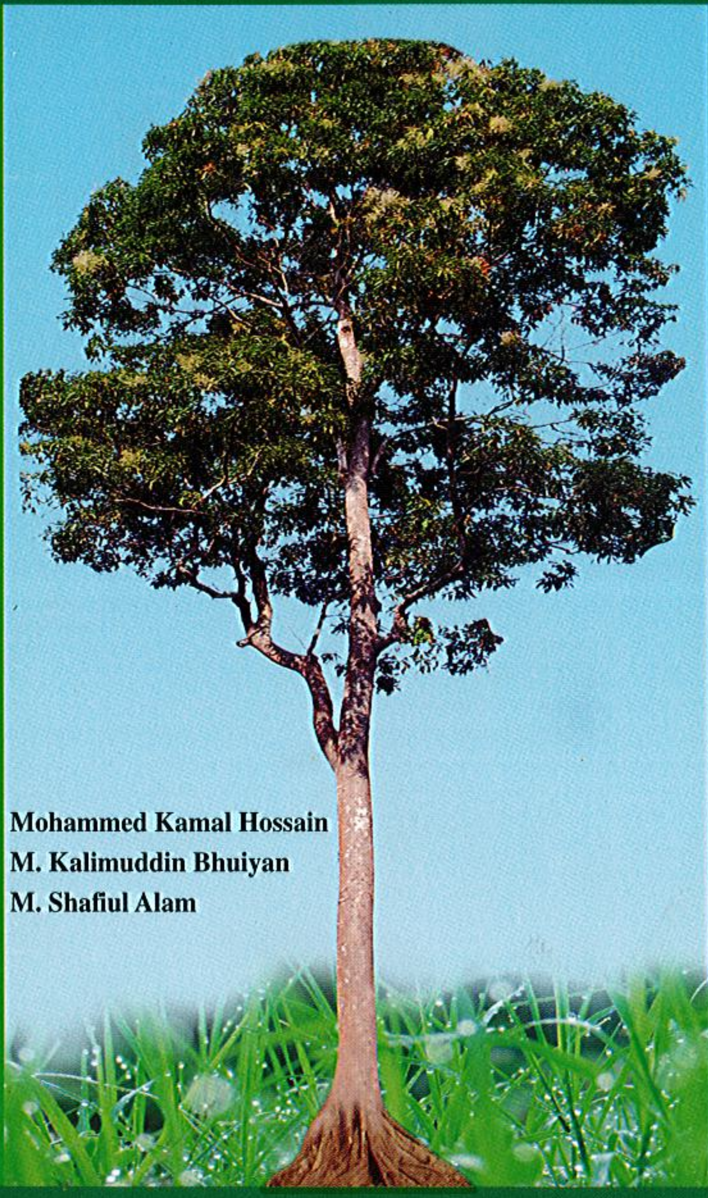
# Civit (*Swintonia floribunda* Griff.)
## A threatened tree species of Bangladesh



**Mohammed Kamal Hossain**
**M. Kalimuddin Bhuiyan**
**M. Shafiul Alam**

Institute of Forestry and Environmental Sciences
Chittagong University, Chittagong
Bangladesh

ARANNAYK FOUNDATION
Conserving forests for the future

# Civit (*Swintonia floribunda* Griff.)
## A threatened tree species of Bangladesh


**Mohammed Kamal Hossain**
**M. Kalimuddin Bhuiyan**
**M. Shafiul Alam**



Institute of Forestry and Environmental Sciences
Chittagong University, Chittagong
Bangladesh

ARANNAYK FOUNDATION
Conserving forests for the future

# FOREWORD

Civit (Swintonia floribunda) has become endangered due to over-exploitation of the species for making composite wood (Plywood) for tea chest since 1960. Prior to that the species was considered as D-class timber having almost no commercial value of the timber. However, the species has high biodiversity value as it provides habitat for nesting of White Winged Duck. It is said that due to lack of Civit trees in the forest, the white winged duck has also become endangered. Realizing the importance of the species, Arannayk Foundation took an initiative to conserve and restore the species in its natural habitat and develop its propagation protocol including seed handling procedure for multiplication of the species. Institute of Forestry and Environmental Sciences, Chittagong University (IFESCU) worked as partner of Arannayk Foundation in this initiative and made exploratory survey to locate the species in its natural range and develop propagation protocol for the species. This publication documented the distribution of the species in the forests of Bangladesh and propagation methods for raising seedlings of the species in the nurseries. The IFESCU has established seed orchard of the species within the Chittagong University Campus which will act as future seed source of the species. It will also help students to learn about its silviculture and management. It may be mentioned that through the project, IFESCU has produced more than 15,000 seedlings which are distributed to 32 organizations including Forest Department for plantation in the field. IFESCU has been keeping record of the survival and growth of the species. During the exploratory survey, it was found some other species have also become critically endangered which include Boilam (Anisoptera scaphula), Moos (Brownlowia elata), Pairag (Canarium resiniferum), Batna or Sil Batna (Castanopsis indica), Udal (Firmiana colorata), Sida Jarul (Lagerstroemia parviflora), Raktan (Lophopetalum fimbriatum), Uriam (Mangifera sylvatica), Tali (Palaquium polyanthum), Haldu (Adina cordifolia), Muchigandha (Pterospermum acerifolium), Buddu Narikel (Pterygota alata), Dharmara (Stereospermum personatum), Parul (Stereospermum suaveolens), Goda (Vitex glabrata), Baitta Garjan (Dipterocarpus species) etc. We must create mass awareness about conservation of endangered species for better ecosystems.

We sincerely thank the authors of this publication for documentation of the study and sharing knowledge with wider audience.

Farid Uddin Ahmed
Executive Director
Arannayk Foundation

# ACKNOWLEDGEMENT

All praises goes to the Almighty Allah, the most benevolent and merciful. Who created all creatures for the well being of human kind.

The authors are grateful and acknowledge to the Tropical Forest Conservation Programs of the US Government for providing financial support to the project "Recolonization and Mass Propagation of Civit *(Swintonia floribunda)* implemented by the Institute of Forestry and Environmental Sciences, Chittagong University (IFESCU). The authors are grateful to Mr. Farid Uddin Ahmed, Executive Director, Arannayk Foundation for writing the forward of this book. We gratefully acknowledge the heartfelt support of Dr. M. A. Quddus, Mr. Abedul Hoque Chowdhury, Mr. Shawkat Hossain, Mr. A. K. Azad of Arannayk Foundation, Dhaka for their critical comments and suggestions during the implementation of the project both in financial and technical aspects. We are also grateful to many stakeholders, especially the Arannayk Foundation Project implementing entities for lending their experience, knowledge and information in preparing the book.

We are also grateful to Dr. A.F.M. Akhtaruzzaman, Director *(Retired)*, Bangladesh Forest Research Institute for critical review of the manuscript. Authors are grateful to the Director and all faculty members of the Institute of Forestry and Environmental Sciences, Chittagong University in completing the project successfully and finalizing the manuscript for publication. We would like to express our heartfelt and profound gratitude to all officials and field staff of the IFESCU nursery wing, especially Mr. M. Kamaluddin, Senior Plantation Officer, Mr. Badiul Alam, Mr. Abdur Rahman, Mr. Badsha, Mr. Nuru, Mr. Nasir without whom the project would not be ended with success. Special thanks are to the concerned Conservator of Forests, Divisional Forest Officers and Field Staff in Cox's Bazar, Chittagong and Chittagong Hill Tract forest areas. Thanks to the nurserymen who show their interest in collection, raising and distributing the seedlings of threatened tree species of Bangladesh.

Special thanks to Mr. Shafiul Alam Chowdhury, Conservator of Forests, Chittagong Circle; Dr. Mohammed Mohiuddin, Divisional Officer, Forest Botany Division of Bangladesh Forest Research Institute for their critical review and comments.

We are also grateful to Md. Shariful Islam, Abdullah Al-Mamun, Md. Jahirul Huq Jahir, Jahirul Islam, Akther Hossain, Israt Jahan Diti for conducting both field and laboratory experiments on civit.

**Mohammed Kamal Hossain**
**M. Kalimuddin Bhuiyan**
**M. Shafiul Alam**

# CONTENTS

# Introduction

Civit (*Swintonia floribunda* Griff.) is a native tree of Chittagong, Cox's Bazar and Chittagong Hill Tracts forests. It belongs to the family Anacardiaceae. Civit is a tall tree with straight cylindrical bole. A large tree is found commonly up to 2.5 -2.8 m in girth, with a 25 m clear bole (Das and Alam 2001). The base of the stem is often very fluted with long buttresses. It is naturally found in the forests of Chittagong (Pearson and Brown 1932). This species is also found in South and South-East Asia, particularly in the lowland and hill forests of Myanmar, Andaman and Nicobar Islands, Thailand, Vietnam, Peninsular Malaysia and Sumatra (Lemmens et al. 1995). Once civit was abundant in the hill forests of Bangladesh, but now it is treated as one of the threatened species in Bangladesh (Khan et al. 2001). Because of indiscriminate felling, it is becoming localized with limited distribution in the natural forests of its native range.

In Bangladesh, the species was not considered as an economically important species and was available in association with some other hardwood tree species in hill forests. The species was widely used in plywood manufacture. It has now becoming rare because of indiscriminate felling to meet the demand of plywood industries during 1950-60s. It is also commonly used in boat building. It also produces a good quality pulp (Razzaque and Das 1969).

Arannayk Foundation (AF), with a mission and vision of Tropical Forest Conservation Program in Bangladesh, has identified the importance of conservation of civit tree. In addressing this issue, initiative also deals with the importance of conservation of other threatened species in Bangladesh. The study has been conducted by the Institute of Forestry and Environmental Sciences of Chittagong University (IFESCU) with the financial support of Arannayk Foundation. The study incorporates the investigation on the natural distribution, silviculture, regeneration and domestication of the species with seed and clonal propagation approaches. This knowledge of a species are helpful for conservation and future breeding programs for the species. The objectives are also to make inventory and assess the ruined civit stands and individuals in their natural habitats and explore the regeneration mechanisms in different habitats.

# Description of the Civit Species

Scientific name: ***Swintonia floribunda* Griff.**

**Taxonomic position**

| | |
|---|---|
| Sub-phylum | : Angiospermae |
| Class | : Dicotyledonae |
| Order | : Sapindales |
| Family | : Anacardiaceae |

**Sub-species/varieties**

*Swintonia floribunda* var. *floribunda*
*Swintonia floribunda* var. *penangiana* (King) Kochummen

**Other scientific names**

*Swintonia griffithii* Kurz, *Swintonia helferi* Hook. f., *Swintonia penangiana* King, *Swintonia puberula* Pearson, *Swintonia schwenkii* Teijsm. & Binn.

**Common names**

| | |
|---|---|
| Bangladesh | : Am-chundul, Civit (in Bangla), Moilam, Moilam-chibuk (Chittagong area), Sangrin (Magh), Sibika (Chakma) |
| Myanmar | : Thayetsan, Thaytkin |
| Indonesia | : Kereta, Bagel, Mirah |
| Sumatra | : Kedondong rabuk |
| India | : Boilam, Boilsur, Am-barola |
| Peninsular Malaysia | : Merpauh daun runching |

**Trade name:** Civit

**Botanical description of civit**

A lofty evergreen, glabrous tree (Fig. 1, 2), the lower part of the stem often buttressed (Fig. 3, 4) which may extend to a height of 2 m or more (Das and Alam 2001). The bark is grayish smooth with shallow vertical fissures, blaze pinkish. Leaves crowded towards ends of the branchlets, lanceolate, 10-15 cm long, thin, coriaceous and glossy green above, glaucous beneath, petioles very slender, 2.5-4.0 cm long (Hossain 2008). Inflorescence of 15-30 cm long panicles, terminal or axillary, profusely branched, glabrous. Bisexual flowers 3-4 mm across, pale- yellow (Fig. 5). Calyx lobes 1 mm long, petals ovate-oblong, 2 x 1 mm, puberulous on both sides, disc elongate, 0.5 x 0.8 mm. Stamens 2-3 mm long, anthers oblong. Ovary subconical, 1 mm in diameter, style 1.5 mm long, simple, stigma disciform. Male flowers elongate, 2.5 x 1.5 mm. Fruit a drupe, unripe fruit sessile, seated on 5 oblong- linear, reflexed, about 5 cm long, longitudinally-veined, purplish, wing-shaped petals (Fig. 6). Flowering and fruiting from February to May (Motaleb and Hossain 2010).

Figure 1. Mature Civit tree with a clear glabrous bole

Figure 2. Self-pruned bole of civit possesses a top canopy

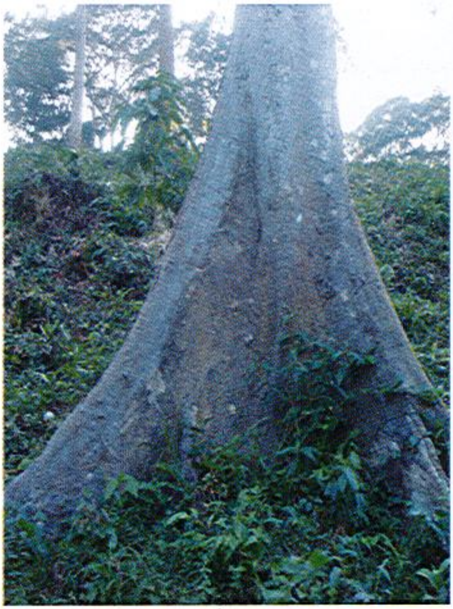


Figure 3. Buttressed stem of a civit tree

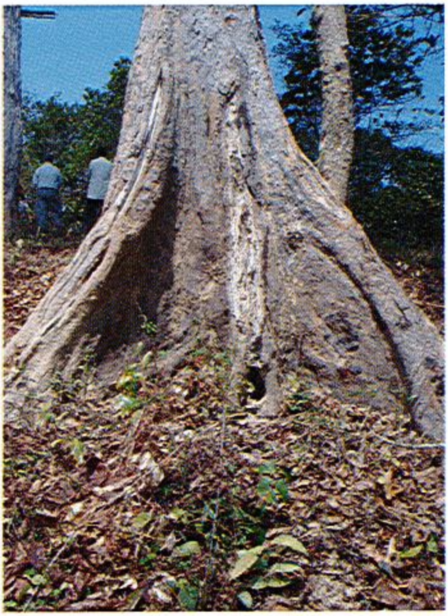


Figure 4. Base of the stem is deteriorating in over-mature trees

Figure 5. Yellowish flowers in a civit tree

Figure 6. Civit fruits with wings

## Natural Distribution of Civit

Globally, the species is found in South and South-East Asia (Fig. 7), particularly in the lowland and hill forests of Myanmar, Bangladesh, Andaman and Nicobar Islands, Thailand, Vietnam, Peninsular Malaysia and Sumatra (Lemmens et al. 1995, Hossain 2008).

### Occurance of civit in the natural forests of Bangladesh

Civit naturally occurs in the hill forests of Cox,sBazar, Chittagong and Chittagong Hill Tracts (Fig. 8). Civit occurred as 6.2% in a diameter class distribution of trees in Ukhiya range, Cox'sBazar Forest Division (Ahmed and Haque 1993). Pablakhali of Bagaichari upa-zila was once famous for both the civit and White Wing Duck (Bhadi Hans) nesting in civit. Paradoxically the species is now extinct in this area. White Wing Duck, an indicator species has disappeared due to loss of habitat and nesting places. Except Rajghat and Bhomorioghona Beat of Fulchari Range in Cox's Bazar North Forest Division, civit is now found scattered in single to a few individuals in other forest areas, though civit was dominant in the hill forest areas (Coffey 1940, Namura 1986, Canonizado and Mabud 1998). According to the Forest officials, Sangu Reserve Forest is supposed to have civit along with some other native hardwood tree species. Unfortunately, site visit to the Sangu reserve was not possible due to political unrest and security problem. However, the research team explores the status of civit in all available hill forest areas of Bangladesh during the project period.

