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Emiti Nibwo Bulora boundary planting technical specification

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By : Geoffrey Onyango, Emmanuel Ekakoro and Joan Sang

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Contact: Bo Lager

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Author: Geoffrey Onyango, Emmanuel Ekakoro and Joan Sang

Signature
Date:

QA: William Garrett



Signature
Date: May 2010

Author contact details: joan.sang@camcoglobal.com

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SUMMARY

This technical specification has been developed for use by Plan Vivo projects involving communities participating in the Kagera region of Tanzania. The activities described in this technical specification are only eligible for establishment on smallholders or community land which is either currently cultivated or neglected. This land management system may not be applied on land that already supports natural forest cover.

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 over a 25 year crediting period from planting and managing indigenous and naturalized tree species on farms in Kagera, Tanzania. 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 Kagera region in Tanzania. Other valuable contributions to the development of this system have been received from SCC-Vi Agroforestry 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 May 2008 and December 2008.

The objective of the boundary planting system involves the planting of a variety of indigenous and naturalised hard wood tree species along the perimeters of farmer's properties for timber, fruit, fuel wood and shade. Some nitrogen fixing trees might also be planted. In the first years after planting farmers will be able to continue cropping around the trees right up to the edge of the property. The carbon finance will make a critical difference in allowing for the implementation of this system by helping to finance the purchase of 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 of small holding farmers 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 Tanzania is the minimum planting area and viability.

The net carbon benefit and tradable carbon offset for the boundary planting system is shown in this table:

Technical Specification	Sink (tC/100m)	Baseline (tC/100m)	Net benefit (tC/100m)	Buffer (%)	Tradeable (tC/100m)	Tradeable (tCO ₂ /100m)
Boundary planting	2	0.06	1.9	20	1.5	5.6

ACKNOWLEDGEMENTS

This work has been undertaken by ESD/Camco as part of the Plan Vivo pilot project implementation in the Kagera Region of Tanzania. It has only been possible because of the financial support received from SCC-Vi Agroforestry. ESD/Camco wish to acknowledge the contribution made by all the staff of SCC-Vi Agroforestry Kagera, and all the other stakeholders engaged during the participatory planning process used to design and collect data for this technical specification.



1 Description of Boundary Land use system

This system involves the planting of trees along the perimeter of individual farmers or communal property with the objective of obtaining environmental and livelihood benefits including windbreaks, soil erosion control, shade/shelter, sale of poles, among others. The system would involve planting of different tree species to meet the intended objectives. This section gives a synopsis of the main tree species ecology, altitudinal range, growth requirements, among other important factors for consideration where it is proposed to use this tree planting system.

1.1 Main tree species

Table 1: Trees species recommended for Boundary planting land use system

Botanical name	Common name (English)	Natural range
<i>Markhamia lutea</i>	Markhamia	Indigenous
<i>Maesopsis eminii</i>	Umbrella tree	Indigenous
<i>Casuarina equisetifolia</i>	Australian pine, beach she-oak, beefwood tree	Naturalized
<i>Albizia lebbek</i>	East Indian walnut, English woman's tongue, fry wood	Naturalized
<i>Grevillea robusta</i>	Silky oak	Naturalized
<i>Acacia polyacantha</i>	African catechu tree, white thorn tree	Indigenous
Other indigenous tree species	e.g. <i>Khaya nyassica</i> , <i>Albizzia spp</i> ¹	Indigenous

1.2 Ecology

Table 2: Ecological requirements of species recommended for boundary planting land use system

Botanical name	Ecology
<i>Markhamia lutea</i>	The tree is drought resistant but cannot withstand waterlogging.
<i>Maesopsis eminii</i>	Very common in the ecozone between high forest and savannah.
<i>Casuarina equisetifolia</i>	Its natural range is semi-arid to sub humid. Commonly confined to a narrow strip adjacent to sandy coasts, rarely extending inland to lower hills
<i>Albizia lebbek</i>	The species occurs on soils overlying basalt and among sandstone boulders and basalt outcrops on breakaway slopes. It is also found on the banks of riverine sites, on stabilized dunes or low lateritic ledges above the beach.
<i>Grevillea robusta</i>	Grows on fairly well drained and neutral to acidic soils
<i>Acacia polyacantha</i>	The species occurs in wooded grasslands, deciduous woodland and bushland, riverine and groundwater forests in altitudes between sea level and 1800 m.

