Technical Specification

HINIDUMA BIO-LINK PROJECT

Reforesting traditional home gardens using the analog forestry concept in tropical wet zone of Sri Lanka

Report presented to:
Conservation Carbon Company (Pvt) Ltd,
Sri Lanka

Authors
Chalaka Fernando
Sampath Wahala
Lakmini Senadheera
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carbon consulting company.

info@carbonconcultco.com

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1 Introduction

This Plan Vivo technical specification is for smallholder reforestation and assisted regeneration to create corridors between, and buffers around natural forest patches in Hiniduma, Galle, a tropical wet zone area of Sri Lanka, through the establishment of tree plantations in line with the Analog Forestry Concept[1] (see Annex 1). Following this approach a mix of species are selected using participatory processes to include a combination of both cash crops and wild varieties that occur in the project region.

2 Applicability and Eligibility

The tree growth models used in this technical specification are applicable under specific environmental conditions. The baseline scenario and additionality conditions are valid under specific eligibility criteria. These conditions are described below.

2.1 Applicability

The environmental conditions that characterise the region covered by this technical specification are described below:

2.1.1 Climate

Annual rainfall over 1,600 mm, with little seasonal variation in rainfall or seasonal variation in temperature. Temperatures have a high diurnal range and fluctuate between 19°C and 34°C (Zoysa & Raheem, 1990).

2.1.2 Soil

Lowland wet-zone eco-region with red-yellow podzolic soils (Survey Department, 1988). Physical characteristics of the soil are moderate to deep, well drained and relatively unsusceptible to soil erosion.

2.1.3 Topography

Rolling hills and floodplains with elevations that range from 200 to 1,100 meters.

2.1.4 Land use

Land cover is heterogeneous and includes remnant forest patches, riverine forest, smallholder sustenance cash crops – mainly tea and traditional faming plots of rubber, coffee, spices and

[1] Analog Forestry is a system of silviculture, which aims to restore the local biodiversity while providing economic opportunities to small-scale farmers.(www.Rainforest Rescue International,com,2011) More details can be found in annex I.

palm. This technical specification was developed to support Plan Vivo project activities in Hiniduma, Galle, Sri Lanka. It is applicable to the potential project areas shown in **Error! Reference source not found.**1. The yellow polygons show 5 corridor candidates; initial project activity is within polygon 1, approximately 2,000 ha. These are lowland wet areas in SE Sri Lanka (**Error! Reference source not found.**2).

Figure 1: The project area

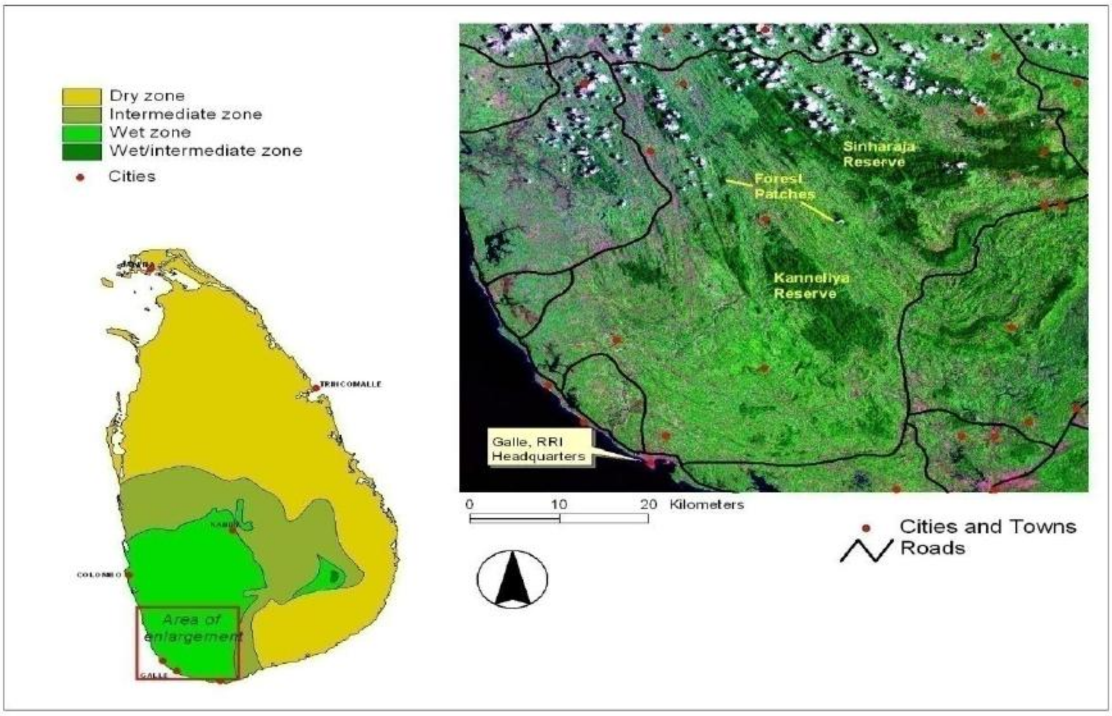

Figure 2: Climatic zones in Sri Lanka (left) and project (right)

2.2 Eligibility

In addition to meeting these environmental applicability criteria, for an area of land to be eligible for project activities it must fulfil the following criteria:

- ✓ Severely degraded forest, or deforested and currently used for traditional tea planting, small rubber plantations, coffee or paddy cultivation;
- ✓ Within or adjacent to an area of natural forest or in an area identified as a potential corridor between patches;
- ✓ Solely owned by the farmers or covered by Swarnabhoomi or Jayabhoomi deeds[2];
- ✓ Where the project area includes trees at the start of the project, biomass is expected to either remain constant or decline through further degradation and exploitation;
- ✓ Where the project area includes areas that are currently used for agricultural crops, the activities proposed must not reduce food production or cash income.

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[2] Swarnabhoomi and Jayabhoomi is a long-term lease scheme which awards land to traditional farmer communities by the Sri Lankan government. The government grants farmers a perpetual lease thus giving complete rights to farm and generate income.

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Figure 3 shows an example of a farmer's land surrounded by forest

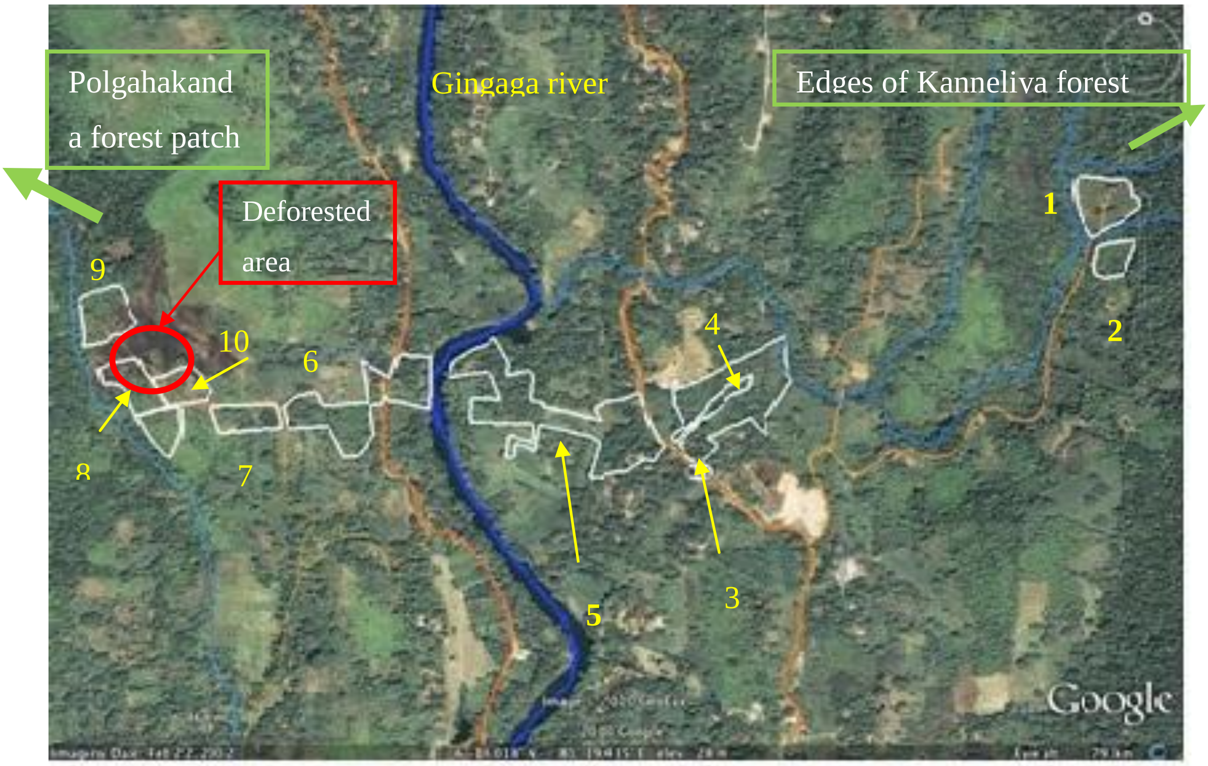


Figure 3: Google maps based image, initial farmer plots

The above picture (Figure 4) is an aerial view of the selected farmers' land in the pilot project (phase one). This demonstrates the target area of the first biolink in between Polgahakanda and Kanneliya forest patches. This figure (2002 satellite image) shows existing deforested patches in the home gardens in selected land area. The key below identifies the specific areas.

Key

1	Land area of Upul	6	Land area of Wijedasa
2	Land area of Karunadasa	7	Land area of Ariyadasa
3	Land area of Sunil	8	Land area of Danapala
4	Land area of Subasinghe	9	Land area of Ajith
5	Land area of Weerasinghe	10	Land area of Gunasiri

3 Baseline conditions and additionality

3.1 Current land uses and threats to carbon stocks and ecosystem services

The first step towards establishing a project baseline was to create a map of the project boundary and identify the land use patterns. Land owned by the initial participating 15 farmers was taken as the pilot project area and all plots were surveyed and mapped. Land cover in the project area is heterogeneous and includes remnant forest patches, riverine forest, smallholder sustenance cash crops -mainly tea, and plots of rubber, coffee and palm.

Land is either solely owned by the farmers via Swarnabhoomi or Jayabhoomi deeds for farmers. Swarnabhoomi and Jayabhoomi is a long term land lease scheme which awarded rights to small scale traditional farmers from the Sri Lankan government. The resettlement scheme of Swarnabhoomi and Jayabhoomi in the buffer area of Kanneliya was done in 1996. (Annex 10: A Jayabhoomi deed of a land given to farmers) After 1996 farmers started to clear land for tea and other crop cultivation.