Figure 7. Native ranges of civit in south-east Asia

## Civit in Hill Forests Areas of Bangladesh

The hill forests of Bangladesh are situated in the eastern border of the country in relatively high altitude hills in Chittagong Hill Tracts, Chittagong and Cox's Bazar. The hill forests of Bangladesh are ecologically divided into two classes: i) tropical wet evergreen forests, and ii) tropical semi-evergreen forests (Das 1990).

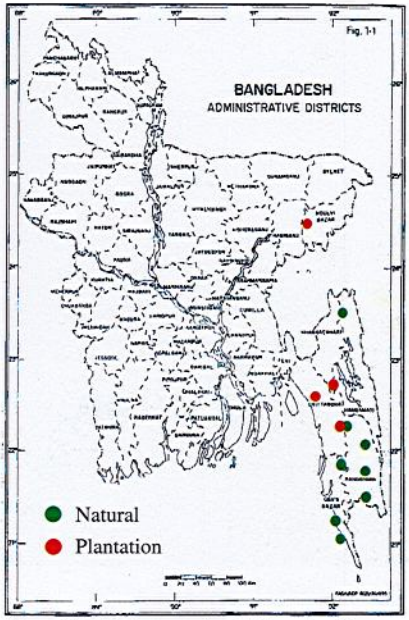



Figure 8. Civit in natural and plantation forests of Bangladesh

### The Tropical wet evergreen forests

The tropical wet evergreen forests are an important type of forests in Bangladesh in terms of biodiversity, forest assets and environmental concerns. The trees in the top canopy reach a height of 45-60 m. The floral diversity of forests is rich with epiphytes, orchids, and woody and non-woody climbers, ferns, mosses, aroids, and palms, particularly in northern shady moist places (Fig. 9). Herbs and grasses are abundant and the undergrowth is a tangle mass of shrubs, bamboo and cane. These forests occur usually in hills and moist shady areas in Chittagong Hill Tracts (Khagrachari, Rangamati and Bandarban), Sylhet, Habigonj, Moulavibazar, Cox's Bazar and Chittagong (Das 1990).

### The Tropical semi-evergreen forests

The tropical semi-evergreen forests occur in more exposed dry locations of Cox's Bazar, Chittagong, Chittagong Hill Tracts and Sylhet. The top canopy species of these forests reach a height of 25-57 meters. In these forests, the evergreen species predominate, but there are many deciduous species also found (Fig. 10).

Figure 9. Evergreen forests of Barkol, Rangamati

Figure 10. Semi-evergreen forests of Tankawati, Chittagong

## Civit in natural hill forests of Cox's Bazar South Forest Division

Cox's Bazar Forest Division once was dominant with civit (Namura 1986, Ahmed and Haque 1993, Mamun and Hossain 2011), but at present the population is limited to a solo tree to few individuals (Table 1).

Table 1. Enumeration of civit in Cox's Bazar South Forest Division

| Locality | Remarks |
|---|---|
| Silkhali natural forests patch | Eleven civit tree was found in association with other native tree species (Fig. 11). |
| Whykheong Range | Some isolated civit was found in this Range (Fig. 12). |
| Swankhali, Monkhali of Inani forests | Natural regeneration is observed, but most of the individuals are in small posts and poles size. Mature trees are already illegally felled (Fig. 13). |
| Dochari beat of Ukhiya Range | Provisional Plus Tree (PPT) of civit selected by Bangladesh Forest Research Institute (BFRI) (Fig. 14). |

Figure 11. Natural forests of Silkhali Range

Figure 12. Isolated civit tree in Whykheong range

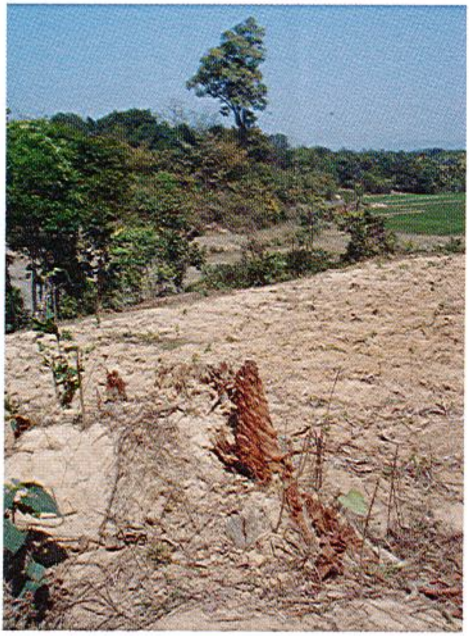


Figure 13. Mature trees are disappearing from Swankhali, Monkhali of Inani range

Figure 14. Provisional Plus Tree (PPT) of civit in Dochari beat of Ukhiya Range

The height (m), dbh (cm) and age (year) of few civit PPT in Chenkhula Jumer Pahar, Ukhiya are shown in Table 2.

Table 2. Provisional Plus Tree (PPT) of Bangladesh Forest Research Institute in Chenkhula Jumer Pahar, Ukhiya

| PPT No. | Ht (m) | Dbh (cm) | Age (yrs.) (approx.) | Remarks |
|---|---|---|---|---|
| 01 | 43 | 82.0 | 80 + | Clear bole up to 6.5 m height followed by multiple stem |
| 02 | 42 | 87.0 | 50 + | Promising PPT but isolated tree |
| 03 | 37 | 64.0 | 45 + | Promising PPT |
| 04 | 24.5 | 78.2 | 30-35 | Promising PPT |
| 05 | 26.2 | 41.0 | 30-35 | Promising PPT |
| 06 | 36.0 | 25.5 | 30-35 | Promising PPT |

Note: Ht = Height; Dbh = Diameter at breast height

## Civit in natural hill forests of Coxs's Bazar North Forest Division

The forest areas of this Division are situated in Cox'sBazar, Ramu, Eidgah and Chakoria upazila. Bangabandhu Safari Park at Dulahazara includes a wide variety of native tree species including garjon, telsur, civit, chapalish etc. (Fig. 15). Only 4 natural civit trees were available in this park in association with garjan, telsur, kadam etc.

Civit is also naturally found in Fulchari and Fasiakhali Range of this Division. Most of the trees are mature to over-mature and scattered in the forest area (Fig. 16). Encroachment and participatory forest management initiatives with fast growing species has threatened the existence of the native tree species in future.

Figure 15. Civit in Bangabandhu Safari Park at Dulhazara

Figure 16. Civit - Garjan in Rajghat Forest of Fulchari Range, Cox's Bazar

Few mature to over-mature garjan, civit, batna and boilam are available in Bhomorioghona Beat of Eidgar Range in Cox's Bazar North Forest Division (Fig. 17). Natural regeneration of civit and garjan are available, but are not able to establish due to fuelwood collectors (Fig. 18).

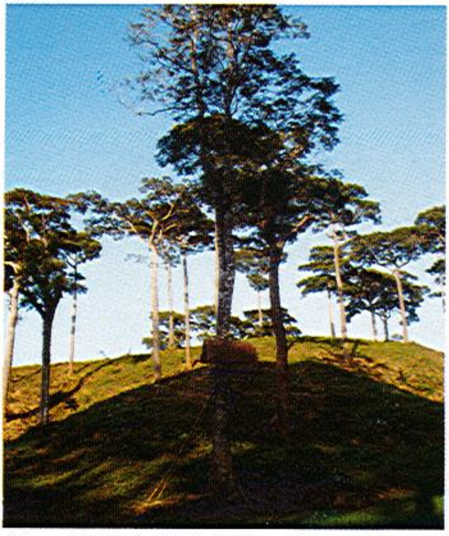


Figure 17. Garjan-Civit in Bhomarioghona forest of Eidgar Range

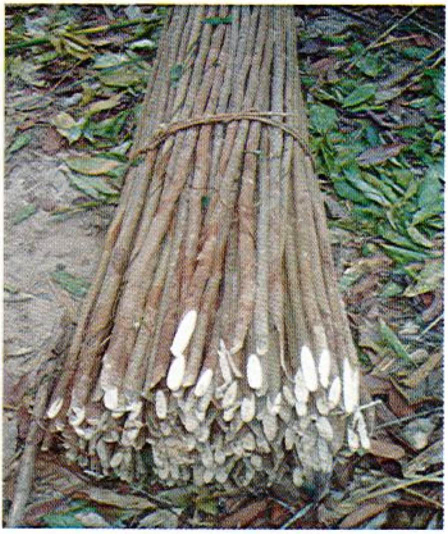


Figure 18. Regeneration and recruitment are damaged by the fuelwood collectors

## Civit in Chittagong South Forest Division

The Chittagong South Forest Division comprises of Chittagong Sadar, Kalipur, Jaldi, Patiya, Dohazari, Padua, Chunati, Barabakia, Madarsa, Rangunia, Khurusia and Kalurghat Ranges. The forests are under serious threat due to deforestation, encroachment, illegal felling etc.; but some patches in Baraitoli, Tankawati, Dud-pukuria, Dopachari, etc. are rich with native tree species (Motaleb and Hossain 2009).

Three planted civit trees of about 25 years old were found in front of Padua rest house of Padua Range. The trees attained a height ranging from 12.9 - 15.0 m and dbh of 23.7 - 37.8 cm. In the Tankawati natural forest area, about 14 civit trees were found in Latikhata Fuittajuri area having height ranging from of 33 - 41 m and dbh of 61.0 - 71.3 cm (Fig. 19, 20).

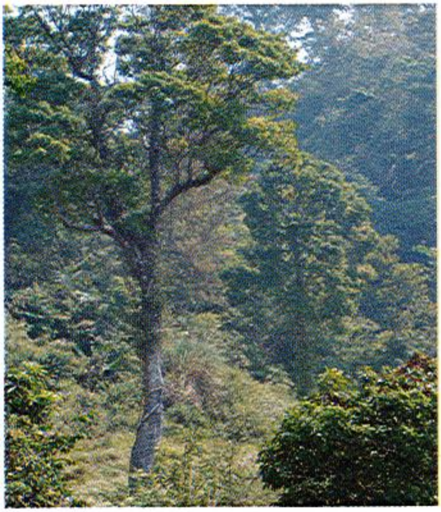


Figure 19. Civit in Tankawati natural forests

The Dudpukuria - Dhopachari Wildlife Sanctuary (WS) is rich with diverse flora, fauna, tribal culture and hillocks (Feeroz et al. 2012). Civit trees were scatteredly distributed in this forest (Fig. 21). Some native tree species were also available in this WS. These needs to be maintained with a functionally effective conservation agenda. Scattered jhum and tobacco cultivation is becoming a threat to this species rich natural forests (Fig. 22, 23).

Figure 20. Twin civit in Tankawati forest

Figure 21. Civit in Dudpukuria-Dopachari WS

Figure 22. Jhum cultivation disappearing the native flora in Dudpukuria-Dopachari WS

Figure 23. Tobacco cultivation is also destroying the biodiversity of WS

### Civit in Chittagong North Forest Division

Two civit trees were found in the office compound of Hyanko Rubber Estate in Hyanko, Chittagong. These trees are about 15-16 years old. Three more civit trees were also found on way to Ramgarh from Hyanko. Three civit trees were found close to the Hazarikhil forest office. These seemed to be planted, the age of which was about 50-55 years. The total height, clear bole height and dbh of the trees are shown in Table 3.

Table 3. Growth performance of 3 civit trees in Hazarikhil forest range

| Tree No. | Ht (m) | Clear bole (m) | Dbh (cm) | Buttress up to (cm) | Number of main buttresses |
|---|---|---|---|---|---|
| 1 | 19.8 | 12.5 | 62.1 | 160 | 7 |
| 2 | 20.4 | 13.0 | 65.3 | 150 | 5 |
| 3 | 16.8 | 11.0 | 68.2 | 152 | 4 |

Note: Ht = Height; Dbh = Diameter at breast height

There are 2-5 secondary buttresses of each main buttress (Fig. 24). The horizontal length of the buttress to ground is 90-140 cm (Fig. 25); and the maximum thickness of the buttress is 18 cm.

Figure 24. Buttress of a typical Civit tree

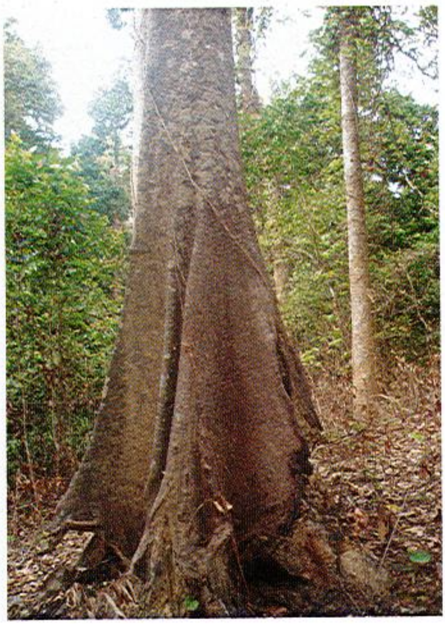


Figure 25. Horizontal length of the buttress

### Civit in Chittagong Hill Tracts

Civit was found sporadically in Dochari mouza of Tulatoli Beat of Naikhyongchari Range in Lama Forest Division. Some rich natural vegetation in Lemuchari area (close to BGB camp and Myanmar border) were found in this range. Matamuhuri reserve forest was found degraded and only scattered civit was visible (Fig. 26). Civit was also available in the remote forest areas of Sangu reserve (Fig. 27). Some illegally felled logs of civit were seized by the forest officials and were lying in the Matamuhuri Range office compound (Fig. 28).

Figure 26. Scattered civit was found in Matamuhuri reserve

Figure 27. Well stocked natural forests of Sangu reserve

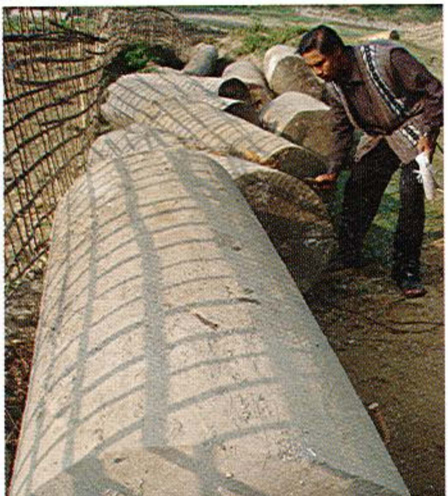


Figure 28. Civit logs in the office compound of Matamuhuri Range

Few civit is still available in remote areas of Pablakhali Wildlife Sanctuary. Old forest staff informed that once Bhadi hans (White Wing Duck) was available in this area, but it is not seen for at least last 15-20 years.

The Sangu reserve is a good patch of forest; but most of the mature trees already disappeared from the forest (Fig. 29). Similarly there is no civit in Barkol reserve forest at Andermanik mouza of Shovolong union. However, some scattered civit trees were found in Sitapahar block, Rampahar and Kaptai mukh beat forests (Fig. 30).

Few scattered civit were found in Alikheong Sadar beat of Alikheong Range having a height range of 19.8 - 21.3 m and dbh of 48 - 50 cm (Fig. 31).

