germination percentage by Kumar, 1999, Cumulative germination percentage (CGP) by Hasnat *et al.*, 2019, Germination energy (GE) by Dwivedi, 1993, Germination index (GI) by AOSA, 1983, Mean germination time (MGT) by Bewley *et al.*, 2013, Soltani *et al.*, 2015, Ellis and Roberts 1981, and Afzal *et al.*, 2005, Germination Uniformity (GU) by Abdolahi *et al.*, 2012, Germination value (GV) by Hasnat *et al.* 2019, and Germination capacity by Kumar 1999 were measured. All the recorded data were analysed statistically using computer package software SPSS ver. 23. Duncan's Multiple Range Test (DMRT) was employed to define the statistical significance and demarcated by different letters in different tables (Table 43 and 44).

**Key Findings:** The study on *Aphanamixis polystachya* demonstrated that seed sown in propagator house provided highest germination percentage (85.71%). Seeds sown in propagator house in controlled environment and sand media showed maximum germination percentage followed by seed treated with normal water at room temperature for 24 hours. After attaining certain height (10 cm) seedlings need to transfer from propagator to polybag with soil and cow dung media to get vigor and maximum seedlings for afforestation and reforestation.

**Key words:** *Aphanamixis polystachya*, propagator house, germination percentage and Initial Growth.

## B. Implementation Status

### 1. Procurement (Component wise):

#### Coordination Component (BARC)

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
<b><u>Year: 2018-19</u></b>					
(a) Office equipment					Procurement completed
1. Laptop computer	1	59,800	1	59,800	
2. Tabloid	1	24,700	1	24,700	
3. Desktop computer	2	1,19,600	2	1,19,600	
4. Digital Camera	1	24,700	3	24,700	
<b>Total</b>		<b>2,28,800</b>		<b>2,28,800</b>	
(b) Lab &field equipment	-	-	-	-	-
(c) Other capital items	-	-	-	-	-

#### Component -1 (BAU-Horticulture, Mymensingh)

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment		106000		105800	100% completed
1. Almirah	1		1		
2. Steel seed rack,	1		1		
3. Executive table	2		2		
4. Visitors chair	1		1		
5. File cabinet	1		1		
6. Executive chair					
(b) Lab &field equipment	2	257000	257000	255250	100% completed
1. Desktop Computer	1				
2. Laser printer,	1				
3. Digital slide calipers	1				
4. Refracto meter,	1				
5. Digital camera	2				
6. Measuring tape,					
7. Sprayer					
(c) Other capital items	-	-	-	-	-

### Component-2 (BFRI)

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment	05	285000	100%	283740	Procurement completed
(b) Lab & field equipment	10	118000	100%	117500	Procurement complete
(c) Other capital items					

### Component-3 (IFESCU)

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
	--	--	--	--	
(b) Lab & field equipment					
1. GPS	1	40000	1	40000	
2. Desktop Computer	1	60000	1	60000	
3. Digital Camera	1	24000	1	24000	
4. Precision Balance	1	28500	1	28500	
5. Measuring Balance (Big)	1	19000	1	19000	
6. Slide Calipers	2	2000	2	2000	
7. Binoculars	1	7500	1	7500	
8. Measuring Tape	2	4800	2	4800	
9. Diameter Tape	2	10000	2	10000	
10. Laser Printer	1	19500	1	19500	
	Sub-total	2,15,300	Sub-total	2,15,300	
(c) Other capital items (Furniture)					
1. Visitor Chair	4	16000	4	16000	
2. Laboratory Table	1	48000	1	48000	
3. Almirah	1	22500	1	22500	
	Sub-total	86500	Sub-total	86500	
	<b>Total</b>	<b>3,01,800</b>		<b>3,01,800</b>	

**2. Establishment/renovation facilities:**

**Coordination Component (BARC)**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target (800000.00)	Achievement (796576.00)	
-	-	-	-	-	
-	-	-	-	-	
-	-	-	-	-	

**Component -1 (BAU-Horticulture, Mymensingh)**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Repair, renovation and maintenance medicinal field and office laboratory	-	-	Repair, renovation and maintenance of medicinal field and office laboratory	100% completed	

**Component-2 (BFRI)**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Repair, renovation and maintenance work of MFPD nursery shed	NA	NA	MFPD Nursery Shed Room Maintenance Works and Drain works	100%	The old nursery shed MFPD has been repaired and the internal drainage system has been improved.
Development of Conservation plots through earth work	NA	NA	Establishment of medicinal plants conservation plot	100%	Development of conservation plots of medicinal plants in the nursery has been achieved.

### Component-3 (IFESCU)

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Propagator House	--	--	01	100%	
Seed Research laboratory	--	--	01	100%	

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

#### Coordination Component (BARC)

Description	Number of participants			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	23	7	30	2 days (26-27/01/2020)	Training on “Medicinal and Aromatic Plants in Bangladesh”
(b) Workshop					
Inception workshop	28	14	42	1 day (05/11/2018)	Some sub-project activities have been changed which is mentioned in this inception report.
1 <sup>st</sup> annual review workshop	26	06	32	1 day (17/09/2020)	The participating organizations formulated the specific information in quantitative terms concerning their intervention.

#### Component -1 (BAU-Horticulture, Mymensingh)

Description	Number of participants			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	53	7	60	Day long (Two times)	100% completed
(b) Workshop	-	-	-	-	-
(c) Others (if any)	-	-	-	-	-

### Component-2 (BFRI)

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	60	08	68	Three trainings have been conducted in three hill districts in three days	Successfully conducted.
(b) Workshop					
(c) Others (if any)					

### Component-3 (IFESCU)

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training-1	7	7	14	01 Day	Certificate given to the participants
(b) Workshop	-	-	-	-	
(c) Others (if any)	-	-	-	-	

### C. Financial and physical progress (Combined & Component wise)

#### Combined

**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	8068971	8058586	8058586	0	100	
b. Field research/lab expenses and supplies	11270789	11180119	11180119	0	99	
c. Operating expenses	1930858	1913524	1913524	0	99	
d. Vehicle hire and fuel, oil & maintenance	1481450	1477230	1477230	0	100	
e. Training/workshop/ seminar etc.	886966	886040	886040	0	100	
f. Publications and printing	1891300	1832335	1832335	0	97	
g. Miscellaneous	338282	337230	337230	0	100	
h. Capital expenses	1292890	1292890	1292890	0	100	
<b>Total</b>	<b>27161506</b>	<b>26977954</b>	<b>26977954</b>	<b>0</b>	<b>99</b>	

**Coordination Component (BARC)**

**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	5020271	5020271	5020271	0	100	
b. Field research/lab expenses and supplies	0	0	0	0	0	
c. Operating expenses	527534	527037	527037	0	100	
d. Vehicle hire and fuel, oil & maintenance	178285	174065	174065	0	98	
e. Training/workshop/ seminar etc.	532726	531800	531800	0	100	
f. Publications and printing	1693300	1690800	1690800	0	100	
g. Miscellaneous	86120	86120	86120	0	100	
h. Capital expenses	228800	228800	228800	0	100	
<b>Total</b>	<b>8,267,036</b>	<b>82,58,893</b>	<b>82,58,893</b>	<b>0</b>	<b>100</b>	

**Component -1 (BAU-Horticulture, Mymensingh)**

**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	1126580	1121580	1121580	0	100	
b. Field research/lab expenses and supplies	3842015	3841715	3841715	0	0	
c. Operating expenses	451900	451900	451900	0	100	
d. Vehicle hire and fuel, oil & maintenance	460465	460465	460465	0	100	
e. Training/workshop/seminar etc.	180800	180800	180800	0	100	
f. Publications and printing	80000	24990	24990	0	31	
g. Miscellaneous	74990	73948	73948	0	99	
h. Capital expenses	361050	361050	361050	0	100	
<b>Total</b>	<b>65,77,800</b>	<b>65,16,448</b>	<b>65,16,448</b>	<b>0</b>	<b>99</b>	

**Component-2 (BFRI)****Fig in Tk**

<b>Items of expenditure/activities</b>	<b>Total approved budget</b>	<b>Fund received</b>	<b>Actual expenditure</b>	<b>Balance/unspent</b>	<b>Physical progress (%)</b>	<b>Reasons for deviation</b>
a. Contractual staff salary	696120	695735	695735	0	100	
b. Field research/lab expenses and supplies	5149475	5148739	5148739	0	100	
c. Operating expenses	512263	512140	512140	0	100	
d. Vehicle hire and fuel, oil & maintenance	437700	437700	437700	0	100	
e. Training/workshop/seminar <i>etc.</i>	90000	90000	90000	0	100	
f. Publications and printing	80000	80000	80000	0	100	
g. Miscellaneous	106472	106462	106462	0	100	
h. Capital expenses	401240	401240	401240	0	100	
<b>Total</b>	<b>7473270</b>	<b>7472016</b>	<b>7472016</b>	<b>0</b>	<b>100</b>	

**Component-3 (IFESCU)****Fig in Tk**

<b>Items of expenditure/activities</b>	<b>Total approved budget</b>	<b>Fund received</b>	<b>Actual expenditure</b>	<b>Balance/unspent</b>	<b>Physical progress (%)</b>	<b>Reasons for deviation</b>
a. Contractual staff salary	1226000	1221000	1221000	0	100	
b. Field research/lab expenses and supplies	2279299	2189665	2189665	0	0	
c. Operating expenses	439161	422447	422447	0	96	
d. Vehicle hire and fuel, oil & maintenance	405000	405000	405000	0	100	
e. Training/workshop/seminar <i>etc.</i>	83440	83440	83440	0	100	
f. Publications and printing	38000	36545	36545	0	96	
g. Miscellaneous	70700	70700	70700	0	100	
h. Capital expenses	301800	301800	301800	0	100	
<b>Total</b>	<b>4843400</b>	<b>4730597</b>	<b>4730597</b>	<b>0</b>	<b>98</b>	

**D. Achievement of Sub-project by objectives: Technology generated/developed:**

**1. Component -1 (BAU-Horticulture, Mymensingh)**

<b>General/specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output (i.e. product obtained, visible, measurable)</b>	<b>Outcome (short term effect of the research)</b>
Multiplication of <i>Terminalia chebula</i> for <i>Ex-situ</i> conservation by enhance seed germination	<ul style="list-style-type: none"> <li>• Collection of matured, uniform and disinfected <i>Terminalia chebula</i> fruits,</li> <li>• Depulped fruits soaked in normal cow dung slurry for six (06) days,</li> <li>• Germination and survival percentage are recorded at 120 DAS.</li> </ul>	In cow dung slurry, higher seedling germination percentage (85.25%) and survival percentage (85.21%) is observed than control 63% and 47.50%, respectively.	Enhanced higher percentage of germination and survival technique of <i>Terminalia chebula</i> seedling

**2. Component-3 (IFESCU)**

<b>General/specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output(i.e. product obtained, visible, measurable)</b>	<b>Outcome (short term effect of the research)</b>
a) Determining the phenology of the selected FGR	Determining the phenology of the seed trees	Assessing the phenophase of the 93 seed trees and tree species	i) Information on the species phenology
b) Studies on the seed biology and standardization of propagation techniques	<ul style="list-style-type: none"> <li>i) Set seed biology experiments with pre-sowing treatments and growing media</li> <li>ii) Collation and analysing the data for identifying the technology</li> </ul>	Develop nursery raising technology for two tree species	Nursery raising technology of selected endangered tree species is found out

## E. Information/knowledge generated/policy generated

### 1. Component -1 (BAU-Horticulture, Mymensingh)

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
Multiplication of medicinal plant	Medicinal plants are propagated	Propagation of <i>T. chebula</i> is developed for rapid multiplication	Good planting materials are available
Conservation of medicinal plant	Conducted survey to Nator, Tangail, Jamalpur, Sherpur and Mymensingh	Conservation of 127 species of medicinal plant	Medicinal plants are conserved at BAU-GPC
Morphological characterization of medicinal plants	Different morphological parameters observed	Characterized 108 species of medicinal plant	Morphological characterization of medicinal plants recorded

### 2. Component -1 (BFRI)

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
i) Collection, identification and characterization of available medicinal plants in Chattogram and CHT (Khagrachari, Rangamati and Bandarban hill districts).	<ul style="list-style-type: none"> <li>Collected and documented 566 medicinal plant specimens from three hill districts through survey. Out of them, 266 plants were found common.</li> </ul>	<ul style="list-style-type: none"> <li>Identified and documented 300 plant species belongs to the 97 families and 228 genera were used for the treatments of 139 different ailments.</li> </ul>	<ul style="list-style-type: none"> <li>Academicians, researchers, policy makers, herbal practitioners, and local tribal people will get the benefits.</li> </ul>
ii) Conservation of medicinal plants at BFRI campus.	<ul style="list-style-type: none"> <li>Propagules of 64 medicinal plants are conserved at germplasm center of BFRI</li> <li>Two mini medicinal plants garden has established at two hill districts with 13 selected priority species and 10000 seedlings were distributed among the herbal practitioners.</li> </ul>	<ul style="list-style-type: none"> <li>Germplasm of 64 species has been conserved at BFRI which will can be used as future genetic resources.</li> </ul>	<ul style="list-style-type: none"> <li>Academicians, researchers, herbal practitioners and local tribal people will get opportunity of using these plants after having saplings from the garden set at BFRI and the scope of further extinction is reduced.</li> </ul>

### 3. Component-3 (IFESCU)

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
Exploration and Identification of endangered forest genetic resources	Identify the endangered tree species (with GPS location) from Wildlife Sanctuary, National Park and biodiversity rich forest reserves	Ninety tree species are studied	<ul style="list-style-type: none"> <li>Information on the threatened FGR</li> <li>GPS location for future seed collection</li> <li>Identify the status (necessity of <i>In situ</i> conservation) of the seed trees</li> </ul>
Establishment of conservation stand	Establish conservation stand of 90 tree species in the IFESCU campus	Conservation stand of native tree species	<i>Ex-situ</i> conservation program
Phenology information	Phenology of 93 tree species are studied	Phenology of 93 tree species are recorded	Academicians, and researchers will get opportunity for further study
Seed biology information	Seed biology of <i>Cryptocarya amygdalina</i> and <i>Aphanamixis polystachya</i> are determined	Seed pre-sowing treatments for about two tree species	Seedling raising techniques develop

### F. Materials Development/Publication made under the Sub-project:

#### 1. Coordination Component (BARC)

Publication	Number of publications		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.		2	<b>Booklet:</b> Conservation of Endangered Forest Genetic Resources and Medicinal plants (বিলুপ্তপ্রায় বনজ কৌলীসম্পদ ও ঔষধী বৃক্ষ সংরক্ষণ) <b>Leaflet:</b> Conservation of Medicinal plants and Endangered Forest Genetic Resources (ঔষধী বৃক্ষ ও বিলুপ্তপ্রায় বনজ কৌলীসম্পদ সংরক্ষণ)
PCR		1	Saifullah, M., Yousuf, M., Jewel, K.N.A., Rahman, M.H., Rahim, M.A,

Publication	Number of publications		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
			M.A., Haider, M.R., Alam, M.S., and Rahman M.M., Hossain, M.K. and Miah, M.D. 2022. Exploration, Identification, Characterization, Multiplication and <i>Ex-situ</i> Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh, Sub-Project Completion Report, Forest Unit, BARC. pp: 1-261.
Videoclip/Populer Article		1	Consevation of Endangered Forest Genetic Resources and Medicinal plants (বিলুপ্তপ্রায় বনজ কৌলীসম্পদ ও ঔষধী বৃক্ষ সংরক্ষণ) Youtube Chennai: Agroforestry Lover
Others Publication a. Books/Training Manuals		2	1. Book title: “Ethnomedicinal Plants of Chattogram Hill Tracts in Bangladesh” 2. Book title: “Endengered Forest Genetic Resources in Bangladesh”

## 2. Component -1 (BAU-Horticulture, Mymensingh)

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.	-	-	-
Journal publication	-	Accepted	Alam, M.A., Rahman, M. H., Rahim, M. A., Hossain, M. M., Saifullah, M. and Jewel, K.N.A. 2022. Enhancing seed germination and seedlings growth of Chebulic myrobalan ( <i>Terminalia chebula</i> Retz.) by soaking duration and sowing time after collection of fruits, Ban. J. of Agric.
Video clip/TV program	-	-	-
News Paper/Popular Article	-	-	-
Other publications, if any	-	-	-

