# CHARACTERIZATION OF FOREST SOILS OF SEED ORCHARD AND ADJOINING TEAK PLANTATION AT HYANKO

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## ABSTRACT

One soil series, Hyanko covering 75% of the land and one soil complex, Hyanko Rangamati with 50% occurrence of the Rangamati series in the remaining portion were recognized from a detailed soil survey of Hyanko Seed Orchard Centre of BFRI and the adjoining 1976 teak plantation and mapped on phase level. The Hyanko series has been classified as Plinthic Paleustults and the Rangamati series as Typic Dystrochrepts. Hyanko series contains iron-manganese nodules to the extent of 15% in the upper 100 cm. Although the soil fertility is low, the planted gamar ramets are growing successfully and do not show much variation in growth except on eroded phase. Similar land can be utilized by introducing nitrogen fixing short rotation fuel wood species on eroded phase and economically important timber trees on gently sloping to moderately steep and smooth relief phases even without manuring.

## সারসংক্ষেপ

হিঁয়াকো বীজ বাগান ও তৎসংলগ্ন ১৯৭৬ সালের সেগুন বাগানে বিস্তারিত জরিপ থেকে হিঁয়াকো মৃত্তিকা ও হিঁয়াকো-রাংগামাটি মৃত্তিকা কমপ্লেকসটি সনাক্ত করা হয়েছে এবং মানচিত্রে মৃত্তিকা শ্রেণীকে 'ফেজ' ধাপ পর্যন্ত দেখান হয়েছে। জরিপকৃত এলাকায় ৭৫% হিঁয়াকো সিরিজ এবং অবশিষ্ট অংশ হিঁয়াকো-রাংগামাটি কমপ্লেকসের অন্তর্ভুক্ত, যাতে হিঁয়াকো সিরিজের আধিক্য রয়েছে ৫০%। হিঁয়াকো সিরিজটি প্লিনথিক পেলিউস্টান্টস এবং

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রাংগামাটি সিরিজ টাইপিক ডিসটোক্রেপটস্ শ্রেণী ভুক্ত। হিঁয়াকো সিরিজের মাটিতে ১০০ সেঃ মিঃ গভীরতা পর্যন্ত ১৫% লোহা ও ম্যাংগানিজের ছোট ছোট পিন্ড রয়েছে। উক্ত এলাকায় মৃত্তিকার উর্বরতা কম থাকা সত্ত্বেও রোপণকৃত গামার রেমেট সফলতার সাথেই জন্মাচ্ছে এবং মৃত্তিকা ক্ষয়প্রাপ্ত অংশ ব্যতীত অন্যত্র গাছ বর্ধনে কোন পার্থক্য পরিলক্ষিত হয়নি। এ ধরনের জমি নাইট্রোজেন সংবন্দনকারী স্বল্প মেয়াদী জ্বালানী কাঠের গাছ ভূমি ক্ষয়প্রাপ্ত অংশে এবং অর্থকরী কাঠের গাছ সামান্য ঢালু ও সমতল স্থানে সার প্রয়োগ ছাড়াই ব্যবহার করা যেতে পারে।

## INTRODUCTION

The surveyed area covered 68.8 hectares at Hyanko under Fatikchari Upazila of Chittagong district of which 58.8 hectares are seed orchard, the rest being the teak plantation. The site is located about 93 km north-east of Chittagong city, about 11 km east of Karerhat and beside the northern side of Karerhat-Ramgarh Road (Figure 1). Except a reconnaissance soil survey report of SRDI, Bangladesh (Anon. 1976) no detailed previous information about the surveyed area is available. The report contains general information useful only for agricultural crops. An attempt was, therefore, made to identify, classify, and delineate the soils on a map which will ensure better management and will help in the evaluation of the site capability for planting different forest species.

## GEOLOGY AND LANDFORM

The surveyed area is a part of the Sitakunda-Mirsharai hill ranges. The land is gently sloping to moderately steep (Anon. 1951). Further sub-divisions of the land form with percentage covered by each mapping unit have been presented in Table 3. The hills are low, ranging in elevation from 18 to 42m above mean sea level and are comprised of unconsolidated tertiary sediments of Dupitila formations. The hills are higher on the north and shallowly dissected. The valleys are used for agriculture.