The dominant proximate threat to forests in the project area is agricultural and silvicultural expansion. The majority of land between forest reserves has already been converted to rice paddies, tea, rubber, oil palm, and cinnamon plantations. Forested crown land is frequently allocated to private estate holders leading to rapid forest conversion. In addition to agricultural expansion, anthropogenic threats include gem mining, illegal timber extraction and hunting. Anthropogenic threats in the project area are expected to increase substantially following the construction of a new highway 15 km South of the project area.

One of the primary underlying causes of deforestation in the area is the Land Development Ordinance (Chapter 464), which was established to encourage agricultural production. Under this ordinance smallholders are required to clear land for cultivation in order to claim property rights. Not surprisingly, this land tenure system leads to rapid deforestation and greatly inhibits community based forest conservation initiatives.

Another underlying cause is the misuse of agro-chemicals. In response to land degradation, farmers turn to chemical fertilizers. However, improper use of these inputs results in gross imbalances of soil nutrients, which leads to a further reduction in soil productivity. The end result is that farmers need more land, often at the cost of natural forest, to maintain productivity.

Baseline scenario

Current threats to ecosystem services within the proposed project area are expected to increase. Existing carbon stocks are therefore expected to reduce over time in the absence of project activities. This technical specification is only applicable to areas where this assumption is valid. The baseline scenario is conservatively assumed to remain constant over the project period. Carbon benefits are quantified on the basis of trees planted in each *plan vivo*, so there is no requirement to deduct a baseline figure as no significant clearing is involved.

There was no evidence found in pilot areas that farmers practice commercial timber harvesting and commercial fuel wood collection, except for the use of dead and dry branches to supply domestic fire wood requirements. Hence the potential disturbance for the existing trees (carbon stock) in is very minimal. On the contrary, by participating in the project activities and awareness programmes, famer attitudes towards conservation have significantly improved and farmers are more likely to conserve existing trees on their land.

3.2 Monitoring of the baseline

All land owned by the initial group of farmers will be monitored to test baseline assumptions. CCC technical team with the help of the students at University of Sabaragamuwa, have established permanent sampling plots to cover all the land use patterns, to monitor any changes to the baseline and to carry out the studies on natural regeneration rates to test assumptions. The baseline monitoring will be carried out according to Table 1 below.

Baseline monitoring plan

Table 1: Baseline monitoring plan

Responsible party	Monitoring frequency	Parameters to be measured	Reporting
CCC and RRI technical teams	Monitor the permanent sampling plots annually	Diameter Height Land uses in each plan vivo	Results will include in the annual reports
Selected committee from the CBO	Once in three months	Any dramatic changes in the baseline of plan vivos	CBO have to provide a report to project coordinators

3.3 Additionality

Carbon services to be generated by project activities could not be achieved in the absence of the project, because there is a lack of effectively enforced policy to encourage ecosystem conservation. There are also barriers to planting wild tree species and protecting forests that the project will help to overcome.

3.3.1 Regulatory surplus

A number of policies exist that if enforced, hold potential for effective ecosystem conservation. However, enforcement is inconsistent and weak, particularly outside protected areas. If small farmer communities do not get financial benefits from conservation, regaining forest patches is a difficult task. When the price of tea goes down farmers have a tendency to expand their crops, either disturbing the forest buffers or watershed buffers or reducing remnant forest patches in their own lands.

3.3.2 Financial barriers

Under the project activities, species to be planted are wild varieties. Some of these provide cash benefits and increase the farmer interest in protecting them. However in future these plants will also make few canopy structures and reduce the space for cash crop growing. As such landowners are not currently inclined to plant wild varieties since it may reduce their income sources. This was identified during the initial socio-economic survey performed by RRI (see Annex 6). Introducing an ecosystem-valuing mechanism through carbon benefits and passing financial gains to these farmers, will increase farmer interest towards conservation aspects and will sustain plant maintenance activities also.

3.3.3 Technical barriers

A lack of agro-technicality is also identified as a main barrier to activities. The project aims to overcome this barrier by introducing ‘analog forestry concepts, home garden practices, organic food practices and composting trainings with the target communities.

During initial project activities, it was observed that a there was a high acceptance rate for technical inputs from the project coordinators. These training and knowledge sharing activities would not be possible without the project.

3.3.4 Institutional barriers

Farmers are reluctant to engage with agriculture and forestry extension workers, which are typically state sector representatives.

4 Project activities and management system

4.1 Activity Plan

The activity plan sets forth the various steps that need to be undertaken for the proper establishment of planting and who is responsible for the various tasks. Participants (farmers) are responsible for most of the planting and post planting activities, therefore the activity plan serves as the minimum standards required for the project to be successful. The farmer payment scheme is based on the successful implementation of the activity plan and the key performance indicators (KPI’s) described here, which are communicated and agreed upon with communities. Activities are planned through a process of consultation between interested stakeholders and priority is given to the needs of the communities involved.

4.2 Species selection process

The main criteria to select plants were based on the ‘Analog forestry’ concept meaning the bio-link will mimic the neighboring forests, while enhancing the livelihoods of the famers. (Rain Forest Rescue International Sri Lanka, 2010). Tree species to be used have been determined by interviewing local farmers and technical inputs from Rainforest Rescue International (RRI). Biodiversity improvement, watershed conservation and crop productivity, soil and climate conditions, carbon sequestration rates and the value of associated forest products were the main factors taken into consideration during the selection process. All of the selected species are native to the region.

Individual land management plans, called *plan vivos*, are then integrated within individual smallholder land plots. Species selected for each *plan vivo* are based on a combination of farmer preference, and trees that mimic neighboring forest trees.

For this phase of the project it was decided to limit the number of species to ninety three for logistical and technical reasons. The total number of seedlings distributed to the first group of farmers is listed in Annexure 02

4.3 Technical support to the farmers

RRI provides guidance and technical support to farmers on planting activities based on the analog forestry concept, according to the processes laid out in table 2 below.

Table 2: Technical support framework

<table>
<tr><td rowspan="2">Pre Planting activities – Nursery management and location identification (see Figure 5)</td><td>Seed collection carefully done with participation of nursery management people;
As many seeds as possible will be collected from trees within the community.
Additional seeds required will be purchased from seed banks.
Nurseries established by RRI are set quality criteria and supervised by the community technicians.
Over time the farmer community will receive training to develop and maintain the nurseries.
The soil for the seedlings comes from a mix of sand from the riverbed and humus, on site soil and some compost manure.</td></tr>
<tr><td>Each farmer discusses and negotiates their management plan and expectations with RRI
Planting places are demarked, identified by experts along with farmers</td></tr>
<tr><td>Planting activities (see Figure 6)</td><td>Spacing will be done according to the habitat of the tree species (Eg: light demanding tree vs. shade tolerant tree species etc)
Small areas (50cm) will be cleared around each site to remove competing grasses and shrubs just before the seedling is planted.
Particular attention will be given to ensure the right species are planted in the right location according to the plan vivo.</td></tr>
</table>

	• All trees will be planted before the monsoon rains.
Maintenance	• Weeding will be done as required particularly in the first year to ensure successful establishment. However as per the "Analog Forestry' concepts farmers are strongly guided to minimize weeding and artificial weedicide usage is not permitted. • For the first two years after planting any dead trees will be replaced at the beginning of the following wet season. • No harvesting, burning, and pruning is permitted without the express consent of the project coordinator. Any foliage and green waste will be left on site and worked into the ground or collected and used for composting. Dead woody material can either be used as fuel wood or for poles etc.
Compost making/training	• Every farmer is advised to build up their own compost plant at their lands. Guidance will be given by RRI.

Figure 4: Nursery management

Figure 5: Planting activities

4.3.1 Costs of implementation

The cost of implementation of a *plan vivo* differs from case to case and will change as the project scales up. The project coordinator will generate financial reports in order to monitor and make decisions on the project expense and incomes by recording the costs described in table 3. Financial records are maintained by CCC.

Table 3: Costs associated with project activity

Main phases	Details	Cost ownership
Nursery cost	Cost of seeds, planting and nursery management	RRI
Planting activities	Demarcation, soil test and hole making	RRI, farmers
	Distribution of seedlings	RRI
	Technical advisory, awareness sessions – logistics, awareness, personnel fees	CCC, RRI
	Labeling, mapping charges	CCC, RRI
	Materials for demarcating plots	CCC
Maintenance cost	Watering	Farmers
	Weeding	Farmers
Monitoring	Monitoring in defined cycles	RRI,CCC farmers

5 Methodology for quantifying carbon benefits

This technical specification provides a unique methodology for ex-ante quantification of carbon services from establishment of lowland wetland tree species. The project has developed a suite of models that provide conservative estimates of carbon sequestration for more than 90 tree species. Since the aim is to support regeneration of diverse forests using wild species as well as cash crops, there were particular technical challenges given several of the wild species are poorly studied and there is little available information on growth rates.

Species-specific models are then used to estimate the total carbon benefit from each *plan vivos* according to which species have been selected by farmers. Baseline carbon stocks are conservatively assumed to remain constant.

This technical specification quantifies the carbon sequestered in planted trees over a 20 year crediting period.

5.1 Carbon pools

Only increases in above ground biomass are considered. The carbon stocks in soil, litter and deadwood are also expected to increase as a result of project activities, and approaches for quantifying these benefits may be added in future versions. Because these carbon pools are excluded at present, this ex ante quantification of carbon services is considered to be highly conservative.

5.2 Developing growth curves and DBH values at 20 years

Calculation of individual tree growth rates is based on published growth data and models developed for this project with forest expert involvement. Available baseline data collected from the field (see figure 7) was combined with published growth data to calculate and predict growth increments; hence growth prediction models were developed for each tree species to be planted. Project partners consulted with the Forest Department of Sri Lanka, academic expertise involved in forestry and botanical research, and a comprehensive literature survey through relevant journals. Table 5 summarises the approaches used to construct growth prediction models. All ninety four plant species were initially categorized in to families.

Figure 6: Newly planted trees (left) and baseline survey of existing vegetation (right)

Table 4: Summary of approaches to developing growth models

Approach	Data source	Number of species	Percentage
Approach one	Growth prediction models were derived using available individual tree growth rate data with field verifications	81	86 %
Approach two	Due to lack of data resources, approximation criteria were used by selecting similar plant species with similar growth performances.	13	14 %

Approach one:

Growth prediction models were derived using available individual tree growth rate data with field verification to estimate the diameter growth at 20 years time. (Literature and research databases are listed in Annexure 03: Accessed literature and research databases for the growth rate predictions. Figures 8 and 9 illustrate the process of model development for each above mentioned tree categories. Graphs were plotted from the sourced growth rate data and regression models were developed. Expert opinions for growth performances and biological features were used to verify that DBH value predictions at 20 years were reasonable.