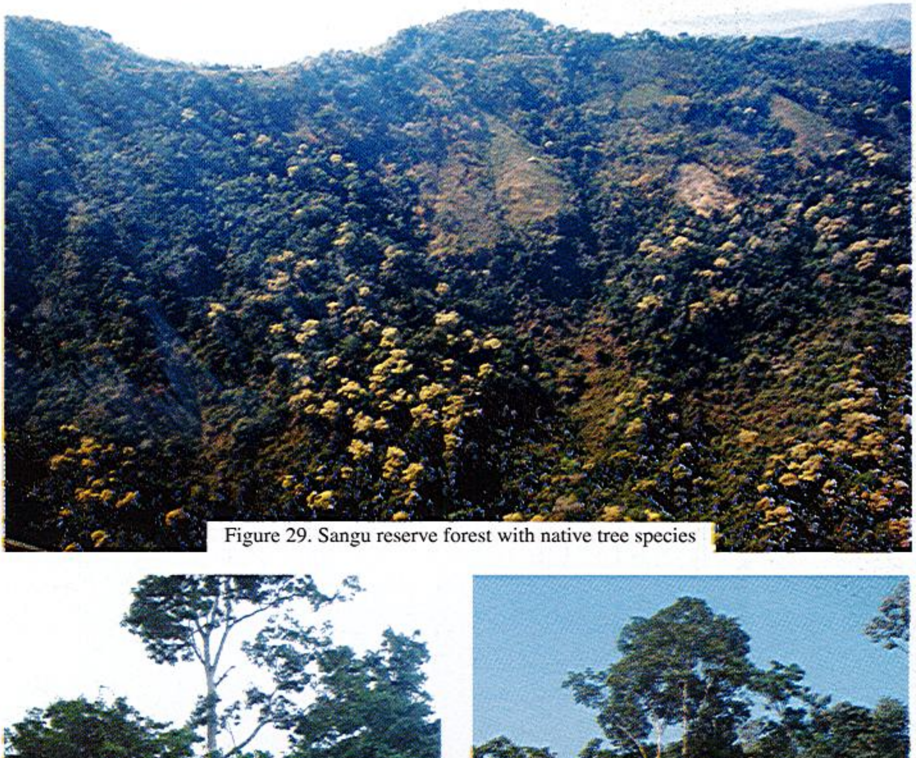


Figure 29. Sangu reserve forest with native tree species

Figure 30. Civit in Kaptai mukh beat forests

Figure 31. Civit in Alikheong sadar beat forests

## Major Causes Responsible for Loss of Native Tree Species from Natural Forests

There are many forces responsible for natural forest degradation, collectively and individually, and the trends of these forces are very complex. The major causes of forest degradation in Bangladesh are conversion of forest lands for agricultural crops, over-extraction of wood and non-wood resources, population growth, deforestation, settlement, urbanization and wrong management practices (Hossain 1998, Salam et al. 1999, Hasan and Alam 2006). The state of natural forest degradation in Bangladesh and their causes are as follows:

### Deforestation

Estimates of deforestation in Bangladesh reported in various sources are not consistent (Khan et al. 2004). However, estimation is that about half of the land area controlled by the Forest Department lacks tree covers (Fig. 32, 33).

Figure 32. Deforestation in Kassalong reserve at Bagaihat, Bagaichari upazila, Rangamati

Figure 33. Deforestation in Ukhiya, CoxsBazar

**Shifting (Jhum) cultivation**

With a developing market economy and the inevitable population pressure on land, the system of shifting (Jhum) cultivation collapsed into degradation and retrogression, influenced by factors both internal and external to the system. In addition, clearing of natural vegetation for cultivation of pineapple, ginger and turmeric along the slopes has a negative effect, which increases soil erosion in the hilly areas. After 5-7 years of cultivation by this method, these lands totally degraded to an almost irreversible state. Clearing of forestland for settlements and unscientific land management for agricultural use accelerate erosion of the topsoil through extensive surface runoff during heavy monsoon rain (Fig. 34, 35).

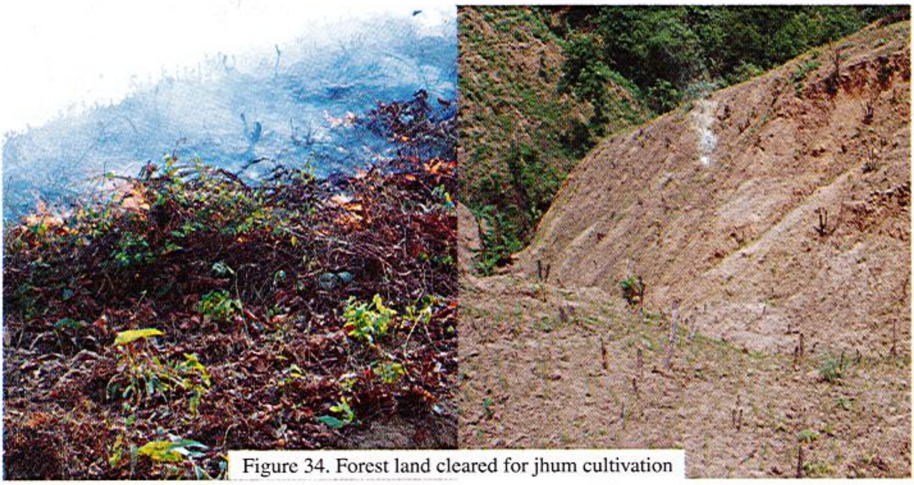


Figure 34. Forest land cleared for jhum cultivation

Figure 35. Jhumias are sowing the crop seeds in jhum field

## Encroachment

Encroached lands in Bangladesh lack legal surveys and the exact area of encroached land is unknown. Current data are the visual estimates of the Forest Department field staff. The encroachment problem in the forest areas of Chittagong, Chittagong Hill Tracts and Cox's Bazar is due to political influence for settlement of both the Ruhinga and cyclone refugees (Hossain and Rahman 1994) (Fig. 36, 37).

Figure 36. Forest land encroachment by making a house initially in the core of a reserve forest

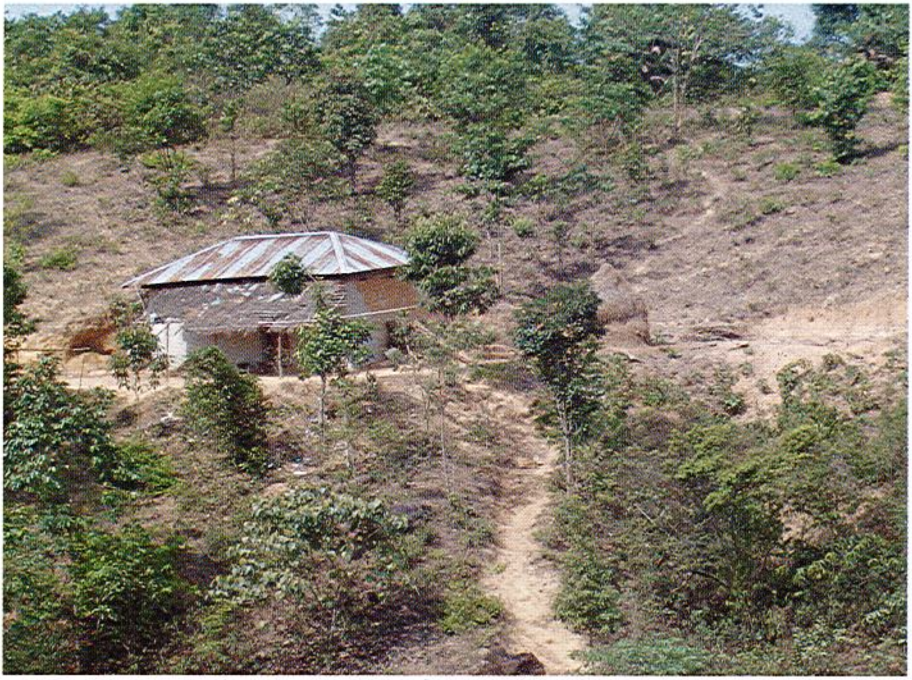


Figure 37. Forest lands encroached for cultivation and habitation

## Forest land transfer for other uses

A significant area of forest land has already been transferred for human settlement (de-reserved areas in CHT), development of industry (in sal forest areas), fishery (coastal or Chakoria mangrove forests), communications (Betbunia or Kaliakoir), irrigation, energy and power, mining, tourism, educational institutions, defense etc.

## Population pressure

The population density of Bangladesh is 941 per $km^2$ (Anon 2006), which is one of the highest in the world. The population pressure is the single most important factor for destruction of forests in Bangladesh.

## Settlement and urbanization

To meet the demand of a huge population, the only available land in this land-scarced country is the forestland. Conflict also arises from the settlers with rehabilitation program in CHT. Recent climate change refugees are fueling these problems gradually. The encroachers and settlement in hill forest areas of Cox's Bazar, Sitakunda- Mirsorai and CHT are the example of such natural victims.

**Wrong management practices**

The Forest Department adopted a forest management practice called clear felling followed by artificial regeneration systems in the hill forest areas. Later on, this proved to be very detrimental to sustainable hill forest management. Following this system, the forest was cleared by slash and burning of all vegetation, and replanted with only one or two commercially important species (e.g., mono-plantation of teak) (Fig. 38). As a consequence, the rich biodiversity of the hill forest ecosystem was destroyed as well as its soil was exposed to erosion through torrential rains during the monsoon (Fig. 39).

Figure 38. Teak dominates in hill forest plantations

Figure 39. Soil erosion is common in mono-plantations

### Establishment of brick fields within fringe forests

Brick fields in the vicinity of forests have been identified as one of the notorious causes of deforestation (Fig. 40). Brick fields in the vicinity of forests have caused not only deforestation, but it has also caused environmental degradation to the biological production systems. Moreover, the energy used for firing bricks comes from woody biomass of the forests.

### Tobacco cultivation

Extension of tobacco cultivation in Lama, Ali Kadam and Naikhongchhari Upazila of Bandarban district, and recently in Khagrachari and Rangamati has also contributed towards deforestation in two ways- i) through bringing fringe forest lands under tobacco cultivation, and, ii) supplying fuel wood from adjacent forests for tobacco curing (Fig. 41, 42).

### Match factories and plywood industries in Chittagong and Cox's Bazar area

During mid 1950-60's the establishment of plywood industries in Chittagong and Cox's Bazar area drastically destroyed civit from natural forests, especially from Cox's Bazar and Matamuhuri reserve forest areas (Fig. 43).

Figure 40. Brick-fields also responsible for destruction of natural forests

Figure 41. Expansion of tobacco cultivation in and within the forest areas

Figure 42. Tobacco curing needs huge firewoods

Figure 43. Most of civit logs were used by ply-wood industries

## Civit in Plantation Forests of Bangladesh

Civit was never a popular species in the plantation programs of Bangladesh. However, a small plantation of civit was found in Satgaon Tea Estates of Srimongal Upazila in Moulavi Bazar district. Similarly, few individuals of civit were found in Mirpur National Botanical Garden, Sitakunda Eco-Park, Chittagong University Botanical Garden, Botanical Garden of Bangladesh Agricultural University Mymensingh, Hyanko Rubber Estate (BFIDC office compound) and Padua Rest house compound of Padua range, Chittagong.

### Civit planted in front of Padua Rest House, Chittagong

Three civit trees of about 20-21 years old having a height of 12.9 m, 13.7 m and 15.0 m with dbh of 23.7, 31.9 and 37.8 cm respectively were found in front of Padua rest house.

### Civit plantation in Sitakunda Botanical Garden and Eco-park

Eight young civit trees were found behind the range office in Sitakunda Botanical Garden and Eco-park. The trees were planted in 2001. The trees attained an average height of 8.1 m and dbh of 8.8 cm at the age of 7.5 years (Fig. 44).

### Civit plantation in Botanical Garden of Bangladesh Agricultural University, Mymensingh

Seven civit seedlings were planted in the north-west corner of the botanical garden of Bangladesh Agriculture University, Mymensingh. The trees are about 10 years old attaining a height range of 16-17 m and dbh of 9-15 cm (Fig. 45). Besides the southern part of the Curator office, there are 5 civit trees having height ranges of 6.7 - 8.5 m and dbh of 5.5-14.5 cm.

### Civit plantation at National Botanical Garden in Mirpur

There are 7 civit trees in Mirpur Botanical Garden of which 5 were planted in 1973 and 2 in 1990. The older trees attained an average dbh of 54.3 cm, total height of 23.4 m and merchantable height of 17 m at an age of 36 years (Fig. 46). The remaining 2 trees attained an average dbh of 28.3 cm, total height of 16.0 m and merchantable height of 8.5 m at the age of 19 years. Natural regeneration was found (Fig. 47), but no management is done and is subjected to clearing of the ground vegetation by fuelwood collectors.

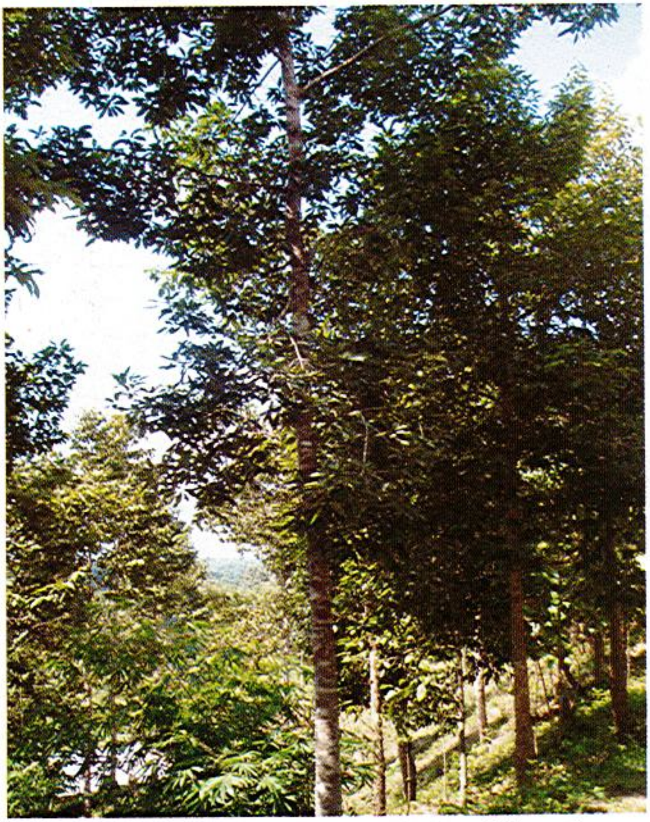


Figure 44. Civit in Sitakunda Botanical Garden and Eco-park

Figure 45. IFESCU students in front of Civit trees of BAU Botanical Garden

Figure 46. 36 years old civit in Mirpur National Botanical Garden

Figure 47. Natural regeneration of civit in Mirpur National Botanical Garden

## Civit plantation in Satgaon Tea Estate

There is a small civit plantation comprising 19 trees in the vacant areas of Satgaon Tea Estate (besides Dhaka-Srimongal road near Lasna Bazar) in Srimongal (Fig. 48). The trees were about 22-25 years old and attained an average height of 21.2 m and 41.6 cm dbh. Natural regeneration is available (Fig. 49) and few seedlings attained a height of 50-60 cm, but no management is done and these are prone to repeated grazing by the goats and cattle.

Figure 48. A small patch of civit in Satgaon Tea Estate, Srimongal

Figure 49. Natural regeneration of civit in Satgaon Tea Estate

## Environmental Requirements and Site Factors for Civit

Some environmental requirement and site factors are important for the better growth of civit. During plantation the following factors should be considered.