## MATERIALS AND METHODS

Detailed soil survey of the area was conducted during February, 1983 using enlarged aerial photographs (1:10,000). Field checkings at 75 spots were made using an augar upto a depth of 1.25 m. Interval between two checking spots was 100 m. Differentiating characteristics of soils such as colour (Anon. 1971) texture, consistency, mottles, etc., were studied for each augar hole. Texture and sub-soil colour were given priority over the other diagnostic characteristics in splitting the soil series (Anon. 1951). Each checking spot was delineated on the base map. Two soil series, namely, Hyanko and Rangamati were identified in the surveyed area. The intensity of erosion hazard, slope class and vegetation were also noted during the survey. As a measure of site index, height and diameter of three planted sample trees showing maximum, medium and minimum growth around the field checking spots in several places were also recorded. Standard pits were dug upto a depth of 1.90 m in the representative area. Two pits for Rangamati and three pits for Hyanko series were dug. Soil samples were collected from each genetic horizon. The profiles under study did not exhibit well differentiated horizons. Symbols for horizon designation have different connotations by different workers which are misleading (Patrick 1978). Horizon designation by SRDI is also tentative and was, therefore, avoided. Soil series were named according to the Reconnaissance Soil Survey Reports (Anon.

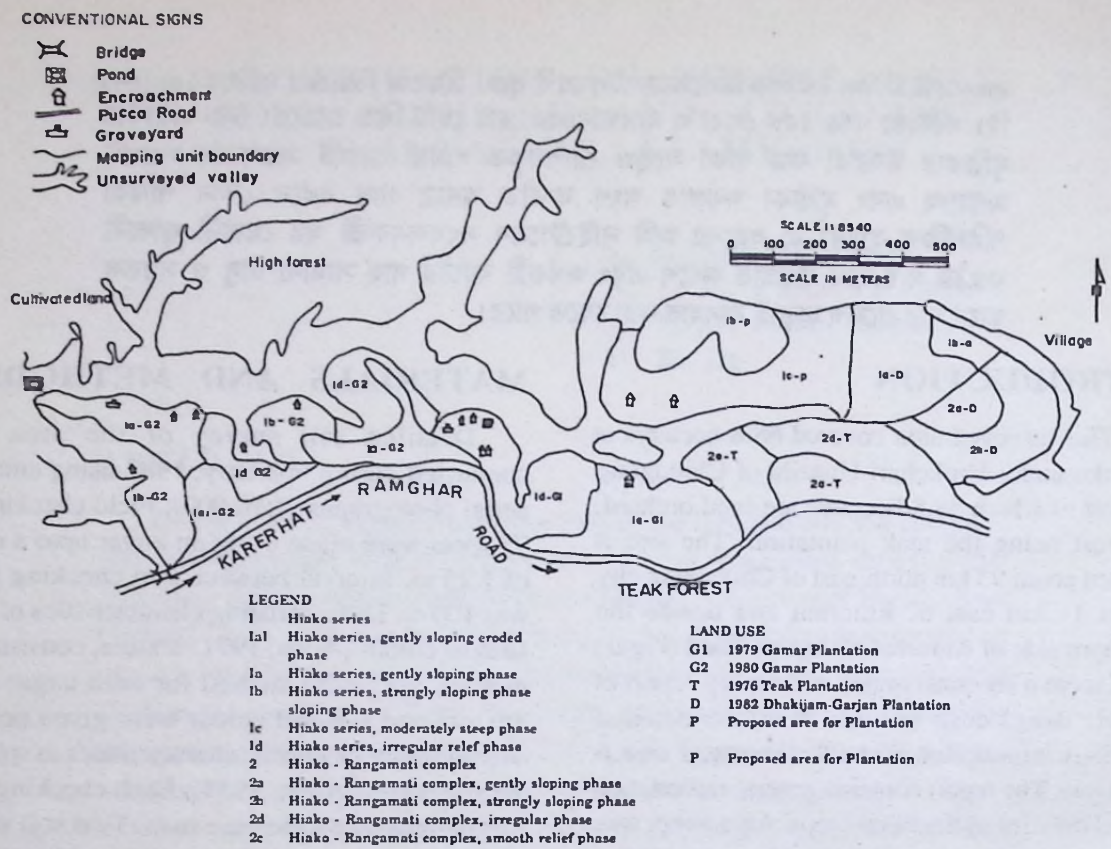


Fig. 1. Soil Phases and plantation map, 1983 of Seed Orchard Centre and teak plantation at Hyianko, Chittagong.