Available tree details at project site and climatic conditions were considered as described in table 6. A full list of the species developed growth prediction models is contained in table 7 below.

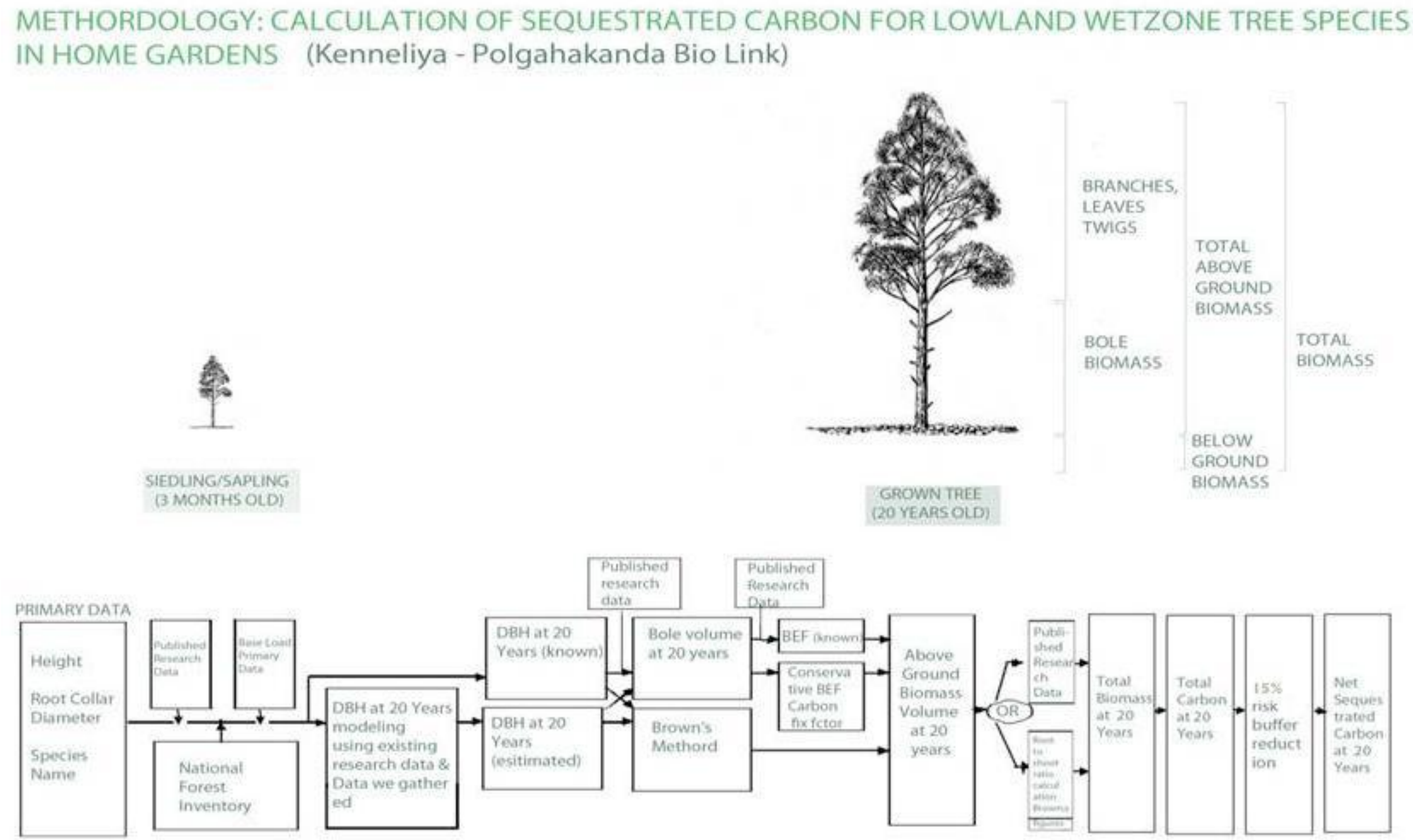


Figure 7: Methodology from primary data collection to quantifying carbon benefits

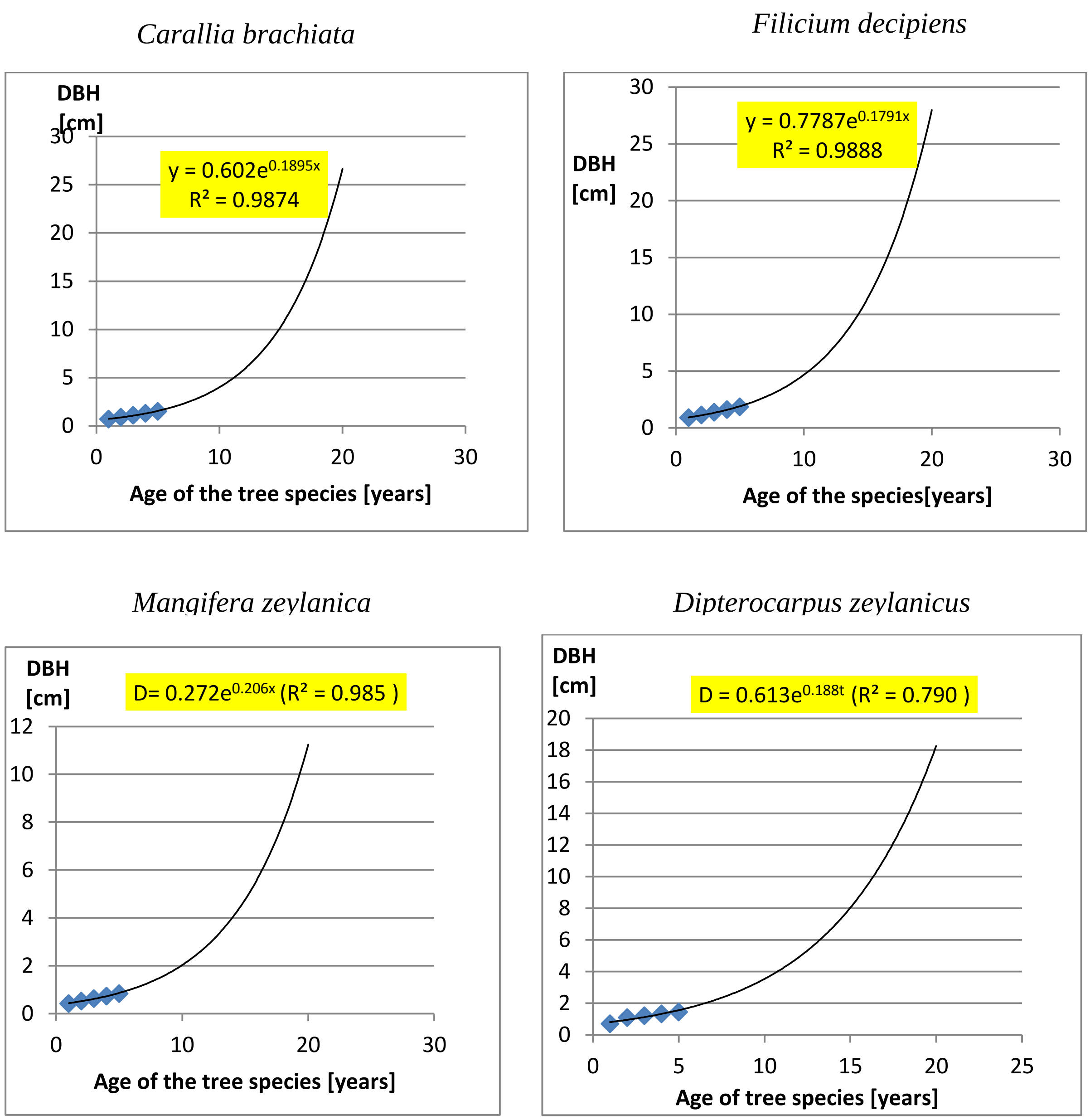


Figure 8: Example growth curves for with predicted DBH for at 20 years

Table 5: Parameters considered to develop growth models with examples

Category	**Example 01**	**Example 02**	**Example 03**	**Example 04**
Botanical Name	*Carallia brachiata*	*Dipterocarpus zeylanicus*	*Filicium decipiens*	*Mangifera zeylanica*
Plant Family	Rhizophoraceae	Dipterocarpaceae	Sapindaceae	Anacardiaceae
Common Name (Sinhala)	Dawata	Hora	Pihibiya	Etamba,
Habit	Tree	Tree	Tree	Tree
Life form	tree to 45 m	tree to 40 m	medium tree	large tree
Habitat	wet zone low land	wet and intermediate zones	wet and intermediate zones	wet zone low country
Growth habit/Stratum	Intermediate Rainforest Canopy	Intermediate Rainforest Canopy	Intermediate , Rainforest Canopy	Intermediate Rainforest Canopy
Developed growth Model	D= 0.602e0.189x (R^2 = 0.987)	$D = 0.613e^{0.188t}$ (R^2 = 0.790)	$D = 0.778e^{0.179t}$ R^2 = 0.9888	$D= 0.272e^{0.206x}$ (R^2 = 0.985)

Table 6: Growth models with DBH predicted at 20 years

Botanical Name	***GM Adjusted***	***Adjusted DBH in 20 yrs***	Adjusted AGBM (kg)	Information about the data point	No of Data points	Max age of data points	Ref for data
Adenanthera pavonina	D = 0.868e0.145t (R^2 = 0.997)	15.78	95.77		14	18yrs	http://www.ctfs.si.edu/site/Sinharaja/census/
Areca catechu	D= 0.830e0.156t (R^2 = 0.644)	18.80	76.04		6	15yrs	http://www.ctfs.si.edu/site/Sinharaja/census/
Artocarpus altilis	**D= $0.42e^{0.234t}$ (R^2 = 0.980)**	31.13	521.88		8	17 yrs	Unpublished field collected data by RRI (2011)
Artocarpus heterophyllus	**D= $0.42e^{0.234t}$ (R^2 = 0.980)**	33.39	614.22		115	between 2 to 13 years	*doi:10.1155/2010/507392*
Artocarpus nobilis	**D= $0.42e^{0.234t}$ (R^2 = 0.980)**	30.41	494.10				
Azadirachta indica	**D = $1.647e^{0.109t}$ (R^2 = 0.757)**	14.57	77.08		4	16yrs	Unpublished field collected data by RRI (2011)
Bhesa ceylanica	D = 0.343e0.194t (R^2 = 0.986)	16.61	109.96		665	not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Calophyllum calaba	**D= $0.374e^{0.194t}$ (R^2 = 0.931)**	18.11	138.09	growth curve developed using *C. bracteatum* data - growth rate per year ,calculated using 343 individuals		not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Calophyllum inophyllum	D = 0.427e0.201x (R^2 = 0.985)	23.78	274.54	growth curve developed using *C. bracteatum* data - growth rate per year ,calculated using 343 individuals		not available	http://www.ctfs.si.edu/site/Sinharaja/census/

