Boundary Planting (BP) Technical Specification

TREES OF HOPE PROJECT
A PLAN VIVO PAYMENT FOR ECOSYSTEM SERVICES (PES) PROJECT


Photo Credit: Peter Kasengwa/Clinton Foundation

PREPARED BY **Clinton Development Initiative**
Kambuku Road
Area 43
Plot No. 2/24 Lilongwe, Malawi

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SUMMARY

This technical specification has been developed for use by Trees of Hope Project, a Plan Vivo Payment for Ecosystem Services (PES) project involving rural 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 establishing boundary planting on small holding farms in Malawi. It further 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 Neno and Dowa districts of southern and central Malawi respectively. Other valuable contributions to the development of this system have been received from Clinton Development Initiative (CDI) 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 wind breaking and improve soil fertility where fertility-improving tree species are used whilst also providing a source of fuel wood and poles for local uses. Additional benefits will include enhanced biodiversity through various flora and fauna that the trees environment might attract and support. 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. Boundary planting may be widely adopted by individual farmers with small areas of landholding without jeopardising their food security, hence allowing for wide spread participation in the carbon markets. This system may also be suitable for use along roadsides, water courses and other amenities.

This technical specification is being implemented in Neno and Dowa districts.. This technical specification is not a stand-alone system as regards selection of land pockets where it can be established since it is designed to be established around existing structures, mainly gardens. As such it could be established on many land types as shown in Table 1 below.

Table 1: Land type eligibility for Boundary Planting technical specification

Land type	Basic characteristics	Eligibility
Natural forest	• Covered with trees (government controlled or under customary control).	• Eligible
Cultivated land	• Generally of high fertility and production potential. • Less prone to erosion. • Slopes of not more than 12%. • Grown to food crops annually for the household.	• Eligible
Degraded land	• Low soil fertility with low production potential. • Shallow soils. • High soil erosion hazard. • Rarely put to arable cropping.	• Eligible.
Neglected land	• Very low soil fertility and productive capacity. • Shallow rocky soils with high erosion hazard. • Abandoned for arable crop production.	• Eligible.

	• Slopes of over 12%. • Fit for grazing.	
Wetlands	• Permanent wetness.	• Eligible

The boundary planting technical specification, like others in the project, can be established by individuals or communal groups. The net carbon benefit of this system above the baseline (with 20% set aside as risk buffer) is calculated to be 46.43 tonnes of carbon per hectare as a long term average over 50 years. This is equivalent to 170.25 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 2.32 tonnes of carbon per 100 metres which is equivalent to 8.51 tonnes of carbon dioxide.

ACKNOWLEDGEMENTS

This work has been undertaken by Edinburgh Centre for Carbon Management (ECCM) for Trees of Hope Payment for Ecosystem Services (PES) of the Clinton Development Initiative (CDI), formerly Clinton Hunter Development Initiative (CHDI) in Malawi. ECCM wish to acknowledge the contribution made by all the staff of CDI 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 tree species along the perimeters of farmers' properties for timber, fuel wood, shade, wind breaking and fertility improvement. Less shading tree species should be selected that will not compete with crops growing in close proximity. 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 boundary line. This system is very useful to demarcate property / land holding boundaries but can also be used with woodlots as a practical complement.

1.1 Tree species

Table 2: Tree species for the Boundary Planting technical specification

Botanical name	Common name (English)	Status
Acacia polyacantha	Whitethorn	Indigenous
Melia azedarach	China berry, Siringa, Persian liliac.	Naturalised
Senna spectabilis	Cassia	Naturalised
Senna siamea	Pheasant wood, Siamese senna	Naturalised
Albizia lebbeck	Woman's tongue, Siris tree	Naturalised
Faidherbia albida	Faidherbia	Indigenous

1.2 Ecology

Table 3: Ecological requirements for tree species for Boundary Planting technical specification.

Species	Ecology
Acacia polyacantha	The species occurs in wooded grasslands, deciduous woodland and bush land, riverine and groundwater forests in altitudes between sea level and 1800 m.
Melia azedarach	A tree of the subtropical climatic zone. The natural habitat of *M. azedarach* is seasonal forest, including bamboo thickets, *Tamarindus* woodland.
Senna spectabilis	Will grow up to 2,000 m.a.s.l.
Senna siamea	Will grow up to 1,600 m.a.s.l.
Albizia lebbeck	Will grow up to 1,800 m.a.s.l.
Faidherbia albida	Grows on the banks of seasonal and perennial rivers and streams on sandy alluvial soils or on flat land where vertisols predominate. It thrives in climates characterized by long summers, or a dry season with long days.

1.3 Altitudinal range and Climatic factors

Table 4: Altitudinal and climatic requirements for the tree species in the Boundary Planting technical specification.

