DISPERSED SYSTEMATIC INTERPLANTING

TECHNICAL SPECIFICATIONS

Prepared by

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TREES OF HOPE PROJECT

(A Plan Vivo Carbon Sequestration Project)

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SUMMARY

This ñtechnical specificationò 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 nitrogen fixing trees 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 dispersed interplanting system is to improve soil fertility and therefore increase yields of agricultural food products. Additional benefits will include soil conservation, improved water quality, enhanced biodiversity, firewood, and potential bee keeping 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 land use 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. Dispersed interplanting may be widely adopted by individual farmers with small areas of landholding whilst contributing to enhanced food production.

The net carbon benefit of this system above the baseline (with 20% set aside as risk buffer) is calculated to be 20.8 tonnes of carbon per hectare. This is equivalent to 76 tonnes of carbon dioxide per hectare.

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 nitrogen-fixing *Faidherbia albida* at a low stocking density throughout the area of cultivated land. Crops can continue to be grown. Nitrogen fixing trees will increase and extend the expected productivity of the cultivated land. These species increase soil nitrogen by actively manufacturing nitrogen compounds through symbiotic bacteria located in the roots. Any litter will act as green manure (organic fertiliser) and the tree roots will also help to preserve the soil structure by retaining moisture and preventing erosion.

Planted trees should be pruned carefully every year to allow crops to continue to be grown throughout. Many studies indicate that interplanting of nitrogen fixing trees with crops (e.g. sorghum, maize) will increase crop yields significantly (University of Queensland, 1998) as well as extending the expected productivity of the land thereby reducing the pressure to clear new areas of forest.

1.1 Main tree species

Botanical name	Common name (English)	Range
Faidherbia albida	Faidherbia	Indigenous

1.2 Minor tree species

Botanical name	Common name (English)	Range
Markhamia lutea	Markhamia	Indigenous
Grevillea robusta	Silky oak	Naturalised
Pterocarpus angolensis	Kiatt tree	Indigenous

Note: Although *Faidherbia albida* is preferred by the community, a few other minor species have been included for future consideration as a way of introducing greater biodiversity.

1.3 Ecology

Botanical name	Ecology
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.
Pterocarpus angolensis	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.
Grevillea robusta	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.
Markhamia lutea	Stand acid heavy clay soil, prefers red loam and has deep roots but cannot withstand water logging

1.4 Altitudinal range and Climatic factors

Species	Altitudinal range and climatic factors
Faidherbia albida	Altitude: 270-2700 m, Mean annual temperature: 18-30 deg. C, Mean annual rainfall: 250-1000 mm
Pterocarpus angolensis	Altitude: 0-1650 m, Mean annual rainfall: 700-1500 mm
Grevillea robusta	Altitude 0-2300 m, Mean annual temperature: 25-31 deg. C, Mean annual rainfall: 600-1700 mm
Markhamia lutea	Altitude 900-2000 m, Mean annual temperature: 12-27 deg. C, Mean annual rainfall: 800-2000 mm

1.5 Habitat requirements.

Botanical name	Habitat requirement
Faidherbia albida	Coarse-textured well-drained alluvial soils. It tolerates seasonal water logging and salinity but cannot withstand heavy clayey soils.
Pterocarpus angolensis	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.
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1.6 Growth habit.

Botanical name	Growth habit
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 sowing of food crops.
Pterocarpus angolensis	It is a medium-size to large, deciduous tree that grows up to 30 m tall;
Grevillea robusta	Is a deciduous medium-sized to large tree 12-25m (max. 40m) tall; crown conical, dense, with branches projecting upwards. Bole straight, branchless for up to 15 m, up to 80cm (max. 120cm) in diameter, usually without buttresses.
Markhamia lutea	This is an upright evergreen tree 10-15m high, with a narrow, irregular crown and long taproot.

2.0 MANAGEMENT OBJECTIVES OF THE SYSTEM

The main management objective is soil improvement to increase yields of agricultural products principally maize and in some cases cotton. However, some fuel wood and fodder may also be obtained from thinnings and branches such as offcuts / pruning material while at maturity the trees can also be sewn into high value timber for various purposes including utensils, canoes, furniture, boxes, drums and oil presses. *F. Albida* is very suitable for apiculture because its flowers provide bee forage at the end of the rainy season and the leaves and pods are palatable to domestic animals and an important source of protein for livestock in the dry season.

3.0 COSTS OF IMPLEMENTATION

3.1 Nursery costs

The activities and costs (for 200 seedlings) during the setting up of the nursery are

- Cost of seeds.
- Digging and mixing of the soil.
- Pot filling, transfer, and topping.
- Seed sowing and bed management.
- Pricking out and selection/transfer.
- Watering and sanitation.
- Stores operations cost.