Calophyllum mooni	D = 0.427e0.201x (R² = 0.985)	23.78	274.54	growth curve developed using *C. bracteatum* data - growth rate per year ,calculated using 343 individuals		not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Calophyllum walkeri	**D= 0.374e$^{0.194t}$ (R² = 0.931)**	18.11	138.09	growth curve developed using C. bracteatum data - growth rate per year ,calculated using 343 individuals		not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Canarium zeylanicum	D= 0.415e0.260x (R² = 0.976)	34.48	661.54	8	8	not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Carallia brachiata	D= 0.602e0.189x (R² = 0.987)	26.38	352.76	4	4	not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Caryota urens	**D = 0.813e$^{0.161t}$ (R² = 0.638)**	20.35	96.43	per year diameter growth rate were used with 33 data points with diameter and height measurements where used to		not available	fieald data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Casearia zeylanica	D = 0.566e$^{0.154t}$ (R² = 0.993)	12.32	47.90	average growth data for 5 year time in 2 trees		not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Chloroxylon swietenia	**D = 0.284e$^{0.185t}$ (R² = 0.987)**	11.49	39.07	growth curve developed using *D. sylvatica* data - growth rate per year ,calculated using 12 *individuals* between 1996 to 2005		not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Dillenia retusa	**D = 0.255e$^{0.209t}$ (R² = 0.984)**	16.67	111.00		192	not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Dillenia triquetra	**D= 0.492e$^{0.181t}$ (R² = 0.988)**	18.37	143.29		7	not available	http://www.ctfs.si.edu/site/Sinharaja/census/

Dimocarpus longan	D= $0.473e^{0.188t}$	20.31	185.44	growth curve developed using *Filicium decipiens* data - growth rate per year ,calculated using 1 individuals between 1996 to 2005 and 2 field measures data on *D longan* trees			Field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Diospyros chaetocarpa	**$y = 0.378e^{0.189x}$ ($R^2 = 0.987$)**	21.08	203.45		18	not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Dipterocarpus sp	**$y = 0.613e^{0.188t}$ ($R^2 = 0.790$)**	29.42	457.22	growth curve developed using *Dipterocarpus zeylanicus* data	6	20	field collected data and http://www.ctfs.si.edu/site/Sinharaja/census/
Dipterocarpus zeylanicus	**$y = 0.613e^{0.188t}$ ($R^2 = 0.790$)**	29.42	457.22		6	20	field collected data and http://www.ctfs.si.edu/site/Sinharaja/census/
Filicium decipiens	D = $0.778e^{0.179t}$	27.91	403.66		8	18	field collected data and http://www.ctfs.si.edu/site/Sinharaja/census/
Garcinia quaesita	D = $0.432e^{0.192t}$ ($R^2 = 0.925$)	20.10	180.49		7	15yrs	Unpublished field collected data by RRI (2011)
Horsfieldia irya	D= $0.792e^{0.152t}$	16.56	109.03				
Horsfieldia iryaghedhi	D= $0.669e^{0.170t}$	20.05	179.28		6	not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Madhuca longifolia	D = $2.057e^{0.103t}$ ($R^2 = 0.721$)	16.14	101.83			not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Mangifera indica	D = $1.905e^{0.122t}$ ($R^2 = 0.916$)	21.86	222.82		5	20yrs	field collected data and http://www.ctfs.si.edu/site/Sinharaja/census/
Mangifera zeylanica	**D= $0.272e^{0.206x}$ ($R^2 = 0.985$)**	16.74	112.35		14	25 yrs	Field data collected (Unpublished),2011
Memecylon capitellatum		7.79	12.05		5	15 yrs	CTFS data and Field data collected by RRI (2011)
Mesua Nagassarium	D = $0.795t^{1.065}$ ($R^2 = 0.879$)	19.32	163.14		4	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/

Mesua thwaitesii (ferrea)	$D= 0.385e^{0.189t}$ ($R^2 = 0.861$)	16.87	114.59		7	15 yr	CTFS data and Field data collected by RRI (2011)
Myristica dactyloides	D= 0.432e0.180x (R^2 = 0.988)	15.81	96.34		8	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Neolitsea cassia	$D = 0.522e^{0.168t}$	15.03	83.93		15	18yrs	Data collected from the field – Base load studies-2011
Pericopsis mooniana	$D = 2.292e^{0.111t}$	21.10	204.12			not available	http://www.ctfs.si.edu/site/Sinharaja/census/
Pongamia pinnata		13.18	58.15		17	19	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Schleichera oleosa	$D = 0.160e^{0.222t}$ ($R^2 = 0.982$)	13.56	63.13		15	10	Unpublished field collected data by RRI (2011)
Semicarpus sp.	$D = 0.431e^{0.182t}$ ($R^2 = 0.988$)	16.42	106.60		16	8	Unpublished field collected data by RRI (2011)
Shorea dyeri	$D = 0.341e^{0.201t}$	18.99	156.20		12	13	Unpublished field collected data by RRI (2011)
Shorea trapezifolia	$D = 0.341e^{0.201t}$	18.99	156.20		6	not available	Field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Shorea zeylanica	$D = 0.341e^{0.201t}$	18.99	156.20		7	15 yr	CTFS data and Field data collected by RRI (2011)
Stemonoporus petiolaris	$D = 0.177e^{0.224t}$	15.62	93.20		6	19	Unpublished field collected data by RRI (2011)
Symplocos coronata		15.81	96.34		7	12	Unpublished field collected data by RRI (2011)
Symplocos cochinchinensis		15.97	99.02		12	10	Unpublished field collected data by RRI (2011)
Syzygium aromaticum	$D = 0.666e^{0.158t}$ ($R^2 = 0.991$)	15.70	94.51			16	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Syzygium assimile	$D = 0.525e^{0.158t}$ ($R^2 = 0.991$)	12.37	48.57			Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Syzygium cumini	$D= 0.406e^{0.164t}$ ($R^2 = 0.962$)	10.80	32.55		4	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Syzygium javanicum	$D = 0.272e^{0.205t}$ ($R^2 = 0.985$)	16.41	106.52			23	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Syzygium operculatum		18.25	140.86		7	12	Unpublished field collected data by RRI (2011)
Syzygium samarangense	$D = 0.272e^{0.205t}$	16.41	106.52		9	14	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Tamarindus indica	$D = 0.346e^{0.176t}$	11.69	41.14		9	18	Unpublished field collected data by RRI (2011)
Terminalia bellirica	$D = 0.204e^{0.210t}$	13.60	63.66		23	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/

Terminalia catappa	$D = 0.574e^{0.195t}$	28.36	419.18		123	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Timonius flavescens	$D= 0.583e^{0.147t}$	11.03	34.62		19	17	Unpublished field collected data by RRI (2011)
Vateria copallifera		18.20	139.96		7	15	Unpublished field collected data by RRI (2011)
Vitex altissima	$D = 0.428e^{0.195t}$	21.14	205.12		5	Not available	Data collected from base line data,2011
Diospyros discolor		16.09	100.98		17	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Flacourtia indica/ Flcourtia ramontchi		9.72	23.66		25	12	Unpublished field collected data by RRI (2011)
Lijndenia capitellata		9.44	21.62		19	16	Unpublished field collected data by RRI (2011)
Nephelium lappaceum	$D = 0.296e^{0.217t}$	22.71	244.92		8	11	Unpublished field collected data by RRI (2011)
Acronychia pedunculata	$D= 0.604e^{0.183t}$	23.47	265.79		110	Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Annona muricata		19.26	161.89		5	16	Unpublished field collected data by RRI (2011)
Annona reticulata		19.26	161.89		9	23	Unpublished field collected data by RRI (2011)
Annona squamosa		19.26	161.89		17	20	Unpublished field collected data by RRI (2011)
Berrya cordifolia	$D = 1.926e^{0.132t}$	26.99	372.68		5	13	Unpublished field collected data by RRI (2011)
Citrus aurantifolia		11.15	35.77			Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Citrus limon		11.15	35.77		12	18	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Citrus sinensis		11.15	35.77		6	12	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Cyathocalyx zeylanica		16.52	108.44		9	Not available	Unpublished field collected data by RRI (2011)
Coffea arabica		9.69	23.43			Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Cananga Odorata	$D= 0.636e^{0.176t}$	21.49	213.55		4	9	Unpublished field collected data by RRI (2011)

Aegle marmelos		14.81	80.66		11	13	Unpublished field collected data by RRI (2011)
Limonia acidissima	$D = 1.244e^{0.118t}$	13.18	58.14			Not available	Unpublished field collected data by RRI (2011)
Persea americana	$D = 2.265e^{0.119t}$	24.47	294.35		9	14	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Psidium guajava		11.19	36.15		5	26	Unpublished field collected data by RRI (2011)
Theobroma cacao		9.45	21.65	4	4	30	Unpublished field collected data by RRI (2011)
Mimusops elengi		18.46	145.10		6		field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/
Murraya paniculata		13.81	66.44			Not available	field data measured for base load study and http://www.ctfs.si.edu/site/Sinharaja/census/640

Approach two

For the species where growth data was not available, carbon sequestration rates were developed using approximation criteria, by selecting the similar plant species with similar growth performance, with reference to expert opinion. The outcome was an estimation of DBH at 20 years for each species. The following example explains the process:

Example: *Memecylon capitellatum* – Family - Melastomataceae (Memecylaceae)

Life form- large shrub or small tree 5 m

Habitat - dry zone

To determine the growth rate of *Memecylon capitellatum*, growth rates *(Source: http://www.ctfs.si.edu/site/Sinharaja*) of species of the same family and genus were compared and a suitable figure was taken to develop a model, as shown in Table 8 and Figure 10 below.

