

CITRUS (*Citrus sinensis* and *C. reticulata*) ORCHARD
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 citrus fruit orchards 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 fruit orchard (citrus) system is to provide an alternative / additional source of income from other agricultural activities. Additional benefits will include soil conservation, enhanced biodiversity 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 fruit orchards and putting in place frequent monitoring to ensure compliance with the technical specification that will create the carbon sink. The most suitable areas for this system are neglected / degraded lands. This system may be more widely adopted on community land and amongst individuals with slightly larger landholdings (>1 hectare) i.e. those farmers that have sufficient land

not to jeopardise their food security by introducing a land use system that cannot be combined with growing other food crops in the long term.

The net carbon benefit of this system above the baseline (with 20% set aside as risk buffer) is calculated to be 15.26 tonnes of carbon per hectare. This is equivalent to 55.9 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 citrus fruit trees for commercial fruit production as well as providing a source of additional nutrition to those households that use this system.

1.1 Main tree species

Botanical name	Common name (English)
<i>Citrus sinensis</i>	Sweet orange
<i>Citrus reticulata</i>	Tangerine

1.1 Ecology

Botanical name	Ecology
<i>Citrus sinensis</i> and <i>Citrus reticulata</i>	Subtropical rather than tropical species. Prefer a prominent change of seasons and do not tolerate water logging.

1.2 Altitudinal range and Climatic factors.

Botanical name	Altitudinal range and climatic factors
<i>Citrus sinensis</i> and <i>Citrus reticulata</i>	Do well in areas below 1000 metres above sea level, Mean annual temperature of 26 degrees. Celcius, Mean annual rainfall: 900-2500 mm

1.2 Habitat requirements.

Citrus cultivars will generally not do well in the humid tropical lowlands. They will prosper more in areas of intermediate elevation - high constant humidity makes trees very susceptible to pests and diseases. They have a moderate frost tolerance but no tolerance of waterlogging

Botanical name	Habitat requirements
<i>Citrus sinensis</i> and <i>Citrus reticulata</i>	Grows well in almost any soil type if well aerated. Fertile, light to medium, well-drained, deep, loose loams; soils with a high water table should be avoided. The species are sensitive to excess salts; pH range of 5-8 is preferred. High constant humidity makes them susceptible to pests and diseases.

1.3 Growth habit.

Botanical name	Growth habits
<i>Citrus sinensis</i> and <i>Citrus reticulata</i>	Small, shallow-rooted evergreen shrubs or trees about 6-13 m high with an enclosed conical top and mostly spiny branches. Twigs angled when young, often with thick spines.

2.0 MANAGEMENT OF CITRUS ORCHARD LAND USE SYSTEM

2.1 Management objectives

The main management objective is the commercial production of citrus fruits.

Citrus fruits will provide a dietary supplement to those households that introduce this system.

Any offcuts / pruning material can be used as fuelwood.

Citrus fruit trees are also important for apiculture, as the flower nectar provides excellent fodder for bees.

3.0 COSTS OF IMPLEMENTATION

3.1 Nursery costs

The activities and costs for establishing 400 seedlings during the setting up of the nursery are

- Cost of seeds
- Digging, transporting and mixing of the soil
- Pot filling, transfer, and topping
- Seed sowing and bed management
- Pricking out and selection/transfer
- Watering and sanitation
- Grafting
- Green house sheeting
- Cost of one wheelbarrow, hoes, spades, machete, shade netting, poles, water, and fuel costs

The total nursery cost is \$ 600

3.2 Establishment cost

The activities in the establishment phase would include

- Demarcation and soil test
- Bush clearing
- Chaining/marketing
- Planting

The total cost for this phase for per hectare would be \$ 50

3.3 Maintenance cost

Operations for year one are grass slashing, spot weeding, firebreaks, uprooting shrubs. The cost per hectare will be \$40

Year two operations include grass slashing, spot weeding, firebreaks maintenance, and uprooting shrubs. The total cost in this year would be \$20

Operations for years 3, 4, and 5 are maintaining of firebreaks and pruning which will cost \$20 per hectare per year.

Other costs would go to buying equipments such as one slasher, one hoe, one machete, a pair of boots, and one overall coat. This will cost \$ 50. In total, the maintenance cost will be \$ 295

Activity	Cost (per hectare for fruit orchard)
Nursery costs	\$600
Establishment	\$50
Maintenance year 1	\$40
Maintenance year 2	\$20
Maintenance year 3	\$20
Maintenance year 4	\$20
Maintenance year 5	\$20
Equipment cost	\$50
Total	\$820

4.0 POTENTIAL INCOME

There will be a total of 400 citrus fruit trees per hectare from a spacing of 5m by 5m. The average yield per hectare of a citrus orchard is estimated at 60kg per year for an estimated productive life of 10 years giving a cumulative total production of 240000kg. At an estimated price of MK75 per kg, the yield would have a value of MK18000000 over ten years, however, it should be noted that this

is a conservative estimate since the productive life of citrus orchards can reach 15 years under good management and optimal climatic conditions.

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 rows in holes dug 60cm wide and 60cm deep at a spacing of 5m by 5m.