The total cost of these activities for 200 trees tree seedlings is estimated at $30

3.2 Establishment cost

The activities in the establishment phase would include

- Land preparation (bush clearing)
- Marking at a spacing of 5m by 10m
- Pitting
- Planting

The total cost for this phase for 200 trees per hectare is estimated to be $50

3.3 Maintenance cost

Maintenance activities in Year one will include grass slashing, spot weeding, firebreaks, and uprooting shrubs. The cost for 200 trees per hectare is estimated to be $35 while Year two operations include grass slashing, spot weeding, firebreaks maintenance and uprooting shrubs costing an estimated $20. Operations for years 3, 4, and 5 (including maintenance of firebreaks) are estimated to be $45 for 200 trees per hectare and additional costs for equipment (e.g. one slasher, one hoe, one machete, a pair of boots and one overall coat are estimated at $50. The full cost profile is summarized in the table below:

Activity	Cost (per hectare for dispersed interplanting)
Nursery costs	$30
Establishment	$50
Maintenance year 1	$35
Maintenance year 2	$20
Maintenance year 3	$15
Maintenance year 4	$15
Maintenance year 5	$15
Equipment	$50
Total	**$230**

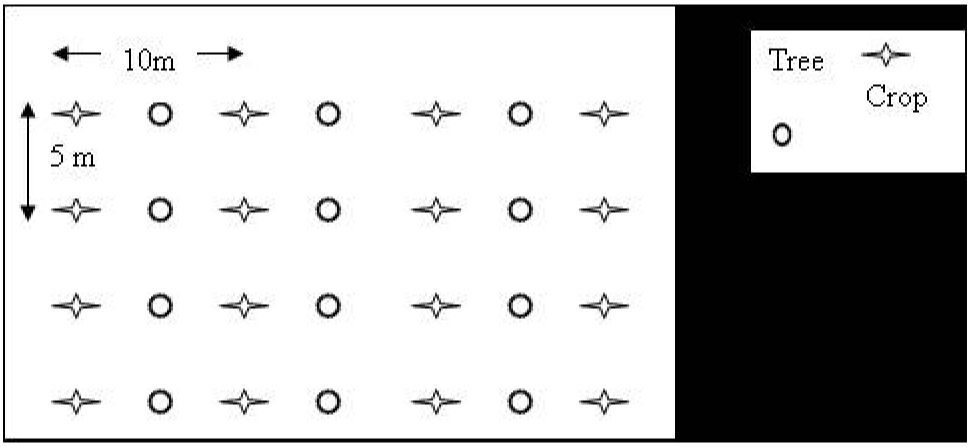
4.0 POTENTIAL INCOME

Poles and fuel wood may be sold but any additional income from this system is likely to be small. The primary objective of this system is soil improvement with by-products (fuel wood and fodder) from pruning crown for household use. Other incomes will be realised through increased crop production in the medium to long term due to increased soil fertility and from savings on mineral fertilizers as organic nutrients from the system become increasingly significant.

5.0 MANAGEMENT OPERATIONS

5.1 Establishment

The farmer must first remove any competing vegetation from the farm. All foliage and green waste should be spread on site to break down and enrich the soil. This will also help to retain moisture. The whole site must be turned to a low depth (5 ï 10 cm). The farmer will then sow any crops (e.g. maize, sorghum), before planting the trees in small planting pits. Planting should establish 200 trees per hectare at a spacing of 10m x 5m. Propagation can either be done through potted plants or direct sowing. However, direct seeding is not advisable due to the high failure rates.



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 nursery grown stock:

- 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 soil). Never plant deeper than in nursery 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 Mycorrhizal inoculation

The following simple mycorrhizal inoculation process is recommended as a way of promoting an association between soil borne fungus and the leguminous trees being planted in farm land.

1. Collect soil (only top 15 ï 20 cm) from under an area of undisturbed vegetation (including non burning in recent years). Either place this soil in a large container or in a ground pit lined with plastic.
2. Plant a mixture of food crops (maize) and leguminous plants (pigeon peas) into this soil. Maintain by watering regularly.
3. After 3 months cut both the food and leguminous crops at ground level. Stop watering.
4. After a further week (with no watering) pull up the roots of the food and leguminous crops and cut into 1 cm sections. Mix the soil and cuttings together. This is the inoculum.
5. The inoculum should be placed around the root ball of the plant when planting out. Alternatively the inoculum is placed in the container in which the seed is sown, a few centimeters below the seed.

5.3 Maintenance

Any weeding should be done as required particularly in the first year after planting to ensure successful establishment. It is assumed that extensive weeding will be associated with crop maintenance and pruning in the 2nd year to about half the tree height may be needed to control low branching.

For the first two years after planting any dead trees should be replaced at the beginning of the following wet season. Crops will continue to be grown throughout the area planted with trees and there should be **no** burning at any time even when the associated crop is harvested. Any foliage and green waste should be left on site and worked into the ground. Woody material from pruning / thinning can either be used as fuel wood or for poles etc. Heavy crown pruning is expected to provide fodder and fuelwood whilst maintaining suitable conditions for growing crops in association with the trees.