### 3. Component-2 (BFRI)

Publication	Number of publications		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/ flyer etc.	-	-	-
Journal publication	1		An article titled “Ethnomedicinal plant uses of Marma tribe of Kaptai Upazilla, Rangamati, Bangladesh” is submitted to Bangladesh Journal of Forest Science.
Video clip/ TV program	-	Completed	A video clip on the project activity prepared (পার্বত্য এলাকায় ভেষজ চিকিৎসক কর্তৃক ব্যবহৃত ঔষধী বৃক্ষের সংরক্ষণ).
News Paper/Popular Article	-	-	-
Other publications, if any	-	-	-

### 4. Component-3 (IFESCU):

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.			
Journal publication (Published)			<ol style="list-style-type: none"> <li>1. Soma Dey, Mohammed Kamal Hossain and Md. Danesh Miah. 2020. Germination and initial seedlings growth response of <i>Ehretia serrata</i> in different Pre-sowing treatments. International Journal of Forestry, Ecology and Environment, 02(02), 79-86.</li> <li>2. Sumi Akhter, G.N. Tanjina Hasnat &amp; M. K. Hossain. 2020. Phenological traits of recalcitrant seed-bearing trees in Bangladesh. Bangladesh. Journal of Forest Science, 36(1):22-32</li> <li>3. S. Dey, M.K. Hossain and Md. Saifullah. 2020. Germination and seedling growth response of Bhuia gachh (<i>Cryptocarya amygdalina</i> Nees)- a threatened tree species of Bangladesh on different pre-sowing treatments. J. Bangladesh Agriculture, 10(1):79-90.</li> </ol>

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
		<ol style="list-style-type: none"> <li>4. Soma Dey, Mohammed Kamal Hossain, G. N. Tanjina Hasnat, Rajasree Nandi and Md. Saifullah. 2021. Growing media effects on germination and initial growth attributes of <i>Antidesma ghaesembilla</i> seedlings: a native plant species of Bangladesh. MFP News, XXXI (2): 8-16</li> <li>5. Soma Dey, Mohammed Kamal Hossain and Md. Danesh Miah. 2021. Germination and initial growth performance of <i>Aphanamixis polystachya</i> (Wall) parker -a threatened medicinal tree species in Bangladesh". International Journal of Environment, 10(2): 95- 102.</li> <li>6. Azharul Islam, Hong Hao, Mohammed Kamal Hossain and Mahmudur Rahman. 2022. Nursery Growing Media Practice: Impact on Seed Germination and Initial Seedling Development of <i>Hymenodictyon orixensis</i> (Roxb.) Mabblerley - A Vulnerable Native Tree Species, Journal of Forest and Environmental Science, 38(1): 38-47.</li> <li>7. Soma Dey, M.K. Hossain, G. N. Tanjina Hasnat and MD. Danesh Miah. 2020. Comparative growth performance of <i>Uvaria cordata</i>: a woody climber of hill forests of Bangladesh. Bangladesh Journal of Forest Science, 36(2):91-100.</li> </ol>	
Manuscripts (Submitted)		<ol style="list-style-type: none"> <li>1. Hossain, R.R., M.K. Hossain, A. Islam and Md. Danesh Miah. 2020. "Influence of seed treatments and growing media on germination and initial seedling growth of <i>Dysoxylum binectiferum</i> in the nursery" submitted to <b>Iranian journal of plant physiology</b>" on 8th of April 2020.</li> <li>2. A. Islam, R.R. Hossain, M.K. Hossain and Md. Danesh Miah. 2020. Effect of growing media on seed germination and early seedling development of a vulnerable forest tree species in the nursery: <i>Dehassia kurzii</i> king. <b>Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)</b>.</li> <li>3. M. N. Ali and M. K. Hossain. 2021. Assessment of Germination and Initial Growth of Barun (<i>Crateva magna</i> (Lour.) DC.) Seedlings Raised in Different Containers. Submitted to the Journal "IAR Journal of Agriculture Research and Life Science" on 24 July 2021.</li> <li>4. M. Nur Ali, M. K. Hossain and Md. Saifullah. 2021. Bringing back the native rare tree species <i>Ormosia robusta</i> (Roxb.) Baker through improved nursery techniques. MS submitted to the Journal "BJFS"</li> <li>5. M.K. Hossain, Md. Danesh Miah, Md. Akhter Hossain and Md. Saifullah. 2021. Exploration, identification, multiplication, and conservation of rare forest genetic resources in Chittagong University campus, Bangladesh. A <b>book chapter for Springer Nature Book "Plant Genetic Resources Inventory, Collection and Conservation.</b></li> </ol>	

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Video clip/TV program			
News Paper/Popular Article			
Other publications, (Project paper submission)			Nur Ali (Student ID- 14208003)- <b>Effects of containers and growing media on germination and initial growth performance of four native lesser-known tree species of Bangladesh</b>
2 MS in Forestry Thesis submission			1.Fatema Khatun (Student ID- 13208034)- <b>Effects of pre-sowing treatments and growing media on germination and initial seedling growth of 11 native threatened tree species of Bangladesh</b> 2. Soma Dey (Student ID- 13208032)- <b>Seed biology and initial seedling growth performance of eleven threatened tree species of Bangladesh</b>

## G. Description of generated Technology/knowledge/policy

### 1. Component -1 (BAU-Horticulture, Mymensingh)

**Title: Enhance seed germination and seedlings growth of Chebulic myrobalan (*Terminalia chebula* Retz.) by soaking in cowdung slurry**

#### Introduction

Chebulic myrobalan in bengali horitoki (*Terminalia chebula* Retz.) belongs to the family 'Combretaceae' is an important medicinal tree species used for a number of purposes in the Indian sub-continent. It is a medium to large-sized tree distributed throughout the tropical and sub-tropical Asia. In Bangladesh it occurs in the hill forest of Chattogram, Gazipur, Modhupur, Tangail, Mymensingh, Dinajpur and homestead of different districts. This species is widely used in combination with *Terminalia belerica* and *Embllica officinalis* in Triphala which is believed to remove toxins and other undesirable accumulations from body, improve digestion, assimilation and acts as antioxidant. It is used as traditional medicine to cure several ailments such as fever, cough, diarrhoea, gastroenteritis, skin diseases, urinary tract infection, and wound infections. Due to tremendous population pressure, poverty, absence of appropriate government policy and unsustainable utilization of forest resources, the population of this valuable medicinal tree species is declining rapidly. The success of plantation programs largely depends on germination of seeds and growth of seedlings in the nursery.

Poor natural regeneration due to lower rate of seed germination has led to the scarcity of this species in their natural habitat. People don't get interest in raising the seedlings of this species in nursery due to poor germination percentage. Low germination percentage as well as long time requirement is believed due to the hard seed coat and thick fleshy pulp of fruits. Delayed and irregular germination of seeds in the nursery is a serious constraint of efficient nursery management and plantation establishment. Thus a new method to enhance seed germination and growth performance of *Terminalia chebula* Retz is developed where seeds are soaked in cowdung slurry for six days before sowing.

## Description

Optimum matured, uniform and disinfected fruits of *Terminalia chebula Retz* is collected from trees. Fruits are depulped at two ends with sharp knife in such a way that the embryo is not damaged before soaking. Depulped seeds are soaked in normal cow dung slurry for six (06) days. The sandy loamy soils are collected, sieved ( $\leq 3$  mm) and mixed with decomposed cow dung at a ratio of 3:1, after that filled in polybags (12.5 cm  $\times$  15.25 cm). To facilitate aeration and proper drainage, a number of perforations are made in the polybags before filling them with mixed soil. After soaking in cow dung slurry one depulped is sown in each polybag by dibbling method in the germination media with depth of 0.5 cm and then covered the seed with a thin layer of soil. Seeds and seedlings are carefully protected from hot sun, heavy rain, birds, rodent, pest, ants, termites and fungal infection. Watering, weeding and loosening of soil are done regularly to obtain maximum germination and growth of seedlings. Germination percentage is calculated, growth performance and survival percentage are recorded at 120 days after sowing.

**Suitable Area/Location:** The technology is suitable in the area of Bangladesh where nursery of medicinal plants is present. This technology can be practiced in any nursery.

**Benefit of the Technology:** Seedling survival percentage is higher in cowdung slurry (85.21%) than control (47.50%).

**Name and address of author:** (1) Prof. Dr. Md. Habibur Rahman, Dept. of Horticulture, BAU, Mymensingh, Phone: +88 01727735271, E-mail: [mhrahmand3@yahoo.com](mailto:mhrahmand3@yahoo.com); (2) Dr. Md. Saifullah (Coordinator), MD (A&F) & CSO (Forestry) (AC), MRM Division, BARC, Farmgate, Dhaka, Cell: 01712722504, E-mail: [m.saif@barc.gov.bd](mailto:m.saif@barc.gov.bd); (3) Kazi Noor-E-Alam Jewel (Senior Scientific Officer), PBRG Sub-project (Forestry), NATP-2, NRM Division, BARC, Farmgate, Dhaka, Cell: 01819482046, E-mail: [wwwjewel@gmail.com](mailto:wwwjewel@gmail.com).

### i. Effectiveness in Policy Support (if applicable)

The simple technique invented for increasing germination and survival percentage would be conducive in favouring budget allocation for further activity in case of medicinal plants.

## H. Technology/Knowledge generation/Policy Support (as applied)

### 1. Component -1 (BAU-Horticulture, Mymensingh)

- i. Farmers, students, researchers as well as visitors have chance come to know about 120 medicinal conserved at BAU-GPC, Bangladesh Agricultural University, Mymensingh.
- ii. By adopting new technology of propagation farmers easily can multiply some medicinal plants within short time.
- iii. Policymaker may take new initiative to propagate medicinal plants further for future growth.

### 2. Component-2 (BFRI)

#### i. Immediate impact on generated technology (commodity & non-commodity)

The knowledge generated under the sub-project provides immense prospect for conservation and commercial cultivation of medicinal plants in CHTs. The study identified 300 plant species belonging to the 97 families and 228 genera were described by the tribal people of CHT's and used for the treatments of 139 different ailments. Based on these findings a book titled "Ethnomedicinal Plants of Chattogram Hill Tracts,

Bangladesh” is submitted for publication. This book serves as database of ethnomedicinal plant uses of CHTs and will serves the interests of researchers, medical or pharmacological scientists, academia and local people. It will also help providing information regarding rare and endangered medicinal plants to conserve them under *In-situ* or *Ex-situ* conditions. Ultimately it will support in gaining sustainability of ethnomedicinal plants and also increase the plants diversity of CHTs.

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

The information generated under the study may be the driving force for developing more technology in the coming days, in the context of ingredient analysis, pharmacological study, improved propagation techniques for commercial purposed of the top ranking ethnomedicinal plants found in CHTs.

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

Based on the generated technologies on ethnomedicinal plant uses in CHTs by herbal practitioner is able to enhance the productivity of medicinal plants and also income of the local people. Commercial cultivation of priority ethnomedicinal plants will enhance the production of raw materials which will help for savings hard earning foreign currency for importing medicinal plants raw materials for Ayurveda and Unani industry. So technology based productive cultivation method will increase the production of scares ethnomedicinal plants raw materials with increase in farmer’s income.

iv. **Policy Support**

Every year Bangladesh imports huge amount of raw medicinal plants material from the neighboring countries. Government policy support for commercial cultivation of identified potential ethnomedicinal plants is the need of time. It will stimulate the productivity of ethnomedicinal plants of CHTs and enhance income generation of the local people. On the other hand it reduced the existing pressure on natural medicinal plant resources and also enhance the medicinal plants diversity of CHT’s.

### **3. Component-3 (IFESCU)**

i. **Immediate impact on generated technology (commodity & non-commodity)**

The techniques of seed biology and nursery techniques of native tree species are useful for large scale afforestation/reforestation programs by the Forest Department of the country. The SUFAL project of BFD is encouraging in introducing native threatened tree species.

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

The seed biology indicated the appropriate treatment for maximum seed germination and initial seedling growth. This new knowledge may be useful for determining the seed collection time, seed storage, seed pre-sowing treatments and nursery raising techniques of the species. Species growth data may be useful for determining the choice of species in different plantation programs of BFD.

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

Technology transfer to plant growers may identify the productivity of the native tree species and choose the climate resilient native tree species for afforestation/reforestation programs.

iv. **Policy Support**

The findings may be conducive in implementing Forest Policy 2016 and Forestry Master Plan toward future plantation and restoration programs.

**I. Information regarding Desk and Field Monitoring**

**1. Coordination Component (BARC)**

**i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):**

Continually monitored and evaluated by organized meetings, workshops as per activity time frame.

**ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output):**

<b>Date</b>	<b>No. of visit</b>	<b>Name of team visit</b>	<b>Addresses of team visit</b>	<b>Output</b>
01-03-Feb-2019	1	Dr. Sultan Ahammed MD, NRM & Coordinator PBRG Sub-project, NATP-II, BARC  Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC	BFRI, Chattogram	Provided instructions to PI and Co-PI on agroforestry research design
12-13-Feb-2019	2	Dr. Sultan Ahammed MD, NRM & Coordinator PBRG Sub-project, NATP-II, BARC  Dr. Md. Saifullah CSO (Forest) & Associate Coordinator PBRG Sub-project, NATP-II, BARC	BAU- Horticulture, Mymensingh	Observed research activities and give necessary instructions
20-June-2019	3	Dr. Md. Saifullah CSO (Forest) & Associated Coordinator PBRG Sub-project, NATP-2, BARC	BAU- Horticulture, Mymensingh	Observed research activities and gave necessary instructions
16-July-2019	4	Dr. Md. Saifullah CSO (Forest) & Associated Coordinator	BAU- Horticulture, Mymensingh	Observed research activities and

<b>Date</b>	<b>No. of visit</b>	<b>Name of team visit</b>	<b>Addresses of team visit</b>	<b>Output</b>
		PBRG Sub-project, NATP-2, BARC		give necessary instructions
28-30-Sep-2019	5	Dr. Mohammad Yousuf Consultant, PBRG Sub-project, NATP-2, BARC  Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC	BAU-Horticulture, Mymensingh	Observed research activities and give necessary instructions
31-Oct-2019 to 03-Nov-2019	6	Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC		Observed research activities and give necessary instructions
21-24-Dec-2019		Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC	IFESCU, Chattogram	Observed research activities and give necessary instructions
13-Jan-2020	7	Dr. Md. Saifullah CSO (Forest) & Associated Coordinator PBRG Sub-project, NATP-II, BARC	BAU-Horticulture, Mymensingh	Observed research activities and give necessary instructions
17-20-March-2020	8	Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC	BFRI, Chattogram	Observed research activities and give necessary instructions
17-19-March-2020	9	Dr. Mohammad Yousuf Consultant, PBRG Sub-project, NATP-2, BARC	BFRI, Chattogram	Observed research activities and give necessary instructions
28-March-2021	10	Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC	BAU-Horticulture, Mymensingh	Observed research activities and give necessary instructions
16-May-2021	11	Miraj Hossen Program Officer PBRG Sub-project, NATP-2, BARC	BAU-Horticulture, Mymensingh	Observed Budget and SoE
10-Sep-2021	12	Miraj Hossen Program Officer PBRG Sub-project, NATP-2, BARC	BAU-Horticulture, Mymensingh	Taking some Still picture for PCR

<b>Date</b>	<b>No. of visit</b>	<b>Name of team visit</b>	<b>Addresses of team visit</b>	<b>Output</b>
01-02-Dec-2021	13	Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC  Miraj Hossen Program Officer PBRG Sub-project, NATP-2, BARC	BAU- Horticulture, Mymensingh	Observed Video Documentation and Taking some Still picture
05-09-Dec-2021	13	Kazi-Noor-E-Alam Jewel, Senior Scientific Officer PBRG Sub-project (Forest), NATP-II, BARC  Miraj Hossen Program Officer PBRG Sub-project, NATP-2, BARC	BAU- Horticulture, Mymensingh and IFESCU, Chattogram	Observed Video Documentation and Taking some Still picture

## **2. Component -1 (BAU-Horticulture, Mymensingh)**

### **i. Desk Monitoring**

- i. In 2018-19 fiscal year, Dr. Md. Mosharrrof Uddin Molla, Member Director and Dipok mahato, monitoring officer of NATP-2 monitored financial and field work.
- ii. In 2019-20 fiscal year, Dr. Mohammad Yusuf, consultant of PBRG-074 and Kazi Noor-E-Alam Jewel, SSO, BARC visited activities of PBRG-074 (BAU component).
- iii. In 2020-21 fiscal year, Director, Procurement specialist, Assistant manager of NATP-2 visited and gave instruction about procurement and financial management.