### Climate

Civit *(S. floribunda)* grows in the humid tropics. It occurs in regions with a mean annual temperature of 21-27°C, where the mean minimum temperature of the coldest month is 6-18°C, and the mean maximum is 28-45°C in the hottest month. It requires an annual climate with more than 120 rainy days, and the number of dry days may be as low as 0-4 months. Civit prefers regions with a mean annual rainfall 1200 - 4500 mm. Civit is unsuitable for areas where absolute minimum temperature falls below 6°C (Anon. 2005).

### Soil and physiography

Civit (*S. floribunda*) tolerates a diversity of soils, although light-medium loams and freely drained conditions are preferable. It is commonly found on sandy red or yellow soils, and can tolerate shallow to infertile soils. Civit can also grow in slightly acid to neutral soils. Civit tends to grow well on flat valleys on all aspects, in areas liable to flood; and also on low-lying hills where northern and eastern aspects are preferred. Civit can also be available in a range of 10 - 1000 m altitude (Anon. 2005).

## Phenology

Civit is an evergreen species, but generally the older leaves are shed in January -February, and new brown foliages appear in February-March. Yellowish flowers appear in January-February, and fruits tend to mature approximately from late April to early May in Bangladesh (Motaleb and Hossain 2010). In late April to May, fruit-fall occurs as the monsoon wind and rains begin. Fruiting is irregular in different forest patches, and good seed years often occur on alternate years.

## Silvicultural Characters

Civit prefers shade in its early stages but later on requires light for its further growth and development. Nurse crops, e.g., *Tephrosia candida* or *Cajanus cajan* are beneficial in the early stages of the plantations. The species has the ability to shed the lower branches (self pruning), so a clean cylindrical bole is formed.

### Natural regeneration

Civit can sustain in natural forests through natural regeneration. In the secondary forests, natural regeneration is possible but due to lack of mother trees and seeds, natural regeneration is site specific. Thick ground vegetation and heavy competition for growing space and light also retards the success of its regeneration and recruitment. However, 208 seedlings per ha with an

Importance Value Index of 9.20 was reported from a field survey of Tankawati natural forests in Padua range, Chittagong (Motaleb and Hossain 2007). Mamun and Hossain (2011) performed a study in the natural remnant civit stands of Rajghat forest, Cox's Bazar (North) Forest Division. The average highest number of seedlings was found in the 15 metre periphery from the mother tree and the average lowest number of seedlings was found in the 50 meter periphery from the mother tree (Fig. 50). Scattered natural regeneration was also found in other natural forests of Chittagong and Cox's Bazar (Fig. 51) and plantation forests at Satgaon Tea Estates, but recruitment was very few. Firewood collection is responsible for the failures of the natural regeneration of civit in these forests (Fig. 52).

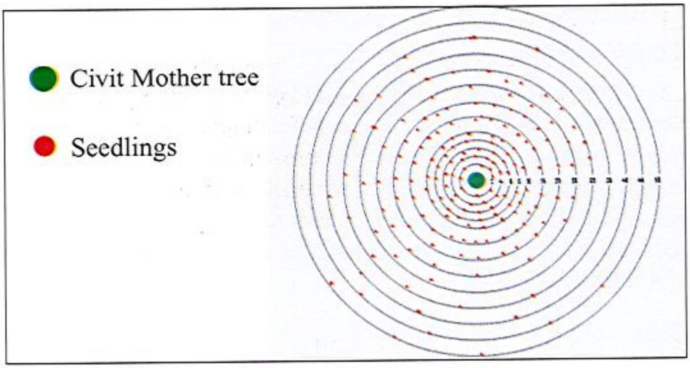



Figure 50: Regeneration distribution of Civit (*S. floribunda*) at different distances from a mother tree at Rajghat Beat, Cox's Bazar Forest Division.

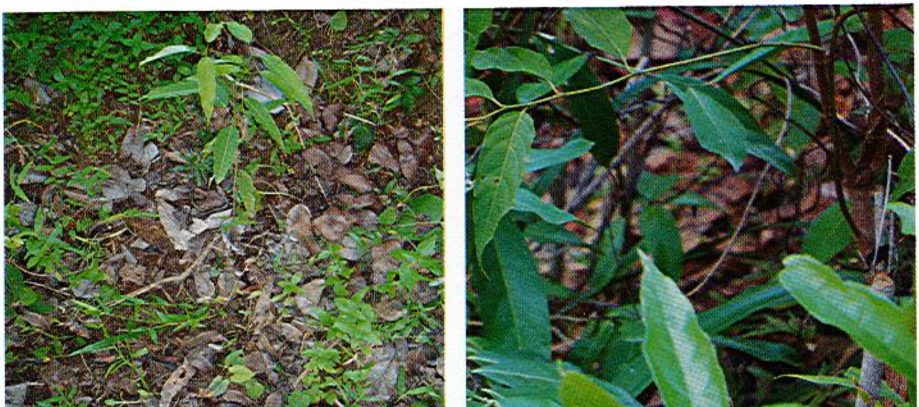


Figure 51. Natural regeneration in Tonkawati natural forests, Padua Range, Chittagong

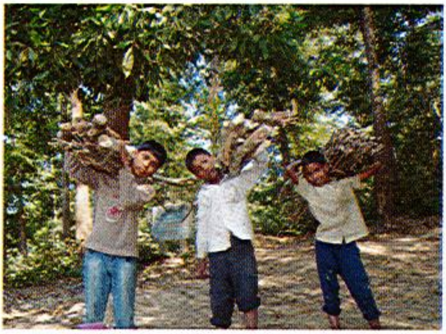


Figure 52. Seedlings and saplings are removed by fuelwood collectors

## Artificial regeneration

The seeds of civit are recalcitrant type with short viability. At optimum conditions, seeds possess a germination rate of 92% and a plant survival rate of more than 60%. An adult tree with a well developed canopy may produce 15-17 kg of seeds. One kilogram of fresh fruit (approximately 900-1700 fruits) is estimated to produce 870 seedlings, if sown within 2 weeks time of seed collection.

## Germination percentage

Germination percentage of civit seeds collected from different forest areas (Bangabandhu Safari park, Ukhiya, Srimongol, Tankawati, Hazarikhil, and Cox's Bazar) were studied (Fig. 53). The germination percentage varied from 57.8 to 97.6. The highest germination percentage (97.6) was observed with seeds collected from Srimongol followed by those from Ukhiya (82), Cox's Bazar (79.2), Hazarikhil (78.2), Safari park (74.1) and Tankawati (57.8). Germination percentage of seeds collected from Srimongol was significantly ($P<0.05$) higher than other sources (Fig. 53).

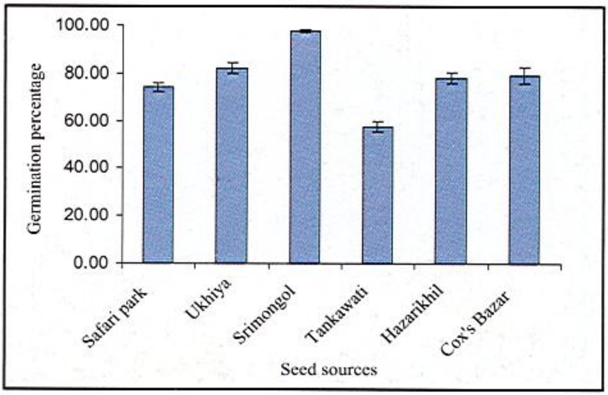



Figure 53: Germination percentage of civit seeds collected from different sources

In addition, civit seeds were collected from the selected Provisional Plus Trees (PPT) of Seed Orchard Division of Bangladesh Forest Research Institute at Ukhiya and Dulhazara. A series of experiments on seed biology were done in the nursery of the Institute (Figs. 54 - 59). Seedling Seed Orchard was established in the University Campus and seedlings were distributed to different organizations and individuals for domestication and popularization of civit.

Figure 54. Fresh de-winged civit seeds

Figure 55. Seeds start germination within 3 days

Figure 56. Polybags ready for sowing civit seeds

Figure 57. Civit seeds complete germination within 12 days

Figure 58. Civit seedlings after 50 days


Figure 59. Civit seedlings are ready for out-planting at the age of 12 months

## Determination of the viability of civit seeds (*S. floribunda*) in the nursery

Hundred percent germination was observed when seeds were sown immediately after collection. After storage of seeds in different storage conditions, 92.2% germination was observed at room temperature followed by storage at normal fridging condition (81.1%). But, there was no germination at all on deep fridging from first week till to fifth week (Table 4). Gradually germination reduces to 21.1% for seeds at room temperature, but optimal on normal fridging condition (77.8%). From third week, there was no germination observed in any of the treatments. Germination percentage, germination capacity, germination energy and germination potential of civit seeds are shown in Table 4.

Table 4. Determination of seed viability of civit *(S. floribunda)* in the nursery

| Seeds sown on | Treatments | Germination (%) | Germination capacity | Germination energy (%) | Germination potential |
|---|---|---|---|---|---|
| 1st week | Fresh seeds (02 days after collection) | 100 | very good | 100 | 90 |
| 2nd week | Seeds store at room temperature | 92.2 | very good | 96.7 | 87 |
| | Seeds store at normal fridge (3°C) | 81.1 | Good | 91.1 | 82 |
| | Seeds store at deep fridge (-14°C) | 0 | ...... | ..... | ..... |
| 3rd week | Seeds store at room temperature | 21.1 | Very poor | 21.1 | 19 |
| | Seeds store at normal fridge (3°C) | 77.8 | Good | 77.8 | 70 |
| | Seeds store at deep fridge (-14°C) | 0 | ...... | ..... | ..... |
| 4th week | Seeds store at room temperature | 0 | ...... | ..... | ..... |
| | Seeds store at normal fridge (3°C) | 0 | ...... | ..... | ..... |
| | Seeds store at deep fridge (-14°C) | 0 | ...... | ..... | ..... |
| 5th week | Seeds store at room temperature | 0 | ...... | ..... | ..... |
| | Seeds store at normal fridge (3°C) | 0 | ..... | | ..... |
| | Seeds store at deep fridge (-14°C) | 0 | ....... | ..... | ..... |
| 6th week | Seeds store at room temperature | 0 | ...... | ..... | ..... |
| | Seeds store at normal fridge (3°C) | 0 | ...... | ..... | ..... |
| | Seeds store at deep fridge (-14°C) | 0 | ...... | ..... | ..... |

### Germination of seeds with different seed grade/seed weight

An experiment with 4 different grades of seeds shows that highest germination (91.3%) was observed in large seeds ($T_0$) followed by medium seeds ($T_1$), random mixed seeds ($T_3$) and small seeds ($T_2$). Germination percentage, germination potential, germination energy and germination capacity of different weight classes of civit seeds are shown in Table 5.

Table 5. Germination behavior of civit seeds with size and weight (g)

| Treatments (average seed weight in gram) | Germination (%) | Germination capacity | Germination potential | Germination energy (%) |
|---|---|---|---|---|
| $T_0$ (Large seed, 2.0 - 2.05 g) | 91.3 | Very good | 138 | 92.0 |
| $T_1$ (Medium seed, 1.1 - 1.6 g) | 85.3 | Good | 142 | 94.7 |
| $T_2$ (Small seed, 0.5- 1.0 g) | 68.0 | Average | 140 | 93.3 |
| $T_3$ (Random mixed seed, 0.5 - 2.0 g) | 80.9 | Good | 137 | 91.3 |

### Relationship between seed size/weight and seedling height

This experiment was continued for the determination of seedlings height in relation to seed weight or size classes (Table 6). Seedling height was measured at twenty days interval. Highest mean height (11.5 cm) was observed in $T_0$ followed by $T_1$ (10.6 cm), $T_3$ (10.0 cm) which were significantly different from $T_2$ (8.2 cm). After another twenty days, it was observed that each treatment were significantly different from others. The highest mean height (17.6 cm) was observed with large seeds and was significantly different from $T_1$ (13.5 cm), $T_3$ (12.1 cm) and $T_2$ (10.7 cm). The highest mean height (60 cm) was observed in large seeds ($T_0$) after 150 days, followed by $T_1$ (53 cm), $T_3$ (43.5 cm) and lowest mean height was observed in $T_2$ (33.5 cm) and was significantly different from others at ($P<0.05$) (Table 6).

Table 6. Height increment (cm) of seedlings for each treatment at different time intervals up to 5 months

| | Height (cm) of the seedlings on | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatments | 14 May 2009 | 4 June 2009 | 24 June 2009 | 14 July 2009 | 3August 2009 | 23 August 2009 | 12 September 2009 |
| $T_0$ (Large seeds) | 11.5a* | 17.6a | 18.8a | 28.5a | 42.0a | 51.6a | 60.0a |
| $T_1$ (Medium seeds) | 10.6a | 13.5b | 14.2c | 21.5b | 31.6b | 43.0b | 53.0b |
| $T_2$ (Small seeds) | 8.2b | 10.7c | 11.9d | 13.9d | 19.4d | 20.2d | 33.5d |
| $T_3$ (Random seeds) | 10.0a | 12.1b | 16.3b | 18.4c | 29.5c | 35.3c | 43.5c |

(*) Means followed by the same letter(s) in the same column are not significantly different at $P<0.05$, Duncan's Multiple Range Test (DMRT).

## Seedling growth performance in relation with seed weight

Seedling growth parameters, e.g., shoot length, root length, total length, collar diameter and leaf number was assessed in relation to the seed weight. The mean shoot length of seedlings was highest (62.7 cm) with large seeds ($T_0$), followed by $T_1$ (52.8 cm), $T_3$ (42.2 cm) and $T_2$ (32.8 cm) and were significantly ($P<0.05$) different from each other (Table 7). Root length was highest in $T_0$ (12.5 cm), followed by $T_3$ (10.5 cm), $T_1$ (10.3 cm) treatments and lowest in $T_2$ (7.9 cm). Considering the collar diameter of seedlings, treatments $T_0$ (6.7 mm), $T_1$ (6.6 mm), $T_3$ (6.7 mm) attained the maximum collar diameter that were significantly different from $T_2$ (5.3 mm) at ($P<0.05$). The number of leaves was highest in medium seed origin seedlings, but the treatment variations were not statistically significant (Table 7).

Table 7. Effect of seed weight on seedling shoot length, root length, collar diameter and mean leaf number (after 5 months)

| Treatments | Shoot length (cm) | Root length (cm) | Total length (cm) | Collar diameter (mm) | Leaf number |
|---|---|---|---|---|---|
| $T_0$ (Large seeds) | 62.7 a* | 12.5 a | 75.2 a | 6.7 a | 21.0 a |
| $T_1$ (Medium seeds) | 52.8 b | 10.3 b | 63.2 b | 6.6 a | 25.7 a |
| $T_2$ (Small seeds) | 32.8 d | 7.9 c | 40.8 d | 5.3 b | 20.7 a |
| $T_3$ (Random mixed seeds | 42.2 c | 10.5 b | 52.7 c | 6.7 a | 21.0 a |

(*) Means followed by the same letter(s) in the same column are not significantly different at $P<0.05$, Duncan's Multiple Range Test (DMRT).