Species	Altitudinal range and climatic factors
Acacia polyacantha	Altitude 200-1 800 m, Mean annual rainfall: 300-1 000 mm
Melia azedirach	Altitude: 0-1800 m, Mean annual temperature: 23-27 Deg. C, Mean annual

	rainfall: 350-2000 mm
Senna spectabilis	Does well in cool conditions (15-25c) and an elevation of up to 2000m. requires a mean rainfall of between 800mm – 1000mm
Senna siamea	Will grow well in areas of up to 1,600 m.a.s.l. Grows all over the tropics from sub-humid to semi-humid and even arid zones.
Albizia lebbeck	Will grow well in areas of up to 1,800 m.a.s.l. *Albizia lebbeck* prefers annual rainfall of 1,300-1,500 mm and a very dry winter. It is tolerant of long, hot, dry periods and cold winters. *Albizia lebbeck* requires mean annual temperature between 19 - 35^{0}C.
Faidherbia albida	Altitude: 270-2700 m, Mean annual temperature: 18-30 deg. C, Mean annual rainfall: 250-1000 mm

1.4 Habitat requirements.

Table 5: Habitat requirements for the tree species in the Boundary Planting technical specification.

Botanical name	Ecology
Acacia polyacantha	Widely adaptable. It prefers sites with a high groundwater table, indicating eutrophic and fresh soils. It occasionally prospers on stony slopes and compact soils.
Melia azedarach	Deep, fertile, sandy loam soils support the best growth. It is highly adaptable and tolerates a wide range of conditions e.g. frost.
Senna spectabilis	Prefers deep, moist sandy or loamy soils and is also drought resistant.
Senna siamea	It prefers a deep, fairly fertile, well drained and neutral or alkaline soils. Does better in a high water table but will tolerate extended

	drought and a variety of soils.
Albizia lebbeck	*Albizia lebbeck* establishes well on fertile, well-drained loamy soils but poorly on heavy clays. Tolerates acidity, alkalinity and waterlogged conditions.
Faidherbia albida	Coarse-textured well-drained alluvial soils. It tolerates seasonal water logging and salinity but cannot withstand heavy clayey soils.

1.5 Growth habit.

Table 6: Growth habits for the species used in the Boundary Planting technical specification.

Botanical name	Growth habit
Acacia polyacantha	Fast growing to 20m with open canopy. It responds well to pollarding and coppicing.
Melia azedarach	It is a deciduous tree up to 45m tall; bole fluted below when old, up to 30-60 (max. 120) cm in diameter, with a spreading crown and sparsely branched limbs.
Senna spectabilis	Fast growing in good sites; pollards and coppices well. A small rounded deciduous tree generally less than 10m tall. The bole is short and tend to fork near the ground. The species is resistant to termites and is not browsed much so it is easily established.
Senna siamea	Fast growing; pollards and coppices well. An evergreen tree up to 20m, more upright than S. spectabilis The species is resistant to termites and is not browsed much so it is easily established.
Albizia lebbeck	*Albizia lebbeck* can attain heights of 30 m with a dbh of 1m. It is fast growing and responds well to pollarding, coppicing and lopping.

Faidherbia albida	It is one of the largest thorn trees, reaching 30 m in height, with spreading branches and a rounded leafless crown during the wet season allowing for more light to reach crops during the growing season whilst also reducing competition for nutrients because the trees are dormant during this period. The roots can grow to 40 m deep. When the leaves return during the dry season, the shade will greatly reduce soil moisture losses through evaporation. The leaves drop at the onset of the wet season so that valuable organic matter is fed into the soil in advance of the planting of food crops.

2.0 MANAGEMENT OBJECTIVES OF BOUNDARY PLANTING

This system is managed primarily for land delimitation but also for timber, fuel wood, soil fertility improvement and protection against strong winds. 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) at a spacing of 3m in a single row.

3.1 Nursery Cost

Nursery establishment and seedling raising costs would include the following:

- 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.
- Cost of strings for pot alignment in the nursery.

The total cost of these activities is estimated to be $100.

3.2 Establishment cost

The activities in the establishment phase for 34 seedlings would include:

- Land preparation.
- Chaining/marking.
- Pitting.
- Planting.

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

3.3 Maintenance cost

The costs on maintenance of the trees in the field especially in the early years are indicated and tabulated below:

i. Operations for year one are grass slashing, spot weeding, firebreaks, and uprooting shrubs totalling $6.

ii. Operations for year two are grass slashing, spot weeding, firebreaks maintenance, and uprooting shrubs. The total cost in this year would be $4.

iii. Operations for year 3, 4, and 5 are maintaining of firebreaks and pruning and will cost $6.

Table 7: Nursery, establishment and maintenance cost profile for BP technical specification.