Intercropping with other fruits and vegetables will only be possible until canopy closure. 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 risk of termite invasion in case 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.

At planting, the following actions need to be considered:

- Water seedlings before planting to hold nursery soil together and to assist establishment in case it fails to rain on the day of planting
- Plant at the beginning of the rainy season
- 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
- Regular watering especially in the first year will help trees survive

5.2 Maintenance

Particular attention should be paid to weeding and uprooting of competing shrubs where citrus has been planted. In a case where spot weeding is preferred, grass slashing will immediately follow. Pruning is practised to encourage branching and to keep the tree low for easy harvesting of the fruits. Any growth below where budding took place should be removed. Pruning, sanitation, use of resistant varieties and spraying are used to control pests and diseases.

5.3 Pruning and harvest

Pruning of unwanted branches should be done carefully to leave smooth scars to minimise infection. This activity is necessary to allow better penetration of photosynthetic active radiation vital for fruit set. As the orchard ages, its productivity will decrease hence pollarding should be considered or complete re-establishment at approximately year 25.

6.0 DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BENEFITS

The establishment of this land use system will bring about the following environmental and socio-economic benefits:

- 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 encouragement of water infiltration which will help to reduce flooding (climate change adaptation benefit)
- Biodiversity benefit ó through the protection of wildlife habitat for a diverse plant and animal life.
- Provision of potential bee keeping habitat as beehives could be hung in the trees.
- Shading for humans and livestock.
- Pruning 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 fruit orchards that are overcome through the project activity and receipt of carbon finance are:

- Community mobilisation and participation in planning processes.
- Awareness of climate change issues, carbon trading and role of mango orchards in climate change management and livelihood improvement leading to renewed efforts in tree planting.
- Building of technical competence in development of grafted mango seedlings and their subsequent field establishment and management vital for sustainability.
- Access to high value mango planting materials.
- Access to tools and other nursery materials including polythene tubes, watering cans, seed etc to enable seedling production.
- 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 establishing citrus orchards this is most likely to occur where farmers are establishing trees on currently cultivated land (these fruit trees are not suitable to be grown in combination with other cultivated food crops). If this were to occur it may result in displacement.

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 establishing citrus orchards 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.
- In many instances it may be most appropriate to establish citrus fruit orchards on degraded bush / scrub land which is not currently being used for producing other food crops. In this case any leakage resulting from displaced grazing or firewood collecting activities should also be assessed.
- A plan to monitor leakage on specific other woodland areas to ensure leakage is not occurring.
- Formation of community based policing 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 citrus fruit orchards there should be no assumption of leakage.

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 fruit orchards 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.

10.0 QUANTIFICATION OF THE 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 citrus fruit orchards is set out in *Assesment 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 19.5 tonnes of carbon per hectare.

11.0 BUFFER

Twenty percent (20%) of all VERs generated by the project activities are maintained as a risk buffer and similarly 20% of carbon credits generated by this land use system should be set aside as buffer stock. 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 VERs 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 offset (Plan Vivo certificates) generated by the citrus fruit orchard land use system (technical specifications) is presented in the table below:

Table 10.1: The net carbon benefit and tradable carbon offset for the citrus fruit orchard land use system.

Technical Specification	Sink (tC/ha)	Baseline (tC/ha)	Net benefit (tC/ha)	Buffer (%)	Tradeable (tC/ha)	Tradeable (tCO ₂ /ha)
Fruit Orchard (Citrus)	19.5	0.42	19.08	20	15.26	55.96

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

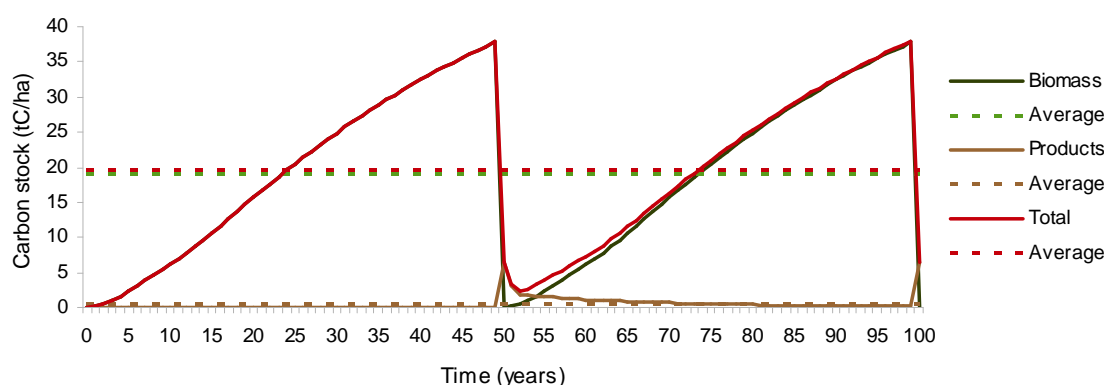


Figure 1: Citrus fruit orchard technical specification carbon sequestration potential over 100 years

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

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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	
<i>General comments and recommendations</i>	
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	
<i>General comments and recommendations</i>	
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