The oven dry weight of seedling components (root, shoot and leaves) of different treatments were statistically analyzed (Table 8). Mean shoot dry weight was highest (3.8 g) in large seeds ($T_0$) and significantly different ($P<0.05$) from $T_1$ (2.7 g), $T_3$ (1.3 g). The lowest shoot dry weight was observed in $T_2$ (0.3 g). Similarly, mean root dry weight was highest in $T_0$ (1.7 g), followed by that in $T_3$ (1.3 g), $T_1$ (1.2 g), and significantly different from $T_2$ (0 g). Again, leaf dry weight was highest in $T_0$ (3.2 g), followed by $T_3$ (3.0 g), $T_1$ (2.3 g) and significantly different from $T_2$ (2.0 g) at ($P<0.05$). Total biomass was highest (8.7 g) in large seeds ($T_0$), followed by that in $T_1$ (6.2 g), $T_3$ (5.5 g) and significantly ($P<0.05$) lowest in $T_2$ (2.3 g). Seedling Quality Index (QI) was highest (0.3) in $T_0$ followed by that in $T_1$ (0.1), $T_3$ (0.1) and lowest in $T_2$ (0.03) and significantly ($P<0.05$) different from other treatments (Table 8).

Table 8. Effect of seed weight on shoot dry weight, root dry weight, leaves dry weight, total dry weight and quality index of civit seedlings

| Treatments | Shoot dry weight (g) | Root dry weight (g) | Leaf dry weight (g) | Total dry weight (g) | Quality Index |
|---|---|---|---|---|---|
| $T_0$- Large (2.0-2.05 g) | 3.8 a* | 1.7 a | 3.2 a | 8.7 a | 0.3 a |
| $T_1$- Medium (1.1-1.6 g) | 2.7 ab | 1.2 a | 2.3 ab | 6.2 b | 0.1 b |
| $T_2$- small (0.5-1.0 g) | 0.3 c | 0 b | 2.0 b | 2.3 c | 0.03 c |
| $T_3$- Random (0.5-2.0 g) | 1.3 bc | 1.3 a | 3.0 a | 5.5 b | 0.1 b |

(*) Means followed by the same letter(s) in the same column are not significantly different at $P<0.05$, Duncan's Multiple Range Test (DMRT).

**Comparative growth performance of seedlings grown on different containers**

The study was conducted for the determination of growth performance of civit seedlings grown in different types of containers (polybags and root trainers). Three different sizes of polybags (30 x 23 cm, 23 x 15 cm and 15 x 10 cm) and root trainer (one root trainer having 40 cavities) were used as treatments to investigate their effects on the seedling growth in the nursery. Highest germination (96 %) was observed in $T_2$ followed by $T_0$ (94.4 %), $T_3$ (93.8 %) and $T_1$ (90.7 %) (Table 9). The germination capacities of the treatments were not significantly different. Germination percentage, germination potential, germination energy and germination capacity are shown in Table 9.

Table 9. Effect of container size and type on seed germination of civit

| Treatments | Germination (%) | Germination energy (%) | Germination potential | Germination capacity |
|---|---|---|---|---|
| $T_0$ (Large polybag-30 x 23 cm) | 94.4 | 100 | 90 | Very good |
| $T_1$ (Medium polybag- 23 x 15 cm) | 90.7 | 98 | 147 | Very good |
| $T_2$ (Small polybag- 15 x 10 cm) | 96.0 | 99.3 | 149 | Very good |
| $T_3$ (Root trainer) | 93.8 | 100 | 160 | Very good |

**Growth performance of civit seedlings grown in different containers**

Civit seedling growth parameters, e.g., shoot length, root length, collar diameter and leaf number was assessed for the seedlings grown in the nursery. The mean shoot length of seedlings was highest (63.5 cm) in $T_1$, followed by that in $T_3$ (62.0 cm) and $T_2$ (60.7 cm) and was significantly different from $T_0$ (51.2 cm) (Table 10). Root length was longest (15.0 cm) in $T_0$, followed by that in $T_3$ (14.0 cm) and was significantly different from $T_1$ (13.7 cm). It was the shortest (10.0 cm) in $T_2$ treatment at ($P<0.05$). Similarly, the total length of the seedlings was highest for $T_1$ (77.2 cm) and lowest for $T_0$ (66.2 cm). The collar diameter of seedlings was the highest in $T_1$ (7.2 mm), followed by that in $T_0$ (6.7 mm) and $T_2$ (6.4 mm) was significantly different ($P<0.05$) from $T_3$ (5.9 mm).

The number of leaves in each treatment was also significantly different in each treatment ($P<0.05$), highest number was found in $T_1$ (30 numbers) and was significantly different from $T_0$ (27.7 numbers). Lowest leaf was observed in $T_2$ (21.7 leaf) and $T_3$ (21.3 leaf) (Table 10).

Table 10. Effects of container type and size on seedling shoot length, root length, collar diameter and mean leaf numbers

| Treatments | Shoot length (cm) | Root length (cm) | Total length (cm) | Collar diameter (mm) | Leaf number |
|---|---|---|---|---|---|
| $T_0$ (Polybag - 30 x 23 cm) | 51.2b* | 15.0a | 66.2c | 6.7b | 27.7b |
| $T_1$ (Polybag - 23 x 15 cm) | 63.5a | 13.7b | 77.2a | 7.2a | 30.0a |
| $T_2$ (Polybag - 15 x 10 cm) | 60.7a | 10.0c | 70.7b | 6.4b | 21.7c |
| $T_3$ (Root trainer) | 62.0a | 14.0a | 76.0a | 5.9c | 21.3c |

(*) Means followed by the same letter(s) in the same column are not significantly different at $P<0.05$. Duncan's Multiple Range Test (DMRT).

## Experiment on sowing positions of civit seeds and seedling growth behavior

Germination of seeds is also influenced by sowing position of seeds. Civit seeds however, rapidly lose its viability. So, sowing position of seeds may play a vital role in germination and initial growth of the seedlings. Sowing depth is an important factor in germination. Increased sowing depth of civit seeds in nursery declined germination rate. The present investigation was, thus, undertaken to determine the effect of sowing orientation of seed on germination and seedling development.

### Seed germination and development of seedlings

Seed germination trials of civit were conducted by sowing single seed in each polythene bag (15 x 10 cm) filled with normal forest top soil with cowdung in a ratio of 3:1. Seeds were sown in seven different positions or treatments (Table 11). In each position, 150 seeds were sown with 3 replications followed by a Randomized Complete Block Design. Counting of seed germination was continued till no more germination was observed. Germination of seed is epigeous (epi, upon; ge, earth). The cotyledons are seen to be pushed upwards by rapid elongation of the hypocotyle (hypo, below), i.e., the portion of the axis lying immediately below the cotyledons. It was seen that the germination percentage of civit seeds was more in horizontal and vertical orientations than in inverted positions. Seeds left on the polybag with the wing showed the poorest germination percentage. Best germination (99 to 100%) was observed in vertical both in half and full buried orientations. In case of vertical orientations radicle remained into the soil and plumule emerged normally, that

Figure 64. Straight root system

Figure 65. Tap root slightly undulating

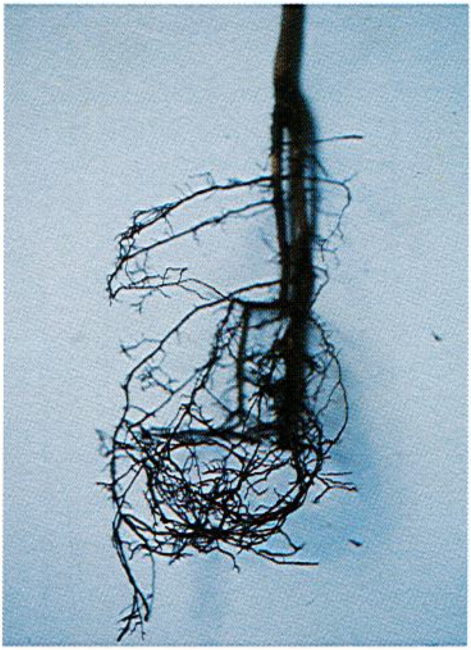


Figure 66. Cluster root formation

**Development of a hedge bed/ stock plant management system to allow continuous supply of juvenile shoots for vegetative propagules**

Eight hedge beds of civit seedlings were established in the Institute nursery with 25 individuals from mixed stands, 45 seedlings from Cox's Bazar, 24 from Tonkawati, 24 from Hazarikhil, 24 from Cox's Bazar, 20 from Bangabandhu Safari park at Dulhazara, 20 from Ukhiya and 20 from Satgaon Tea Estates of Śrimongal (Fig. 67, 68). The hedgebed establishment was aimed to continuously supply juvenile shoots for setting of further clonal experiments, and studies on the coppicing ability of the stock plants. A propagator house was established for setting experiments with the civit cuttings in the nursery (Fig. 69, 70).


Figure 67. Civit hedge bed established in 2006


Figure 68. Civit hedge bed established in 2007


Figure 69. Propagator house for the experiments of clonal planting materials

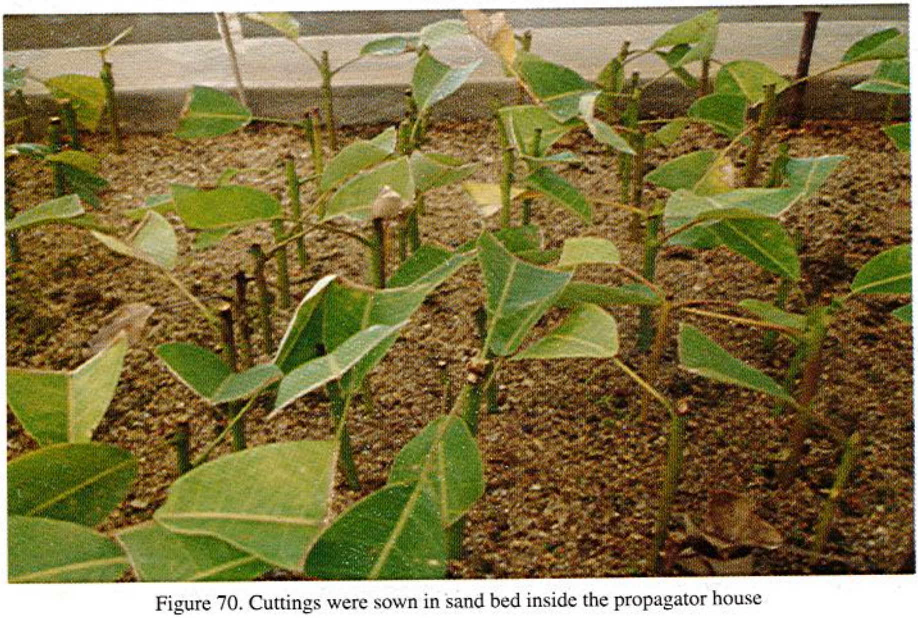


Figure 70. Cuttings were sown in sand bed inside the propagator house

## Optimization of the clonal methods for obtaining maximum number of planting propagules

Cuttings were collected from both the hedge beds established in the nursery (young saplings) and natural forests of Rajghat Bcat (mature tree). The cuttings were set in the propagator house for rooting experiments. Shoots were collected from stock plants and graded as soft, semi hard and hard based on hardness of the young shoot. The cutting size varied from 8.0 to 16.0 cm. The cutting diameter varied from 1.9 to 4.7 mm for soft shoot, 2.2 to 5.6 mm for semi hard shoot and 3.0 to 7.8 mm for hard shoots. The cuttings were planted in sand bed of propagator house for the initiation of root and shoot. Root initiation hormone, e.g., Indole Acetic Acid (IAA), Indole Butryic Acid (IBA) and Rhizodix were used for root initiation of the cuttings.

### Rooting percentage of civit cuttings

Rooting percentage of cuttings taken from 2 years old stock-plants varied from 16.7% (2000 ppm IAA) to 62.5% (2500 ppm IBA) (Fig. 71.). Rooting percentage was highest (62.5%) at 2500 ppm followed by 3000 ppm (53.9%), 2000 ppm (46.2%), 3500 ppm (37.5%), 4000 ppm (33.3%) of IBA solution. Rooting percentage was highest (50.0%) at 3000 and 3500 ppm followed by 4000 ppm (37.5%), 2500 ppm (33.3%), and 2000 ppm (16.7%) of IAA solution. Rooting percentage was highest (53.9%) at 2500 ppm followed by 3000 ppm (46.2%), 2000 ppm (45.8%), 3500 ppm (41.7%) and 4000 ppm (30.8%) of Rhizodix solution. The mean rooting percentage of civit cuttings treated with 2500 ppm IBA, 3000 and 3500 ppm IAA and 3000 ppm Rhizodix solution was significantly ($P<0.05$) higher within different concentrations of same hormone. However, mean rooting percentage of civit cuttings treated with 2500 ppm IBA was significantly ($P<0.05$) higher among different concentrations of three hormones (IBA, IAA and Rhizodix).

### Development of root and root number in civit cuttings

Mean root number of civit cuttings varied from 1.3 to 3.8 in different treatments (Fig. 72). The root number significantly enhanced due to the effect of applied auxins. Highest number of root (3.8) was developed in 3000 ppm Rhizodix treated cuttings and lowest (1.3) in cuttings treated with 4000 ppm IAA. With IBA solution, mean highest root number was 3.7 at 2500 ppm followed by 3000 ppm (3.3), 2000 ppm (2.7), 3500 ppm (2.3), and 4000 ppm (1.7). With IAA solution, root number was highest (2.3) at 3000 ppm followed by 2500 ppm (2.3), 3500 ppm (1.9), 2000 ppm (1.8) and 4000 ppm (1.3). With Rhizodix solution, root number was highest (3.8) at 3000 ppm followed by 2500 ppm (3.2), 2000 ppm (2.9), 3500 ppm (1.8) and 4000 ppm (1.5). The mean root number of civit cuttings treated with 2500 ppm IBA, 3000 ppm IAA and 3000 ppm Rhizodix solution was significantly ($P<0.05$) higher within different concentrations of same hormone. Mean root number of civit cuttings treated with 2500 ppm IBA and 3000 ppm Rhizodix showed no significant difference between them (Fig. 72). Cuttings treated with these concentrations (2500 ppm IBA and 3000 ppm Rhizodix) showed significantly ($P<0.05$) higher root number than other concentrations of three hormones (IBA, IAA and Rhizodix).

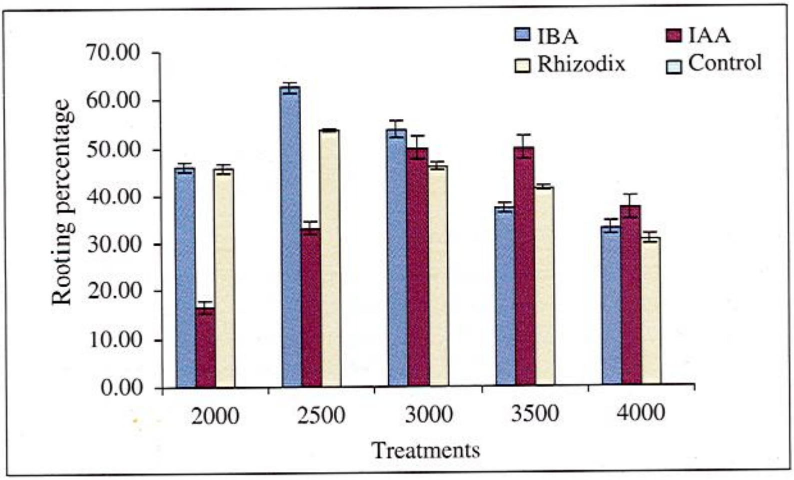



Figure 71. Rooting percentage of cuttings of civit with different concentrations of IBA, IAA and Rhizodix solution with control (No rooting in control)

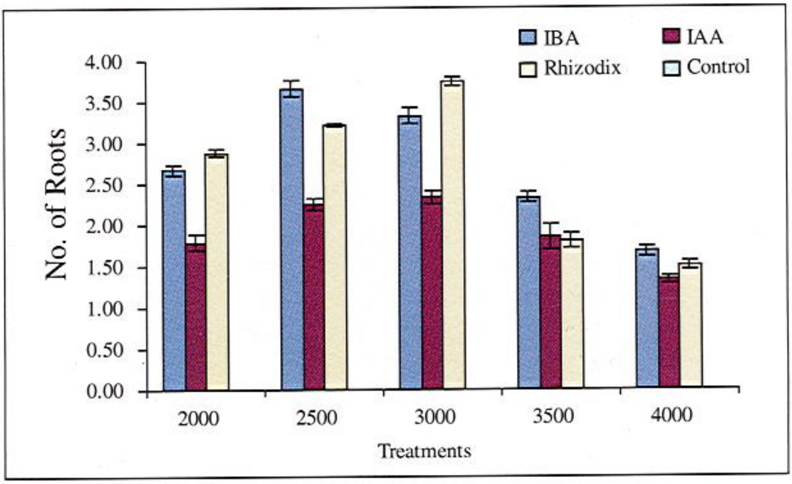



Figure 72. Root number of cuttings of civit with different concentrations of IBA, IAA and Rhizodix solution with control (No rooting in control)

**Rooting percentage of civit cuttings collected from hedgebed**

In another experiment, rooting percentage of cuttings taken from hedge bed stock-plants varied from 18.8 % (control with hard shoot) to 75.0 % (3500 ppm IBA with soft shoot) (Table 12). However, the rooting percentage did not follow any definite trends.