Activity	Cost (per hectare for boundary planting)

Nursery costs	$100
Establishment	$8
Maintenance year 1	$6
Maintenance year 2	$4
Maintenance year 3	$2
Maintenance year 4	$2
Maintenance year 5	$2
Total	**$124**

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 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 environmental conditions and stand management. Income from this land use system will come from the following:

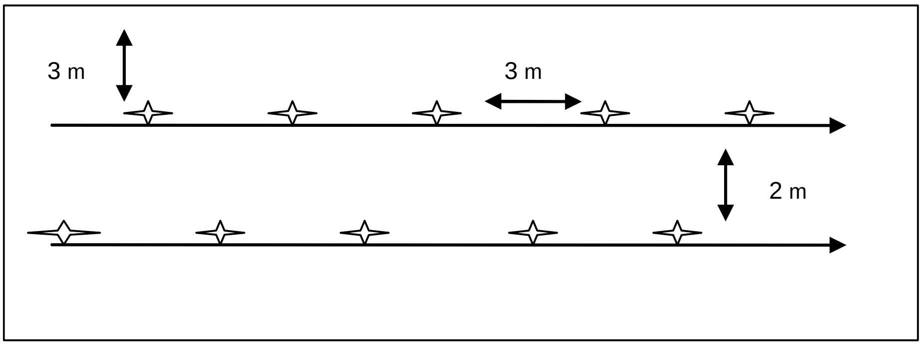
- Timber: It is recommended to harvest the trees for timber at the age of between 20 and 25 years. The value of the timber crop may be as high as $400 per 100 m planted using the boundary system (assuming recovery rate of 25%).
- Fuelwood and poles and income arising from potential beekeeping enterprise.

5.0 MANAGEMENT OPERATIONS

5.1 Establishment

Minimal land preparation should be done at the site of planting to facilitate digging of holes and making of basins around the trees. Any existing trees on site should not be cut but only planted around and all plots showing wholesale clearing of vegetation will be disqualified. Create basins of 1m by 1m around each tree so that water is trapped and percolates into the soil instead of running off. Apply mulch in the basins to assist in moisture conservation and weed suppression but the mulch should stay clear of the root collar. Trees should be planted in a single row 3 meters apart in holes 60cm deep and 60cm wide. When digging the holes, top soil should be put on one side of the hole and subsoil on the other and when filling the hole, top soil should be put back first before the sub soil.

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. An illustration of the planting pattern is shown below:



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 and planting of crops may continue between the trees for several seasons 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 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 planting should be done on a wet day when there is adequate soil moisture to minimize establishment failure.
- Care should be taken in 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.
- 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).

5.2 Maintenance

Slashing and minimal weeding will be required regularly especially during the early years of establishment when weeds may suppress growth of the young trees. 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 and trees should be protected from fires through maintenance of fire breaks. Any foliage should be worked into the soil.

5.3 Thinning, maintenance and re-establishment

Table 8 below, outlines the thinning schedule for this land-use system with full re-establishment at the end of the rotation cycle.

Table 8: Thinning and harvesting schedule and intensity for Boundary Planting technical specification.

Tree species	Thinning intensity and year	Harvesting time (years)
Acacia polyacantha	50% at year10	20-25
Melia azedarach	50% at year10	20-25
Senna spectabilis	50% at year10	20-25
Senna siamea	50% at year10	20-25
Albizia lebbeck	50% at year10	20-25
Faidherbia albida	50% at year10	20-25

6.0 DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BENEFITS

- Definition of property boundaries.
- Wind break - the row of trees will form an effective wind shield protecting the crop or other property inside the boundary from strong winds that could potentially cause damage. Wind erosion could also be minimized.
- Hydrological benefit – harvesting of incidental moisture and improved water flows which will help to reduce catastrophic flooding (climate change adaptation benefit) through the trapping of water by the 1m by 1m basins made around the base of each tree thereby allowing the water to percolate into the soil aiding in recharging underground water resources.
- Biodiversity benefit – through the provision of wildlife habitat through the microenvironment created by the trees where varied fauna and flora can thrive.
- NTFP – 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 – 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 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 for 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 planting 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.

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 PERMANENCE AND RISK MANAGEMENT

The project recognizes the importance of permanence of its activities (carbon stocks) so that they are not only initiated but also become sustained in the community and further realizes that risks exist that could threaten this intention. These risks have been foreseen and risk management measures put in place to minimize any effects. One of the threats to sustainability of project activities is the mere lack of sense of ownership of the project by the targeted communities. To minimize this threat, the project has a deliberate policy of striving to involve the communities in all project processes coupled with free flow of updated program information through a rigorous participatory training program. The project further attaches highest priority for admission into the project to individuals and groups that show tendencies of self-selection. Other risks to permanence are also foreseen and are presented in Table 9 below along with their management measures.

