

# BOUNDARY PLANTING TECHNICAL SPECIFICATIONS

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TREES OF HOPE PROJECT  
**(A Plan Vivo Carbon Sequestration Project)**

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## SUMMARY

This technical specification has been developed for use by Plan Vivo projects involving communities participating in Malawi.

Through the Plan Vivo system communities may be able to access carbon finance by land use change activities that involve afforestation and reforestation.

This technical specification sets out the methods that should be used to estimate the carbon benefits from planting and managing boundary planting on small holding farms in Malawi. This technical specification also details the management requirements for this system over a long period of time, and the indicators to be used for monitoring the delivery of the carbon benefit.

The technical specification aims to summarise the best available evidence about the environmental benefits associated with the sustainable management of this land use system. Further information and research is welcome and will be incorporated periodically.

This land use system has been developed in consultation with communities and individual farmers in the following districts in Malawi: Neno, Mwanza and Dowa. Other valuable contributions to the development of this system have been received from CHDI staff, national and district government officials and forestry and agricultural extension workers. The inputs have been received through a structured process of meetings and interviews with these key stakeholders between September 2007 and October 2008.

The objective of the boundary planting system is to diversify land use, help with soil conservation and improved soil fertility whilst also providing a source of fuelwood and poles for local uses. Additional benefits will include enhanced biodiversity, beekeeping etc. The carbon finance will make a critical difference in allowing for the implementation of this system by providing tree seedlings, increasing capacity in managing this tree planting system and putting in place frequent monitoring to ensure compliance with the technical specification that will create the carbon sink. This system should allow for widespread participation in carbon markets. Boundary planting may be widely adopted by individual farmers with small areas of landholding without jeopardising their food security. This system may also be suitable for use along roadsides, water courses etc. The

boundary planting system is very popular with many farmers because it helps to clearly define their area of landholding. However, the key limiting factor to bear in mind for this planting system in Malawi is the minimum planting area and viability

The net carbon benefit of this system above the baseline (with 20% set aside as risk buffer) is calculated to be 44.6 tonnes of carbon per hectare. This is equivalent to 163 tonnes of carbon dioxide per hectare. Where this tree planting system is used it is considered to be more appropriate to calculate the number of carbon credits per 100 metres planted. This equates to 2.2 tonnes of carbon per 100 metres which is equivalent to 8.1 tonnes of carbon dioxide.

## **ACKNOWLEDGEMENTS:**

This work has been undertaken by ECCM as part of the Clinton Hunter Development Initiative in Malawi. It has only been possible because of the financial support received from the Hunter Foundation. ECCM wish to acknowledge the contribution made by all the staff of CHDI Malawi, and all the other stakeholders engaged during the participatory planning process used to design and collect data for this technical specification.

## 1.0 DESCRIPTION OF LAND USE SYSTEM

This system involves the planting of a variety of indigenous and naturalised hard wood tree species along the perimeters of farmers' properties for timber, fuel wood and shade. Less shading tree species should be selected that will not compete with other food crops. This system will also sometimes be used to divide homesteads by creating internal boundaries. By managing this system in accordance with this technical specification farmers will be able to continue cropping around the trees right up to the edge of the homestead. This system is very useful to demarcate property / land holding boundaries

### 1.1 Main tree species

Botanical name	Common name (English)	Status
<i>Acacia polyacantha</i>	Whitethorn	Indigenous
<i>Melia azedarach</i>	China berry	Naturalised
<i>Grevillea robusta</i>	Silky wood	Naturalised
<i>Markhamia lutea</i>	Markhamia	Indigenous
<i>Pterocarpus angolensis</i>	Kiatt tree	Indigenous

## 1.2

## Ecology

Species	Ecology
<i>Acacia polyacantha</i>	The species occurs in wooded grasslands, deciduous woodland and bush land, riverine and groundwater forests in altitudes between sea level and 1800 m.
<i>Melia azedarach</i>	A tree of the subtropical climatic zone, the natural habitat of <i>M. azedarach</i> is seasonal forest, including bamboo thickets, <i>Tamarindus</i> woodland.
<i>Pterocarpus angolensis</i>	Occurs in woodlands and sometimes as stunted trees in wooded grassland on mountain tops. It is regarded as an indicator of well-drained soils.
<i>Grevillea robusta</i>	Grows well in climates with a winter maximum or a bimodal rainfall regime. In temperate areas, it can survive moderate winter frosts. It is not resistant to persistent strong winds.
<i>Markhamia lutea</i>	Common in the lake basins and highland areas of eastern Africa. The tree is drought resistant.