1976, Anon. 1979). pH (1.1 Soil water ratio), organic carbon, total nitrogen, available calcium and available phosphorus of soil were determined according to Jackson (1958). Soil texture was determined by Bouyoucos hydrometer method (Chowdhury *et al.* 1969).

## RESULTS AND DISCUSSION

**Soils** : The soils of the area are medium to moderately fine textured, moderately to well drained and slightly to extremely acidic in reaction. Considerable amounts of iron-manganese concretions were found on the surface of the eroded top and steep slope. The sandy clay loam sub-soil is yellowish brown to dark brown (Table 1). There are some remarkable air pockets in the soil mass and locally some profiles contain worm casts. Depth of the soil down to the unweathered substratum varies between 0.1 m and 1.40 m from place to place. The top soil is dark yellowish brown to brown, sandy loam with weak to moderate, granular to sub-angular blocky structure. The soil is homogenized, and strongly leached throughout. The soil development is better on gentle slope by the activities of wide ranging tree roots of the past vegetation, earthworms and termites. On hill top the soils are comparatively less developed on account of constant removal of weathered material from the surface. The sandy loam topsoil, sandy clay loam subsoil and clay loam substratum in all the profiles suggest that the soils are truly pedogenic in nature and the textural differentiation attribute to the soil forming processes.

**Table 1. Soil series and the diagnostic characteristics of the subsoils of Hyanko Seed Orchard Centre and 1976 teak plantation**

| Soil Series | Colour | Texture | Structure | Drainage | Special features |
|---|---|---|---|---|---|
| Hyanko | Yellowish brown to brown | Sandy clay loam | Moderate medium sub-angular to angular blocky | Well | Presence of iron manganese concretions; many air pockets of about 1.3 cm diameter; eroded hill top contains about 75% big hard rocks |
| Rangamati | Brown to strong brown | Sandy clay loam | Moderate medium angular blocky angular | Well | Presence of few small air pockets |

** Summarized from three and two profiles of Hyanko and Rangamati Series respectively*

**Soil Series and Complex** : From field observations one soil series. Hyanko and one soil complex, Hyanko-Rangamati, were recognized. Hyanko series occupies 75% land of the area (Fig1) and the remaining portion is occupied by the Hyanko-Rangamati association in which the occurrence of Rangamati is 50%. In many respects, topsoil and subsoil characteristics of Hyanko and Rangamati series are similar (Table 1). Rangamati series differs from Hyanko series being deeper in column depth and darker in colour. Hyanko series is yellowish brown to brown while Rangamati series is strong brown to dark brown in the subsoil. Moreover, Hyanko series contains more than 15% concretions almost in every layer with few fine indistinct reddish brown mottles in substratum between 36 and 102 cm in depth. In some profiles, iron-manganese concrections occur in the surface and light coloured soft plinthitic concretions at 76 to 97 cm depth. Concretions in the Rangamati series are less intense and are located at a greater depth. Where the topsoil of low hills of Hyanko series is eroded, the surface soil contains locally big hard rocks constituting about 75% of the total soil volume. The Hyanko series has been classified as Plinthic Paleustults (Anon. 1979) and Rangamati series as Typic Dystrochrepts (Anon. 1976)

**Soil Mapping Units** : The soil series and the complex have been further subdivided into phases based on relief, slope and erosion hazard (Table 2) and mapped on phase level. Based on relief there are two phases - smooth relief phase and irregular relief phase. The former refers to soil that occur at flat topography surrounded by sloping land from three sides while the latter occurs on narrow, irregular topography.

Three slope phases are gently sloping, strongly sloping and moderately steep phase having 3 to 8%, 8 to 16% and 16 to 30% slope respectively (Anon. 1951). The gently sloping area with complete removal of topsoil is recognized as eroded phase. The extent of erosion

**Table 2. Mapping units showing per cent area covered by each unit.**

| Mapping units | Series/Phase | % area |
|---|---|---|
| 1 | Hyanko Series | 75.00 |
| $1a_1$ | Gently sloping eroded phase | – |
| 1a | Gently sloping phase | 27.16 |
| 1b | Strongly sloping phase | 16.29 |
| 1c | Moderately steep phase | 13.09 |
| 1d | Irregular relief phase | 14.42 |
| 2 | Hyanko-Rangamati complex | 25.00 |
| 2a | Gently sloping phase | 6.41 |
| 2b | Strongly sloping phase | 7.52 |
| 2d | Irregular relief phase | 7.10 |
| 2e | Smooth relief phase | 3.97 |
| | | 100.00 |

and area covered by gamar *(Gmelina arborea)* plantation of 1979 and 1980 raised from ramets in seed orchard and the teak plantation of 1976 raised by the Forest Department have also been shown by codes in the map.