### **ii. Field Monitoring**

- i. In 2018-19 fiscal year, Dr. Md. Sultan Ahmed-Coordinator, Dr. Md. Saifullah-Associate Coordinator of PBRG-074 and Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist of NATP-2 visited medicinal plant garden and expressed their satisfaction.
- ii. In 2019-20 fiscal year, Dr. Gowher Rizvy, Honorable Adviser to The Prime Minister, Md. Nasiruzzaman, Secretary, Ministry of Agriculture, Professor Dr. Lutful Hassan, Honorable Vice Chancellor, BAU, Dr. Mohammad Yusuf, consultant of PBRG-074 and other important officials visited conserved medicinal plants in BAU-GPC.
- iii. In 2020-21 fiscal year, Mercy Miyang Tembon, Country Director of World Bank and other higher officials visited conserved medicinal plants of BAU-GPC.
- iv. Dr. Md. Harunur Rashid, Director-NATP-2, Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist and Dr. Md. Abdur Razzaque, Sector Coordinator Extension of NATP-2 and other higher officials visited conserved medicinal plants of BAU-GPC.



**Fig. 62.** Visitors at Medicinal plant garden of BAU-GPC

**iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities:** Seasonal flooding totally destroyed drumstick tree species and partially affected malta, Aonla and beleric tree species in different experimental plots. Weather data are shown in below:

**Table 48.** Monthly weather parameters of the study areas during the year 2018

Weather Parameters	Value	January	February	March	April	May	June	July	August	September	October	November	December
Air pressure (mb)	Max.	1014.1	1016.3	1010.6	1010.2	1007.7	1005.2	999.7	1002.8	1010.0	1013.3	1015.1	1016.0
	Min.	1007.4	1008.4	1003.9	1000.3	999.3	990.3	994.8	994.7	999.6	1006.7	1008.3	1010.1
Air temperature (°C)	Max.	20.3	25.1	28.1	28.2	32.4	32.3	33.3	32.3	31.3	30.4	26.5	22.5
	Min.	12.7	18.1	22.7	22.6	21.4	25.1	27.1	28.0	26.3	23.6	21.2	15.5
Dew point (°C)	Max.	16.0	20.0	24.0	24.0	26.0	27.0	27.0	29.0	27.0	25.0	23.0	19.0
	Min.	8.0	11.0	15.0	20.0	20.0	24.0	25.0	25.0	24.0	20.0	15.0	9.0
Relative humidity (%)	Max.	92.0	93.0	84.0	95.0	92.0	95.0	94.0	92.0	96.0	95.0	91.0	95.0
	Min.	67.0	64.0	62.0	57.0	73.0	78.0	73.0	76.0	73.0	77.0	73.0	71.0
Wind speed (km/h)	Max.	5.6	7.6	11.1	12.1	13.2	13.0	13.8	10.1	13.5	8.6	5.0	3.8
	Min.	0.7	1.0	1.5	1.3	2.8	2.5	2.4	2.7	1.5	1.0	0.9	0.7
Sunshine (h)	Max.	9.0	9.0	9.7	11.1	10.0	9.2	11.3	9.6	10.2	10.1	10.2	9.0
	Min.	0.0	0.0	1.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	3.8	0.0
Pan evaporation (mm)	Max.	2.0	2.5	2.8	2.9	3.1	3.4	3.3	3.3	3.2	2.9	2.7	2.3
	Min.	1.1	1.8	2.0	2.2	2.1	2.6	2.6	2.7	2.6	2.1	1.9	1.4
Water temperature (°C)	Max.	21.3	25.0	28.9	30.0	31.8	33.7	35.4	33.8	33.7	31.9	28.2	22.9
	Min.	16.5	18.7	23.0	24.5	26.3	28.3	29.6	29.7	29.1	26.3	22.7	18.0

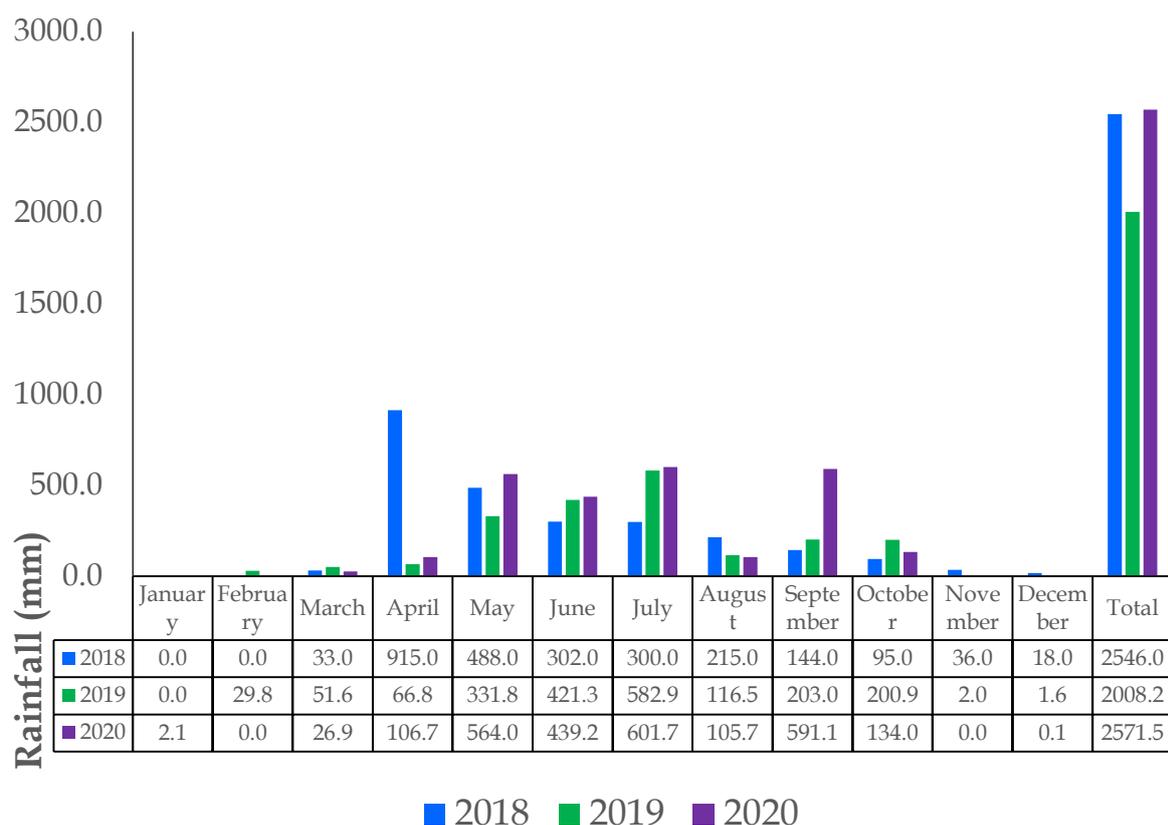
**Table 49.** Monthly weather parameters of study areas during the year 2019

Weather Parameters	Value	January	February	March	April	May	June	July	August	September	October	November	December
Air pressure (mb)	Max.	1017.1	1016.5	1012.9	1009.4	1005.5	1003.8	1001.8	1003.6	1014.1	1011.5	1012.6	1016.0
	Min.	1011.0	1008.2	1006.2	1003.3	999.7	996.4	993.6	992.9	998.7	1006.6	1006.5	1011.8
Air temperature (°C)	Max.	23.2	24.0	27.3	30.5	27.0	32.2	31.8	32.8	32.1	29.2	26.9	30.5
	Min.	17.2	19.4	19.6	21.9	24.3	24.4	25.6	26.6	25.8	22.0	22.4	14.3
Dew point (°C)	Max.	16.0	20.0	22.0	25.0	27.0	27.0	28.0	28.0	28.0	26.0	23.0	17.0
	Min.	10.0	12.0	11.0	2.0	22.0	24.0	24.0	24.0	24.0	20.0	19.0	12.0
Relative humidity (%)	Max.	82.0	89.0	85.0	89.0	94.0	95.0	96.0	89.0	96.0	97.0	96.0	96.0
	Min.	63.0	68.0	62.0	70.0	71.0	74.0	71.0	76.0	77.0	79.0	70.0	73.0
Wind speed (km/h)	Max.	7.2	9.6	13.8	10.4	18.4	10.2	13.8	17.8	11.7	5.6	6.5	7.1
	Min.	0.9	1.1	2.3	1.8	4.4	2.3	2.1	1.5	1.6	1.1	0.7	0.9
Sunshine (h)	Max.	9.0	9.7	9.9	11.0	10.4	11.1	10.6	11.4	9.7	10.2	9.8	9.4
	Min.	4.0	0.1	0.2	1.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Pan evaporation (mm)	Max.	4.3	4.3	6.1	6.0	5.9	5.2	7.3	8.7	7.8	6.7	5.4	3.9
	Min.	0.8	0.3	0.8	0.0	0.0	0.3	0.0	2.0	0.0	0.8	0.1	0.3
Water temperature (°C)	Max.	21.9	24.2	27.8	30.4	30.9	31.5	32.5	32.5	31.0	29.0	32.4	22.2
	Min.	13.8	16.4	17.7	18.0	23.4	24.1	24.5	27.5	24.5	21.5	18.5	13.6

**Table 50.** Monthly weather parameters of study areas during the year 2020

Weather Parameters	Value	January	February	March	April	May	June	July	August	September	October	November	December
Air pressure (mb)	Max.	1017.3	1016.4	1012.2	1010.5	1007	1005	1004.7	1004.2	1006.4	1008	1013.7	1014.4
	Min.	1010.5	1008.5	1005.3	1005.1	996	997.2	997.3	990.6	997	1001.2	1008.5	1010.3
Air temperature (°C)	Max.	27.7	30.3	34	35.7	36.2	36.5	34.6	37.2	36.2	35.6	33	29.1
	Min.	9	9.4	16.1	18	20	33.6	25	26	24	23.5	13	9
Dew point (°C)	Max.	17	18	22	25	27	24	28	28	27	27	25	18
	Min.	11	10	15	19	20	27	26	25	25	24	14	11
Relative humidity (%)	Max.	100	99	99	98	100	97	97	98	99	99	100	100
	Min.	40	29	30	28	47	53	60	55	60	55	38	41
Wind speed (km/h)	Max.	6.32	5.55	8.77	11.11	17.15	10.72	15.31	13.22	10.7	8.95	3.98	2.28
	Min.	0.84	1.27	1.08	3.21	2.86	1.86	1.67	1.9	1.69	0.56	0.56	0.57
Sunshine (h)	Max.	7.6	9.9	10.7	10.6	9.9	11.1	9.6	10.4	10.9	9.8	10.2	9.6
	Min.	0.8	0.1	0.7	0.1	0.5	0.5	0.1	0.4	0.1	2.2	0.5	0.3
Pan evaporation (mm)	Max.	2.7	3.8	99	5.7	6.2	7.9	6.3	7.4	6.4	5.3	4.5	3.4
	Min.	0.6	0.5	2.1	0.5	0.7	0.4	0.5	1	0.4	1	1.4	0.3
Water temperature (°C)	Max.	22.5	21.8	27.5	28.3	31.8	33.3	32	33.5	34.8	32	27.8	22.8
	Min.	13.6	17	20	22	21.7	25.4	27	27	26	24.1	18	14

**Table 51.** Monthly rainfall of the study areas during the year 2018, 2019 and 2020



### 3. Component-2 (BFRI)

#### i. Desk Monitoring:

Reporting type	Submission	Remarks
a. Inception report	Submitted	Accepted
b. Statement of Expenditure (SoE)	Submitted the all the SoE in due time	Accepted
c. Quarterly report (s)	NA	-
d. Half yearly report	Three half yearly report submitted	Accepted
e. Yearly report	Three yearly report submitted	Accepted

#### ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output):

- A two member team leading by Dr. Sultan Ahmmmed, Member Director, NRM Division, Kazi Noor-E-Alam Jewel, Senior Scientific Officer, Bangladesh Agricultural Research Council (BARC) visited field activities at Rangamati on 02-03 February 2019 and participated a group discussion with herbal practitioner. They observed collection of ethnomedicinal plants information's from the *Boiddays* and expressed their satisfaction over collection process.
- A four member team leading by Md. Monirul Islam, Member Director, Fisheries Division; Md. Al Mobasher Hussen, Senior Training Officer; Md. Jashim Uddin Chowdhury, DD (Budget) and Md. Hasan Mahmud, Capacity Development Associate, Bangladesh Agricultural Research Council (BARC) visited Rowanghari, Bandarban on

08 March 2019. The team observed the information collection activities and participated a group discussion with herbal practitioners at Rowangchari Upazilla of Bandarban.

- A four member team visited BFRI on 21 September 2019 and monitoring sub-project activity at BFRI headquarter under the leadership of Dr. M. N. Ali. Sarder, monitoring specialist, PIU, BARC, NATP-2. The other member of the teams are Md. Abdur Rahman Monitoring Associate, Dipok Kumar Monitoring Associate and Md. Hasan Mahmud, Capacity Development Associate PIU, BARC, NATP-2. They have observed the processing of plant specimen for preparation of permanent herbarium sheet, identification of the plants and also collected propagules in rearing center and conservation plots at BFRI. They showed their satisfaction regarding the progress of the activity.
- Dr. Md. Saifullah, Chief Scientific Officer, Forestry Unit, NRM Division, Bangladesh Agricultural Research Council visited BFRI component activities at BFRI, Rangamati and Khagrachari on 18-19 December 2019. He expressed his satisfaction over the BFRI activity and encourage to publish a book on Ethnomedicinal plants of Chattogram Hill Tracts with wide information's.

### iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities

**Table 52:** Weather data of Jamalpur during 2018 to Dec 2020.

Month	Temperature (C)						Avr. RH (%)			Total rainfall (mm)		
	Avr. Max			Avr. Min			2018-19	2019-20	2020	2018-19	2019-20	2020
	2018-19	2019-20	2020	2018-19	2019-20	2020						
February	28.32	27.17	27.80	14.40	14.66	12.08	83.82	76.1	76.20	3.2	22.25	1.75
March	32.94	30.69	30.96	18.49	14.08	16.73	81.25	73.01	73.08	60.95	14.75	16.75
April	33.50	33.20	33.87	21.27	21.43	20.33	79.71	78.92	81.38	219.80	222.75	64.50
May	32.91	36.18	33.60	22.90	16.14	23.02	75.35	77.29	80.93	381.85	256.00	380.25
June	35.60	36.43	34.93	28.43	23.37	24.17	78.44	82.96	82.46	131.13	333.75	252.25
July	34.56	34.27	34.32	24.34	26.41	23.81	79.03	81.84	82.14	242.55	484.25	501.25
August	35.78	36.69	35.17	27.25	27.32	24.43	77.87	78.59	81.31	166.25	149.5	123.00
September	34.77	34.07	33.97	23.97	25.97	26.00	79.79	85.20	84.36	213.30	223.25	531.25
October	32.73	32.30	33.84	24.31	23.16	24.97	78.25	82.12	82.25	44.85	192.25	264.25
November	30.67	30.10	30.20	17.70	18.80	17.20	77.17	81.69	79.17	77.23	7.25	0
December	26.57	24.98	24.93	12.78	12.45	16.46	77.24	79.73	77.01	15.50	0	0
January	21.47	26.43	23.43	10.04	10.89	11.77	81.51	73.49	79.00	0	0	8.75

**Table 53:** Weather data of Sherpur during 2018 to Dec 2020

Month	Temperature (C)						Avr. RH (%)			Total rainfall (mm)		
	Avr. Max			Avr. Min			2018-19	2019-20	2020	2018-19	2019-20	2020
	2018-19	2019-20	2020	2018-19	2019-20	2020						
January	15.32	0	0	26.06	0	0	0	1.12	0	0	35	0
February	16.00	17.03	17.34	24.60	26.28	25.41	0.85	2.53	0.1	24	71	3
March	19.51	20.48	12.00	28.83	29.41	31.29	7.11	3.58	1.96	220.50	111	61
April	30.03	23.23	23.5	30.22	29.46	32.80	19.38	20.60	13.70	601	616	411
May	25.12	26.61	26.93	26.19	33.12	30.96	74.8	36.77	56.45	2318.8	1140	1750
June	28.90	28.43	29.60	21.86	32.56	30.86	16.38	34.67	53.93	491.5	1040.50	1618
July	29.54	27.67	28.64	30.90	31.67	29.8	33.16	69.58	81.58	1028	2157	2529
August	25.70	29.09	29.22	34.48	33.38	34.83	37.06	24.97	19.12	1149	774	593
September	5.76	27.56	28.10	30.00	31.56	32.26	32.90	33.3	67.33	987	999	2020
October	25.64	25.54	28.35	29.09	30.29	34.25	6.25	32.58	24.12	194	1010	748
November	20.10	24.30	22.03	27.20	28.96	29.58	0.5	2.06	00	17	62	00
December	15.93	16.64	14.78	24.38	22.12	25	1.87	0	00	58	0	00

#### 4. Component-3 (IFESCU)

##### i. Desk Monitoring:

Date	Program	Venue	Findings
01.08.2018	Inception Workshop	BARC	
04.11.2018	Inception Workshop	BARC	
17.06.2019	PBRG NATP-2 PID # 074 Monitoring Workshop	BARC	
23.07.2019	PBRG NATP-2 PID # 074, Financial Management Workshop	BARC	
18.11.2019	PBRG NATP-2 PID # 074 Annual Workshop	BARC	
19.02.2020	PBRG NATP-2 PID # 074 Annual Workshop	BARC	

##### ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output):

Date	Visit No.	Name & Designation	Output
13.03.2019		BARC Monitoring Team	Visits the IFESCU seed laboratory, Nursery, Propagator house
03.02.2019		i) Dr. Sultan Ahamad, MD, NRM & Co-ordinator ii) Kazi Jewel, SRO, BARC	Visits the IFESCU seed laboratory, Nursery, Propagator house
27.03.2019			
17.06.2019			



**Fig. 63.** Visitors at Endangered FGR seed bank and conservation plot of IFESCU

**iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities:**  
Not applicable

**J. Sub-project auditing (covers all types of audits performed)**

**1. Coordination Component (BARC)**

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD audited 2018-2019	No objection is raised.	14,08,611.00	Satisfactory	
FAPAD audited 2019-2020	No objection is reported.	15,34,303.00	Satisfactory	
FAPAD audited 2020-21	No objection is reported.	15,20,728.00	Satisfactory	

**2. Component -1 (BAU-Horticulture, Mymensingh)**

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
2018-19	No objection	16,41,478/-	30 December, 2021	No objection
2019-20	No objection	19,00,551/-		
2020-21	No objection	19,83,533/-		
2021-22	Not audited	9,96,161/-		Not audited

**3. Component-2 (BFRI)**

Types of audits (Financial)	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
Financial 2018-19	NA	26,75,625/-	NA	No major deviation was observed
Financial 2019-20	NA	24,61,892/-	NA	No major deviation was observed

Types of audits (Financial)	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
2020-21	NA	17,70,439/-	NA	No major deviation was observed

### 3. Component-3 (IFESCU)

Types of audit	Major observation/issues/objections raised: if any	Amount of Audit (Tk.)	Status at the sub- project end	Remarks
2018-2019	Nil	12,41,458.00	Satisfactory	
2019-2020	Nil	14,25,014.00	Satisfactory	
2020-2021	Nil	14,72,104.00	Satisfactory	

## K. Lessons Learned

### 1. Component -1 (BAU-Horticulture, Mymensingh)

- i) Characterization of medicinal plant may help protection of piracy
- ii) Endangered medicinal plants may be protected through special propagation efforts

### 2. Component-2 (BFRI)

- i) Chattogram Hill Tracts is recognized as biodiversity rich spots of the country and immense reservoir of the ethnomedicinal plants but depleting due to several anthropogenic causes significantly.
- ii) Appropriate measures should be undertaken to reduce the depletion process of biodiversity and potential ethnomedicinal plant resources of CHTs.
- iii) In spite of availability of modern medicine a good number of tribal people still relies on ethnomedicine.
- iv) Traditional knowledge of the herbal practitioner is passing from generation to generation orally, resulting in a massive erosion of such knowledge requiring measures to document this valuable ethnomedicinal plant knowledge for future generations.
- v) Awareness and stimulus program about the potentials of these medicinal plants and knowledge to be taken for continuance among further generations.
- vi) Research should be intensified to conserve the traditional knowledge of herbal practitioners, natural medicinal plant resources of CHTs and pharmacological research to find out the potential drugs.

### 3. Component-3 (IFESCU)

- i) Bangladesh is facing tremendous pressure on her forest resources and forest lands from deforestation and forest degradation.
- ii) Distribution, status and phenology of some endangered tree species including medicinal plants are essential to bringing back the species in *Ex-situ* conservation.

## **L. Challenges (if any)**

### **1. Component -1 (BAU-Horticulture, Mymensingh)**

- i. Due to the COVID-19 pandemic, molecular characterization of medicinal plant germplasm is being delayed.

### **2. Component-2 (BFRI)**

- i) Due to rapid degradation of forest ecosystem in CHTs there is scarcity of water resource particularly in dry seasons. Commercial cultivation of important medicinal plants in CHTs is challenging due to scarcity of water resources.
- ii) Lack of awareness and indiscriminate harvesting is another challenge for ethnomedicinal plants in CHTs.
- iii) Existing socio-political situation of Chattogram Hill Tracts is identified another challenge for implementing exploratory type of research work.

### **3. Component-3 (IFESCU)**

- i) Deforestation and degradation of natural forests caused eroding native Forest Genetic Resources in Bangladesh in an alarming way,
- ii) Exploration and identification of the threatened FGR in different forest ecosystems is an extensive and challenging job,
- iii) Studies in phenology and seed biology needs long term project support,
- iv) Extensive conservation program needs to be taken by the relevant departments/ organizations, *e.g.* Forest Department, Universities, and Botanical Gardens etc.
- v) Research activities disrupted due to COVID-19 pandemic.

## **M. Suggestions for future planning (if any)**

### **1. Coordination Component (BARC)**

- i. Conservation research and development activities should be strengthened through out the country
- ii. Strong linkage should be developed among the NARS, DAE, Agri. University and NGOs for dissemination of the technology
- iii. Conservation research sub-project should be continued at least for five years for better results and recommendations.

### **2. Component -1 (BAU-Horticulture, Mymensingh)**

- i. Need phyto-chemical analysis of medicinal plant.

### **3. Component-2 (BFRI)**

- i. Care should be taken to keep the knowledge alive for future generations and proper management for their conservation and exploration should be continued.

- ii. The medicinal plants having high UV and RFC must be further assessed for phytochemical and pharmacological study to identify their active constituents for potential drug extraction and preparation of novel medicine/drugs.

#### **4. Component-3 (IFESCU)**

- i. Need an extensive assessment of the status of the endangered Forest Genetic Resources in the different forest ecosystems is recommended,
- ii. Further evaluation of the remaining native tree species for seed biology, seedling production protocol and establish conservation stands of the threatened species is recommended.

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## Appendix 01

### Appendix 01. Documented ethno-medicinal plant species from Chattogram Hill Tracts

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
1	<i>Abelmoschus hostilis</i> (Wall. ex Mast.) M.S.Khan & M.S.Hussain	Malvaceae	Kolong raja (Marma)	Herb	Wild	Root	Juice	0.32	0.05	Snake bite, cough, fever, anaemia and insect bite	External
2	<i>Abelmoschus moschatus</i> (L.) Medik.	Malvaceae	Falu Mao wabang (Marma)	Herb	Wild	Seed	Powder	0.30	0.07	Throat sores, Snake bite, fever, anaemia, tonsillitis and insect bites	Oral
3	<i>Abroma augusta</i> (L.) L.fil.	Malvaceae	Gach chala (Chakma)	Shrub	Cultivate, Wild	Whole plant	Juice	0.48	0.12	Paralysis, leucorrhoea, dysmenorrhoea, fever, stomach pain, diabetes and dermatitis	External
4	<i>Achyranthes aspera</i> L.	Amaranthaceae	Abang gach, Uvolengra (Chakma), Chai ka kirlu (Marma), Uktalang garang (Tripura)	Herb	Wild	Whole plant	Powder	0.55	0.12	Rheumatic pain, swellings of the body and hysteria	Oral
5	<i>Acmella oleracea</i> (L.) R.K.Jansen	Asteraceae	Ozon shak (Chakma)	Herb	Wild	Whole plant	Direct	0.48	0.08	Digestive problem, hydrocele and abdominal pain	Oral
6	<i>Acorus calamus</i> L.	Acoraceae	Langyoo, Bospata (Chakma), Langhi, Langyee (Marma), Langhi (Khumi), Laing gach (Tripura)	Herb	Wild	Rhizome	Paste	0.53	0.13	Cold and cough related problems of children and headache	External
7	<i>Actinodaphne angustifolia</i> (Blume) Nees	Lauraceae	Chickrassia (Chakma)	Tree	Wild	Leaf and root	Direct	0.28	0.15	Paralysis, tuberculosis and abnormality	External
8	<i>Actinodaphne obovata</i> (Nees) Blume	Lauraceae	Boro chigirasi (Chakma)	Tree	Wild	Leaf and root	Juice	0.27	0.13	Body pain, headache and eye problems	External
9	<i>Actinostemma tenerum</i> Griff.	Cucurbitaceae	Kangbui (Marma)	Climber	Wild	Flower	Direct	0.28	0.10	Hydrocele, weakness, headache, dysentery, and gastric problem	External
10	<i>Adenia trilobata</i> (Roxb.) Engl.	Passifloraceae	Chokkhe lodi (Chakma)	Climber	Wild	Root	Poultice	0.27	0.12	Boils, hiccup and headache	External

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
11	<i>Adenosma indianum</i> (Lour.) Merr.	Plantaginaceae	Paruk (Marma)	Herb	Wild	Leaf	Paste	0.30	0.05	Asthma, gastric pain, dyspepsia and stomach pain	External
12	<i>Aegle mermelos</i> (L.) Corr.	Rutaceae	Uraikfang (Chakma), Siplaw bofang (Tripura)	Tree	Cultivated	Whole plants	Juice	0.32	0.05	Weakness, constipation, amoebic dysentery, headache and gastric problems	Oral
13	<i>Aerva sanguinolenta</i> (L.) Blume	Amaranthaceae	Rang-gach (Chakma)	Herb	Wild	Leaf	Decoction	0.33	0.05	Piles, bone and joint pain	Oral
14	<i>Agave cantala</i> (Haw.) Roxb.	Asparagaceae	Kaladure (Marma)	Herb	Wild	Leaf	Juice	0.20	0.03	Joint pain, dyspepsia and stomach pain	External
15	<i>Ageratum conyzoides</i> L.	Asteraceae	Moni muijja kher (Chakma), Wichee (Marma), Munpuria (Tripura)	Herb	Wild	Whole plant	Poultice	0.35	0.08	Catarrh, bleeding, headache, bone and joint pain	External
16	<i>Albizia procera</i> (Roxb.) Benth.	Fabaceae	Choipang (Marma), Ghepa (Mogh)	Tree	Wild	Leaf and bark	Juice	0.37	0.05	Insomnia and threadworm	Oral
17	<i>Allium sativum</i> L.	Amaryllidaceae	Ron (Chakma), Krasengpru (Marma)	Herb	Wild	Rhizome	Paste	0.35	0.03	Abdominal and rheumatic pain	Oral
18	<i>Allophylus cobbe</i> var. <i>villosus</i> (Roxb.) Prain	Sapindaceae	Maygransi (Marma)	Shrub	Wild	Leaf	Direct	0.42	0.08	Joint pain, gout and paralysis	External
19	<i>Alocasia acuminata</i> Schott	Araceae	Skhimi (Marma)	Herb	Wild	Rhizome	Poultice	0.20	0.03	Insect bite	External
20	<i>Alocasia cucullata</i> (Lour.) G. Don	Araceae	Bish kochu (Chakma)	Herb	Wild	Whole plant	Direct	0.43	0.07	Tuberculosis, whooping cough and indigestion	Oral
21	<i>Aloe vera</i> (L.) Burm. f.	Asphodelaceae	Grita kanchan, Grita kumari, Musabbar	Herb	Cultivated, Wild	Leaf	Juice	0.23	0.05	Headache	Oral
22	<i>Alpinia calcarata</i> (Haw.) Roscoe	Zingiberaceae	Ketranga puli (Chakma), Padagro, Phuli bang (Marma)	Herb	Wild	Rhizome	Decoction	0.23	0.05	Digestive problems	Oral
23	<i>Alpinia conchigera</i> Griff.	Zingiberaceae	Pada gru (Marma)	Herb	Wild	Rhizome	Juice	0.47	0.20	Gastric	Oral
24	<i>Alpinia nigra</i> (Gaertn.) Burt	Zingiberaceae	Tara (Chakma)	Herb	Wild	Rhizome	Direct	0.40	0.07	Diabetes, rheumatism and liver problem	Oral
25	<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	Sensa (Chakma), Chuinui pang, Chai lang (Marma), Chetoyang (Tripura), Chenchana gaith (Tanchangy)	Tree	Wild	Bark	Powder	0.47	0.18	Joint pain, dysentery, fever and earache	External

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
26	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Kanta marish (Chakma)	Herb	Wild	Root	Juice	0.50	0.22	Fever	Oral
27	<i>Amomum aromaticum</i> Roxb.	Zinziberaceae	Kheranga (Chakma)	Herb	Cultivated	Rhizome	Juice	0.43	0.07	Gastric and vomiting	Oral
28	<i>Amomum corynostachicum</i> Wall.	Zingiberaceae	Diyotara (Chakma)	Herb	Wild	Rhizome	Juice	0.3	0.05	Rheumatic pain, gastric pain and abdominal pain	Oral
29	<i>Ampelgynomum salarkhanii</i> Hassan	Polygonaceae	Tara tabah (Marma), Koccha komra (Tripura)	Herb	Wild	Root	Paste	0.40	0.05	Weakness and poisonous snake bite	Oral
30	<i>Angiopteris evecta</i> (G.Forst.) Hoffm.	Marattiaceae	Ariboo (Tanchangya)	Herb	Wild	Rhizome	Direct	0.42	0.10	Knee or bone pain	External
31	<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	Jarbo aring shing (Chakma), Domfao (Marma), Shipri gach (Tripura)	Herb	Wild	Whole plant	Direct	0.43	0.08	Satanophobia	Oral
32	<i>Anogeissus acuminata</i> (Roxb. ex DC.) Guillaum. & Perr.	Combretaceae	Samankhuun (Marma)	Tree	Wild	Leaf	Juice	0.50	0.10	Dysentery, anemia and toothache	Oral
33	<i>Antidesma ghaesembilla</i> Gaertn.	Euphorbiaceae	Gang prejang gach, Prejam (Chakma)	Shrub	Wild	Leaf	Juice	0.37	0.07	Urinary problems	Oral
34	<i>Antidesma montanum</i> Blume var. <i>salicinum</i> (Ridl.) P. Hoffm.	Euphorbiaceae	Gang pera janh (Chakma)	Shrub	Wild	Leaf and stem	Juice	0.40	0.10	Liver problem	Oral
35	<i>Antidesma velutinsum</i> Blume.	Euphorbiaceae	Chuney chunna perajang (Chakma)	Shrub	Wild	Leaf	Decoction	0.33	0.05	Dysentery, mental disorder	External
36	<i>Ardisia humilis</i> Thw.	Myrsinaceae	Dekadeling (Khumu)	Shrub	Wild	Leaf	Juice	0.35	0.05	Head louse	External
37	<i>Argyreia capitiformis</i> (Poir.) Ooststr.	Convolvulaceae	Hada turing (Chakma), Anuway khujeya (Marma)	Climber	Wild	Leaf	Direct	0.30	0.05	Bone fracture and hair growth	External
38	<i>Argyreia nervosa</i> (Burnf.) Boj.	Convolvulaceae	Bistak, Buth turing (Chakma)	Climber	Wild	Leaf and fruit	Juice	0.27	0.03	Men's sexual problem	Oral
39	<i>Argyreia splendens</i> (Roxb.) Sweet.	Convolvulaceae	Rupar ludi (Chakma)	Climber	Wild	Leaf	Paste	0.47	0.07	Headache	External
40	<i>Aristolochia indica</i> L.	Aristolochiaceae	Tajiya ludi (Chakma)	Climber	Cultivated	Leaves	Juice	0.3	0.05	Asthma, constipation, gastric tumour, muscular rheumatism and stomachache	Oral