Table 7: Deriving the growth rate for Memecylon capitellatum by analysing growth rates of the Malastomatacae

Family	Genus	Species	Life form	Habitat(climatic zone)	D < 1cm
Melastomataceae	Memecylon	arnottianum	shrub or small tree	wet zone forests	0.998
Melastomataceae	Memecylon	clarkeanum	shrub or small tree	wet zone	1.209
Melastomataceae	Memecylon	giganteum	shrub or small tree	wet lowlands forests	1.785
Melastomataceae	Memecylon	grande	shrub or small tree	wet zone forests	0.912
Melastomataceae	Memecylon	procerum	shrub or small tree	wet lowland forest	0.972
Melastomataceae	Memecylon	rostratum	small tree	wet lowland forest	1.181
Melastomataceae	Memecylon	royeni	shrub	wet zone forest	1.445
Melastomataceae	Memecylon	sylvaticum	shrub or small tree	dry and wet lowland forests	0.938
Melastomataceae	Memecylon	varians	shrub or small tree	wet zone forests	1.018
Average growth rate taken in consultation with experts					**1.162**

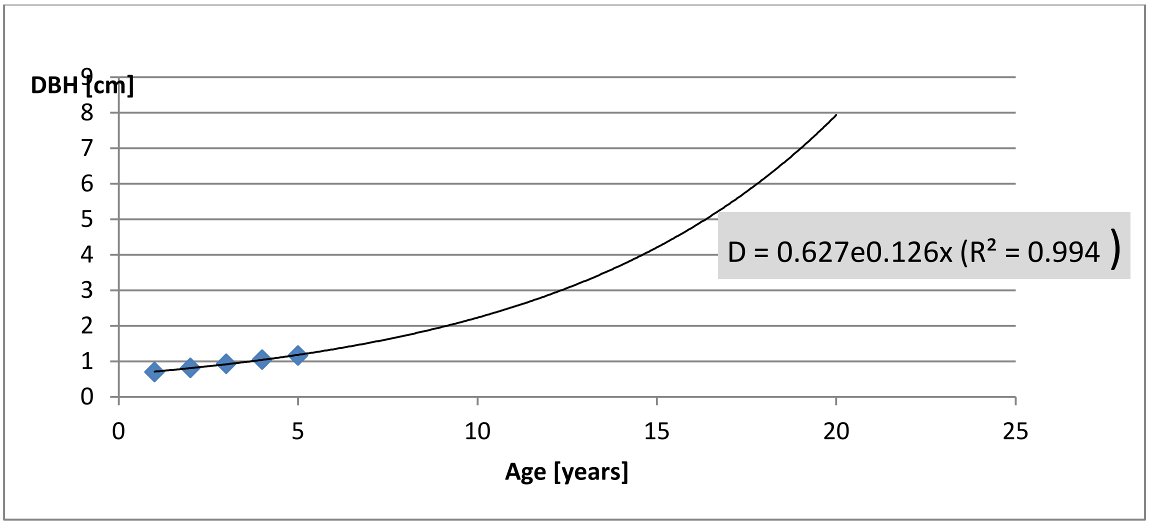


Figure 9: Growth curve derived for Memecylon capitellatum

Species were then categorized according to their carbon sequestration rates as shown in table 9. The complete list of species and their categorization can be found in Annex 02.

Table 8: Categorisation of species according to biomass accumulation rates

Category	Criteria	Number of ground plants	% distributed	Example
Plant species produce > 405 kg AGB (forecasted for 20 yrs time)	>75% of fractional value from cumulative AGB(forecasted for 20 yrs time) from grounded 80 plants	4057	60	*Dipterocarpus zeylanicus** *Terminalia catappa*
Plant species produce 214 - 405kg AGB (forecasted for 20 yrs time)	50% - 75% of fractional value from cumulative AGB(forecasted for 20 yrs time) for 80 plants	1415	20	*Carallia brachiata** *Calophyllum mooni*
Plant species produce 139 - 214kg AGB (forecasted for 20 yrs time)	25% -50% of fractional value from cumulative AGB(forecasted for 20 yrs time) for 80 plants	751	10	*Mesua Nagassarium Garcinia quaesita*
Plant species produce 10 - 139kg AGB (forecasted for 20 yrs time)	<25% of fractional value from cumulative AGB(forecasted for 20 yrs time) for 80 plants	552	10	*Mangifera zeylanica** *Dipterocarpus zeylanicus**

Since most of the selected plant lists comprise of lowland wet species, growth rates could not be found for any of the wild variety species. However growth models that are already available for the wet zone cash crops were directly taken for the future carbon calculation (Growth rates for some of the cash crops found were taken.)

Some woody climbers, lianas and vines will be distributed to participants to enrich biodiversity and are not included in the carbon stock calculations. In addition, four tree species planted are not included in carbon calculations since there was insufficient growth rate data to develop growth prediction models. These are listed in table 10 below including the number of plants distributed to the first group of farmers in the project (planted over 10.88ha).

Table 9: Species distributed for biodiversity improvements

Species Name	**No of plants distributed**
Pagiantha dichotoma	15
Salacia prinoid	119
Couroupita guianensis	4
Manilkara zapota	2
Assarolla	62
Artabotrys zeylanicus	92
Asparagus falcatus	14
Bambusa vulgaris	104
Calamus rotang	60
Dalbergia peudo-sissoo	156
Dalvergia peudo-sissoo – 2	21
Calamus pseudotenus	43
Sandoricum indicum	9
Hedyotis fruticosa	4

5.3 Carbon benefit calculations

Diameter at breast height (DBH) values after 20 years is predicted using growth prediction models. Above ground and below ground biomass is derived from DBH figures using the following equations.

Total above ground biomass of a particular tree is estimated using the general biomass model Eq - 01 (Brown S. , 1997).

Above ground biomass [kg] $=21.297-6.953(DBH) + 0.740(DBH)^2$ ………………….Eq - 01

*DBH – Diameter at breast height in centimeters

For palms: total above ground biomass is estimated using the general biomass model Eq - 02, developed by Frangi and Lugo (1985).

Above ground biomass [kg] $= 10.0 + 6.4 \times$ Total Height ……………………….Eq - 02

Below Ground Woody (BGW) biomass was calculated using below Eq – 03.

BGW[kg] = Aboveground Woody (AGW) biomass[kg] × Root to Shoot ratio....Eq - 03

Root to shoot ratio of 0.127 is taken from (Brown & Iverson, Biomass estimates for tropical forests, 1992)

The total biomass of a tree can be derived following the below equation Eq – 04

Total biomass [kg] = BGW biomass [kg] + AGW biomass [kg]…………………Eq - 04

The calculation of carbon sequestration is shown in the below equations from known total biomass applying the CarbonFix methodology.

(From Eq – 04) onwards,

Total carbon content = Total biomass [kg]/ 2…..Eq - 05

Total CO_2 sequestrated = Total carbon content × C to CO_2 fraction (3.667)……Eq – 06

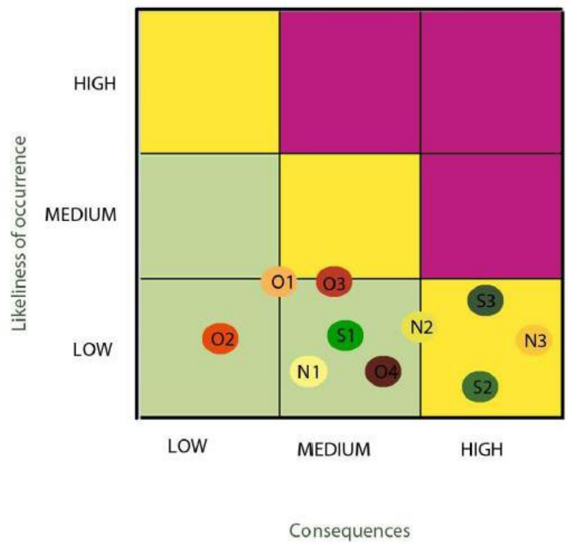
(Carbonfix standards, version 3.1 , 2010)

5.4 Project carbon benefits

Species-specific models are used to estimate the total carbon benefit of each *plan vivo* according to which species and how many trees are selected for planting by the farmer. The project uses an excel tool to calculate the carbon benefits separately for individual tree species in accordance to the growth models developed for each of them. (Annexure 07: Carbon benefit calculation Tool). The Species- specific model will be used as a tool to calculate the carbon benefit of the project as it scales up, and will be part of the reporting to the Plan Vivo Foundation.

6 Risk assessment

Carbon services will only be delivered if land-use practices are viable over the long-term and provide sustainable environmental and economic benefits to communities The following risk and mind map (figure 11) was constructed for te project.



Key

O1	Dispute caused by conflicts	N2	Pests and disease
O2	Lack of organizational resources	N3	Extreme climate conditions
O3	Poor record keeping	S1	Understanding of communities
O4	On time & effective monitoring	S2	Selling of farmer land slots
N1	Fire	S3	Tree cutting

Figure 10: Project risk map

For the smooth running of project activities, proper management, monitoring and precautionary actions will be applied as part of an integrated plan for sustainable land-use that incorporates risk management. Factors that pose risks to the permanence of carbon stocks are listed below in table 10, and mitigation measures described. These were discussed during brainstorming sessions involving farmer representatives and the coordinating organizations.

Table 10: Risk factors and mitigation measures

Risk Factor	Mitigation options
Natural factors	
Fire	Regular monitoring practices and plantation clearing to minimize deadwood fuel load. The local government has recently imposed heavy restrictions on the use of fire to clear land
	Forest cover in the area is minimal and isolated making it difficult for fires to spread
Pests and diseases	Careful selection of tree species.
	Introduce and Implement proper monitoring system
Extreme climatic events	Carful Site selection criteria
Social/legal	
Disputes caused by conflict of project aims/activities with local communities/groups	Participatory planning and continued stakeholder consultation over project life-span
	Good communication and awareness between community and project coordinators
Project organization	
Management not carried out effectively	Recruit adequately trained staff.
Double-counting due to poor record keeping	Transparent record-keeping procedures
	Maintain up-to date database with records of all carbon monitored and sold.
Lack of resources/skills/expertise	Training the community, Setting up the CBO and training skilled employees

6.1 Risk buffer

A carbon buffer can be defined as a stock of unsold and non-saleable carbon generated by each *plan vivo*, generated by deducting a specified percentage from each participant's carbon sequestration potential according to the risk level determined to the project as a whole.

The project has followed the VCS AFOLU Non-Permanence Risk Tool (version 3), to assess the non-permanence risk and to determine the buffer required. The risk buffer level identified using the tool is 15%. Both internal risks and external risks were assessed.

6.1.1 Internal Risks

Project management risks

According to the VCS AFOLU Non-Permanence Risk Tool, we have assessed the day today management practices and the adaptive management plans.