**1.3****Altitudinal range and Climatic factors**

Species	Altitudinal range and climatic factors
<i>Acacia polyacantha</i>	Altitude 200-1 800 m, Mean annual rainfall: 300-1 000 mm
<i>Melia azedirach</i>	Altitude: 0-1800 m, Mean annual temperature: 23-27 deg. C, Mean annual rainfall: 350-2000 mm
<i>Pterocarpus angolensis</i>	Altitude: 0-1 650 m, Mean annual rainfall: 700-1 500 mm
<i>Grevillea robusta</i>	Altitude 0-2300 m, Mean annual temperature: 14-23 to 25-31 deg. C, Mean annual rainfall: 600-1700 mm
<i>Markhamia lutea</i>	Altitude 900-2000 m, Mean annual temperature: 12-27 deg. C, Mean annual rainfall: 800-2000 mm

## 1.4

**Habitat requirements.**

Botanical name	Ecology
<i>Acacia polyacantha</i>	It prefers sites with a high groundwater table, indicating eutrophic and fresh soils. It occasionally prospers on stony slopes and compact soils.
<i>Melia azadirach</i>	Deep, fertile, sandy loam soils support the best growth. It is highly adaptable and tolerates a wide range of conditions e.g. frost
<i>Pterocarpus angolensis</i>	Adaptable to red loams and deep sandy soils, but not coastal sands or black clays. Prefers soils whose physical characteristic permit water to rapidly drain down the soil profile, at least through the top 30 cm. It is sensitive to frost and is reputed to be fire tolerant, making it an important species for enrichment planting in areas where fire cannot be excluded completely.
<i>Grevillea robusta</i>	Establishes well in riverine habitats, on alluvial soils that are free of water-logging and mildly acid to neutral. Loam soil is preferred. It also occurs on clay loam and sand.
<i>Markhamia lutea</i>	Stand acid heavy clay soil, prefers red loam and has deep roots but cannot withstand water logging

## 1.5 Growth habit.

Botanical name	Growth habit
<i>Acacia polyacantha</i>	Fast growing to 20m with open canopy. It responds well to pollarding and coppicing.
<i>Melia azadirach</i>	It is a deciduous tree up to 45 m tall; bole fluted below when old, up to 30-60 (max. 120) cm in diameter, with a spreading crown and sparsely branched limbs.
<i>Pterocarpus angolensis</i>	It is a medium-size to large, deciduous tree that grows up to 30 m tall;
<i>Grevillea robusta</i>	Is a deciduous medium-sized to large tree 12-25 (max. 40) m tall; crown conical, dense, with branches projecting upwards. Bole straight, branchless for up to 15 m, up to 80 (max. 120) cm in diameter, usually without buttresses
<i>Markhamia lutea</i>	This is an upright evergreen tree 10-15 m high, with a narrow, irregular crown and long taproot.

## 2.0 MANAGEMENT OBJECTIVES OF BOUNDARY PLANTING

This system is managed primarily for land delimitation but also for timber, fuel wood, soil conservation, and wind protection. This system may also provide secondary benefits such as beekeeping and increased biodiversity.

## 3.0 COSTS OF IMPLEMENTATION

These costs of implementation are based on planting 100 metres (i.e. 34 trees).

### 3.1 Nursery Costs

Nursery establishment and seedling raising costs are included.

- Cost of seeds and polythene tubes
- Cost of media (sand, topsoil and manure)
- Labour for all silvicultural operations including pot filling, watering, root pruning, pest management and sowing.