Table 12. Rooting % of civit cuttings with different shoot types and concentrations of IAA, IBA and Rhizodix solution with control treatments

| Treatments | Shoot type | Concentration of IAA, IBA and Rhizodix (ppm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 (Control) | 2000 | 2500 | 3000 | 3500 | 4000 |
| IAA | Soft | 28.6 | 35.7 | 57.1 | 50.0 | 57.1 | 64.3 |
| | Semi hard | 43.8 | 50.0 | 43.8 | 56.3 | 62.5 | 68.8 |
| | Hard | 23.1 | 38.5 | 61.5 | 30.8 | 38.5 | 46.2 |
| IBA | Soft | 50.0 | 46.4 | 64.3 | 71.3 | 75.0 | 53.6 |
| | Semi hard | 39.3 | 50.0 | 42.9 | 46.4 | 53.6 | 50.0 |
| | Hard | 28.6 | 33.3 | 47.6 | 52.4 | 38.1 | 52.4 |
| Rhizodix | Soft | 36.4 | 40.9 | 45.5 | 50.0 | 54.6 | 59.1 |
| | Semi hard | 40.0 | 50.0 | 60.0 | 65.0 | 55.0 | 40.0 |
| | Hard | 18.8 | 25.0 | 25.0 | 31.3 | 18.8 | 37.5 |

**Rooting percentage of civit cuttings collected from natural forests**

Civit cuttings were collected from mature trees of Rajghat natural forest beat and the cuttings were set in the propagator house for rooting experiments. Shoots were graded as soft, semi hard and hard on the basis of hardness. The cuttings were treated with various concentrations of IAA, IBA and Rhizodix and compared with the control. The rooting percentage of civit cuttings taken from mature trees of natural forest did not change with the application of exogenous hormone (IAA, IBA and Rhizodix). Hence, the rooting percentage of cuttings was zero (Table 13). This indicates that the cuttings or shoots of civit from mature trees are not able to produce root.

Table 13. Rooting % of civit cuttings collected from mature trees of Rajghat natural forest with different shoot types (soft, semi hard and hard) and various concentrations of IAA, IBA and Rhizodix solution and control

| Treatments | Shoot type | No. of cuttings inserted | | | | | | Total Inserted cuttings | Rooted cuttings (No.) | Rooting (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Concentrations (ppm) | | | | | | | | |
| | | 0 (Control) | 2000 | 2500 | 3000 | 3500 | 4000 | | | |
| IAA | Soft | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Semi hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| IBA | Soft | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Semi hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| Rhizodix | Soft | 6 | | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Semi hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |
| | Hard | 6 | 6 | 6 | 6 | 6 | 6 | 36 | 0 | 0 |

**Variation of rooting percentage of civit cuttings among different sources (Provenances)**

Highest rooting percentage of civit cuttings was found in cuttings taken from the provenances of Cox's Bazar and lowest in the Srimongal provenances (Table 14). Though the rooting percentage of all provenances did not follow any definite trend, but application of root hormone enhances the rooting percent (Table 14).

Table 14. Rooting % of cuttings of civit taken from different provenances (established in hedge bed) with various concentrations of IBA solution and control.

| Provenances | Concentrations of IBA solution (ppm) | | | | | |
|---|---|---|---|---|---|---|
| | 0 (Control) | 2000 | 2500 | 3000 | 3500 | 4000 |
| Cox's Bazar | 28.6 | 71.4 | 42.9 | 57.1 | 71.4 | 42.9 |
| Safari Park | 14.3 | 28.6 | 57.1 | 42.9 | 57.1 | 42.9 |
| Srimongol | 14.3 | 28.6 | 42.9 | 28.6 | 42.9 | 28.6 |
| Hazarikhil | 14.3 | 42.9 | 28.6 | 42.9 | 57.1 | 57.1 |
| Tankawati | 28.6 | 71.4 | 42.9 | 57.1 | 42.9 | 28.6 |

**Variations in root length (cm) of civit cuttings**

Highest mean root length (cm) of civit cuttings was found in soft and semi-hard shoots and lowest in hard shoots and highest root length was found in Rhizodix treated cuttings and lowest in control treatments (Table 15).

Table 15. Mean root length (cm) of civit cuttings with different shoot types (soft, semi hard and hard) and various concentrations of IAA, IBA and Rhizodix solution and control treatments

| Treatments | Shoot type | Concentrations of IAA, IBA and Rhizodix solution (ppm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 (Control) | 2000 | 2500 | 3000 | 3500 | 4000 |
| IAA | Soft | 7.3 | 4.5 | 7.4 | 6.3 | 3.2 | 6.9 |
| | Semi hard | 7.7 | 11.4 | 6.2 | 9.0 | 7.9 | 7.4 |
| | Hard | 3.3 | 4.5 | 3.0 | 6.0 | 5.0 | 5.8 |
| IBA | Soft | 7.3 | 6.1 | 7.1 | 7.5 | 6.1 | 7.5 |
| | Semi hard | 4.1 | 5.9 | 5.4 | 4.9 | 6.4 | 5.9 |
| | Hard | 3.8 | 5.6 | 5.5 | 4.9 | 5.3 | 2.8 |
| Rhizodix | Soft | 8.2 | 6.0 | 8.7 | 8.4 | 7.1 | 7.0 |
| | Semi hard | 7.6 | 7.6 | 5.7 | 5.9 | 5.2 | 4.8 |
| | Hard | 2.5 | 4.3 | 5.0 | 7.4 | 5.8 | 2.5 |

**Survival percentage of rooted cuttings of civit in polybags**

Steckling capacity, i.e., the survival ability of the cuttings (rooted cuttings) after transferring into polybags in the nursery was also studied. To explore the survival and initial growth performance, the rooted cuttings were placed in shade for a week. Then the cuttings were placed under direct sunlight and allowed to grow for three months (Fig. 73). Survival percentage of rooted cuttings of civit after transferring to the polybags is shown in Table 16. After transferring the seedlings

Figure 73. Stecklings in the polybag of Institute nursery

from propagator house to polybags, mortality was significant in control treatments in comparison to the root hormone treatments. Maximum survival (34%) was found in the cuttings treated with IAA and IBA (Table 16).

Table 16. Mean survival % of rooted cuttings of civit with different shoot types (soft, semi hard and hard) and various concentrations of IAA, IBA and Rhizodix solution and control treatments

| Shoot type | Treatments | | | | | Mean |
|---|---|---|---|---|---|---|
| | IAA | IBA | Rhizodix | Sugar | Control | |
| Soft | 40.5 | 42.8 | 23.5 | 28.1 | 6.7 | 28.3 |
| Semi hard | 34.7 | 36.9 | 38.3 | 27.7 | 8.1 | 29.1 |
| Hard | 27.2 | 22.9 | 19.0 | 8.1 | 4.2 | 16.3 |
| Mean | 34.1 | 34.2 | 26.9 | 21.3 | 6.3 | |

**Sprout production**

Sprout production potential of civit from the hedge plant is variable. However, average highest sprout production (22.9) after 30 days per tree was found in 3 years old stock plants and lowest in 2 years old stock plants (Table 17). Lowest (10.6) shoot production in 2 years old hedge bed may be due to the effect of original seedlings growth and frequencies of cuttings (Table 17).

Table 17. Mean sprout production (number) per tree after different days of topping at 1-3 years old stock plants

| Age of stock plant (years) | Mean sprout production per tree after days of topping | | |
|---|---|---|---|
| | 10 Days | 20 Days | 30 Days |
| 3 | 2.4 | 13.6 | 22.9 |
| 2 | 0.6 | 4.9 | 10.6 |
| 1 | 1.1 | 8.1 | 14.1 |

Shoot production also varies with the time of cut and also total height (m) and collar diameter (mm) of the hedge plants (Table 18). Hedge beds established in 2006 showed that first cut produces a total of 502 shoots, whereas 5th cut produces only 363 coppice shoots (Table 18). Reduction of the coppice shoots production may be due to the frequent cutting cycles and seasons of the year that influences the shoot production potential.

Table 18. Height, collar dia. and shoot production potential of Cox's Bazar 2006 hedge beds in the nursery

| Cox's Bazar 2006 (1st cut) | | | | Cox's Bazar 2006 (5 th cut) | | | |
|---|---|---|---|---|---|---|---|
| Tree no. | ht (m) | Collar dia (mm) | Shoot produced (no.) | Tree no. | ht (m) | Collar dia. (mm) | Shoot produced (no.) |
| 01 | 2.3 | 6.0 | 9 | 01 | 1.05 | 15 | 15 |
| 02 | 2.1 | 5.5 | 19 | 02 | 1.02 | 13 | 11 |
| 03 | 1.3 | 4.5 | 7 | 03 | 0.9 | 11 | 5 |
| 04 | 1.0 | 5.0 | 4 | 04 | 0.46 | 9 | 1 |
| 05 | 2.0 | 3.3 | 24 | 05 | 1.07 | 15 | 29 |
| 06 | 2.5 | 6.5 | 15 | 06 | 1.09 | 16 | 24 |
| 07 | 1.5 | 6.0 | 4 | 07 | 0.8 | 7 | 3 |
| 08 | 2.2 | 3.3 | 16 | 08 | 1.05 | 14 | 14 |
| 09 | 1.8 | 5.6 | 3 | 09 | 0.9 | 8 | 2 |
| 10 | 2.6 | 4.3 | 16 | 10 | 1 | 16 | 18 |
| 11 | 1.9 | 6.2 | 29 | 11 | 1.02 | 14 | 19 |
| 12 | 3.4 | 5.2 | 50 | 12 | 1.05 | 21 | 40 |
| 13 | 1.9 | 8.5 | 12 | 13 | 1 | 5 | 5 |
| 14 | 2.0 | 2.1 | 8 | 14 | 1.02 | 5 | 13 |
| 15 | 2.5 | 2.0 | 13 | 15 | 0.9 | 12 | 14 |
| 16 | 2.3 | 4.3 | 18 | 16 | X | X | X |
| 17 | 2.5 | 2.0 | 44 | 17 | 1.02 | 18 | 21 |
| 18 | 2.1 | 6.5 | 16 | 18 | 0.9 | 11 | 14 |
| 19 | 3.2 | 4.0 | 27 | 19 | 1.02 | 16 | 20 |
| 20 | 2.5 | 6.0 | 34 | 20 | 1.04 | 16 | 21 |
| 21 | 2.5 | 6.1 | 24 | 21 | 1.02 | 10 | 11 |
| 22 | 2.9 | 4.3 | 38 | 22 | 1.03 | 19 | 23 |
| 23 | 2.5 | 7.0 | 25 | 23 | 1.05 | 10 | 11 |
| 24 | 2.5 | 5.0 | 15 | 24 | 1.03 | 10 | 12 |
| 25 | 2.8 | 5.1 | 32 | 25 | 1.03 | 12 | 17 |
| Total | | | **502** | | | | **363** |

Similarly, shoot (sprout) production potential also depends on cutting cycle and season of the year (Table 19). Maximum shoot production was found in 3 years old hedge beds after 8 weeks of the cut. Though the shoot production was maximum after 6 weeks, but for maturity it is better to be cut after 8 weeks.

Table 19. Sprout production number also depends on cutting cycle and season of the year

| Shoot cut from | Shoot production at | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Cox's Bazar, 2006** | 1st wk | 2nd wk | 3rd wk | 4th wk | 5th wk | 6th wk | 7th wk | 8th wk |
| 1st cut (16.8.09) | 0 | 1 | 7 | 15 | 18 | 19 | 19 | 20 |
| 2nd cut (7.11.09) | 0 | 3 | 7 | 12 | 16 | 17 | 18 | 18 |
| 3rd cut (21.3.10)) | 2 | 8 | 11 | 15 | 16 | 16 | 17 | 17 |
| 4th cut (16.6.10) | 0 | 1 | 3 | 7 | 8 | 9 | 10 | 10 |
| **Cox's Bazar, 2007** | | | | | | | | |
| 1st cut (17.8.09) | 0 | 1 | 3 | 7 | 7 | 8 | 8 | 8 |
| 2nd cut (8.11.09) | 0 | 1 | 3 | 6 | 7 | 8 | 8 | 9 |
| 3rd cut (22.3.10) | 1 | 3 | 7 | 7 | 7 | 8 | 8 | 9 |
| 4th cut (17.6.10) | 0 | 1 | 2 | 4 | 5 | 6 | 6 | 7 |
| **Safari park, 2008** | | | | | | | | |
| 1st cut (18.8.08) | 0 | 0 | 2 | 7 | 7 | 8 | 9 | 10 |
| 2nd cut (8.11.09) | 0 | 1 | 2 | 3 | 5 | 4 | 5 | 6 |
| 3rd cut (22.3.10) | 1 | 5 | 6 | 8 | 9 | 9 | 10 | 10 |
| 4th cut (17.6.10) | 0 | 0 | 1 | 4 | 5 | 5 | 6 | 7 |
| **Ukhiya, 2008** | | | | | | | | |
| 1st cut (18.8.09) | 0 | 0 | 1 | 3 | 3 | 3 | 2 | 2 |
| 2nd cut (8.11.09) | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 4 |
| 3rd cut (24.3.10) | 1 | 2 | 3 | 4 | 4 | 5 | 5 | 5 |
| 4th cut (19.6.10) | 0 | 0 | 0 | 1 | 2 | 2 | 3 | 3 |
| **Srimongal, 2008** | | | | | | | | |
| 1st cut (19.8.09) | 0 | 0 | 3 | 6 | 6 | 7 | 7 | 7 |
| 2nd cut (9.11.09) | 0 | 1 | 2 | 5 | 8 | 9 | 10 | 11 |
| 3rd cut (24.3.10) | 1 | 3 | 5 | 6 | 8 | 9 | 14 | 10 |
| 4th cut (19.6.10) | 0 | 0 | 2 | 5 | 5 | 6 | 6 | 7 |
| **Hazarikhil, 2008** | | | | | | | | |
| 1st cut (18.8.09) | 0 | 0 | 1 | 5 | 7 | 8 | 9 | 9 |
| 2nd cut (10.11.09) | 0 | 1 | 1 | 4 | 7 | 7 | 8 | 9 |
| 3rd cut (28.3.10) | 1 | 4 | 7 | 8 | 8 | 10 | 10 | 11 |
| 4th cut (20.610) | 0 | 0 | 1 | 4 | 5 | 6 | 7 | 8 |
| **Tonkwati, 2008** | | | | | | | | |
| 1st cut (18.8.09) | 0 | 0 | 3 | 7 | 7 | 7 | 7 | 7 |
| 2nd cut (10.11.09) | 0 | 1 | 1 | 4 | 5 | 6 | 6 | 7 |
| 3rd cut (28.3.10) | 1 | 4 | 5 | 6 | 6 | 7 | 7 | 8 |
| 4th cut (19.6.10) | 0 | 0 | 2 | 4 | 5 | 5 | 6 | 7 |
| **Cox's Bazar, 2008** | | | | | | | | |
| 1st cut (19.8.09) | 0 | 0 | 4 | 11 | 12 | 12 | 13 | 13 |
| 2nd cut (9.11.09) | 0 | 1 | 5 | 11 | 16 | 17 | 17 | 17 |
| 3rd cut (27.3.10) | 1 | 7 | 13 | 15 | 16 | 16 | 17 | 17 |
| 4th cut (20.6.10) | 0 | 0 | 3 | 8 | 9 | 12 | 11 | 12 |

## Comparative growth performance of seedlings and stecklings grown in the nursery compound

A small block plantation of both the seed origin seedlings and stecklings of civit were established in the campus. The growth performance of both the seed origin seedlings and stecklings are shown in Table 20.