Financial stability

Since CCC has received an advance payment from a buyer for Plan Vivo Certificates, the pilot project's cash flow breakeven point is proven to be between 7 and up to 10 years from the current risk assessment. To ensure the security of the sales obtained from the buyer, CCC is maintaining a separate bank account.

Opportunity cost

An assessment of net impacts of the project on the social and economic well being of the communities who involves with the project and the alternative land use scenarios were assessed and compared with the Net present value of the project crediting period. Since the project has a solid mechanism to make sure income gain from the project as well as an alternative income generation by CBO forming and Forest Garden certification, organic products, NPV from the alternative lad use activities will very low.(Eg: Tea cultivation).

6.1.2 External Risks

Land Tenure (Land ownership and Resource Access)

All the lands in the projects are owned by the farmers thus there are no any risk of land or resource access involve in the project.

Community agreement

Community in the project area in very positively sees the project and results of the social survey shows that the project will increase their livelihood.

Political risk

Political risk to the project was assessed by using the World Bank Institute Worldwide Governance Indicators.

Natural Risks

Natural risks were assessed based on the likelihood (the historical average number of times the event has occurred on the project area over 100 years) and its significance. In addition prevention measures/mitigation options assessed. Following were considered,

- Pest and disease outbreaks
- Extreme weather events
- Geological risks

7 Leakage

Risks of leakage were identified below and mitigation measures also listed in table 12. Risk of leakage overall is thought to be insignificant and no deductions are to be made from the overall carbon benefit, in line with approved CDM methodologies for small-scale afforestation projects.

Table 11: Leakage risks and mitigation measures

Leakage Risks	**Risk level (high/medium/low)**	**Management Measures**
Displacement of existing land use activities	Low	Provide technical support in the development of farm plan to ensure that the farmers have sufficient productivity over and above tree planting
Displacement fuel-wood use	Medium	Establishment of forest plantations on producer's land to provide a sustainable source of fuel-wood + distribution of fuel-efficient cook stoves
Displacement of Livestock grazing	Low	Technical support in the development of farm plan to ensure that the farmers have sufficient land for pasture over and above tree planting.
	Low	Regular socio-economic assessments to monitor land use changes within the project area.

8 Monitoring

8.1 Monitoring *plan vivos*

This section describes the monitoring methods and procedures to ensure delivery of carbon and other ecosystem services. The key parameter of quantifying ecosystem services in this Plan Vivo project is carbon sequestration in planted trees. A monitoring plan is used to assess performance of each *plan vivo*, and sets milestones to be reached in order for payments to be received by farmers (a payments for ecosystem services model). Each *plan vivo* is monitored twice annually using the given indicators. These are described in Table 13.

Apart from the self-monitoring plan given to the famers, CCC's and RRI technical consultants will be fully responsible for monitoring the success of the post planting process. Immediate actions will be taken where famers fail to achieve their targets by providing technical support.

Local research institutions (Sri Lanka University of Sabaragamuwa) will also participate in monitoring in the longer term, to enhance the social engagement and visibility of the project and increase recognition.

Table 12: Monitoring protocol and Key Performance Indicators (KPIs)

Time line	Parameter	KPI	Monitoring Responsible	Monitoring team, resources	Monitoring / review frequency	Status Of Payment
Year 01	Plant establishment in the ground	60%	RRI	RRI, farmers	Two times/year	Deduct if not met
	Participation in farmer awareness sessions (4 sessions/year)	≥75%	CCC	CCC, RRI	After each session	Deduct if not met
Year 02	Plant survival	≥70%	carbon consulting Company	CCC, University students group	Two times/year	Deduct if not met
	Participation	At least	Carbon	CCC, RRI	After each	Deduct if

	in farmer awareness sessions (3 sessions/year)	attend two session out of three	Consulting Company		session	not met
Year 03 onwards (till 20years)	Plant survival	≥80%	Carbon Consulting Company	CCC, University students group	Two times/year	Deduct if not met
	Participation in farmer awareness sessions (2 sessions/year)	100%	Carbon Consulting Company	CCC, RRI	After each session	Deduct if not met
	Growth analysis (DBH, Height)	50% achieved from predicted DBH	CCC, RRI	CCC, and RRI University students group	Two times/year	Deduct if not met
After second year	Baseline		RRI and CCC	CCC, University students group	Annually	Not affected

If a farmer fails to achieve the set KPI's, a portion of the payments will be withheld to make sure the ecosystem services are being delivered. If farmers intentionally damage or destroy planted trees, payments will be withheld. If unexpected damage happens to the trees (e.g. disease, natural hazard), the project coordinator will provide necessary support such as providing new plants. Moreover, farmers will be encouraged to further the objectives of the project by taking care of existing trees (other than new plants) by minimizing tree cutting activities other than for domestic use which is not considered significant.

8.2 Continuous evaluation of growth models

In addition to the above performance based indicators, in order to evaluate the validity of the growth models over time, CCC will monitor the DBH of 25% of trees within a species, unless that number exceeds 100 trees in which case a random sample of 100 trees will be monitored.

If >10 % fall below the growth curve, the curve will be adjusted and the carbon credits claimed adjusted accordingly through a revision to the technical specification. Adjustments may also be made if the growth is significantly above the curve when the technical specification is revised.

9 References

Brown, S. (1997). *Estimating biomass and biomass change in tropical forests.* Rome: Food and Agriculture Organization of the United Nations.

Brown, S., & Iverson, L. R. (1992). Biomass estimates for tropical forests. *World Resources Review* , 4:366-384.

CarbonFix. (2010). *Climate Forestration Projects; version 3.1,*. London: CarbonFix.

Gunatilleke, U. N., Gunatilleke, V. S., & Dilhan, A. B. (2005). Plant biogeography and conservation. *The raffles bulletin of zoology* , 10.

Pethiyagoda, R., & Manamendra-Arachchi, K. (1998). Evaluating Sri Lanka's amphibian diversity. *Occassional Papers of the Wildlife Heritage Trust* , 1-12.

Rain Forest Rescue International Sri Lanka. (2010). Retrieved 2011 from www.rainforestrescueinternational.org: http://www.rainforestrescueinternational.org/rri/index.php?option=com_content&view=article&id=65%3Awhat-is-analog-forestry&catid=38&Itemid=54

Rain Forest Rescue Internatonal Sri Lanka. (2008). From rainforestrescueinternational.org: http://www.rainforestrescueinternational.org/rri/index.php?option=com_content&view=article&id=65%3Awhat-is-analog-forestry&catid=38&Itemid=54

Sri Lanka National Report. (1991). *Sri Lanka national report to the United National Conference on environment and development.* Ministry of Environment and Parliamentary Affairs, Govt of Sri Lanka.

Survey Department. (1988). *The national atlas of Sri Lanka.* Survey Department of Sri Lanka.

The World Conservation Union and Ministry of Environment and Natural resources. (2007). *The 2007 Redlist of threaten flora and founa of Sri Lanka.* Sri Lanka: The World Conservation Union.

Unesco, & iucn. (2005). *Sinharaja forest reserve sri lanka.* Unep.

Wikramanayake, E. D. (1990). Ecomorphology and biogeography of a tropical stream fish assemblage: evolution of assemblage structure. *Ecology* , 1756-1764.

Zoysa, N., & Raheem, R. (1990). *Sinharaja – a Rain Forest in Sri Lanka.* March for Conservation.

Annexure 01: Analog Forestry

Analog Forestry is a system of silviculture, which aims to restore the local biodiversity while providing economic opportunities to small-scale farmers. Inspired by Sri Lanka's tradition of home-gardens it encourages the use of economically viable crops such as tea, spices, fruit and vegetables, as well as ecologically important species. Where Analog Forestry differs from other systems is in the planting design, which mimics both the structure of a natural forest (i.e. different canopy layers) and the ecological functions of a natural forest (i.e. watershed management).

Combing local forest biodiversity with organic crop cultivation has a number of advantages. Using ecologically sustainable farming practices:

- encourages high biodiversity
- produces clean water and soil
- gives watershed protection
- conserves soil

While the first few years of converting a system to Analog Forestry can be intensive, the long-term economic and biodiversity gains make this a sustainable system. Although crops give lower yields than in more intensive farming practices, their diversity provides economic stability. For example, if one crop fails or market prices fall for one commodity, the other crops can still be sold to provide a stable income. Organic farming techniques also require less expenditure on external inputs such as chemical fertilizers, as there is a higher resilience against plagues and diseases.

The practical value of this system is demonstrated in over 25 years of research that is being translated into community projects across the world.

<u>The history of Analog Forestry</u>

Over 30 years ago, a group of environmentalists from the Neo Synthesis Research Centre (NSRC), developed an agricultural method which would encourage native biodiversity to flourish. This system provided an alternative to monocrops which were being widely promoted for "reforestation" purposes.

Led by Sri Lankan Systems Ecologist Dr. Ranil Senanayake, (present Chairman of Rainforest Rescue International), NSRC first applied this system on the abandoned Belipola tea estate in the Sri Lankan hills, in Mirahawatte, near Bandarawela, successfully restoring the ecosystem and its functions as well as the estate's income generation potential.

The name Analog Forestry was coined in 1987, and in April 1994 it was accepted as a methodology integrating the protection of biodiversity within the context of sound landscape management by scientific experts at the Open-ended Intergovernmental Meeting of Scientific Experts on Biological Diversity (sponsored by the UN) in Mexico City.