¹ These other indigenous tree species will only constitute a small proportion of planting (no more than 10%) so additional information is not contained in this report.

1.3 Altitudinal range.

Table 3: Altitudinal range of species recommended for boundary planting land use system

Botanical name	Altitudinal range and climatic factors
<i>Markhamia lutea</i>	900-2000 m, Mean annual temperature: 12-27 deg. C, Mean annual rainfall: 800-2000 mm
<i>Maesopsis eminii</i>	700-1500 m, Mean annual temperature: 22-27 deg. C, Mean annual rainfall: 1200-3000 mm
<i>Casuarina equisetifolia</i>	0-1 400 m, Mean annual temperature: 10-35 deg. C, Mean annual rainfall: 200-3 500 mm
<i>Albizia lebbbeck</i>	0-1 800 m, Mean annual temperature: 19-35 deg. C, Mean annual rainfall: 500-2 500 mm
<i>Grevillea robusta</i>	0-2300 m, Mean annual temperature: 14-23 to 25-31 deg. C, Mean annual rainfall: 600-1700 mm
<i>Acacia polyacantha</i>	Altitude 200-1 800 m, Mean annual rainfall: 300-1 000 mm

1.4 Habitat requirements

Table 4: Habitat requirements of species recommended for boundary planting land use system

Botanical name	Habitat requirements.
<i>Markhamia lutea</i>	Trees prefer red loam soil but can tolerate well-drained, heavy, acidic clay soils.
<i>Maesopsis eminii</i>	Tolerates a wide range of site conditions but grows best on deep, moist and fertile sandy loam soils with a neutral to acid pH.
<i>Casuarina equisetifolia</i>	The species tolerates both calcareous and slightly alkaline soils but is intolerant of prolonged water logging and may fail on poor sands where the subsoil moisture conditions are unsatisfactory.
<i>Albizia lebbbeck</i>	Roots are near the surface so requires a high water table - prefers black-cotton soils but will grow in a wide range of soils including acid, , alkaline and saline
<i>Grevillea robusta</i>	Does not stand water logging or heavy clays
<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.

1.5 Growth habit

Table 5: Growth habits of species recommended for boundary planting land use system

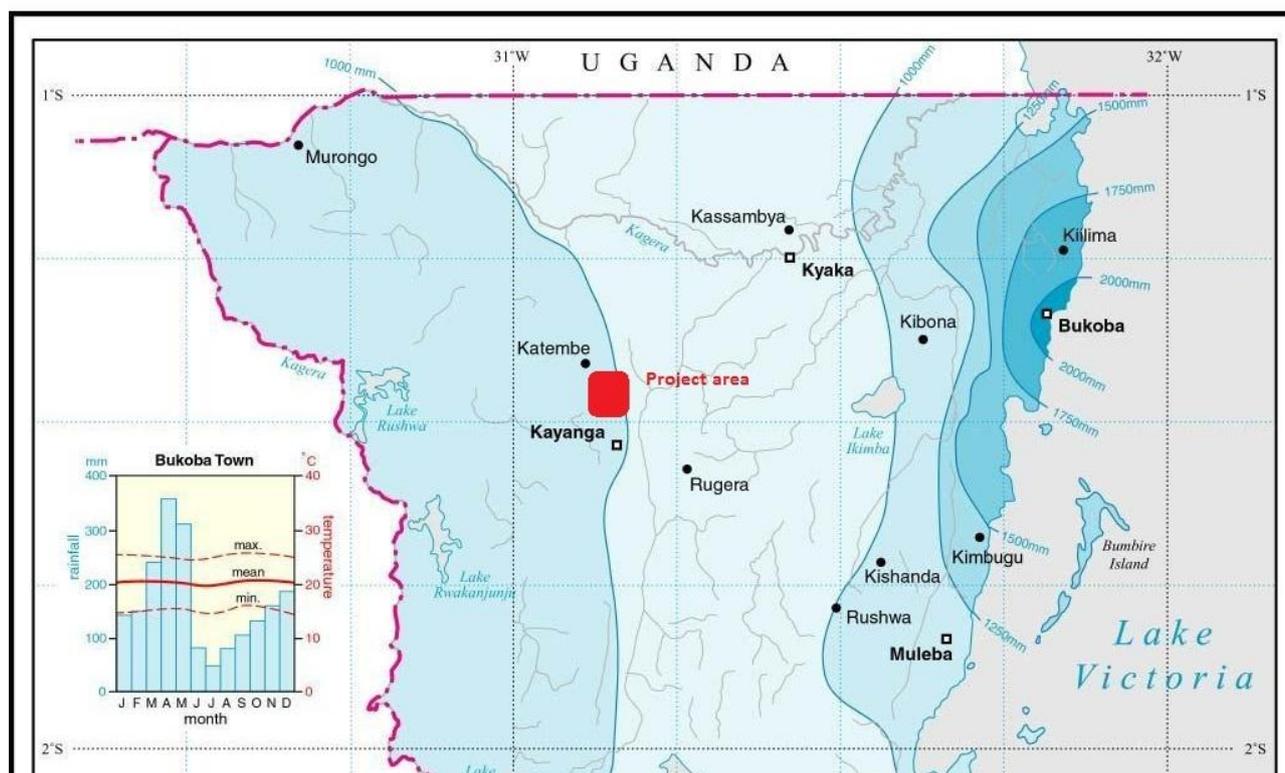
Botanical name	Growth habit.
<i>Markhamia lutea</i>	It is an upright evergreen tree 10-15 m high, with a narrow, irregular crown and long taproot.
<i>Maesopsis eminii</i>	It is an early successional species, adept at colonizing grasslands and disturbed areas in the high forest.
<i>Casuarina equisetifolia</i>	Crown shape initially conical but tends to flatten with age.
<i>Albizia lebeck</i>	Fast growing on good sites. A deciduous tree which may reach 25m, usually 8-14m, trunk often short, crown low and spreading
<i>Grevillea robusta</i>	Moderate to fast growing. Only young trees copies well
<i>Acacia polyacantha</i>	Fast growing to 18m with open canopy