**Soil Fertility Status** : The soils are generally medium to strongly acidic (pH 5.3 to 5.8) with only two occasions showing extreme acidity (pH 4.2 to 4.3). The considerable amount of available calcium (3.6-6.4 m.e./100 g soil) probably resisted further acidification of the soils. Soil organic matter, total nitrogen and available phosphorus contents are low (Table 3). The low organic matter content accounts for the deficiency of total nitrogen, and the intensity of acidity is responsible for such low amount of phosphorus. The C/N ratio of the surface soil varied between 9 to 13 and it generally narrowed downward.

**Land Use** : The soils in the studied area have certain limitations which restrict their utilization for growing agricultural crops. They may profitably be utilized through scientific afforestation to reduce the prolonged vertical exposure to erosive forces. A consideration of the growth condition of the plants in the seed orchard centre and in the adjoining teak plantation may help in choosing the tree species suitable for these soils.

Presently, seedlings of gamar raised in polybags are planted in 0.6 m X 0.6 m X 0.6 m pits containing manure and composts at 12 m X 12 m spacing. The nutrients in the added materials are utilized by the seedlings for their establishment. The growth of three and four year old gamar trees have been found to be satisfactory. There is little variation in growth between the plants occuring on various soils and sites except on the eroded phase (Table 4). However, better growth of plants was observed in the deposition zones and medium growth on gently to strongly sloping phase. Since hard concretionary layers were disrupted for digging pits of composts there was also satisfactory growing. Teak in normal plantation at 2 m X 2 m spacing shows satisfactory growth on Hyanko-Rangamati complex having deep soil on hill top and slope of varying gradients.

Plantations other than those in seed orchard and without manuring may also be successful with

nitrogen fixing short rotation fuel wood species e. g. *Acacia* spp., *Albizia falcataria Casuarina equisetifolia, Leucaena leucoce phala,* etc., without considering market value in the first rotation on eroded phase. They will protect soil capital from deterioration. Block plantation of economically; important species like gamar *(Gmelina arborea)* Teak *(Tectona grandis),* pines, Eucalyptus, etc., on gently sloping to moderately steep phase, and *(Anthocephalus chinensis),* pitali. *(Trewia nudiflora),* Kainjal *(Bischofia javanica)* etc., on smooth relief phase near to the valley can be tried. Soil acidity of the surveyed area varied within a very narrow range and perhaps may not affect growth performance of the species among sites. However, the soil are not homogenous in pH values with depth, and trees may escape the unfavourable condition by feeding on the favourable portion. Moreover, roots of planted seedlings can cope with any extreme reaction (Wilde 1958). The amount of available calcium is quite appreciable for development of roots and root hairs.

**Table 3. Analytical data of soil profiles of Hyanko Seed Orchard Centre and 1976 teak plantation**

| Soil series/ No. | Soil depth (cm) | Texture * | Organic C (%) | Total N (%) | C/N ratio | pH ($H_2O$) | Available phosphorus (mg/kg) | Available calcium m. e./100g |
|---|---|---|---|---|---|---|---|---|
| Hyanko | 0 -8 | SL | 0.78 | 0.058 | 13 | 5.8 | - | - |
| 1 | 8 - 33 | SCL | 0.75 | 0.059 | 13 | 5.8 | - | - |
| | 33 - 120 | SCL | 0.50 | 0.039 | 13 | 5.5 | - | - |
| 2 | 0 - 10 | SL | 0.90 | 0.074 | 12 | 4.3 | 7 | 3.6 |
| | 10 - 48 | SCL | 0.80 | 0.067 | 12 | 5.3 | 7 | 5.2 |
| | 48-108 | CL | 0.60 | 0.040 | 15 | 5.5 | 6 | 6.4 |
| 3 | 0-13 | SL | 0.89 | 0.059 | 15 | 5.7 | - | - |
| | 13-58 | SCL | 0.83 | 0.083 | 10 | 4.2 | - | - |
| | 58-90 | SCL | 0.33 | 0.036 | 9 | 5.6 | - | - |
| | 90-152 | SCL | 0.30 | 0.03 | 10 | 5.5 | - | - |
| Rangamati | 0-20 | SL | 0.60 | 0.059 | 10 | 5.6 | - | - |
| 1. | 20-61 | SCL | 0.50 | 0.051 | 10 | 5.5 | - | - |
| | 61-152 | SCL | 0.33 | 0.034 | 10 | 5.6 | - | - |
| | 152-190 | SCL | 0.19 | 0.024 | 8 | 5.5 | - | - |
| 2 | 0-18 | SL | 0.76 | 0.080 | 9 | 5.8 | 4 | 4.0 |
| | 18-45 | SCL | 0.74 | 0.078 | 9 | 5.5 | 5 | 4.0 |
| | 45-140 | SCL | 0.31 | 0.042 | 7 | 6.2 | 12 | 5.6 |