Source: www. rainforestrescueinternational.org

Annex 02: Distributed plant list categorized to carbon contribution

Plant species produce 10 - 139kg AGB (forecasted for 20 yrs time)	Plant species produce 139 - 214kg AGB (forecasted for 20 yrs time)	Plant species produce 214 - 405kg AGB (forecasted for 20 yrs time)	Plant species produce > 405 kg AGB (forecasted for 20 yrs time)
Memecylon capitellatum	*Vateria copallifera*	*Mangifera indica*	*Terminalia catappa*
Lijndenia capitellata	*Syzygium operculatum*	*Nephelium lappaceum*	*Dipterocarpus sp*
Theobroma cacao	*Dillenia triquetra*	*Palaquium petiolare*	*Dipterocarpus zeylanicus*
Coffea arabica	*Mimusops elengi*	*Acronychia pedunculata*	*Artocarpus nobilis*
Flacourtia indica/ Flcourtia ramontchi	*Shorea dyeri*	*Calophyllum inophyllum*	*Artocarpus altilis*
Syzygium cumini	*Shorea trapezifolia*	*Calophyllum mooni*	*Artocarpus heterophyllus*
Timonius flavescens	*Shorea zeylanica*	*Persea americana*	*Canarium zeylanicum*
Citrus aurantifolia	*Annona muricata*	*Carallia brachiata*	
Citrus limon	*Annona reticulata*	*Berrya cordifolia*	
Citrus sinensis	*Annona squamosa*	*Filicium decipiens*	
Psidium guajava	*Mesua Nagassarium*		
Chloroxylon swietenia	*Horsfieldia iryaghedhi*		
Tamarindus indica	*Garcinia quaesita*		
Casearia zeylanica	*Dimocarpus longan*		
Syzygium assimile	*Diospyros chaetocarpa*		
Garcinia echinocarpa	*Pericopsis mooniana*		
Limonia acidissima	*Vitex altissima*		
Pongamia pinnata	*Cananga Odorata*		
Schleichera oleosa			
Terminalia bellirica			
Murraya paniculata			
Areca catechu			
Azadirachta indica			
Aegle marmelos			
Neolitsea cassia			
Stemonoporus petiolaris			
Syzygium aromaticum			
Adenanthera pavonina			
Myristica dactyloides			

Symplocos coronata *Caryota urens* *Symplocos cochinchinensis* *Diospyros discolor* *Madhuca longifolia* *Syzygium javanicum* *Syzygium samarangense* *Semicarpus sp.* *Cyathocalyx zeylanica* *Horsfieldia irya* *Bhesa ceylanica* *Dillenia retusa* *Mangifera zeylanica* *Mesua thwaitesii (ferrea)* *Calophyllum calaba* *Calophyllum walkeri*			

Annexure 03: Accessed literature and research databases for the growth rate predictions

Ashton, P. M. S., Gamage, S., Gunatilleke, I., and Gunatilleke, C. V. S. 1997. Restoration of a Sri Lankan rainforest: using Caribbean pine Pinus caribaea as a nurse for establishing late-successional tree species. Journal of Applied Ecology 34: 915-925.

Ashton, P. M. S., Gunatilleke, C. V. S., and Gunatilleke, I. 1995. Seedling Survival and Growth of 4 Shorea Species in a Sri-Lankan Rain-Forest. Journal of Tropical Ecology 11: 263-279

Assessment of Net Carbon Benefit for Emiti Nibwo Bulora project in Kagera, Tanzania (Final Version). 2010. CAMCO

Berry, N (2008). Carbon modelling for reforestation and afforestation projects. Unpublished but available at ECCM (part of the Camco Group), UK.

Berry, N (2008). Estimating growth characteristics of agroforestry trees. Unpublished but available at ECCM (part of the Camco Group), UK.

Carbonfix standards, version 3.1, 2010, Climate Forestration Projects.

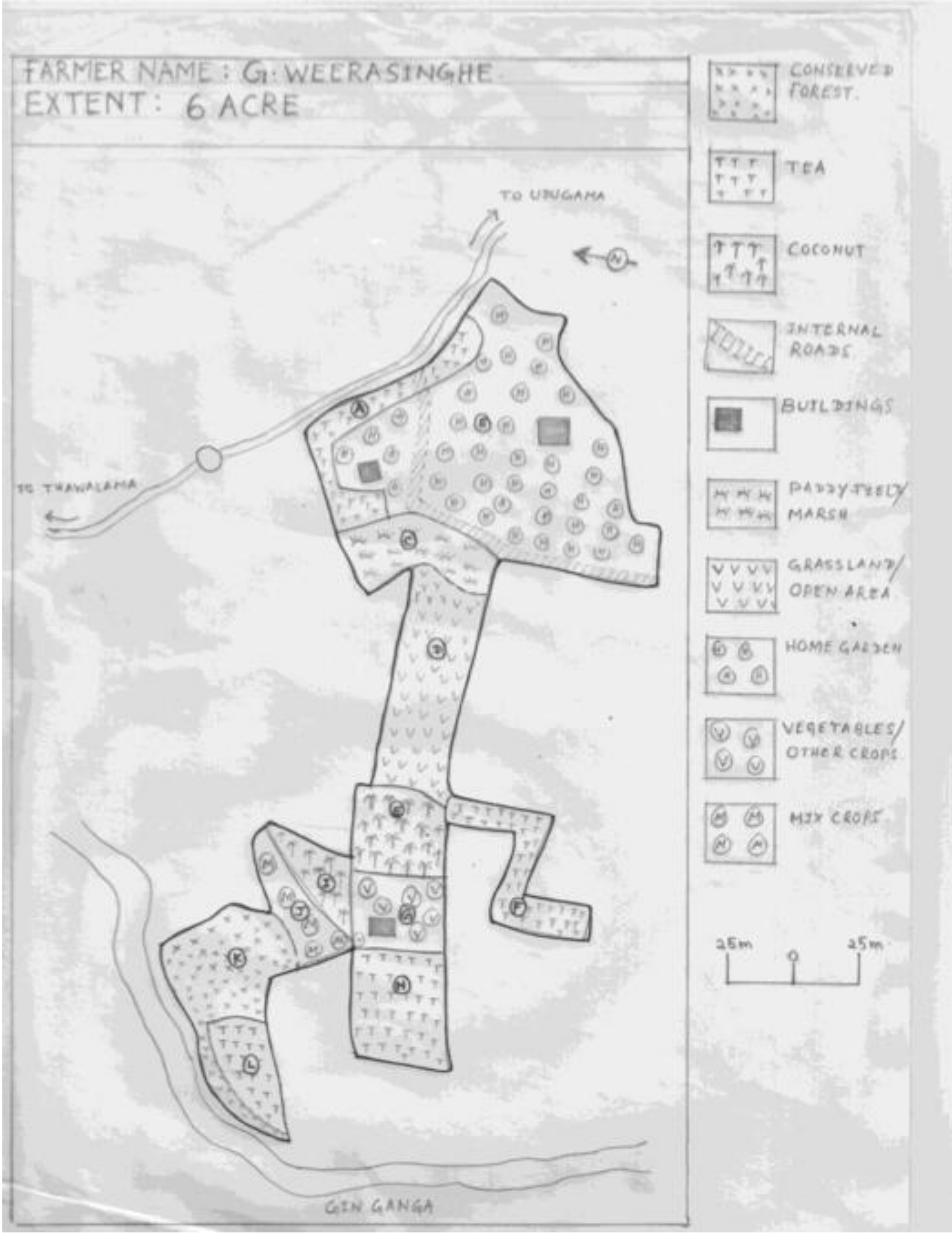
Henry M., A. Besnard, W.A. Asante, J. Eshun, S. Adu-Bredu, R. Valentini, (1998). Using Caribbean pine to establish a mixed plantation: testing effects of pine canopy removal on plantings of rain forest tree species. Forest Ecology and Management 106: 211-222.

http://www.ctfs.si.edu/site/Sinharaja, 05.02.2011

M. Bernouxb, L. Saint-André,(2010) Wood density, phytomass variations within and among trees, and allometric equations in a tropical rainforest of Africa, of Journal Forest Ecology and Management

Timothy R. Baker, Michael D. Swaine & David F.R.P. Burslem (2003), Variation in tropical forest growth rates: combined effects of functional group composition and resource availability, Perspectives in Plant Ecology, Evolution and Systematic, Vol. 6/1,2, pp. 21–36

Annexure 04: Example of a *plan vivo* with different land use patterns



Annex 05: The sales agreement of the farmers

AGREEMENT

*I ……………………………………………………holder of National Identity Card No………… of ………………… **(“the Farmer”)** do hereby request Conservation Carbon Company (Private) Limited a company registered under No…….in terms of the Companies Act No. 7 of 2007 and having its registered office at No. 104/11, Grandpass Road, Colombo 14, Sri Lanka*[X1] ***(“the Company”)*** *to grant me the stipend and other support as provided herein to plant, grow and maintain trees on the land owned to me by the State as per the details set out in the First Schedule hereto subject to the terms and conditions set out in the Second Schedule hereto.*

THE FIRST SCHEUDLE REFERRED TO ABOVE

1. *Details of Trees(Annex 1 : Green list)*

1.1 Type of Trees

1.2 Number planted per species

2. *Location (Describe the location on which the trees are planted).*

3. *Right of the Farmer to the location (eg. details of State lease etc.).*

THE SECOND SCHEDULE REFERRED TO ABOVE

Terms and Conditions

1. *The Farmer will plant, grow and maintain the trees at the location as per the details set out in the First Schedule hereto.*

2. *The Farmer will always ensure that the minimum number of trees as appears in Annex 1 is planted on the location described in the First Schedule hereto.*

3. *The Farmer will meet all expenses for planting growing and maintaining the said trees.*

4. *The Farmer shall not destroy or cut the said trees without the prior written permission of the Company.*

5. *The Farmer shall ensure that the necessary manuring and pesticides are done correctly.*

6. *This Agreement comes into operation on the day of signing and shall continue for a period of 20 years from sign date.*

7. *Either party may terminate this agreement by written notice of at least three calendar months to the other party excepting the first five years from planting where compensation for payments made or alternative plantations are provided by the farmer.*

8. *Nothing in this Agreement shall do not constitute a partnership between the parties nor constitute any party as agent of the other party.*

9. *The Agreement shall bind and accrue to the benefit of the Company and its successors and to the Farmer and his heir's executors and administrators.*

10. *The Company may assign its rights hereunder to any other institution but with at least one calendar month's written notice to the Farmer*

11. *Notice if any required to be given by one party to the other sent under registered post to the other party and if the other party does not dispute its receipt within 7 days of posting of the notice it shall be deemed to be accepted by the other party.*

12. *The Farmer confirms and declares that he is executing this Agreement giving the above undertakings to the Company in consideration of the Company agreeing to pay a stipend of 3.00 Sri Lanka Rupees per tree per month as a performance payment based on plant quality and maintenance.*

13. *After the clear agreement with the farmer the Company is liable to pay a stipend for a 20 year period and farmer will have the right to decide the frequency of Stipend payment, and it will be negotiable with both parties.*

14. *The Farmer recognizes and appreciates that the Company has agreed to pay the said stipend as a part of the programme for protection and development of bio diversity in the region under the programme of analog forestry.*

15. *The Farmer agrees and undertakes to permit the Company and its authorized representatives to inspect the location and the trees planted thereon and take photographs and also to furnish whatever information is required from the Farmer in respect of the trees.*

16. *The Farmer agrees and undertakes that in the event of any tree dying or is destroyed to plant another tree agreed to by the company in writing in place thereof.*

17. *The company has the full authority to monitor the survival of the plants distributed and if plants die for any reason company will provide plants for replanting. The cost of seedlings is deducted from carbon payments over the 20year projects period..*

18. *The Farmer agrees to attend individual or group training programmes or workshops in analog forestry organized by the Company and also to comply with the instructions and guidelines given by the Company in the implementation of the Project of planting growing and maintaining trees in the circumstances set out above*

19. *The Farmer agrees and undertakes not to do any act or allow any third party to disturb or drive away native fauna excepting known pest species that may enter upon the location from time to time nor cause any harm to them.*

20. *The farmer agrees and undertakes minimize harm and displacement of existing trees in the project area.*

21. ***Good Faith***

In entering into this Agreement the parties hereto recognize that it is impracticable to make provisions for every contingency that may arise in the course of their performance. Accordingly, the parties hereby declare it to be their intention that this Agreement shall operate between them with fairness and without detriment to the interests of either of them and that none of the parties shall make undue gains at the other party's expense and that all provisions of this Agreement shall be applied in good faith. If in the course of the performance of this Agreement unfairness to any party is disclosed or anticipated then the parties shall use their best endeavors to agree upon such action as may be necessary and equitable to remove the cause of the same.