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41	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Chui matha (Marma)	Climber	Wild	Rhizome	Juice	0.40	0.07	Anthrax disease of cow	Oral
42	<i>Asplenium simonsianum</i> Hook.	Aspleniaceae	Am kuruth (Chakma)	Fern	Wild	Petiole	Juice	0.3	0.05	Diarrhea and gastric problem	Oral
43	<i>Ayapana triplinervis</i> (Vahl.) R. King & H. Robinson	Asteraceae		Herb	Wild	Leaf	Paste	0.53	0.08	Insect bite and rheumatism	External
44	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Neem (Chakma), Tamakha (Marma)	Tree	Cultivated	Bark and leaves	Juice	0.88	0.37	Gastric ulcer, skin problem and liver disorder	Oral
45	<i>Baliospermum solanifolium</i> (Burm. f.) Suresh	Euphorbiaceae	Shovan phul (Chakma)	Herb	Wild	Root and bark	Powder	0.52	0.08	Enlarged spleen	Oral
46	<i>Barleria lupulina</i> Lindl.	Acanthaceae	Hanuman parbat gach (Chakma)	Shrub	Wild	Leaf	Juice	0.55	0.10	Boils	Oral
47	<i>Barleria prionitis</i> L.	Acanthaceae	Kural gach, Bisallah koroni (Chakma), Khung busu (Tripura)	Shrub	Cultivated	Whole plant	Direct	0.58	0.07	Bleeding, poisonous insect stings, fever and whooping cough	External
48	<i>Bauhinia scandens</i> L.	Caesalpiniaceae	Kesing sima pata (Tanchangya)	Climber	Wild	Leaf	Direct	0.43	0.05	Swellings problem	External
49	<i>Begonia barbata</i> Wall. ex A. DC.	Begoniaceae	Silkhullam (Tanchangya)	Herb	Wild	Whole plant	Juice	0.37	0.08	Abdominal pain	Oral
50	<i>Begonia roxburghii</i> (Miq.) A. DC.	Begoniaceae	Khor tetui (Chakma)	Herb	Wild	Whole plant	Paste	0.63	0.15	Throat pain and tounge infections of infants	External
51	<i>Belamcanda chinensis</i> Leman.	Iridaceae	Chandraketu (Chakma)	Herb	Wild	Leaf and root	Powder	0.40	0.05	Gastric problem and dysmenorrhea	Oral
52	<i>Blumea balsamifera</i> (DC.)	Asteraceae	Seratagun gach (Marma), Charafudung (Chakma)	Shrub	Wild	Leaf	Powder	0.37	0.08	Stomach pain	Oral
53	<i>Blumea membranacea</i> Wall. ex DC.	Asteraceae	Kala- ambus (Chakma)	Herb	Wild	Whole plant	Direct	0.40	0.05	Satanophobia	External
54	<i>Blumea virens</i> Wall ex DC.	Asteraceae	Kalo ambush (Chakma)/ Marma/Tripura/Tanc	Herb	Wild	Leaf	Juice	0.60	0.10	Headache, body-pain and eye-problems	External
55	<i>Boehmeria glomerulifera</i> Miq.	Urticaceae	woathoe (Tripura)	Herb	Wild	Leaf	Poultice	0.37	0.05	Epilepsy	External
56	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	Pryonoa (Marma)	Herb	Wild	Stem, roots and leaves	Juice	0.3	0.05	Cough, dysentery and asthma	Oral

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57	<i>Boesenbergia longiflora</i> O. Kuntze	Zingiberaceae	Chil ada (Chakma)	Herb	Wild	Rhizome	Juice	0.33	0.07	Digestive problem (Indigestion) and gastritis	Oral
58	<i>Bridelia retusa</i> (L.) A. Juss.	Euphorbiaceae	Faima (Marma)	Tree	Wild	Root	Juice	0.38	0.05	Seasonal cough and fever, shutika disease of the women	Oral
59	<i>Buddleja asiatica</i> Lour.	Buddlejaceae	Lulanga, Dhub tora (Chakma), Chikon tora (Marma)	Shrub	Wild	Leaf	Direct	0.28	0.10	Pneumonia and satanophobia	External
60	<i>Byttneria pilosa</i> Roxb.	Sterculiaceae	Choloyang mrong (Marma)	Shrub	Wild	Whole plant	Direct	0.40	0.07	Bone fracture and hair growth	External
61	<i>Caesalpinia hymenocarpa</i> (Prain) Hattink	Caesalpiniaceae	Bagho adra ludi (Chakma)	Shrub	Wild	Stem	Juice	0.47	0.07	Red eye (Itching and allergy)	External
62	<i>Cajanus cajan</i> (L.) Millsp.	Fabaceae	Domorsumi gach, Arol pata (Chakma), Fangkhung bang, Orol pata (Marma, Cocabi (Tripura)	Shrub	Cultivated	Leaf	Juice	0.62	0.10	Asthma, stop vomiting, intestinal worms, gastric problem and cough	Oral
63	<i>Calliandra umbrosa</i> (Wall.) Benth.	Mimosaceae	Sayuon (Marma)	Herb	Wild	Root and leaf	Paste	0.47	0.03	Piles	External
64	<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	Aur gach (Chakma)	Shrub	Wild	Whole plant	Decoction	0.65	0.10	Relief pain and cough problems of children	Oral
65	<i>Campanumoea lancifolia</i> (Roxb.) Meer.	Campanulaceae	Bisoma (tanchangya)	Herb	Wild	Leaf	Juice	0.57	0.05	Hum or chicken fox	External
66	<i>Canavalia ensiformis</i> (L.) DC.	Fabaceae	Pithanang (Marma)	Climber	Wild	Seed	Direct	0.60	0.08	Body burning, breast pain, gallstone and pain	Oral
67	<i>Cardiospermum halicacabum</i> L.	Sapindaceae	Kheta foxsa ludi (Chakma)	Climber	Wild	Whole plant	Decoction	0.70	0.10	Chicken pox, blood dysentery, indigestion, conjunctivitis and insomnia	Oral
68	<i>Celosia argentea</i> L.	Amaranthaceae	Phul morich, Chutti marish (Chakma), Maringmeda, Soo non (Marma)	Herb	Cultivated, Wild	whole plant	Juice	0.40	0.05	Hiccup	Oral
69	<i>Celosia cristata</i> L.	Amaranthaceae	Radha chula phul (Chakma), Cram pang gach (Marma), Khongacha (Tripura)	Herb	Cultivated, Wild	Leaf, root and flower	Juice	0.32	0.07	Nasal bleeding, irregular menstruation, piles, abdominal pain, sore and body swollen	Oral

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70	<i>Centella asiatica</i> L.	Apiaceae	Minmini (Chakma)	Herb	Cultivate, Wild	Whole plant	Direct	0.67	0.10	Vomiting and diarrhea of children, blood dysentery, insomnia, digestion problem and conjunctivitis.	Oral
71	<i>Cheilocostus speciosus</i> (J. Koenig) C. Specht	Costaceae	Khedogi (Chakma)	Herb	Cultivated	Rhizomes and leaves	Decoction	0.3	0.05	Stomachache, evil spirit and paralysis	Oral
72	<i>Christella dentata</i> (Forssk.) Brownsey & Jermy	Thelypteridaceae	Kyak graygadok (Marma)	Herb	Wild	Whole plant	Decoction	0.33	0.05	Weakness	Oral
73	<i>Chromolaena odorata</i> (L.) King & Robinson	Asteraceae	Oila (Khumi)	Herb	Wild	Leaf, stem and flower	Juice	0.3	0.05	Cough and gastric problem	Oral
74	<i>Cissus adnata</i> Roxb.	Vitaceae	Lori-sibang (Tanchangya)	Climber	Wild	Leaf	Juice	0.30	0.07	Stomach pain due to gas formation	Oral
75	<i>Cissus javana</i> DC.	Vitaceae	Lal hoilla (Chakma)	Climber	Wild	Whole plant	Juice	0.60	0.05	Sexual infertility, constipation and ulcer	Oral
76	<i>Cissus repens</i> Lamk.	Vitaceae	Oarong khaen (Marma)	Climber	Wild	Leaf	Direct	0.27	0.07	Jaundice	Oral
77	<i>Citrus maxima</i> (Burm. f.) Merr.	Rutaceae	Kondal pada (Chakma)	Tree	Cultivated	Fruits	Juice	0.25	0.05	Stone from urinary tract	Oral
78	<i>Clausena anisata</i> (Willd.) Hook. f. Benth.	Rutaceae	Sadiraichha (Chakma)	Tree	Wild	Whole plant	Decoction	0.23	0.07	Satanophobia	Oral
79	<i>Clerodendrum chinense</i> (Osbeck) Mabberley	Verbenaceae	Clea shak (Chakma)	Shrub	Wild	Leaf	Paste	0.27	0.05	Rheumatic pain	External
80	<i>Clerodendrum indicum</i> (L.) O. Kuntze.	Verbenaceae	Nuli gach, Bhég gach (Chakma), Sibreacha gach (Marma)	Shrub	Wild	Leaf, root and stem	Powder	0.65	0.10	Fever, cough, rheumatic pain and nose bleeding	Oral
81	<i>Clerodendrum viscosum</i> Vent.	Verbenaceae	Khumchhe (Marma)	Shrub	Wild	Leaf	Juice	0.70	0.18	Abdominal pain, cancer, fever, hysteria and mental disorder	Oral
82	<i>Clerodendrum wallichii</i> Merr.	Verbenaceae	Male thong, Keyamusi (Chakma), Tara tabo gach (Marma), Terateba (Khumi and Tripura)	Shrub	Wild	Leaf and root	Direct	0.47	0.07	Fever and skin allergy	External
83	<i>Coccinia grandis</i> (L.) Voigt.	Cucurbitaceae	Paranga shak, Ludi iswarmuli (Chakma)	Herb	Cultivated, Wild	Leaf	Direct	0.28	0.08	Diabetes	Oral

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84	<i>Combretum ternatum</i> (Wall. ex Clarke) O. Lecompte	Combretaceae	Tinthup peya (Chakma)	Climber	Wild	Stem	Juice	0.28	0.03	Uterus problem	Oral
85	<i>Commelina bengalensis</i> L.	Commelinaceae	Khemia her (Chakma)	Herb	Wild	Leaf	Juice	0.22	0.05	Infant malnutrition	Oral
86	<i>Conyza semipinnatifida</i> Wall. ex DC.	Asteraceae	Fyoichi (Marma)	Herb	Wild	Leaf	Paste	0.25	0.03	Boils	External
87	<i>Crateva magna</i> (Lour.) DC.	Capparaceae	Kain thak (Marma), Puru modab shok (Tripura)	Tree	Wild	Stem and bark	Paste	0.53	0.08	Joint pain or rheumatic pain	External
88	<i>Crinum latifolium</i> L.	Liliaceae	Tongkrasui (Marma)	Herb	Wild	Root	Juice	0.62	0.10	Abdominal pain and rheumatic pain	Oral
89	<i>Crotolaria acicularis</i> Buch.-Ham. ex Benth. & Hook.	Fabaceae	Bormajol (Chakma)	Herb	Wild	Whole plant	Juice	0.58	0.08	Boils and headache	External
90	<i>Croton lobatus</i> L.	Euphorbiaceae	Nariaingachip (Marma)	Herb	Wild	Leaf	Decoction	0.25	0.05	Boils in children	Oral
91	<i>Curculigo orchiioides</i> Gaertn.	Hydroxylaceae	Charabindu (Tanchangya)	Shrub	Wild	Leaf	Paste	0.47	0.07	Lesion	External
92	<i>Curcuma amada</i> Roxb.	Zingiberaceae	Aam ada, Aam halud (Chakma)	Herb	Wild	Rhizome	Direct	0.23	0.05	Gastric	Oral
93	<i>Curcuma longa</i> (L.)	Zingiberaceae	Nahnu (Marma)	Herb	Cultivated	Rhizome	Direct	0.60	0.08	Diarrhea, dysentery and skin disease	Oral
94	<i>Curcuma rubescens</i> Roxb.	Zingiberaceae	Holka (Chakma)	Herb	Wild	Rhizome	direct	0.33	0.05	abdominal problem	Oral
95	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Tarulata (Chakma), Jirgo nuya (Marma), Ching oh sak (Tanchangya)	Climber	Wild	Whole plant	Juice	0.43	0.05	Jaundice and anthelmintic	Oral
96	<i>Cyathula prostrata</i> (L.) Blume	Amaranthaceae		Herb	Wild	Root	Juice	0.47	0.05	Gastric problem	Oral
97	<i>Cycas pectinata</i> Griff.	Cycadaceae	Maniray phul (Chakma)	Tree	Wild	Flower	Poultice	0.20	0.05	Bites by snakes/spider/poisonous insects	External
98	<i>Cyclea barbata</i> Miers.	Menispermaceae	Tuwang-noyee (Marma), Suchphul (Chakma)	Climber	Wild	Whole plant	Decoction	0.47	0.07	Retraction of uterus	Oral

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99	<i>Cymbidium aloifolium</i> (L.) Sw.	Orchidaceae	Handori hulogugo (Chakma), Kandori phulgach (Marma), Khelenthu (Tripura)	Herb	Cultivate, Wild	Leaf	Decoction	0.57	0.05	Joint pain, fever and boils	External
100	<i>Cymbopogon citratus</i> (DC.) Stapf.	Poaceae	Dhan sabrang, Shon sabrang (Chakma), Piangriesa, Chabanglang (Marma), Maibana (Tripura)	Herb	Cultivate, Wild	Rhizome	Juice	0.52	0.08	Cough and nasal congestion	Oral
101	<i>Cyperus rotundus</i> L.	Cyperaceae	Da-salik (Tanchangya)	Herb	Wild	Whole plant	Juice	0.18	0.05	Dry cough	Oral
102	<i>Dalbergia volubilis</i> Roxb.	Fabaceae	Danduaphal (Chakma), Chema khlung chong (Marma)	shrub	Wild	Leaf and bark	Powder	0.37	0.05	Toothache and sore throat	Oral
103	<i>Datura metel</i> L.	Solanaceae	Dhutura phulgach, Kala dhutura (Chakma), Dutra gach (Marma).	Herb	Cultivate, Wild	Leaf and fruit	Decoction	0.38	0.07	Headache	External
104	<i>Dendrobium aphyllum</i> (Roxb.) Fischer	Orchidaceae	Fasia mach (Chakma)	Climber	Wild	Leaf	Paste	0.40	0.07	Deformed head structure of newly born children	External
105	<i>Dendrocnide sinuata</i> (Blume) Chew.	Urticaceae	Mainjain (Marma)	Shrub	Wild	Leaf	Juice	0.52	0.08	Appendicitis pain	Oral
106	<i>Desmodium gangeticum</i> (L.) DC.	Fabaceae	Belailemu (Tanchangya)	Shrub	Wild	Root	Direct	0.42	0.05	Asthma	External
107	<i>Desmodium triflorum</i> (L.) DC.	Fabaceae	Bormajal (Marma)	Herb	Cultivated	Whole plants	Decoction	0.3	0.05	Stomachache and tuberculosis	Oral
108	<i>Desmodium triquetrum</i> (L.) DC.	Fabaceae	Kingmring (Marma)	Shrub	Cultivate, Wild	Whole plant	Direct	0.68	0.20	Fistula/ piles, blood pressure and general weakness	Oral
109	<i>Dioscorea bulbifera</i> L.	Dioscoreaceae	Thanda manik (Chakma), Ta su dhui (Marma)	Climber	Wild	Tuber	Juice	0.43	0.05	Enlarged spleen	Oral
110	<i>Dioscorea glabra</i> Roxb.	Dioscoreaceae	Kyamro ching (Marma)	Climber	Wild	Whole plant	Direct	0.45	0.05	Diabetes	Oral
111	<i>Diplazium esculentum</i> (Retz.) Sw.	Athyriaceae	Dengishak (Tanchngya)	Herb	Wild	Whole plant	Juice	0.48	0.05	Reaction of drug and allergy	Oral