5.4 Thinning and harvest

Remove 50% (i.e. 100 trees per hectare) after 8 years to leave tree spacing of 10m x 10m (i.e. 100 trees per hectare). The remaining tree should be grown to maturity and not harvested (until year 50 approximately).

6.0 DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BENEFITS.

- Soil improvement through nitrogen fixation and increasing soil organic matter thus improving soil productivity in general.
- Soil conservation - particularly the prevention of soil erosion associated with heavy rainfall as the system improves the soil physical properties including porosity that encourages water infiltration as opposed to run off (climate change adaptation benefit)
- Hydrological benefit ï harvesting of incidental moisture and improved water flows which will help to reduce catastrophic flooding (climate change adaptation benefit)
- Biodiversity benefit ï through the protection of wildlife habitat (birds, bees).
- NTFP ï beekeeping, medicines, livestock fodder etc.
- Shading for humans and livestock.
- Pruning and thinning material may be used as fuelwood.

7.0 DESCRIPTION OF ADDITIONALITY

A key factor is that the emissions reductions from a project activity or intervention should be additional ï 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 nitrogen fixing trees as part of the dispersed interplanting system 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)
- Increased awareness of climate change and the role of dispersed inter planting system in climate change management and livelihood improvement(benefits that may be derived from tree planting)
- Availability of seedlings and materials for producing them.
- 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 dispersed interplanting system where trees are planted in order to increase food yields per hectare on cultivated land leakage is not likely to occur. However, 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 they retain sufficient land to provide food for themselves and their families.
- 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 ópolicingô to ensure that leakage resulting from displaced activities does not occur.

Where communities have a satisfactory plan for managing leakage risk resulting from the establishment of dispersed interplanting there should be no assumption of leakage. In all probability the most likely outcome of the dispersed interplanting system is positive leakage as a result of improved land use reducing the pressure to extend cultivation of food activities to new areas.

9.0 BASELINE CARBON EMISSIONS

The ó**baseline**ô 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 (VERôs) 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 ñbaselineò carbon emissions that would be associated with land management expected in the absence of the establishment of dispersed interplanting system is set out in ó*Assesment 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.

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 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 the dispersed interplanting system is set out in *ÓAssesment 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 26.4 tonnes of carbon per hectare.

11.0 BUFFER

Twenty percent (20%) of all VERÕs 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 VERÕs 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 dispersed interplanting land use system (technical specification) is presented in the table below:

Table 12.1: The net carbon benefit and tradable carbon offset for the dispersed interplanting land use system

Technical Specification	Sink (tC/ha)	Baseline (tC/ha)	Net benefit (tC/ha)	Buffer (%)	Tradeable (tC/ha)	Tradeable (tCO_2/ha)
Dispersed interplanting	26.40	0.42	26.00	20%	20.80	76.34

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

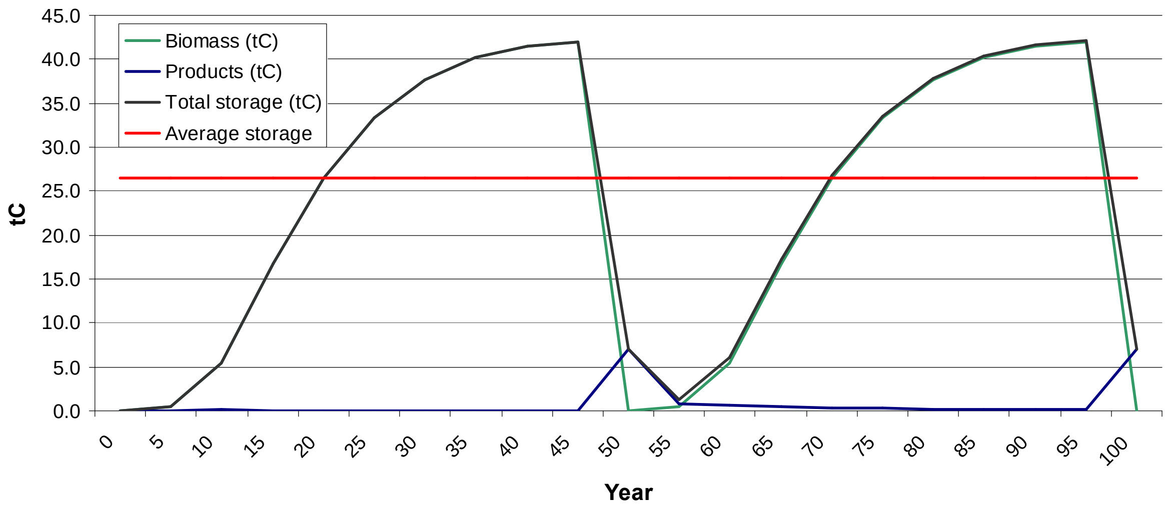


Figure 12.1: Dispersed interplanting technical specification carbon sequestration potential over 100 years

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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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	
General comments and recommendations	
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	
General comments and recommendations	
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