22. ***Interpretation***

For the purpose of interpretation and construction of this Agreement the following provisions shall apply:-

22.1 Expressions in the singular shall include the plural and in the masculine shall include the feminine and vice-versa

22.2 Headings used in this agreement are inserted for convenient only and shall not affect its interpretation or construction

22.3 The Schedules form part of the Agreement.

Date: ………………………….

……………………………………..

(Farmer)

WITNESSES

1.

2

KN/RP

31.12.10

2(453)-AGREEMENT (CON)

Annex 06: A Jayabhoomi deed of a land given to farmers

Land Commissioner 156

(8 වන නියෝගය)

(Regulation 8)

Form "D"

19 වන වගන්තියේ (4) වන උප වගන්තිය යටතේ

නිකුත් කරනු ලබන ප්‍රදාන පත්‍රය

19ஆம் பிரிவின் 4 ஆம் உட்பிரிவின் கீழ் வழங்கப்பட்ட அளிப்பு

GRANT ISSUED UNDER SUB-SECTION 4 OF SECTION 19

I .... President of the Democratic Socialist Republic of Sri Lanka do hereby, in conformity with the provisions of the Land Development Ordinance (Cap. 464), grant unto .... (hereinafter called "the owner") the land described in the First Schedule hereto (hereinafter called the "holding") subject to the provisions of the aforesaid Ordinance and the reservations and conditions set out in the Second Schedule hereto.

Given at Janadhipathi Mandiraya, Colombo, under the Public Seal of the Democratic Socialist Republic of Sri Lanka on this .... day of .... One Thousand Nine Hundred and ....

President of the Democratic Socialist Republic of Sri Lanka.

I certify under Section 23(2) of the Crown Lands Ordinance (Chapter 454) that the facsimile of the President's Signature was stamped hereon in my presence.

Secretary to the President.

Annexure 07: Carbon benefit calculation Tool

Botanical Name	Sinhala name	Growth Model	DBH in 20 yrs	AGBM (kg)	Nerw green list [Phase one]	Nerw green list [Phase two]	Total # plants	AGBM Total kg for phase 01	AGBM Total kg for phase 02	AGBM Total kg
Adenanthera pavonina	මදටිය	D = 0.868e0.145t (R^2 = 0.997)	15.77515818	95.76548073	29	46	75	2777.198941	4405.212114	7182.411055
Memecylon capitellatum	වෙළිකහ/ දොඩම් කහ	y = 0.627e0.126x (R^2 = 0.994)	7.792730108	12.05186304	147		147	1771.623866	0	1771.623866
Lijndenia capitellata	[illegible]	D= 0.622e[illegible] (R^2 = 0.993)	9.442160436	21.61990983	24		24	518.8778359	0	518.8778359
Theobroma cacao	කොකෝවා	D = 1.385e[illegible] (R^2 = 0.868)	9.44702748	21.65410081	33	3	36	714.5853266	64.96230242	779.547629
Coffea arabica	කෝපි	D= 2.037e[illegible] (R^2 = 0.919)	9.693718876	23.43303004	470	47	517	11013.52412	1101.352412	12114.87653
Flacourtia indica/ Ficourtia ramontchi	උගුරැස්ස	D = 0.900e[illegible] (R^2 = 0.995)	9.724412578	23.66066733	3		3	70.982002	0	70.982002
Syzygium cumini	මදං	D= 0.406e0.164t (R^2 = 0.962)	10.8030516	32.54576591	53	56	109	1724.925593	1822.562891	3547.488485
Timonius flavescens	[illegible]	D= 0.583e0.147t	11.0279384	34.61515907	140	18	158	4846.122269	623.0728632	5469.195133
Citrus aurantifolia	දෙහි	D = 2.078e[illegible] (R^2 = 0.918)	11.14962531	35.76612217	56	77	133	2002.902842	2753.991407	4756.894249
Citrus limon	ලෙමන්	D = 2.078e[illegible] (R^2 = 0.918)	11.14962531	35.76612217	1		1	35.76612217	0	35.76612217
Citrus sinensis	දොඩම්	D = 2.078e[illegible] (R^2 = 0.918)	11.14962531	35.76612217	60	61	121	2145.96733	2181.733452	4327.700783
Psidium guajava	පේර	D= 1.742e[illegible] (R^2 = 0.769)	11.19014946	36.15428002	69	63	132	2494.645321	2277.719641	4772.364962
Chloroxylon swietenia	බුරුත	D = 0.284e0.185t (R^2 = 0.987)	11.48703444	39.07210009	307	29	336	11995.13473	1133.090903	13128.22563
Tamarindus indica	සියඹලා	D = 0.346e0.176t	11.68941225	41.13586209	21	6	27	863.8531038	246.8151725	1110.668276
Casearia zeylanica	[illegible]	D = 0.566e0.154t (R^2 = 0.993)	12.31525576	47.90151474	52	20	72	2490.878766	958.0302948	3448.909061
Syzygium assimile	දම්	D = 0.525e0.158t (R^2 = 0.991)	12.37456286	48.57272089	44	8	52	2137.199719	388.5817671	2525.781486
Garcinia echinocarpa	මඩොල්	D= 0.616e0.151t (R^2 = 0.992)	12.62263568	51.4367034	0	12	12	0	617.2404409	617.2404409
Limonia acidissima	දිවුල්	D= 1.473e[illegible] (R^2 = 0.978)	13.17514361	58.14268921	116		116	6744.551948	0	6744.551948
Pongamia pinnata	මගුල් කරඳ	D = 0.390e[illegible] (R^2 = 0.989)	13.1759271	58.15251954	73	38	111	4245.133927	2209.795743	6454.929669
Schleichera oleosa	කෝන්	D = 0.160e0.222t (R^2 = 0.982	13.56399067	63.13313659	5		5	315.6656829	0	315.6656829
Terminalia bellirica	බුළු	D = 0.204e0.210t	13.60401153	63.65946385	21	12	33	1336.848741	763.9135662	2100.762307
Murraya paniculata	ඇට්ටේරියා	D= 0.291e[illegible] (R^2 = 0.986)	13.81241725	66.43858685	184		184	12224.69998	0	12224.69998
Areca catechu	පුවක්	D= 0.830e0.156t (R^2 = 0.644)	18.7964951	76.03913536	49	10	59	3725.917633	760.3913536	4486.308986
Azadirachta indica	කොහොඹ	D = 1.647e0.109t (R^2 = 0.757)	14.56986641	77.08066416	21	8	29	1618.693947	616.6453132	2235.339261
Aegle marmelos	බෙලි	D = 1.485e[illegible] (R^2 = 0.705)	14.81166095	80.65664342	26		26	2097.072729	0	2097.072729
Neolitsea cassia	දවුල් කුරුඳු	D = 0.522e0.168t	15.02795764	83.92884853	3		3	251.7865456	0	251.7865456
Stemonoporus petiolaris	[illegible]	D = 0.177e0.224t	15.61753706	93.19978811	157		157	14632.36673	0	14632.36673
Syzygium aromaticum	කරාබු නැටි	D = 0.666e0.158t (R^2 = 0.991)	15.69801689	94.50521191	10	17	27	945.0521191	1606.588602	2551.640722
Myristica dactyloides	මලබොඩ	D= 0.432e0.180x (R^2 = 0.988)	15.81043728	96.34477556	41		41	3950.135798	0	3950.135798
Symplocos coronata	උගුඩු හල්	D= 0.432e[illegible] (R^2 = 0.988)	15.81043728	96.34477556	100		100	9634.477556	0	9634.477556
Caryota urens	කිතුල්	D = 0.813e0.161t (R^2 = 0.638)	20.34786171	96.43077306	183	6	189	17646.83147	578.5846384	18225.41611
Symplocos cochinchinensis	බොම්බු	D = 0.566e[illegible] (R^2 = 0.990)	15.97202572	99.02165323	82		82	8119.775565	0	8119.775565
Diospyros discolor	වෙල්වට් ඇපල්	D = 0.414e[illegible] (R^2 = 0.988)	16.08859595	100.9767529	33	11	44	3332.232845	1110.744282	4442.977126
Madhuca longifolia	මී	D = 2.057e0.103t (R^2 = 0.721)	16.1391599	101.8310581	127	46	173	12932.54438	4684.228673	17616.77305
Syzygium javanicum	[illegible] ජම්බු	D = 0.272e0.205t (R^2 = 0.985)	16.41255823	106.5158126	40	45	85	4260.632505	4793.211568	9053.844073
Syzygium samarangense	[illegible] ජම්බු	D = 0.272e0.205t	16.41255823	106.5158126	125		125	13314.47658	0	13314.47658
Semicarpus sp.	බදුල්ල	D = 0.431e0.182t (R^2 = 0.988)	16.41758163	106.602925	55		55	5863.160873	0	5863.160873
Cyathocalyx zeylanica	[illegible]	D = 0.701e[illegible] (R^2 = 0.991)	16.52298775	108.439418	87	21	108	9434.229367	2277.227778	11711.45714
Horsfieldia irya	රුක්	D= 0.792e0.152t	16.55695264	109.0346921	31	13	44	3380.075454	1417.450997	4797.526451
Bhesa ceylanica	[illegible]	D = 0.343e0.194t (R^2 = 0.986)	16.60950577	109.959111	77	9	86	8466.851547	989.631999	9456.483546
Dillenia retusa	ගොඩපර	D = 0.255e0.209t (R^2 = 0.984)	16.66829257	110.9980249	14	22	36	1553.972348	2441.956547	3995.928896
Mangifera zeylanica	ඇටඹ	D= 0.272e0.206x (R^2 = 0.985)	16.7441139	112.3455352	68	35	103	7639.496394	3932.093732	11571.59013