1.6 Scope and applicability of this system

The project area (E31.07; S01.48) falls within the perennial banana/coffee agro-ecological zone with elevation of 1300-1600 meter. The annual precipitation is between 1000 and 1250 mm and mean annual temperature 20°C. The agro-ecological zone of the project area as described above supports practicing the system, for example beside carbon revenues the system provides:

1. The commonly practiced banana production requires that banana plantations are protected from strong wind, incidents which are on an increase due to climate change.
2. Farmers adapting to climate change as a result of increased food, income, improved technologies and environmental services.
3. Dependency on wood fuel as main source of energy for household use, boundary planting can sustainably provide such benefits
4. Traditional Land tenure system on un-surveyed land make it necessary for boundary demarcation, boundary planting of long term tree species is the most appropriate in term of affordability by small scale farmers
2. Other needs for tree products such as supporting poles for banana plant management can well be compromised through boundary planting system

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2 Managing this land use system

2.1 Management objectives

The main objective of this system is land demarcation, timber, fruits, fuel wood, shade, soil improvement through nitrogen fixing and mulching. The table below gives management objective of each tree species in the system

Table 5: Management objectives for species recommended for boundary planting land use system

Species	Management objective
<i>Albizia lebbek</i>	Timber , Fodder (leaves), construction , erosion control (good soil binder due to its extensive, fairly shallow rooting system), shade/shelter , soil improver as it is nitrogen fixing, mulch, ornamental,
<i>Maesopsis eminii</i>	Reforestation purposes, firewood, medicines (leaves, barks and roots), bee-forage, fodder (leaves), ornamental, shade (coffee), timber
<i>Casuarina equisetifolia</i>	Boundary planting as it doesn't intercept much of incoming solar radiation. Reclamation on barren polluted sites, firewood (even when green), ornamental, windbreak, intercropping for soil fertility
<i>Grevillea robusta</i>	Fodder : Leaves are browsed by livestock. Fuel (charcoal), timber (strong, durable and termite resistant wood is used for construction, beams and rafters, poles and posts, tool handles and mortars and pestles). Soil improver (mulch), shade or shelter, ornamental

<i>Makhamia lutea</i>	Soil improver (provides mulch which enhances soil moisture retention and increases organic matter), poles used as props to support banana trees soil erosion control, shade
<i>Acacia polyacantha</i>	Firewood, charcoal, timber, medicine, nitrogen fixing, soil conservation, fodder

2.2 Costs of implementation

These costs of implementation are based on planting 100 metres (i.e. 33 trees). All costs are merely indicative.