Table 20: Mean height (m) and dbh (cm) of seedlings and stecklings in the experimental plot of Institute nursery

| Types | Height (m) | | | | | dbh (cm) |
|---|---|---|---|---|---|---|
| Months → | 3 | 6 | 9 | 12 | 36 | 36 |
| Seedlings | 0.42 | 0.50 | 0.87 | 1.44 | 4.15 | 3.4 |
| Stecklings | 0.14 | 0.22 | 0.28 | 0.53 | 2.23 | 2.0 |

## Growth of civit plantations established in Seedling Seed Orchard at Chittagong University Campus

Two seedling seed orchard plantations (1.0 ha and 0.6 ha) were established in the campus in 2008 and 2009 (Fig. 74, 75) Another 25 seedlings were planted in 2007 besides the IFES Director's office. The growth data of these young plantations established in the University campus are shown in Table 21. The initial data indicates that civit is a moderate fast-growing species at the early stage of their life cycle.

Figure 74. Civit Seedling Seed Orchards established in 2008 at University Campus

Figure 75. Civit Seedling Seed Orchards established in 2009 at University Campus

Table 21. Height and dbh of civit seedlings established in the University campus

| Year of establishment and age | ht (m) | ht (m) up to 1st branch | dbh (cm) |
|---|---|---|---|
| 2007 (4 yrs) | 6.5 | 1.8 | 6.4 |
| 2008 (3 yrs) | 5.9 | 2.0 | 7.1 |
| 2009 (2 yrs) | 4.1 | 1.6 | 3.8 |

## Growth and yield of civit planted in different sites of Bangladesh

The growth and yield data of civit are very scarce, though volume table of civit was developed by Islam (1984). However, few individuals planted in different site conditions show that if the plantations are managed properly, the growth is promising particularly in the early stage of the plantations (Table 22).

Table 22. Growth and development of civit in different plantation sites of Bangladesh

| Age (yrs) | Total ht (m) | dbh (cm) | Plantation site(s) |
|---|---|---|---|
| 2 | 4.1 | 3.8 | Chittagong University campus |
| 3 | 5.9 | 7.1 | Chittagong University campus |
| 4 | 6.5 | 6.4 | Chittagong University campus |
| 4 | 6.7 – 8.5 | 5.5 – 14.5 | Botanical garden of BAU, Mymensingh |
| 5 | 7.3 | 7.9 | Chittagong University campus |
| 7.5 | 8.1 | 8.8 | Sitakunda Bot. Garden and Ec-opark |
| 10 | 16.0 – 17.0 | 9 – 15 | Botanical garden of BAU, Mymensingh |
| 19 | 16.0 | 28.3 | National Botanical Garden at Mirpur |
| 20 | 12.9 – 15.0 | 23.7 – 37.8 | In front of Padua Forest Rest house |
| 23 | 21.2 | 41.6 | Satgaon Tea Estate, Srimongal |
| 36 | 23.4 | 54.3 | National Botanical Garden at Mirpur |

## Utilization of civit wood

### General characteristics of the wood

Civit wood more or less resembles mango wood (Anon. 1976). Wood is coarse textured, grey colored which resembles superficially to that of the soft maple (*Acer* spp.), but has more pronounced vessel lines which form a fleck on the radial surface. The wood sometimes has purplish cast, frequently with pale brown lines along the grain which owe their origin to tangential bands of parenchyama. The heartwood is not very distinct from sapwood (Trotter 1982) and is lustrous when first exposed but is subject to stain, working is smooth without characteristic odour, taste, light weight (approx. 0.53), straight gained, even and rather coarse textured (Das 1984).

The vessels are large to medium sized, the orifices are plainly visible by the naked eye, which forms a board conspicuous light brown vessels lines along the grain, open or occluded with tyloses with light brown vessels. Tangential band soft parenchyma is present which are broken or more or less continuous. Grains are interlocked. Sapwood is lighter colored and not well defined (Fig. 76).

### Mechanical properties of wood

Civit is a moderately strong but relatively soft timber. The physical and the mechanical properties of the wood are based on mature heartwood specimens. These properties vary greatly depending on the origin and growth condition. Wood is moderately stable.

### Seasoning

The timber does not split in seasoning, but is very stable to develop stain. The logs should be converted as soon as felling and the sawn stock should be openstacked under cover with plenty of ventilation. If rapid conversion is not possible, the logs should be kept in the floating stream until they can be converted.

## Machining properties

The wood is very difficult to saw or cross-cut. The nailing property ranges from good to very poor depending on the species.

## Durability and adaptability

Wood is not durable in exposed positions on land, but fairly durable in contact with water or under cover. Wood is susceptible to fungal attack, dry wood borers and termites.

## Working Quality

Civit wood is relatively easy to saw, though the saw is somewhat liable to bend due to the fibrous nature of the timber.

## Uses

Civit wood is used for the construction of sailing ship, boats, and dugouts and especially suitable for the hulls and keels. It is also used for making match stick boxes and splints. Timber is suitable for making veneer plywood, pulping, furniture, furniture component of block boards, interior joinery and interior paneling (Razzaque and Das 1969, Yakub et al. 1970, Qasem and Hoque 1972, Salehuddin and Azizullah 1977, Sattar 1980, 1981). In Bangladesh, there are general standard rules for using civit wood (BSTI 1983). Local people are using the timbers for making houses also (Fig. 77). In the market, civit wood is not available except some seized produces coming from the auctions (Fig. 78).


Figure 76. Sapwood is lighter in colour than heartwood

Figure 77. Civit wood used for making local houses in Cox's Bazar

Figure 78. Seized civit sawn planks in front of a forest office

## Restoration and recolonization of civit through distribution of seedlings to different individuals, Organizations and Institutes

### Distribution of civit seedlings in 2008

In an aim to restoration and recolonization of civit, seedlings were raised in the nursery of the Institute and distributed to different organizations and stakeholders during 2008 - 2011. In 2008, about 1,600 civit seedlings were distributed to the following organizations for extension programs (Table 23).

Table 23. Seedlings distributed to the organizations for plantation program in 2008

| Organizations | Seedlings distributed |
|---|---|
| Sitakunda Eco park and Botanical Garden | 50 |
| BCSIR Chittagong at Baluchara | 50 |
| CODEC (Chandanaish and Dohazari) | 1,500 |

### Distribution of civit seedlings in 2009

In 2009, the following number of seedlings were distributed to the interested individuals and organizations (Table 24).

Table 24. Number of seedlings distributed to the organizations/individuals for plantation program in 2009

| Organizations/ Stakeholders | Seedlings distributed | Organization/ Stakeholders | Seedlings distributed |
|---|---|---|---|
| Mirpur Botanical Garden | 10 | Bangabandhu Safari Park, Dulhazara | 50 |
| DFO CHT (N), Rangamati | 100 | DFO Cox's Bazar (S) Forest Division | 250 |
| CODEC (Chandanaish and Patiya) | 3000 | Chittagong (N) Forest Division | 2000 |
| Mr. Faid Ahmed, Fatehpur Hathazari | 20 | Prottyashi, Mirersoroi | 200 |
| Md. Jamal, Fatehpur, Hathazari | 20 | Mr. Debashih Babu, Alir Dargah Hathazari | 200 |
| PHP Chittagong | 300 | Mr. Ali Ahmed, Jangle para Hathazari | 10 |
| BIRAM, Khagrachari | 200 | CF Chittagong circle | 10 |
| Sitakunda Ecopark and Botanical Garden | 50 | | |
| **Total** | | | **6,420** |

### Distribution of civit seedlings in 2010

In 2010, the following number of seedlings were distributed to the interested individuals and organizations (Table 25).

Table 25. Number of seedlings distributed to the organizations/individuals for plantation program in 2010

| Organization/ Stakeholders | Seedlings distributed | Organization/ Stakeholders | Seedlings distributed |
|---|---|---|---|
| Jahangir Nagar University | **20** | Bangladesh National Herbarium | **02** |
| Mirpur National Botanical Garden | **08** | Botany Department, Dhaka University | **04** |
| Baldah Garden, Dhaka | **02** | DFO Office compound Moulavibazar | **05** |
| Shahjalal Sci. & Technology University | **05** | Tila garh Ecopark Sylhet | **02** |
| Murari Chand College, Sylhet | **03** | Banskhali Eco-Park, Chittagong | **200** |
| Chandpur Belgao Tea Est. Banskhali | **500** | Finlays Baraora Tea Estate, Srimongal | **1000** |
| Prottyashi, Mirersoroi | **200** | Hajee Danesh University, Dinajpur | **05** |
| Damurhat Beat Office campus | **03** | Ramsagar Park, Dinajpur | **03** |
| Rajshahi Forest School | **02** | Mr. Nuru, Fatehpur, Hathazari | 20 |
| Mr. Siraj, Fatehpur, Hathazari | 30 | SUS, Sunamgonj (AFIE) | 05 |
| Prottyashi participant, Mirersoroi | 1,000 | Humanitarian, Bandarbon | 600 |
| Botanical Garden, BAU, Mymensingh | 05 | Hathazari beat, Ctg (N) Forest Division | 600 |
| **Total** | **4,224** | | |

### Distribution of civit seedlings in 2011

Civit seedlings also distributed to the following organizations for domestication and popularization in plantation programs during June - July 2011 are shown in Table 26.

Table 26. Civit seedlings distributed in 2011

| Organization/ Stakeholders | Seedlings distributed |
|---|---|
| Seven Circle (Bangladesh Ltd.) Sri Pur, Gajipur | 20 |
| SHED, Teknaf (Inani Protected Area) | 800 |
| Concord Entertainment Co. Ltd., Foy's Lake, Chittagong | 600 |
| **Total** | **1,420** |

About 13,664 civit seedlings were distributed to 7 individuals and 33 institutes or organizations for domestication of the species during 2008 - 2011 (Fig. 79).

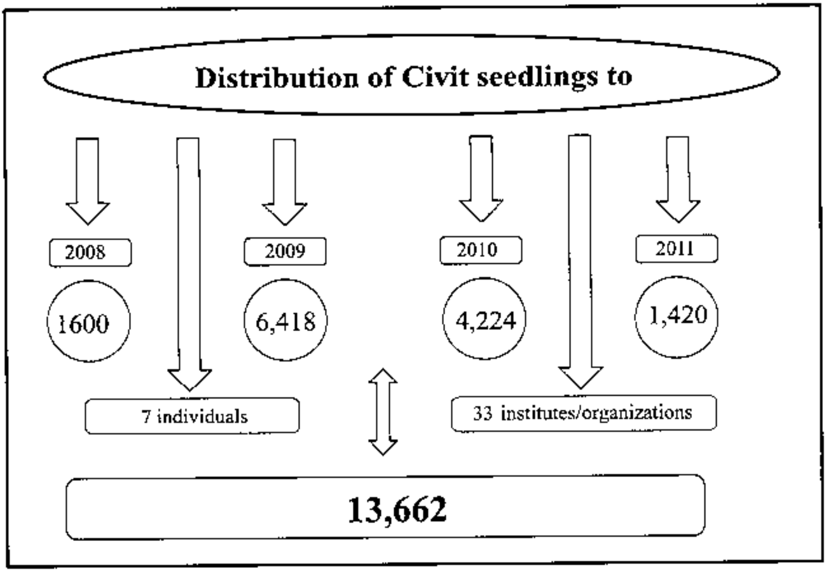



Figure 79. Distribution of civit seedlings to different individuals and organizations for domestication and restoration.

## Growth Performance of civit seedlings distributed to different stakeholders

Available information indicates that most of the seedlings distributed to different organizations are growing well. 800 civit seedlings were distributed to Inani and Ukhiya for recolonization and restoration of the species in their native habitat through SHED. The survival rate of the seedlings is shown in Table 27.

Table 27. Restoration of critically endangered civit at Inani and Ukhiya Reserve Forest and Protected Forest through Community Germ Plasm Center establishment

| Name and address of the participants | Civit seedlings planted (number ) | Seedlings survived | |
|---|---|---|---|
| | | (number ) | % |
| Abdul Kader, Tutur beel village, Ukhiya | 130 | 50 | 38 |
| Sona Mia, Inani (Nidania) village, Ukhiya | 100 | 45 | 45 |
| Nurul Islam, Chota Inani village, Ukhiya | 95 | 35 | 37 |
| Mohammed hossain, Horin Mara village, Ukhiya | 150 | 47 | 31 |
| Mohammed Ishaq, Painnasia village, Ukhiya | 133 | 40 | 30 |
| Kader Hossain, Khairatipara village, Ukhiya | 132 | 125 | 94 |
| Mohammed Rafique, Dochari village, Ukhiya | 50 | 30 | 60 |
| Mohammed Osman, Khairatipara village, Ukhiya | 10 | 05 | 05 |
| Total | 800 | 377 | 47 |

Similarly, seedlings distributed to other institutes or organizations are performing well (Fig. 80, 81, 82, 83). However, it is necessary to have a survey and monitoring of the status of the seedlings distributed to diverse ecosystems.

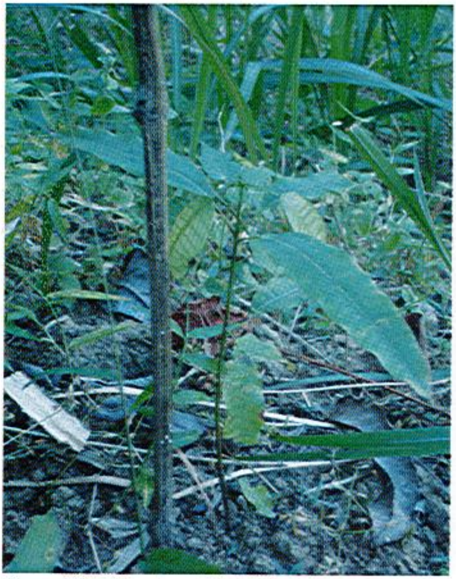


Figure 80. Civit planted in Sitakunda Eco-park

Figure 81. Civit planted in Dohazari by CODEC Participants

Figure 82. Civit planted in the Finlay Tea Estate at Srimongal

Figure 83. Recolonization of civit in the native ranges at Ukhiya, Cox's Bazar

## Conclusions

Civit, a native tree species of hill the forests of Bangladesh, once was abundant in the natural forests of Cox's Bazar, Chittagong and Chittagong Hill Tract. But, the species is becoming threatened in its native habitat, though a few mature to over mature trees are still found in the degraded natural forests. White Wing Duck (Bhadi Hans) was found to nesting in civit of Pablakhali natural forests. Extraction and illegal felling of civit is responsible for the loss of the duck due to dearth of safe nesting place of the species. Raising seedlings and plantation establishment in its native habitat may arrest the loss of civit. It may also bringing back the critically endangered "The White Wing Duck" -*Asarcornis scutulata* (Fig. 84, 85).