** SL= Sandy loam, SCL = Sandy clay loam, CL = Clay loam*

**Table 4. Height and diameter of gamar and teak at different field checking spots**

| Maping units | Spot features | | * Average height (m) | * Average diameter (cm) |
|---|---|---|---|---|
| | Position | Concretions/rock | | |
| | (a) | 3-years old gamar (1980) plantation | | |
| $1a_1$ | Summit | Presence of hard rocks | 1.96 | 5.41 |
| $1a_1$ | Lower slope | No concretions upto (76)* | 2.62 | 8.05 |
| $1a_1$ | Ditto | Few concretions with (15) | 2.74 | 9.68 |
| 1a | Ditto | No concretions upto (76) | 3.05 | 8.86 |
| 1a | Summit | Concretions common within (46) | 3.66 | 5.59 |
| 1b | Ditto | Concretions common within (30) | 3.05 | 5.08 |
| 1d | Near valley | Ditto | 4.42 | 12.90 |
| 1d | Near valley | Very few concretions within (50) | 5.01 | 14.50 |
| | (b) | 4-years old gamar (1979) plantation | | |
| 1a | Summit | Few concretions within (30) | 4.34 | 10.67 |
| 1a | Lower slope | No concretions upto (81) | 4.42 | 14.50 |
| 1a | Ditto | Few concretions within (46) | 4.73 | 12.78 |
| 1a | Middle slope | Slight deposition | 7.16 | 13.72 |
| 1d | --- | Concretions common within (23) | 4.27 | 8.05 |
| 1d | Middle slope | Concretions common between (15-30) | 4.42 | 11.18 |
| 1d | Near valley | Deposited zone | 7.32 | 20.96 |
| | (c) | 7-years old teak (1976) plantation | | |
| 2a | Lower slope | Few concretions within (15) | 3.15 | 6.86 |
| 2a | Ditto | No Concretions upto (91) | 3.67 | 8.05 |
| 2d | Middle slope | Few concretions within (35) | 4.12 | 8.05 |
| 2d | --- | Few concretions within (60) | 5.49 | 6.35 |
| 2d | --- | Few concretions within (46) | 5.64 | 5.59 |
| 2d | Middle slope | Few concretions within (46) | 7.16 | 10.49 |
| 2e | --- | Deposited zone | 7.72 | 8.05 |

** Mean height and diameter of three sample trees. Figures in parentheses represent depth in cm.*

The area is mostly covered by *(Imperata cylindrica)* (sungrass) and herbs and shrubs (Table 5). They protect the soil from erosion but strongly compete for the nutrients and moisture with the planted species. Therefore, measures should be taken to supress the weeds. At this experimental orchard intercropping of leguminous crop is suggested to improve soil fertility and safeguard the soil against erosion.

**Table 5. Percentage occurrence of weeds in the plantation**

| Local name | Botanical name | Per cent |
|---|---|---|
| Mankata | *Xeromphis spinosa* | 5 |
| Sun grass | *Imperata cylindrica* | 25 |
| Lajjabati | *Mimosa pudica* | 10 |
| Assamlata | *Eupatorium odoratum* | 5 |
| Kumarilata | *Smilax macrophylla* | 5 |
| Gilalata | *Entada phaseoloides* | 5 |
| Chitki | *Phyllanthus reticulatus* | 2 |
| Lantana | *Lantana camera* | 5 |
| Nal khagra | *Saccharum spontaneum* | 15 |
| Bhaitgach/Bhat | *Clerodendrum viscosum* | 5 |
| Jangli seem | *Canavalia virosa* | 5 |
| Miscellaneous | - | 13 |

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