Table 9: Management of risks to permanence of project activities

Permanence risk	Level of risk	Management measure
Uncontrolled bush fires	High	• Adoption of recommended fire protection measures including establishment of fire breaks around plantations and working into the soil, all weeds and dry trash from within the plantation. • Civic education to communities and their leaders on the dangers of bush fires to the environment and livelihoods. • Formation of community-based fire monitoring squads in the villages.
Pests and diseases (largely fungal infections and leaf-	Low	• Selection of indigenous tree species which are hardy to most known pathological problems. • Recommended pest and disease management

eaters and damping-off disease in the nursery). Termites in some sections cause damage soon after planting out.		silvicultural practices both in the nursery and in the field following an integrated approach to pest and disease management. • Implement an effective pest and disease surveillance system led by Local Program Monitors (LPMs), a group of farmer volunteers based in the communities.
Drought	Medium	• Early planting of strong healthy seedlings. • Good silvicultural practices like deep pitting and use of organic manure that promote higher soil moisture retention. • Promotion of drought-tolerant tree species. • Promotion of irrigation where applicable.

Table 9: Management of risks to permanence of project activities (*continued*)

Permanence risk	Level of risk	Management measure
Livestock damage	Medium	• Education of communities on recommended livestock management practices like tethering and zero grazing during periods when trees are vulnerable to livestock damage. • Placement of protective structures (normally thorny fences) around plantations or individual trees where feasible. • Enforcement of community by laws by traditional leaders that regulate

		movement of livestock in communities. • In certain cases, establishment of tree species that are not vulnerable to livestock damage through browsing.
Overreliance on external support.	Low	• Capacity building on all technical aspects of tree establishment and management including community-based seedling production. • Broadening income streams to producers over and above carbon finance. • Encouraging communities to contribute all locally available materials and labour for tree seedling production, with the project only providing materials that are difficult to source at community level. The latter materials will later also be the responsibility of the communities through carbon finance.

Based on the risks outlined above, the project will withhold 20% of carbon services generated from sale to form a carbon buffer (reserve of unsold carbon).

10.0 BASELINE CARBON EMISSIONS

The 'baseline' refers to carbon sequestered and stored in any existing vegetation (excluding food crops) on a site at the time of planting. When calculating the number of Voluntary Emission Reductions (VER's) 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 '*Assesment of Net Carbon Benefit of CDI Land Use Activities' (Camco, 2011)*. It is assumed that this system will be used only on cultivated land with an estimated carbon baseline of 0.37 tonnes of carbon per hectare in the absence of project activities. These tonnes of carbon per hectare equates to 0.02 tonnes of carbon per 100 m planted.

11.0 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 50 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 '*Assesment of Net Carbon Benefit of CDI Land Use Activities' (Camco, 2011).* The potential carbon sink created by this land use system (based on long term average carbon storage of 50 years) is calculated to be 58.04 tonnes of carbon per hectare. This is equivalent to 212.82 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 2.90 tonnes of carbon per 100 metres which is equivalent to 10.64 tonnes of carbon dioxide.

12.0 BUFFER

Twenty percent (20%) of all VER's 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 VER's will return to the farmer.

13.0 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 Tables 10 and 11 below:

Table 10: 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)	Net benefit (tCO_2/ha)	Buffer (%)	Tradeable (tCO_2/ha)
Boundary planting	58.04	0.53	58.04	212.82	20%	170.25

Table 11: 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	Buffer (%)	Tradeable (tC/100m)	Tradeable (tCO_2/100m)

(tC/100m)						
Boundary planting	2.93	0.03	2.90	20%	2.32	8.51

The figure below shows the long-term average carbon sink over the simulation period (50 years).

Figure 1: Boundary planting technical specification carbon sequestration profile over 50 years

14.0 MONITORING

Monitoring targets for the first 4 years are based on establishment whereby the whole plot must be established by the fourth year with at least 90% survival of trees. Thereafter monitoring targets are based on tree growth rates indicated by measurement of the Diameter at Breast Height (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. The expected DBH at the time of monitoring is based on a predicted mean annual diameter increment on which carbon sequestration estimates are based. Table 12 below shows the monitoring schedule (in years) and the corresponding key indicators or targets that are expected to be met by producers to warrant receipt of carbon finance upon selling their carbon credits.

Table 12: Monitoring milestones at different monitoring periods

Year	Monitoring Indicator

1	At least 50% plot established.
2	At least 75% plot established.
3	Whole plot established with 85% survival of trees.
4	Whole plot established with at least 90% survival of trees.
5	Average DBH not less than 4cm.
7	Average DBH not less than 8cm.
10	Average DBH not less than 15cm.

15.0 REFERENCES

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