Figure 84. The White Wing Duck (Bhadi Hans) used to nesting in civit trees

Figure 85. Bhadi Hans lost their nesting place due to loss of civit

Rooting and success of the stecklings of civit is poor. The existing Provisional Plus Trees (PPTs) need to be protect for future seed collection, raising seedlings and restoration and recolonization of the species. A simplified leaflet describing the techniques of handling and raising civit seedlings may help the nursery men and private planters for the domestication and popularization of the species.

Not only civit, some other native broad leaved hardwood species, e.g., boilam, telsur, batna, gutguita, tali, konak, narikeli, bazna, chundul, etc. of the hill forests are also disappearing very rapidly from its natural habitats and needs immediate conservation programs. Considering the erosion of the genetic resources, native species must be included in the Government and private plantation programs. An immediate step may be taken to assess, monitor and priority setting for the conservation of threatened native tree species of Bangladesh considering the mission and vision of Tropical Forest Conservation Programs of Arannayk Foundation. During the project period USDA Mission and Arannayk Foundation Team visited the Institute of Forestry and Environmental Sciences, Chittagong University campus and appreciated the initiatives of conservation programs of threatened tree species of Bangladesh (Fig. 86, 87, 88, 89).

Figure 86. USAID Mission Team attended the presentation on civit at IFESCU

Figure 87. USAID Mission and AF Team visit the conservation plot at CU campus

Figure 88. Arannayk Foundation Team visits the civit nursery at IFESCU


Figure 89. USAID Mission and AF Team visit the civit Seedling Seed Orchard at CU campus

Chittagong University campus possesses large hilly lands for plantation programs and the plantations of threatened tree species can be established in the University campus for future seed sources of the country. A small scale plantation of 32 native tree species were already established in the Chittagong University campus (Fig. 90). A designed Seedling Seed Orchard of endangered tree species may be estabalished to ensure quality seed supply for future plantation programs.

Figure 90. Conservation plot of threatened native tree species at CU campus

## References

Ahmed, G.U. and Haque, S.M.S. 1993. Percentage distribution of species and diameter class in a natural forest of Bangladesh. Chittagong University Studies, Science, 17(1):109-113.

Anonymous. 1976. *The Wealth of India. Raw Materials*, Vol. X, CSIR, New Delhi, India. Pp.87-88.

Anonymous. 2005. *Forestry Compendium*. CAB International, UK.

Anonymous. 2006. *Bangladesh Economic Review*. Economic Adviser's Wing, Finance Division, Ministry of Finance, Government of People's Republic of Bangladesh.

BSTI (Bangladesh Standard and Testing Institution). 1983. Bangladesh Standard Specification for General Purposes. Dhaka, Bangladesh: Bangladesh Standard and Testing Institution.

Coffey, T.M. 1940. The Chittagong Hill Tracts Forest Division. Indian For. 66:16-29.

Canonizado, J.A. and Mabud, A. 1998. *Integrated Forest Management Plan for the Cox'sBazar Forest Division*. GOB/WB FRMP Technical Assistant Component, MADC and FD, Dhaka, Bangladesh.

Das, D.K. 1984. Wood anatomy of some timbers of Anacardiaceae of Bangladesh. Bulletin - Wood Anatomy Series, Forest Research Institute (Chittagong), No. 8:i + 31 pp. + 9 pl.

Das, D.K. 1990. *Forest Types of Bangladesh*. Bulletin 6. Plant Taxonomy Series. Bangladesh Forest Research Institute, Chittagong, Bangladesh, 9 pp.

Das, D.K. and Alam, M.K. 2001. *Trees of Bangladesh*. Bangladesh Forest Research Institute, Chittagong. 342 pp.

Feeroz, M.M., Hasan, M.K. and Hossain, M.K. 2012. *Biodiversity of Protected Areas of Bangladesh*, Vol. II: Dudpukuria-Dhopachari Wildlife Sanctuary. BioTrack. Arannayk Foundation, Dhaka, Bangladesh.

Hasan, M.K. and Alam, A.K.M.A. 2006. Land degradation situation in Bangladesh and role of agroforestry. J. Agric. Rural Dev., 4(1&2):19-25.

Hossain, A.B.M.E. and Rahman, M.M. 1994. Rohingya refugee rehabilitation in Bangladesh: some environmental consequences. Aranya, 3(3):4-6.

Hossain, M.K. 1998. Role of Plantation forestry in the rehabilitation of degraded and secondary hill forests of Bangladesh. Proceedings of the IUFRO inter Divisional Seoul Conference on Forest Ecosystem and Land Use in Mountain Areas, 12-17October, 1998, Seoul, Korea. Pp.243-250.

Hossain, M.K. 2008. *Swintonia floribunda* Griff. In: Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., Khondker, M., Kabir, S.M.H., Ahmed, M.,Ahmed, A.T.A., Rahman, A.K.A. and Haque, E.U. (eds.), *Encyclopedia of Flora and Fauna of Bangladesh*, Vol. 6. Angiosperms: Dicotyledons (Acanthaceae – Asteraceae). Asiatic Society of Bangladesh, Dhaka. Pp. 120.

Islam, S.S.1984. Volume tables for some indigenous forest species in Bangladesh. Bulletin, Forest Inventory, Forest Research Institute, Bangladesh, No. 3:iv + 70 pp.

Khan, M.S., Rahman, M.M. and Ali, A. A. (eds.). 2001. *Red Data Book of Vascular Plants of Bangladesh*. Bangladesh National Herbarium, Dhaka. P. 179.

Khan, N.A., Choudhury, J.K., Huda, K.S. and Mondal, M.I. 2004. *An Overview of Social Forestry in Bangladesh*. Forestry Sector Project, Bangladesh Forest Department, 198 pp.

Lemmens, R.H.M.J., Soerianegara, I. and Wong, W.C. 1995. *Plant Resources of South-East Asia* No. 5 (2). Timber trees: minor commercial timbers. 655 pp.

Mamun, M.A. and Hossain, M.K. 2011. Tree species diversity of a remnant natural Dipterocarp forests versus monoplantation in Rajghat, Cox's Bazar (North Forest Division) of Bangladesh. In: Proceedings of the International Conference on Biodiversity – Present State, Problems and Prospects of its Conservation, Eivin Røskaft and David J. Chivers (eds.) held on January 8-10, 2011 University of Chittgaong, Chittagong 4331, Bangladesh.

Motaleb, M.A. and Hossain, M.K. 2007. Studies on natural regeneration of a semi-evergreen forest of Chittagong (South) Forest Division, Bangladesh. J. For. & Environment, 5:95-101.

Motaleb, M.A. and Hossain, M.K. 2009. Studies on the structural composition based on diameter class distribution of a semi-evergreen natural forest of Chittagong (South) Forest Division, Bangladesh. Eco-friendly Agril. J., 2(10):825-829.

Motaleb, M.A. and Hossain, M.K. 2010. Phenology of native tree species in Tankawati natural forest, Chittagong (South) Forest Division, Bangladesh. Indian J. Trop. Biodiv., 18 (1):67-71.

Namura, J. 1986. Forest management in Bangladesh. Tropical Forestry, 7:29-35.

Pearson, R.S. and Brown, H.P. 1932. *Commercial Timbers of India*. A.J. Reprints Agency, New Delhi. Vol.1, pp. 333-335 (reprinted in 1981).

Qasem, M.A. and Hoque, M.S.1972. Bleaching properties of six hardwood species of Bangladesh. Bano Biggyan Patrika, 4(2/3):60-69.

Razzaque, M.A. and Das, P. 1969. Pulping studies of Civit (*Swintonia floribunda*) wood. Forest-Dale News, 1(2):16-29.

Salam, M.A., Noguchi, T. and Koike, M. 1999. The causes of forest cover loss in the hill forests in Bangladesh. Geojournal, 47:539-549.

Salehuddin, A.B.M. and Azizullah, M.A. 1977. Influence of three selected variables on the gluing of civit with a urea formaldehyde resin. Bano Biggyan Patrika, 6(2):17-23.

Sattar, M.A. 1980. Kiln drying schedules for indigenous timbers of Bangladesh. Bulletin, Forest Research Institute, Chittagong, Wood Seasoning, No. 4:ii + 11 pp.

Sattar, M.A. 1981. Some physical properties of 116 Bangladeshi timbers. Bulletin, Forest Research Institute, Bangladesh, Wood Seasoning, No. 7:15 pp.

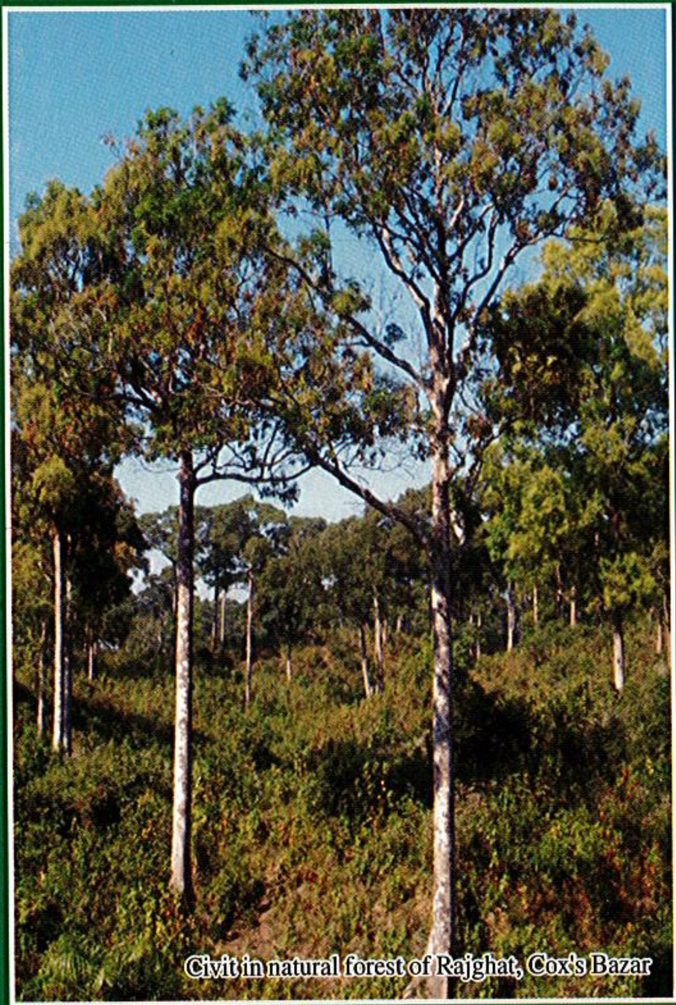
Trotter, H. 1982 (reprinted). *The common commercial timbers of India and their uses*. Government of India press, New Delhi. Pp.288.

Yakub, M., Ali, M.O. and Bhattacharjee, D.K. 1970. Strength properties of: [1] some East Pakistani woods; [2] some Bangladesh timber species; [4] Chittagong teak Tectona grandis representing different age groups. Bulletin, Forest Research Institute, Bangladesh, Timber Physics, No. 1; No. 2; No. 4:14 pp.; 12 pp.; 28 pp.

DR. MOHAMMED KAMAL HOSSAIN, Professor, Institute of Forestry and Environmental Sciences, Chittagong University, Chittagong- 4331 was born in Kutubdia, Coxs Bazar. He obtained B. Sc (Hons) and M. Sc in Botany from Chittagong University (1st class 1st position in both the examinations); PhD from the Department of Forestry (Silviculture), University of Aberdeen, UK with a Commonwealth Scholarship in 1993 and also was a Commonwealth Post-Doctoral fellow in 2002-2003. He has published 95 research papers (45 National and 50 International referred journals); 38 publications in proceedings and in book chapters in the field of silviculture, biodiversity and plantation forestry. Dr. Hossain is the co-author of 4 books and supervised 3 PhD, 53 MS/MSc and 84 BSc (Hons.) students successfully. Dr. Hossain serves as Senior Professional of Arannayk Foundation support nursery project; Team Leader of the Civit project; National Biodiversity Consultant (Flora) in IUCN Bangladesh Country Office; Tree Plantation Specialist for IFSP of CARE- Bangladesh; Director, Institute of Forestry and Environmental Sciences; Director (Administration), Chittagong University Agricultural Development Project (CUADP) etc. Dr. Hossain holds the life membership of Bangladesh Botanical Society; Bangladesh Association for the Advancement of Science (BAAS); Asiatic Society of Bangladesh; Vice-President, Institution of Environmental Professionals, Bangladesh; Member, Editorial Board, Journal of Forestry and Environment, Chittagong University; Editorial Board Member, Journal of Forestry Research, China (2009 - 2013). Countries visited for academic programs are UK, Malaysia, Thailand, Singapore, Indonesia, Finland, Denmark, Sweden, Turkey, South Korea, Switzerland, Canada, China, Taiwan, Nepal, USA, Japan, India, Sri Lanka, Australia and Viet Nam.

M. KALIMUDDIN BHUIYAN is a Professor in the Institute of Forestry and Environmental Sciences, Chittagong University (IFESCU). Mr. Bhuiyan joined as Assistant Professor in the Institute in 1984. In addition of teaching and research work he performed administrative responsibilities as Director of IFESCU and National Project Director of FAO/UNDP funded project BGD/85/011 from 1987-1990. Earlier he served as a Warden Forestry Hostel and a Plantation Coordinator IFESCU and currently working as Provost Shah Amanat Hall. Earlier he served as a Research Officer at Bangladesh Forest Research Institute and as a lecturer of Botany in different colleges. He did B.Sc. Honours in 1970 and M.Sc. in 1971 in Botany from Dhaka University and M. Sc. in Forestry from Pakistan Forest Institute, Peshawar University in 1983. He has published 40 scientific papers in national and international Journals. He participated / attended 30 National and 23 International Short Courses/Training/ Conferences/ Seminars/ Symposium/ Workshops and Study Tours. He guided 50 under graduate and 40 post graduate students in IFESCU. He visited India, Greece, Indonesia, Italy, Qatar, Kenya, Nepal, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Thailand, UK and Russia.

DR. MOHAMMED SHAFIUL ALAM is the Professor of Institute of Forestry and Environmental Sciences at Chittagong University, Bangladesh. He obtained his Ph.D degree from the Aberdeen University, UK under the World Bank Scholarship in 2002. He started his career as Research Officer in Bangladesh Forest Research Institute and later joined to the Institute of Forestry and Environmental Sciences as Lecturer in 1990. He was the Director of IFESCU from 2004-2007 and also served as a Plantation Coordinator of IFESCU from 2008-2011. In addition to his academic responsibilities at IFESCU, he is currently working as Registrar of Chittagong University. He has contributed 26 research articles in national and international journals on Plantation forestry, Forest resources management, Environmental pollution and Pollution effects on plant and soil systems related area. To enhance professional excellence and attending international conference/workshops Prof. Shafiul visited India, Nepal, Thailand, Malaysia, Philippines, Viet Nam. and the United Kingdom.


Civit in natural forest of Rajghat, Cox's Bazar