The total cost of these activities is estimated to be \$10.

### **3.2 Establishment cost**

The activities in the establishment phase for 33 seedlings would include

- Land preparation
- Chaining/marketing
- Pitting
- Planting

The total cost for this phase is estimated to be \$8

### **3.3 Maintenance cost**

The trees in the field will be maintained for five years.

- Operations for year one are grass slashing, spot weeding, firebreaks, and uprooting shrubs. The total cost is \$6
- Operations for year two are grass slashing, spot weeding, firebreaks maintenance, and uprooting shrubs. The total cost in this year would be \$4
- Operations for year 3,4,and 5 are maintaining of firebreaks and pruning and will cost \$6

Activity	Cost (per hectare for boundary planting)
Nursery costs	\$10
Establishment	\$8
Maintenance year 1	\$6
Maintenance year 2	\$4
Maintenance year 3	\$2
Maintenance year 4	\$2
Maintenance year 5	\$2
Total	\$35

#### 4.0 POTENTIAL INCOME

Any income generated using this system is likely to be small, however this system should provide benefits to the households that manage the system in accordance with the technical specification in the form of local fuel wood through prunings and timber supplies. The figures provided for potential income are only intended to be indicative. These figures are based on 2008 market values as market prices may fluctuate. Yields will be affected both by local environmental conditions and stand management. Income from this land use system will come from the following:

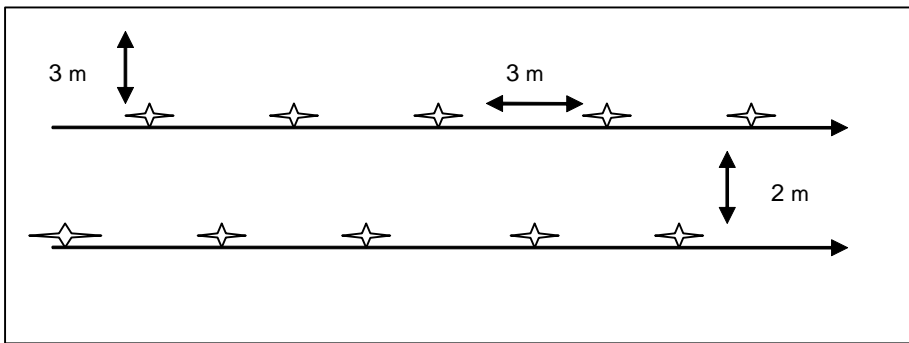
- **Timber.** Timber may be harvested at year 25. The value of the timber crop may be as high as \$400 per 100 m planted using the boundary system (assuming recovery rate of 25%).
- Fuelwood and poles and income arising from potential beekeeping enterprise.

#### 5.0 MANAGEMENT OPERATIONS

##### 5.1 Establishment

All competing vegetation should be removed and the foliage left on site to act as an organic fertilizer, and to conserve soil moisture. Trees should be planted in a single row 3 meters apart.

More than one row of trees may be planted where the planting is not adjoining neighbouring cultivated land. It is also best to plant trees a minimum of 3 metres in from the boundary so as to prevent interference with neighbouring properties. Trees planted for fuel wood, poles and soil improvement (such as *Acacia* and *Albizia*) should be planted between timber trees. These trees will be coppiced and thinned out over time.



Crops may be grown between the trees during the first years until canopy closure. In the first year these crops should be planted after the trees have been planted. Where just one single row of trees is planted it may be possible to continuously crop between the trees if suitable pruning and maintenance is carried out in order to ensure suitable light conditions are maintained.

It is best to plant at the beginning of the wet season to minimize the requirement to water the seedlings. Mulch (rock or organic mulching instead of grass due to termite inversion incase organic green material is used from competing vegetation, or interplanting) should be placed around the base of the seedlings to help retain soil moisture whilst also reducing the growth of competing vegetation and adding fertility to the soil.