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112	<i>Dracaena spicata</i> Roxb.	Agavaceae	Kodurthang gach, Sanai pata gach (Chakma)	Shrub	Wild	Whole plant	Direct	0.23	0.05	Satanophobia	External
113	<i>Dracaena trifasciata</i> Prain.	Agavaceae	Kasabang (Chakma)	Herb	Wild	Leaf	Juice	0.25	0.05	Ear inflammation	Oral
114	<i>Drymoglossum piloselloides</i> (L.) Presl.	Polypodiaceae		Herb	Wild	Whole plant	Direct	0.47	0.10	Swollen knee	External
115	<i>Eclipta alba</i> L. Hassk.	Asteraceae	Kalasona (Chakma)	Herb	Wild	Whole plants	Paste	0.23	0.07	Urinary problem	External
116	<i>Eichhornia crassipes</i> (Mart.) Solms.	Pontederiaceae	Khugukti (Chakma)/ Kuchurc (Marma)	Herb	Wild	Whole plant	Powder	0.27	0.05	Catarrh sores	External
117	<i>Elatostema papillosum</i> Wedd.	Urticaceae	Shil asar (Chakma), Chichobang (Marma)	Herb	Wild	Leaf	Direct	0.38	0.03	Pneumonia and satanophobia	External
118	<i>Elusine indica</i> (L.) Gaertn.	Poaceae	Goradube kher (Chakma)	Herb	Wild	Whole plant	Juice	0.55	0.07	Liquorrhea	Oral
119	<i>Entada rheedii</i> Spring.	Mimosaceae	Gila ludi (Chakma)	Climber	Wild	Leaf and fruit	Direct	0.58	0.03	Skin disease and satanophobia	External
120	<i>Equisetum diffusum</i> D. Don	Equisetaceae	Pinlacha (Marma), Acala (Khumi), Shachuri (Tripura)	Herb	Wild	Stem	Paste	0.62	0.08	Muscle stiffness and bleeding from vein cutting	External
121	<i>Equisetum ramosissimum</i> Desf.	Equisetaceae	Rossa crassa (Marma)	Herb	Wild	Stem and tuber	Direct	0.60	0.05	Fractured bone and abdominal tumour	External
122	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Kanphul gach (Chakama), Saima mungye (Marma), Dutta kher (Tripura)	Herb	Wild	Leaf and stem	Direct	0.52	0.05	Breast problem and piles	Oral
123	<i>Euphorbia neriifolia</i> L.	Euphorbiaceae	Shib gach (Chakma).	Shrub	Wild	Leaf, stem and root	Juice	0.70	0.10	Snake bite, bronchitis, tumour, piles, anal fistula and cough	External
124	<i>Eurya acuminata</i> DC.	Theaceae	Keya apang (Marma)	Shrub	Wild	Leaf	Juice	0.20	0.03	Skin disease	External
125	<i>Fagerlindia fasciculata</i> (Roxb.) Trirvent.	Rubiaceae	Mankanta (Chakma)	Shrub	Wild	Leaf and stem	Decoction	0.3	0.05	Body pain, headache and problem in eye vision	Oral
126	<i>Ficus hirta</i> Vahl	Moraceae	Reng mang gadu (Chakma)	Tree	Cultivated, Wild	Leaf	Direct	0.22	0.07	Satanophobia	Oral
127	<i>Ficus hispida</i> (L.) f.	Moraceae	Khanaung (Marma)	Tree	Wild	Leaf	Paste	0.38	0.08	Gastric problem	Oral
128	<i>Ficus pumila</i> L.	Moraceae	Soro sarbo loti (Chakma)	Climber	Wild	Stem	Decoction	0.18	0.08	Toothache	External

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129	<i>Flemingia macrophylla</i> (Willd.) O. Kuntze ex Mirr.	Fabaceae	Kludongba (Marma)	Climber	Wild	Stem	Paste	0.20	0.05	Polio	External
130	<i>Flemingia stricta</i> Roxb.	Fabaceae	Yamamana (Marma)	Shrub	Wild	Leaf	Paste	0.37	0.07	Lesion	External
131	<i>Flemingia strobilifera</i> (L.) R.	Fabaceae	Asarna (Tanchangya)	Herb	Wild	Leaf	Paste	0.20	0.05	Joint pain	External
132	<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	Phyllanthaceae	Repapok (Marma)	shrub	Wild	Root	Juice	0.45	0.07	Burning eye problem	Oral
133	<i>Gmelina arborea</i> Roxb.	Lamiaceae	Gamber (Chakma)	Tree	Wild	Leaves and barks	Powder	0.3	0.05	Abdominal pain, foot mud sore, hook worm infestation, liver disease and scabies	Oral
134	<i>Gomphandra tetrandra</i> (Wall.) Sleum.	Stemonuraceae	Dekkho(Khumi)Chakho ba (Maram)	Shrub	Wild	Root	Juice	0.27	0.07	Indigestion	External
135	<i>Grewia nervosa</i> (Lour.) Panigr.	Tiliaceae		Tree	Wild	Leaf	Paste	0.37	0.07	Fracture and hair growth	External
136	<i>Grewia serrulata</i> DC.	Tiliaceae	Torbang (Marma)	Shrub	Wild	Leaf	Direct	0.38	0.05	Rheumatism and satanophobia	External
137	<i>Gymnopetalum cochinchinensis</i> (Lour.) Kurz.	Cucurbitaceae	Nurekhog (Marma)	Climber	Wild	Stem and leaf	Direct	0.20	0.03	Diabetes	Oral
138	<i>Gynura nepalensis</i> DC.	Asteraceae	Dhup bei shak (Chakma)	Herb	Wild	Leaf	Paste	0.50	0.13	Boils	External
139	<i>Gynura pseudo-china</i> (L.) DC.	Asteraceae	Mring seba (Marma)	Herb	Cultivate, Wild	Leaf	Juice	0.67	0.08	Snake bite, stop vomiting, intestinal worms and gastric problem	Oral
140	<i>Hedyotis scandens</i> Roxb.	Rubiaceae	Ban pui sak (Chakma), Jarbo pui shak (Marma), Anwaichi (Khumi)	Herb	Wild	Leaf	Paste	0.18	0.05	Insect bites	External
141	<i>Heliotropium indicum</i> L.	Boraginaceae	Saimagri (Marma)	Herb	Wild	Leaf	Direct	0.72	0.15	Injured muscle, dropsy, dyspepsia and abdominal pain	External
142	<i>Hellenia speciosa</i> (J. Koenig) S. R. Dutta	Costaceae	kraitonboi (Marma)	Herb	Wild	Rhizome	Juice	0.32	0.07	Ear infection	Oral
143	<i>Helminthostachys zeylanica</i> (L.) Hook.	Ophioglossaceae	Soymaisha (Chakma)	Fern	Wild	Whole plants	Decoction	0.3	0.05	Leucorrhoea	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
144	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Rakta joba (Chakma), Paini gach (Marma), Khunag sak (Tripura)	Shrub	Cultivate, Wild	Leaf	Paste	0.23	0.05	Boils	External
145	<i>Hibiscus surattensis</i> L.	Malvaceae	Pungru mra (Marma)	Shrub	Wild	Leaf	Juice	0.30	0.05	Itching	Oral
146	<i>Holarrhena antidysenterica</i> (L.) R.Br.	Apocynaceae	Lakthu (Marma)	Tree	Cultivate, Wild	Bark	Juice	0.73	0.10	Diarrhea, hookworm infection, abdominal pain, threadworm infestation, sore in mouth, gastric ulcer and hyperacidity	Oral
147	<i>Homalomena aromatica</i> (Spreng.) Schott.	Araceae	Chikon sak (Chakma)	Herb	Wild	Whole plant	Paste	0.18	0.03	Piles	External
148	<i>Hoya parasitica</i> (Roxb.) Wall. ex Wight	Apocynaceae	Nathoyong (Khumi)	Climber	Wild	Leaf	Direct	0.20	0.03	Hydrocele	External
149	<i>Hymenodictyon orixensis</i> (Roxb.) Mabb.	Rubiaceae	Chuung paing craw (Marma)	Shrub	Cultivate, Wild	Leaf	Juice	0.50	0.07	Snake bite	External
150	<i>Ichnocarpus frutescens</i> (L.) W.T.Aiton	Apocynaceae	Langibkhe nuyee (Marma)	Shrub	Wild	Leaf	Juice	0.53	0.07	Bleeding or haemorrhage	Oral
151	<i>Imperata latifolia</i> (Hook. f.) L. Liu	Poaceae		Herb	Wild	Root	Juice	0.23	0.03	Burning urination	Oral
152	<i>Ixora cuneifolia</i> Roxb.	Rubiaceae	Bakdari (Marma)	Shrub	Cultivate, Wild	Leaf	Juice	0.20	0.03	Irregular menstruation	Oral
153	<i>Ixora nigricans</i> R. Br. ex Wight & Arn.	Rubiaceae	Kyahmochui (Marma)	Shrub	Wild	Leaf	Juice	0.33	0.05	Diarrhea	Oral
154	<i>Jasminum sambac</i> (L.) Ait.	Oleaceae	Kyaklung pai (Marma), Ludi maloti (Chakma)	Shrub	Cultivated	Leaf and stem	Decoction	0.67	0.08	Fever, fracture, headachae and abdominal pain	Oral
155	<i>Jasminum scandens</i> Vahl.	Oleaceae	Nacheraung (Marma)	Shrub	Cultivate, Wild	Whole plant	Juice	0.50	0.07	Paralysis, increase sexual capacity and insect bites	Oral
156	<i>Jatropha curcas</i> L.	Euphorbiaceae	Mura pru (Marma)	Shrub	Wild	Stem	Powder	0.18	0.03	Toothache	External
157	<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Ranga bhedal gach (Chakma), Karachuni (Marma), Liablkamchi (Khumi), Lal- verenda (Tripura)	Shrub	Wild	Leaf and root	Direct	0.33	0.05	Piles/ fistula and hydrocele	External
158	<i>Justicia adhatoda</i> L.	Acanthaceae	Shin Mang gree (Marma)	Shrub	Cultivate, Wild	Leaf	Juice	0.60	0.12	Cough, blood pressure, general weakness and fever disease	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
159	<i>Justicia gendarussa</i> Burm. f.	Acanthaceae	Mohajam (Tanchangya)	Shrub	Wild	Leaf	Direct	0.33	0.05	Itching	External
160	<i>Kalanchoe lecinia</i> (L.) Pers.	Crassulaceae	Geos, Roah-kapanghey (Chakma), Rokkapang bang (Marma), Naproking (Khumi), Geos (Tripura)	Herb	Cultivate, Wild	Leaf	Juice	0.67	0.10	Kidney problem, male infertility, cough, burn problem, headache and asthma	Oral
161	<i>Lapisanthes senegalensis</i> (Poir.) Leeuh	Sapinadiceae	Craw kudung (Marma)	Shrub	Wild	Whole plant	Direct	0.25	0.03	Leucorrhoea	Oral
162	<i>Leea aequata</i> L.	Leeaceae	Tintatia pata (Tanchamgya)	Shrub	Wild	Leaf	Powder	0.35	0.05	Boils and carbuncles	External
163	<i>Leea indica</i> Merr.	Leeaceae	Dhup haskura gach (Chakma), Kra, Ait gach (Marma)	Shrub	Wild	Leaf and root	Juice	0.37	0.05	Jaundice and liver problem	Oral
164	<i>Lepisanthes tetraphylla</i> (Vahl) Radlk.	Sapindaceae	Thomocho (Marma)	Tree	Wild	Root	Juice	0.22	0.03	Body pain	Oral
165	<i>Leucas zeylanica</i> (L.) R. Br.	Lamiaceae	Gassa dagor (Chakma), Paichungcha (Marma), Achasutang (Khumi), Khun (Tripura)	Herb	Wild	Leaf and flower	Juice	0.67	0.25	Mental disease, black fever and headache	External
166	<i>Lippia alba</i> (Mill.) N.E.Br. ex Britton & P. Wilson	Verbenaceae	Kolakonopaw (Khumi)	Shrub	Wild	Leaf	Decoction	0.25	0.03	Skin disease	Oral
167	<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	Lauraceae	Menda bukur (Tripura)	Tree	Cultivate, Wild	Bark	Juice	0.60	0.10	Diarrhea, gastric, wound healing and liver diseases	Oral
168	<i>Litsea laeta</i> Wall. ex Nees	Lauraceae	Chabuchaw(khumi)	Shrub	Wild	Leaf	Decoction	0.27	0.03	Eczema disease	Oral
169	<i>Litsea monopetala</i> (Roxb.) pers.	Lauraceae	Moner moto gach (Chakma)	Tree	Wild	Leaf	Juice	0.28	0.03	Rheumatic pain	External
170	<i>Lygodium altum</i> (Clarke) V. A. V. R.	Lygodiaceae	Ashpada gach, Bara bandar tola (Chakma), Akhayadong, Miaumakla (Marma), Kolomboi (Khumi), Mukhratala (Tripura)	Herb	Wild	Whole plant	Direct	0.50	0.07	Swellness of leg, headache and senseless problem	External
171	<i>Lygodium flexuosum</i> (L.) Sw.	Lygodiaceae	Banolata (Tanchangya)	Herb	Wild	Leaf	Juice	0.65	0.05	Measles, chicken pox, chest pain and mental disorder	External