When planting:

- Water seedlings before planting to hold nursery soil together and to assist establishment in case it fails to rain on the day of planting
- Care should be taken handling plants not to cause damage to shoots, buds or bark
- Only remove plastic from around root-ball at the time of planting. Care should be taken to remove all the plastic
- Prune back roots (especially any circular roots) at the time of planting to stimulate new root growth once in the ground

- Plant to depth of root collar (i.e., for bagged plants, to level of existing nursery soil). Never plant deeper than in nursery soil leaving no roots exposed.

Ensure that soil is replaced firmly around trees (i.e., well heeled in). Put top soil back in planting hole first

## 5.2 Maintenance

The removal of all competing vegetation will be required twice a year for the first three years after planting, or until the trees have reached a height of 1.5 - 2 m. Weeding intensity can be reduced to once per year after the third year until approximately the sixth year (or once the trees are no longer in competition with weeds).

Prune side branches of timber trees to create clean boles of high value and also to allow more side light to penetrate the homestead. Offcuts can be used for fuel wood.

No burning is allowed at any time. Any foliage should be worked into the soil. Fire breaks should also be maintained between woodlots and woodlot with cultivated land.

## 5.3 Thinning, maintenance and re-establishment

The table below outlines the thinning schedule for this land-use system with full re-establishment at the end of the rotation cycle.

Year	Thin	Harvesting
<i>Acacia polyacantha</i>	50% at year10	25
<i>Melia azedarach</i>	50% at year10	25
<i>Senna spectabilis</i>	50% at year10	25
<i>Senna siamea</i>	50% at year10	25

## **6.0 DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BENEFITS**

- Definition of property boundaries
- Soil conservation - particularly the prevention of soil erosion associated with heavy rainfall events and siltation of water courses (climate change adaptation benefit)
- Hydrological benefit ó harvesting of incidental moisture and improved water flows which will help to reduce catastrophic flooding (climate change adaptation benefit)
- Biodiversity benefit ó through the protection of wildlife habitat (birds, bees).
- NTFP ó beekeeping, medicines, fruits etc.
- Shading for humans and livestock
- Pruning and thinning material may be used as firewood

## **7.0 DESCRIPTION OF ADDITIONALITY**

A key factor is that the emissions reductions from a project activity or intervention should be additional ó i.e. the intervention would not have occurred in the absence of the carbon derived finance. Additionality can be demonstrated through an analysis of the barriers to the implementation of activities in the absence of intervention. In this case the barriers to the permanent establishment of boundary planting that are overcome through the project activity and receipt of carbon finance are:

- Community mobilisation and participation in planning processes.
- Capacity (on improved land use management systems, agriculture and silviculture)
- Awareness about climate change and the dual role of tree planting of climate change management and livelihood improvement.
- Availability of seedlings
- Seedling distribution
- Training to enable long term sustainability of programme through participatory monitoring and evaluation.

As there are no formal means by which communities can access funding to cover these costs, the effect of Plan Vivo carbon finance is strongly additional.

## **8.0 LEAKAGE ASSESSMENT**

Leakage is unintended loss of carbon stocks outside the boundaries of a project resulting directly from the project activity.

In the case of the boundary planting system tree plant should not displace any food production activities. The Plan Vivo system requires that potential displacement of activities within the community should be considered and that activities should be planned to minimise the risk of any negative leakage. These actions should include:

- All farmers should be assessed individually to demonstrate that the establishment of the system will not interfere with household food production.
- Signatories to Plan Vivo activities will be contractually obliged not to displace their activities as a result of the tree planting.
- A plan to monitor leakage on specific other woodland areas to ensure leakage is not occurring.
- Formation of community based policing to ensure that activity displacement and eventual leakage does not occur.

Where communities have a satisfactory plan for managing leakage risk resulting from the establishment of fruit orchards there should be no assumption of leakage.

In all probability the most likely outcome of boundary system is positive leakage as a result of improved land use. Boundary planting should combine the use of soil improving trees (reducing the pressure to extend cultivation of food activities to new areas) and fuel wood tree species (removing the pressure on surrounding forest resources).

## 9.0 BASELINE CARBON EMISSIONS

The **baseline** refers to carbon sequestered and stored in any existing vegetation (not including food crops) on a site at the time of planting. When calculating the number of Voluntary Emission Reductions (VERs) that a farmer has generated, the baseline carbon stock is subtracted from the carbon sink achieved by the project activity. The procedure used to quantify the **baseline** carbon emissions that would be associated with land management expected in the absence of the establishment of the boundary planting system is set out in *Assessment of Net Carbon Benefit of CHDI Land Use Activities* (ESD, 2008). It is assumed that this system will be used only on cultivated land with an estimated carbon baseline of 0.42 tonnes of carbon per hectare in the absence of project activities. These tonnes of carbon per hectare equates to 0.021 tonnes of carbon per 100 m planted.

## 10.0 QUANTIFICATION OF CARBON SINK

The approach used for estimating the long-term carbon benefit of afforestation for Plan Vivo VERs is based on average net increase of carbon storage (sink) in biomass and forest products over a 100 year period relative to the baseline. The carbon sink is calculated separately for each of the technical specifications. A three-staged approach as outlined below is used:

- Calculate tree growth rates based on tree measurement data captured within the project area
- The carbon uptake of each species was calculated using the CO2FIX-V3 model (Mohren et al 2004).
- These model outputs were then used to build the result for the technical specification based on the numbers of species in each system and the length of rotations.

The procedure used to calculate the potential carbon sink created by boundary planting is set out in *Assessment of Net Carbon Benefit of CHDI Land Use Activities* (ESD, 2008). The potential carbon sink created by this land use system (based on long term average carbon storage over 100 years) is calculated to be 56.28 tonnes of carbon per hectare. This is equivalent to 206 tonnes of carbon dioxide per hectare. Where this tree planting system is used it is considered to be more appropriate to calculate the number of carbon credits per 100 metres planted. This equates to 2.8 tonnes of carbon per 100 metres which is equivalent to 10.3 tonnes of carbon dioxide.

## 11.0 BUFFER

Twenty percent (20%) of all VERø generated by the project activities are maintained as a risk buffer. Records of all buffer stock should be maintained in the database. It has yet to be decided at what stage the right to trade these VERø will return to the farmer.

## 12.0 CALCULATION OF CREDITS

For the purposes of quantifying Plan Vivo certificates (carbon offset), the net carbon benefit of each tree planting system in addition to the baseline has been calculated. In accordance with Plan Vivo standards (<http://www.planvivo.org/>) 20% of all the carbon offset (i.e. net carbon benefit) is set aside to be kept as a risk buffer (i.e. non tradable carbon asset). Records of all buffer stock should be maintained in the database. The net carbon benefit, buffer stock and tradable carbon offsets (Plan Vivo certificates) generated by the boundary planting land use system (technical specifications) is presented in the table below:

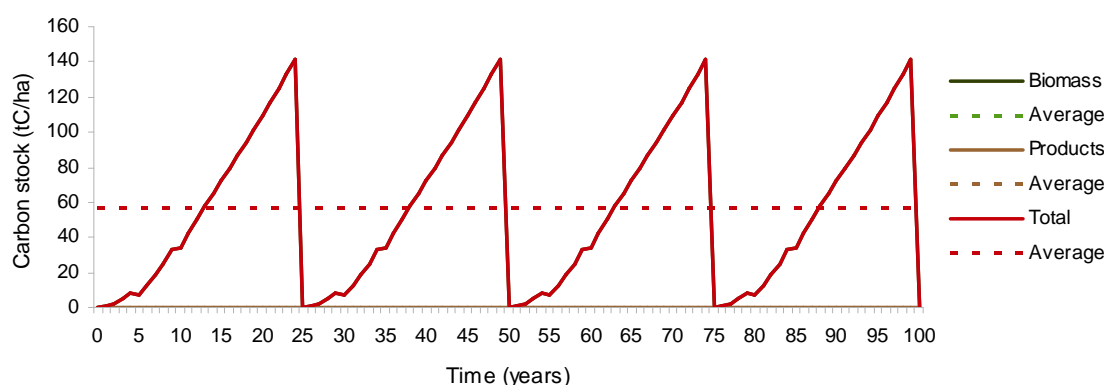
**Table 12.1:** The net carbon benefit and tradable carbon offset for the boundary planting land use system (per hectare).