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
172	<i>Maesa indica</i> Wall.	Myrsinaceae	Ludi salak sara (Chakma), Thah mong shu (Marma), Dikyannng (Khumi), Balai (Tripur)	Shrub	Wild	Whole plant	Juice	0.63	0.10	Fever, headache and dizziness of mother	Oral
173	<i>Maesa ramentacea</i> (Roxb.) A. DC.	Myrsinaceae	Laccha sibeng gach (Chakma), Mesa dai (Marma)	Tree	Wild	Leaf	Direct	0.67	0.10	Pneumonia, tetanus, evil spirit, hysteria and satanophobia	External
174	<i>Mallotus tetracoccus</i> (Roxb.) Kurz	Euphorbiaceae	Monjungbora (Chakma), Moin bura (Marma)	Tree	Wild	Leaf	Poultice	0.20	0.03	Fractured bone	External
175	<i>Mangifera indica</i> L.	Anacardiaceae	Aam gach (Chakma), Sarasi gach (Marma). Aam gaith (Tanchangya)	Tree	Wild	Leaf, bark and fruit	Juice	0.70	0.10	Jaundice, fever, toothache, dysentery, urinary discharge, vomiting and diarrhea	Oral
176	<i>Maranta arundinacea</i> L.	Marantaceae	Siksa dery (Chakma)	Herb	Wild	Rhizome	Direct	0.23	0.03	Cough problem	Oral
177	<i>Melastoma melabathricum</i> L.	Melastomaceae	Kongkoine (Marma)	Shrub	Wild	Leaf and root	Paste	0.68	0.27	Boils, gynecological complexity, snake bite, dysentery, sore problem, toothache, epilepsy and small pox	External
178	<i>Melia azadirach</i> L.	Meliaceae	Sadi raissya (Chakma), Agoroi (Marma)	Tree	Cultivated	Leaf and root	Juice	0.33	0.05	Drug-addiction and diarrhea	Oral
179	<i>Merremia umbellata</i> (L.) Hallier f.	Convolvulaceae	Khut toring (Chakma), Toino luru lata (marma), Apheajong (Khumi), Bangphenophu (Tripura)	Climber	Wild	Leaf, stem and flower	Paste	0.37	0.05	Fractured bone and rheumatic pain	External
180	<i>Merremia vitifolia</i> (Burm.) Hallier f.	Convolvulaceae	Thoring ludi (Chakma)	Climber	Wild	Leaf and root	Decoction	0.23	0.03	lesion	External
181	<i>Mesua ferrea</i> L.	Clusiaceae		Tree	Cultivated	Flower	Juice	0.70	0.10	Irregular menstruation, abdominal pain, boils and itching	Oral
182	<i>Micromelum minutum</i> (G.Forster) Wight & Arn.	Rutaceae	Sadirissa (Chakma), Pukhong cheyinga, Tong paifru (Marma)	Tree	Wild	Leaf	Powder	0.43	0.05	Tooth decay	External
183	<i>Mikania cordata</i> (Burm. f.) Robinson	Asteraceae	Assam ludi (Chakma), Rifuzi nuiyee Moi dui nuiyee (Marma), Bainyachu (Khumi),	Herb	Wild	Leaf	Juice	0.43	0.05	Haemorrhage	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
			Rajjamara (Tripura), Assamlata (Tanchangya)								
184	<i>Mimosa pudica</i> L.	Mimosaceae	Hrapaing (Marma)	Herb	Wild	Whole plant	Paste	0.60	0.08	Swollen area of the body	External
185	<i>Molineria recurvata</i> (Dryand.) Herb.	Hypoxidaceae	Oilay (Marma)	Herb	Wild	Root	Juice	0.63	0.08	Bleeding, insomnia, tumour and bone dislocation	External
186	<i>Momordica cochichinensis</i> (Lour.) Spreng	Cucurbitaceae	Bonkakrol (Chakma)	Herb	Wild	Fruit	Direct	0.25	0.03	Indigestion and stomach pain due to gastritis	Oral
187	<i>Morinda angustifolia</i> Roxb.	Rubiaceae	Chak show (Marma)	Tree	Wild	Bark	Paste	0.67	0.08	Fractured bone, breast pain, gallstone and earachae	External
188	<i>Morinda citrifolia</i> L.	Rubiaceae	Ronch gach (Chakma), Rimi owa rih (Marma)	Shrub	Wild	Leaf, bark and root	Juice	0.57	0.08	Jaundice, irregular menstruation and anal herpes	Oral
189	<i>Morinda persicaefolia</i> Ham.	Rubiaceae	Keyttok gach (Chakma)	Shrub	Wild	Root	Juice	0.33	0.03	Jaundice	Oral
190	<i>Moringa oleifera</i> Lamk.	Moringaceae	Sejnashak (Chakma), Daing tho rai (Marma), Sechena bofang (Tripura)	Tree	Wild	Leaf and bark	Juice	0.68	0.10	High blood pressure, Rheumatic pain, cold, cough and headache	Oral
191	<i>Mucuna pruriens</i> (L.) DC.	Fabaceae	Khuruk ludi (Chakma), Nuifasey (Marma), Liquajong (Khumi), Bamphe (Tripura)	Climber	Wild	Leaf	Poultice	0.53	0.08	Bone-facture, abscess and lymphoedema	External
192	<i>Murrya paniculata</i> (L.) Jack.	Rutaceae	Kamini phu gachl (Chakma)	Tree	Cultivated	Leaf	Direct	0.32	0.05	Toothache	Oral
193	<i>Mussaenda roxburghii</i> Hook. f.	Rubiaceae	Tuacha (Khumi)	Shrub	Wild	Leaf	Juice	0.27	0.05	Head louse	External
194	<i>Myxopyrum smilacifolium</i> (Wall.) Blume	Oleaceae	Ludi karpur (Chakma)	Shrub	Wild	Leaf and stem	Paste	0.20	0.03	Neck pain	External
195	<i>Naravelia zeylanica</i> (L.) DC.	Ranunculaceae	Ludi changra morich (Chakma)	Climber	Wild	Leaf	Juice	0.23	0.03	Gastric problem	External
196	<i>Nelsonia canescens</i> (Lamk.) Spreng.	Acanthaceae	Gondri (Tripura)	Herb	Wild	Stem	Juice	0.38	0.03	Asthma	Oral
197	<i>Neolamarckia cadamba</i> (Roxb.) Brosser.	Rubiaceae	Kadom phul (Chakma). Mou bang, Rang khi	Tree	Cultivated, Wild	Leaf	Juice	0.23	0.03	Enlarged liver	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
			(Marma), Kadam gach (Tripura)								
198	<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Shinguru phul (Chakma), Pafui gach (Marma), Sibalika (Tripura)	Tree	Cultivated	Leaf	Juice	0.47	0.07	Black fever and malaria	Oral
199	<i>Ocimum africanum</i> Lour.	Lamiaceae	Sabarang (Chakma), Hnung pohrak (Marma), Romba (Tripura)	Shrub	Cultivated, Wild	Leaf	Decoction	0.43	0.05	Paralysis and skin diseases	Oral
200	<i>Ocimum americanum</i> L.	Lamiaceae	Midey gula pata, Kobi sabrang (Chakma), Alofang, Mrungbai (Marma)	Herb	Wild	Whole plant	Decoction	0.43	0.05	Satanophobia and abdominal pain of infants	Oral
201	<i>Ocimum gratissimum</i> L.	Lamiaceae	Kalo tulshi (Chakma)	Shrub	Cultivated, Wild	Leaf	Juice	0.53	0.08	Burning urination, cold and cough	Oral
202	<i>Ocimum tenuiflorum</i> L.	Lamiaceae	Sabrarang (Chakma)	Shrub	Wild	Leaf	Direct	0.40	0.05	Fever and cough	Oral
203	<i>Ophiorrhiza trichocarpa</i> Blume	Rubiaceae	Jadiphull (Tonchangya)	Herb	Wild	Leaf	Juice	0.37	0.05	Measles and chicken pox	External
204	<i>Opuntia dillenii</i> (Ker.-Gawl.) Haw.	Cactaceae	Jeogonj lawa (Marma)	Shrub	Wild	Leaf	Juice	0.18	0.03	Asthma	Oral
205	<i>Oroxylum indicum</i> (L.) Vent	Bignoniaceae	Khona gula gach (Chakma), Taita (Marma), Taokharong bofang (Tripura)	Tree	Cultivated, Wild	Bark	Decoction	0.33	0.08	Jaundice	Oral
206	<i>Paederia foetida</i> L.	Rubiaceae	Padabaj ludi (Chakma), Khebang way (Marma)	Climber	Wild	Leaf	Decoction	0.60	0.07	Rheumatism and stomach disorder	Oral
207	<i>Passiflora foetida</i> L.	Passifloraceae	Pakgula (Chakma)	Herb	Cultivated	Laeves, roots and fruits	Paste	0.3	0.05	Ringworm and menopause	Oral
208	<i>Peperomia pallucida</i> (L.) H. B. & K.	Piperaceae	Hangara giluk shak (Chakma), Fopang pang Marma), Chasherrow (Tripura)	Herb	Wild	Leaf and stem	Paste	0.72	0.10	Snake bite, allergy, urinary infection, boils, headache, eczema and eye inflammation	External
209	<i>Pericampylus glaucus</i> (Lamk.) Merr.	Menispermaceae	Khobbuchheho (Marma)	Climber	Wild	Leaf	Poultice	0.47	0.07	Polio	External

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
210	<i>Persicaria hydropiper</i> (L.) Spach	Polygonaceae	Bish Katali (Chakma), Oak tong (Marma), Achakachu (Khumi), Sathimacho (Tripura)	Herb	Wild	Whole plant	Direct	0.58	0.08	Lesion, allergy, itching, boils and joint pain	External
211	<i>Phaulopsis imbricata</i> (Forssk.) Sweet.	Acanthaceae	Krakhripang, Mring meda (Marma)	Herb	Wild	Whole plant	Powder	0.25	0.03	Hair fall	External
212	<i>Phlogacanthus curviflorus</i> Nees	Acanthaceae	Mormojja gach (Chakma)	Shrub	Wild	Leaf	Powder	0.20	0.03	Syphilis	External
213	<i>Phyllanthus amarus</i> Schum.	Euphorbiaceae	Bamuri bangha kher (Chakma), Oshagni, Grukhrri (Marma), Sikangkhlou (Khumi), Louko amlai (Tripura)	Herb	Wild	Root	Juice	0.42	0.05	Tetanus of neonatal	Oral
214	<i>Phyllanthus officinalis</i> Gaertn.	Euphorbiaceae	Chachabang (Marma)	Tree	Cultivated	Fruit	Direct	0.57	0.05	Fever and cough	Oral
215	<i>Phyllanthus reticulatus</i> Pour.	Euphorbiaceae	Sobochi (Marma)	Shrub	Wild	Root	Paste	0.18	0.03	Toothache	External
216	<i>Phyllanthus urinaria</i> L.	Euphorbiaceae	Bauri bagha her (Chakma)	Herb	Wild	Root	Juice	0.20	0.03	Urinary problem	Oral
217	<i>Physalis minima</i> L.	Solanaceae	Pholaopa (Marma)	Herb	Wild	Leaf and stem	Paste	0.42	0.05	Gynecological complexity	External
218	<i>Piper longum</i> L.	Piperaceae	Panpur ludi (Chakma)	Herb	Cultivated	Leaf	Decoction	0.42	0.05	Body pain	Oral
219	<i>Piper nigrum</i> L.	Piperaceae	Golmorich (Chakma)	Climber	Cultivated	Leaf	Direct	0.42	0.05	Cold and cough	Oral
220	<i>Plectranthus apoensis</i> (Elmer) H.Keng	Lamiaceae	Gorbo horin sing (Chakma)	Herb	Wild	Whole plant	Juice	0.20	0.03	Tetanus	Oral
221	<i>Plumbago indica</i> L.	Plumbaginaceae	Aguni tita (Chakma), Aguni tida, Kiang khao (Marma), Agunitida (Tripura)	Herb	Wild	Bark and leaf	Decoction	0.68	0.07	Hidden fever, cough, acidity and paralysis	Oral
222	<i>Plumbago zeylanica</i> L.	Plumbaginaceae	Agune tita, Kadsibang (Chakma), Kain kwak, Sighe (Marma)	Herb	Cultivated, Wild	Leaf	Juice	0.40	0.05	Satanophobia, piles or fistula	Oral
223	<i>Plumeria rubra</i> L.	Apocynaceae	Anggara gach (Chakma), Anggra bang	Tree	Wild	Bark	Juice	0.73	0.10	Anemia, burning sensation of the body, facial paralysis,	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
			(Marma), Gulchi (Tripura)							bone fracture, jaundice, piles and asthma	
224	<i>Pogostemon parviflorus</i> Benth.	Lamiaceae	Grain chon (Marma)	Shrub	Wild	Leaf	Juice	0.37	0.05	Infant asthma, hardening the breast of the mother	Oral
225	<i>Polygala chinensis</i> L.	Polygalaceae	Angmana (Marma)	Herb	Wild	Leaf	Juice	0.18	0.03	Jaundice	Oral
226	<i>Portulaca grandiflora</i> Hook.	Portulacaceae	Taratjil shak (Tanchangya)	Herb	Wild	Whole plant	Paste	0.22	0.03	Urinary problem	External
227	<i>Pouzolzia zeylanica</i> (L.) Benn.	Urticaceae	Bath sak (Chakma)	Herb	Wild	Leaf	Juice	0.45	0.07	Measles and chicken pox	External
228	<i>Premna esculenta</i> Roxb.	Verbenaceae	Lelom pada (Chakma), Kamarah (Marma), Ankungna (Khumi), Arai (Tripura)	Shrub	Wild	Leaf and bark	Paste	0.67	0.10	Fever, headache, abdominal pain, scorpion stings, blister, high blood pressure and respiratory problems	External
229	<i>Prismatomeris tetrandra</i> Roxb.	Rubiaceae	Falumao wabang (Marma)	Herb	Wild	Seed	Paste	0.35	0.03	Throat sores	Oral
230	<i>Pseuderanthemum carruthersii</i> (Seem.) Guillaumin	Pseudoeranthemaceae	Srichanda, Gollackchanda (Tanchangya)	Herb	Wild	Root	Paste	0.40	0.07	Satanophobia, snake and poisonous insect bites	Oral
231	<i>Pseudoelephantopus spicatus</i> (B. Juss. ex Aubl.)	Asteraceae	Abang khey (Tanchangya)	Shrub	Wild	Leaf	Powder	0.33	0.05	Skin diseases	External
232	<i>Psychotria adenophylla</i> Wall.	Rubiaceae	Achakamnu (Khumi)	Shrub	Wild	Root	Juice	0.30	0.03	Indigestive problems	External
233	<i>Pteris semipinnata</i> L.	Pteridaceae	Boidda nath (Chakma)	Herb	Wild	Rhizome and leaf	Juice	0.45	0.07	Diarrhea and constipation in children	Oral
234	<i>Pueraria tuberosa</i> (Roxb. ex Willd.) DC.	Fabaceae	Yang thrih (marma)	Climber	Wild	Leaf	Juice	0.18	0.03	Bleeding	Oral
235	<i>Quisqualis indica</i> L.	Combretaceae	Tuli lota, Ro-woala pailang bang (Chakma)	Climber	Wild	Leaf	Direct	0.22	0.03	Liver diseases	External
236	<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz.	Apocynaceae	Gach pitta (Chakma)	Shrub	Cultivated, Wild	Root, leaf and flower	Decoction	0.70	0.08	Hypertension, insanity, constipation, cough and hysteria	Oral
237	<i>Rhaphidophora grandis</i> Schott.	Araceae	Surchan (Chakma), Bhomaraja (Marma), Mahaga (Khumi), Khungchak (Tripura)	Herb	Wild	Whole plant	Direct	0.23	0.03	Burning urination	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
238	<i>Rhaphidophora hongkongensis</i> Schott	Araceae	Chondroketu (Chakma)	Herb	Wild	Whole plant	Juice	0.20	0.03	Satanophobia	Oral
239	<i>Rhaphidophora hookeri</i> Schott.	Araceae	Gach pitta ludi (Chakma)	Climber	Wild	Whole plant	Paste	0.25	0.03	Headache	External
240	<i>Ricinus communis</i> L.	Euphorbiaceae	Bedul gach, Boro Bherol (Chakma), Crakchu, Anglo gach Kasu (Marma), Letao (Tripura)	Shrub	Wild	Leaf	Decoction	0.62	0.08	Piles, anal fistula and rheumatic pain	External
241	<i>Rubus hexagynus</i> Roxb.	Rosaceae	Hada asanga ludi (Chakma)	Climber	Wild	Leaf and stem	Paste	0.27	0.05	Bone fracture	External
242	<i>Rubus moluccanus</i> L.	Rosaceae	Hada shoal (Chakma)	Shrub	Wild	Stem and fruits	Powder	0.3	0.05	Diabetes and jaundice	Oral
243	<i>Rungia pectinata</i> (L.) Nees.	Acanthaceae	Kala sona (Tanchangya)	Herb	Wild	Leaf	Juice	0.30	0.03	Measles and chicken pox	External
244	<i>Saraca asoca</i> (Roxb.) de Willd.	Caesalpiniaceae	Prajok (Marma)	Tree	Wild	Bark and flower	Decoction	0.3	0.05	Dysmenorrhoea and leucorrhoea	Oral
245	<i>Sarcochlamys pulcherrima</i> Gaudich.	Urticaceae	Orstrua (Chakma), Missa Bang (Marma)	Tree	Wild	Leaf	Direct	0.30	0.03	Throat problem	Oral
246	<i>Schefflera elliptica</i> (Blume) Harms.	Araliaceae	Amuki-khai (Marma)	Shrub	Wild	Leaf	Direct	0.73	0.10	Swelling problem, diabetic, dysentery, asthma and cancer	External
247	<i>Schumannianthus dichotomus</i> Roxb.	Marantaceae	Jank (Chakma)	Shrub	Cultivated	Stem	Powder	0.32	0.05	Tumour problem	Oral
248	<i>Scleria terrestris</i> (L.) Fassett	Cyperaceae	Meekhabrai (Marma)	Herb	Wild	Root	Juice	0.28	0.05	Leukemia	Oral
249	<i>Scoparia dulcis</i> L.	Scrophulariaceae	Mosala kher, Fuji kher (Chakma), To-ganja, Young boi pru (Marma)	Herb	Wild	Leaf and root	Paste	0.80	0.30	Haemorrhage, diarrhea, dysentery, fever, cough, bronchitis, toothache, breast pain, abdominal pain and ear pain	External
250	<i>Scurrula gracilifolia</i> (Roxb. ex Schult)	Loranthaceae	Keyabong (Marma)	Shrub	Wild	Leaf	Direct	0.20	0.03	Paralysis	External
251	<i>Selaginella repanda</i> Desv.	Selaginaceae	Silbuti (Tanchangya)	Herb	Wild	Leaf	Juice	0.20	0.03	Injury problem	External
252	<i>Senna alata</i> (L.) Roxb	Caesalpiniaceae	Dattalong gach (Chakma), Pouchibang (Marma), Khach,	Shrub	Wild	Leaf and flower	Paste	0.22	0.07	Eczema	External