Technical Specification	Sink (tC/ha)	Baseline (tC/ha)	Net benefit (tC/ha)	Buffer (%)	Tradeable (tC/ha)	Tradeable (tCO <sub>2</sub> /ha)
Boundary planting	56.28	0.42	55.86	20%	44.6	163.8

**Table 12.2:** The net carbon benefit and tradable carbon offset for the boundary planting land use system (per 100 m).

Technical Specification	Sink (tC/100m)	Baseline (tC/100m)	Net benefit (tC/100m)	Buffer (%)	Tradeable (tC/100m)	Tradeable (tCO <sub>2</sub> /100m)
Boundary planting	2.8	0.021	2.77	20%	2.2	8.1

The figure below shows the long-term average carbon sink over the simulation period (100 years).



**Figure 12.1:** Boundary planting technical specification carbon sequestration potential over 100 years

### 13.0 MONITORING

Monitoring targets for the first 3 years are based on establishment whereby the whole plot must be established by the third year with at least 100% survival of seedlings. Thereafter monitoring targets are based on DBH. The expected DBH at the time of monitoring is based on a predicted mean annual diameter increment on which carbon sequestration estimates are based. Monitoring field data collection templates for years 0 to 3 (establishment-based) and years 4, 7 and 10 (DBH-based) are presented in the appendix.

Year	Monitoring Indicator
0	At least 50% plot established
1	At least 75% plot established
2	Whole plot established with 85% survival.
3	Whole plot established with 100% survival
4	Average DBH not less than 8cm
7	Average DBH not less than 15cm
10	Average DBH not less than 20cm

**NOTE:** DBH refers to Diameter at Breast Height

## 14.0 REFERENCES

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- World Agroforestry Centre (2004). Agroforestry tree database.

## ANNEXES

**ANNEX 1:** Monitoring field data collection template for Years 0 to 3 (establishment-based indicators)

### **MONITORING FIELD DATA COLLECTION TEMPLATE FOR YEARS 0 TO 3. FOR TREES OF HOPE CARBON SEQUESTRATION PROJECT.**

Identity of producer (name and village)	
Technical specification	
Area (ha) or perimeter (m) of registered plot	
No. of plan vivo	
Expected total number of trees on plot at full establishment	
Year/season of establishment	
Year of monitoring	
Expected min. number of trees on plot at this monitoring	
Number of surviving trees on plot at this monitoring	
<b><i>General comments and recommendations</i></b>	
Name of Local Program Monitor	
Date of Monitoring	
Name of approving CHDI Technician	
Date of approval	
Name & organization of approving partner	
Date of approval	

**ANNEX 2:** Monitoring field data collection template for Years 4, 7 and 10 (DBH- based indicators)

**MONITORING FIELD DATA COLLECTION TEMPLATE FOR YEARS 4, 7 and 10.  
FOR TREES OF HOPE CARBON SEQUESTRATION PROJECT.**

Identity of producer (name and village)	
Technical specification	
Area (ha) or perimeter (m) of registered plot	
No. of plan vivo	
Total number of trees on plot at full establishment	
Average DBH (cm) from 20% random sample	
Expected DBH (cm) from plot	
Year/season of establishment	
Year of monitoring	
Expected min. number of trees on plot at this monitoring	
Number of surviving trees on plot at this monitoring	
<b><i>General comments and recommendations</i></b>	
Name of Local Program Monitor	
Date of Monitoring	
Name of approving CHDI Technician	
Date of approval	
Name & organization of approving partner	
Date of approval	

**NOTE:** DBH refers to Diameter at Breast Height