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
			kochakbalai (Tripura), Ciklaikinga (Khumi)								
253	<i>Senna hirsuta</i> (L.) Irwin & Barneby	Caesalpiniaceae	Bar ketrnga, Jed ketrang (Chakma), Mring chi, Paing sang paing (Marma) Muitopi (Tripura), Puikaocha (Khumi)	Shrub	Wild	Leaf	Poultice	0.37	0.05	Snake bite and purify blood	External
254	<i>Senna tora</i> (L.) Roxb.	Caesalpiniaceae	Dangki (Marma)	Shrub	Wild	Leaf	Juice	0.40	0.07	Insomnia	Oral
255	<i>Sida rhombifolia</i> L.	Malvaceae	Prodolulang (Chakma), Preduang lulang (Marma), Belbliharm (Tripura)	Herb	Wild	Whole plant	Direct	0.63	0.05	Remittent fever, sores, abscess, general weekness and large boils	Oral
256	<i>Smilax glabra</i> Wall. ex Roxb.	Smilacaceae	Kumuchho ludi (Chakma)	Climber	Wild	Leaf	Powder	0.20	0.03	Haemorrhage	External
257	<i>Smilax perfoliata</i> Lour.	Smilacaceae	Angwajjong (Khumi)	Climber	Cultivated	Root	Direct	0.3	0.05	skin diseases	External
258	<i>Solanum lasiocarpum</i> Dunal	Solanaceae	Chanka du (Marma)	Herb	Wild	Root	Juice	0.63	0.05	Irregular menstruation, stop vomiting, intestinal worms and gastric problem	Oral
259	<i>Solanum torvum</i> Swartz.	Solanaceae	Bigal biji (Chakma), Kharaing (Marma), Empaithai (Khumi), Khankha (Tripura)	Shrub	Wild	Leaf and root	Juice	0.43	0.05	Haemorrhage of women after child birth	Oral
260	<i>Sonchus wightianus</i> DC.	Asteraceae	Bosh-mula (Chakma), Prema (Marma)	Herb	Wild	Root	Paste	0.58	0.07	Diabetes	Oral
261	<i>Sphagneticola trilobata</i> (L.) A. S. Hitch	Asteraceae	Bhimraj (Chakma)	Herb	Wild	Whole plant	Decoction	0.25	0.03	Hypertension	External
262	<i>Spilanthes calva</i> DC.	Asteraceae	Chang hang foik (Chakma), Hang foik, Hang fui (Marma)	Herb	Wild	Whole plants	Paste	0.42	0.07	Swollen knee pain and epilepsy	External
263	<i>Staurogyne argentea</i> Wall	Acanthaceae	Rmbung (Marma)	Herb	Wild	Leaf	Decoction	0.25	0.03	Bone pain	Oral
264	<i>Stemona tuberosa</i> Lour.	Stemonaceae	Ukun dudura (Chakma)	Climber	Cultivated, Wild	Root	Direct	0.20	0.03	Cold problem	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
265	<i>Stephania japonica</i> (Thumb.) Miers.	Menispermaceae	Khumi (Marma)	Climber	Wild	Root	Paste	0.67	0.08	Irregular menstruation of women, constipation and anal fistula	External
266	<i>Sterculia villosa</i> Roxb. ex Smith	Sterculiaceae	Deudal (Marma), Ural gach, Sowbang (Marma), Lambak (Tripur)	Tree	Wild	Leaf	Juice	0.53	0.08	Burning urination	Oral
267	<i>Steriospermum colais</i> (Buch.-Ham. ex Dillw.) Mabberley	Bignoniaceae	Sekwai (Chakma), Saing sek pang (Marma)	Tree	Wild	Bark	Powder	0.23	0.03	Intestinal worm anthelmintic	Oral
268	<i>Streblus asper</i> Lour.	Moraceae	Serbo gach (Chakma), Oney bang, Unghari gach (Marma), Sarbo gach (Tripura)	Tree	Wild	Bark and leaf	Decoction	0.57	0.10	Urinary problem	Oral
269	<i>Suregada multiflora</i> (A. Juss.) Baill	Euphorbiaceae	Chasesii, Shamlock chari gach (Chakma), Fa choin da (Marma)	Tree	Wild	Leaf, bark and root	Juice	0.58	0.10	swollen testicles, pneumonia, fever, sore and stomach troubles	Oral
270	<i>Swintonia floribunda</i> Griff.	Anacardiaceae	Dhupsruti (Tanchangya)	Tree	Wild	Leaf	Paste	0.23	0.03	Postpartum recovery	External
271	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Hanphui (Marma), Atangsa (Chakma)	Herb	Wild	Leaf	Paste	0.33	0.05	Allergy	External
272	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Jam gach (Chakma), Sochi tobri (Marma)	Tree	Wild	Bark	Decoction	0.48	0.08	Jaundice and dysentery	Oral
273	<i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem & Schult.	Apocynaceae	Tashuru (Marma)	Shrub	Wild	Whole plant	Juice	0.75	0.10	Hooping cough, chicken pox, healing wounds and asthma	Oral
274	<i>Tabernaemontana recurva</i> Roxb.	Apocynaceae	Sungchung touring (Chakma)	Shrub	Cultivated, Wild	Leaf	Direct	0.22	0.03	Snake bite	External
275	<i>Tacca integrifolia</i> Ker-Gawl.	Taccaceae	Ketikucchan (Tanchangya)	Herb	Wild	Rhizome	Decoction	0.30	0.07	Skin disease like itching, scabies etc.	External
276	<i>Tamarindus indica</i> L.	Caesalpinaceae	Tetul gach (Chakma), Mohoisipang (Marma), Arang katra (Tripura)	Tree	Wild	Fruit	Juice	0.27	0.05	Blood pressure	Oral
277	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wt. & Arn.	Combretaceae	Arjun gach (Chakma)	Tree	Wild	Fruit and bark	Decoction	0.42	0.07	Heart diseases and white leukorrhea	Oral

Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
278	<i>Terminalia chebula</i> Retz.Obs.	Combretaceae	Ajubang (Marma)	Tree	Wild	Fruits	Powder	0.87	0.38	Jaundice, anorexia, eye diseases, hysteria and weakness	Oral
279	<i>Tetracera sarmentosa</i> (L.) Vahl. Subsp. <i>andamanica</i> (Hoogl.) Hoogse	Dilleniaceae	Challa ludi, Ulu ludi (Chakma)	Shrub	Wild	Leaf	Juice	0.58	0.08	Body pain, headache and problem in vision	External
280	<i>Tetrastigma leucostaphyllum</i> (Dennst.) Alston ex Mabb.	Vitaceae	Danelang sak (Tanchangya)	Climber	Wild	Leaf	Direct	0.27	0.05	Leg fracture	External
281	<i>Thladiantha cordifolia</i> (Blume) Cogn.	Cucurbitaceae	Shijok shak (Chakma)	Climber	Wild	Leaf	Decoction	0.58	0.10	Vomiting	Oral
282	<i>Thunbergia grandiflora</i> (Roxb. ex Rottler) Roxb.	Acanthaceae	Del ludi (Chakma)	Climber	Wild	Stem	Juice	0.73	0.27	Conjunctivitis (eye problem), eczema and constipation	External
283	<i>Tinospora cordifolia</i> (Willd.) Hook. f.	Menispermaceae	Geol ludi (Chakma)	Climber	Wild	Stem and root	Juice	0.53	0.10	Skin diseases, syphilis and gonorrhea	Oral
284	<i>Tinospora crispa</i> (L.) Hook. F. & Thoms.	Menispermaceae	Jan ludi (Chakma), Khobonue (Marma)	Climber	Wild	Stem	Decoction	0.38	0.05	Jaundice and appendicitis	Oral
285	<i>Tournefortia roxburghii</i> C.B. Clarke	Boraginaceae		Shrub	Wild	Leaf	Paste	0.28	0.05	Body pain	External
286	<i>Tournefortia viridiflora</i> C. B. Clarke	Boraginaceae	Crau-sowau (Marma)	Shrub	Wild	Whole plant	Paste	0.27	0.05	Skin diseases like daud, eczema etc.	External
287	<i>Trema orientalis</i> (L.) Bl.	Ulmaceae	Simutta gach (Chakma), Monchi (Marma), Kaly kholo ajing (Khumi)	Tree	Cultivated, Wild	Leaf, bark and root	Decoction	0.57	0.07	Muscle stiffness, toothache, dysentery and stomach pain	External
288	<i>Trichosanthes tricuspidata</i> Lour.	Cucurbitaceae	Keta phola ludi (Chakma)	Climber	Wild	Leaf	Decoction	0.23	0.03	Skin disease	External
289	<i>Typhonium trilobatum</i> (L.) Schott	Araceae	Kharbach, Ghetu (Chakma)	Herb	Wild	Whole plant	Direct	0.20	0.03	Gastric problem	Oral
290	<i>Uncaria macrophylla</i> Wall.	Rubiaceae	Borgialtoli (Chakma)	Climber	Wild	Leaf	Direct	0.18	0.02	Rheumatic pain	External
291	<i>Uncaria scandens</i> (Smith) Hutch.	Rubiaceae	Boroi ludi (Chakma)	Climber	Wild	Leaf and root	Juice	0.22	0.03	Paralysis	Oral
292	<i>Uraria crinita</i> Desv.ex DC.	Fabaceae	Bilai lengur (Chakma)	Shrub	Wild	Whole plant	Juice	0.57	0.10	Tetanus and satanophobia	Oral
293	<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	Jatrabon (Tanchangya)	Herb	Wild	Leaf	Direct	0.42	0.05	Headache	External

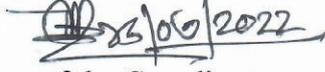
Sl no.	Scientific name	Family	Local/ Tribal name	Habit	Status	Parts used	Form of use	UV	RFC	Ailment	Mode of use
294	<i>Vernonia patula</i> (Dryand) Merr.	Asteraceae	Danda utpan (Chakma), Hungfui, Rakhei apang (Marma), Danda utpal (Tripura)	Herb	Wild	Leaf	Direct	0.37	0.05	Remittent fever	Oral
295	<i>Vitex negundo</i> L.	Verbenaceae	Nirganda (Chakma), Thoaibai gach (Marma)	Tree	Cultivated, Wild	Leaf, flower and root	Paste	0.68	0.10	Abdominal pain, disinfecting wounds and ulcers, leish- mania infantum, black fever, dysentery and liver problem	External
296	<i>Vitex penduncularis</i> Wall. ex Schuer.	Verbenaceae	Ashmul gach (Chakma), Salong (Marma). Chilai- phang (Tripura)	Tree	Wild	Leaf, bark and root	Decoction	0.63	0.08	Burning urination, excessive menstruation and anal fissure	Oral
297	<i>Xanthosoma violaceum</i> (Schott, Oesttern)	Araceae	Prinme (Marma)	Herb	Wild	Rhizome and petiole	Juice	0.23	0.03	Haemorrhage	External
298	<i>Zingiber montanum</i> (J.Koenig) Link ex A.Dietr.	Zingiberaceae	Mur ada (Chakma)	Herb	Wild	Rhizome	Direct	0.37	0.03	Gastric problem	Oral
299	<i>Zingiber officinale</i> Rose.	Zingiberaceae	Deo ada, Mur ada (Chakma), Kheng, Pili (Marma)	Herb	Cultivated	Rhizome	Paste	0.38	0.05	Boils and cough expectorant	External
300	<i>Ziziphus oenoplia</i> (L.) Mill.	Rhamnaceae	Kulma jisi, Banboroi (Chakma), Jiabong gach (Marma)	Shrub	Wild	Leaf	Direct	0.33	0.23	Weakness of women	Oral

Appendix 2. Family wise species distribution of documented species during the study

Sl. No.	Family	No. of sp.
1.	Asteraceae	19
2.	Euphorbiaceae	17
3.	Rubiaceae	16
4.	Fabaceae	14
5.	Zingiberaceae	11
6.	Acanthaceae	10
7.	Lamiaceae	9
8.	Apocynaceae	8
9.	Araceae	8
10.	Verbenaceae	8
11.	Caesalpiniaceae	7
12.	Amaranthaceae	6
13.	Convolvulaceae	6
14.	Cucurbitaceae	6
15.	Malvaceae	6
16.	Combretaceae	5
17.	Lauraceae	5
18.	Menispermaceae	5
19.	Rutaceae	5
20.	Urticaceae	5
21.	Moraceae	4
22.	Oleaceae	4
23.	Sapindaceae	4
24.	Solanaceae	4
25.	Vitaceae	4
26.	Boraginaceae	3
27.	Mimosaceae	3
28.	Myrsinaceae	3
29.	Piperaceae	3
30.	Poaceae	3
31.	Agavaceae	2
32.	Anacardiaceae	2
33.	Asparagaceae	2
34.	Begoniaceae	2
35.	Bignoniaceae	2
36.	Costaceae	2
37.	Cypercaee	2
38.	Dioscoreaceae	2
39.	Equisetaceae	2
40.	Hydroxidaceae	2
41.	Leeaceae	2
42.	Lygodiaceae	2
43.	Marantaceae	2
44.	Meliaceae	2
45.	Orchidaceae	2
46.	Passifloraceae	2
47.	Plumbaginaceae	2
48.	Polygonaceae	2
49.	Rosaceae	2

Sl. No.	Family	No. of sp.
50.	Smilacaceae	2
51.	Sterculiaceae	2
52.	Tiliaceae	2
53.	Acoraceae	1
54.	Amaryllidaceae	1
55.	Apiaceae	1
56.	Araliaceae	1
57.	Aristolochiaceae	1
58.	Asclepiadaceae	1
59.	Asphodelaceae	1
60.	Aspleniaceae	1
61.	Athyriaceae	1
62.	Buddlejaceae	1
63.	Cactaceae	1
64.	Campanulaceae	1
65.	Capparaceae	1
66.	Clusiaceae	1
67.	Commelinaceae	1
68.	Crassulaceae	1
69.	Cycadaceae	1
70.	Dilleniaceae	1
71.	Iridaceae	1
72.	Liliaceae	1
73.	Loranthaceae	1
74.	Marattiaceae	1
75.	Melastomaceae	1
76.	Moringaceae	1
77.	Myrtaceae	1
78.	Nyctaginaceae	1
79.	Ophioglossaceae	1
80.	Phyllanthaceae	1
81.	Plantaginaceae	1
82.	Polygalaceae	1
83.	Polypodiaceae	1
84.	Pontederiaceae	1
85.	Portulacaceae	1
86.	Pseudoeranthemaceae	1
87.	Pteridaceae	1
88.	Ranunculaceae	1
89.	Rhamnaceae	1
90.	Scrophulariaceae	1
91.	Selaginaceae	1
92.	Stemonaceae	1
93.	Stemonuraceae	1
94.	Taccaceae	1
95.	Theaceae	1
96.	Thelypteridaceae	1
97.	Ulmaceae	1

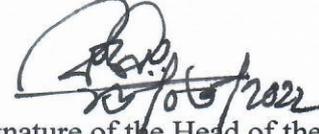
**Endorsed by:**



Signature of the Coordinator

Date ... (ড. মো: হায়ফুল্লাহ)  
সকল পরিচালক (এ এড এক) এবং সিনিয়র (সক) (সংসদ)  
ও কো-অর্ডিনেটর, PBRG উপ-প্রকল্প ID-74, NATP-2  
বিজ্ঞানবাগিচা, ফার্মগেট, ঢাকা-১২১৫

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Counter signature of the Head of the organization/authorized representative

Date .... Dr. Shaikh Mohammad Bokhtiar  
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