2.2.1 Nursery Costs

The activities and costs 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

The total cost of these activities is estimated to be \$ 9

2.2.2 Establishment cost

The activities in the establishment phase for 33 seedlings would include

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

The total cost for this phase is estimated to be \$ 20

2.2.3 Maintenance cost

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

- i. Operations for year one are grass slashing, spot weeding, firebreaks, and uprooting shrubs. The total cost is \$ 10
- ii. Operations for year two are grass slashing, spot weeding, firebreaks maintenance, and uprooting shrubs. The total cost in this year would be \$ 6
- iii. Operations for year 3,4,and 5 are maintaining of firebreaks will cost \$ 12

Table 6: Maintenance costs for species recommended for boundary planting land use system

Activity	Cost (per 100 m for boundary planting)
Nursery costs	\$9
Establishment	\$20
Maintenance year 1	\$ 10

Maintenance year 2	\$ 6
Maintenance year 3	\$ 4
Maintenance year 4	\$ 4
Maintenance year 5	\$ 4
Total	\$ 57

2.3 Potential income

Any income generated using this land use system is likely to be small. The calculations are based on planting 33 trees along 100 metres of boundary. The potential income is merely indicative.

2.3.1 Timber

Assumptions

- 1 hectare = 300m³
- The recovery rate is 25%
- 1m³ is \$260

Therefore 100 m boundary planting (33 trees) would yield

$$\frac{(300 * 0.0297) * 25 * 260}{100} = \$579$$

2.3.2 Fuel wood

Assumptions

- 75% recovery from timber will be used as firewood

$$\frac{(300 * 0.0297) * 75 * 18}{100} = \$120$$

2.4 Management operations

2.4.1 Preparation of site

Demarcate the planting area clear any unwanted undergrowth (competition) and mark where individual trees will be planted as follows:

1. All shrubs and unwanted trees should be removed from the planting area in order to remove undue competition with the young plants.
2. The litter should then be collected and burnt
3. Uprooting of any stumps in the area.
4. Opening of holes (60cm x 60cm). This should be done before the onset of rains.
5. Planting should be done immediately 50 mm of rain is achieved during the onset of rains.
6. During planting, application may be done for some species which are susceptible to termite attack

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

2.4.2 Establishment

Trees should be planted in a row 3 meters apart. More than one row of trees may be planted (staggered with spacing of 3X2 metres) where the planting is not adjoining neighbouring cultivated land. 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 should be planted between timber trees. These trees will be coppiced and thinned out over time.

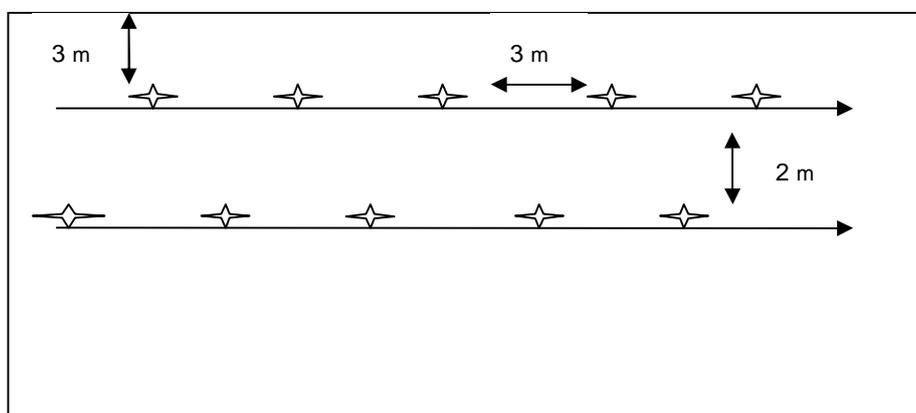


Figure 1: Layout for boundary planting on two lines

The system should be developed 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.

Table 7: Establishment of species recommended for boundary planting land use system

Species	Establishment
<i>Markhamia lutea</i>	Trees may also be propagated by seedling or wildings They should be planted in a deep hole, as the roots are long.
<i>Maesopsis eminii</i>	Established by use of seeds but best with seedling
<i>Casuarina equisetifolia</i>	- Propagation is mainly by seed; however, there is an increasing use of cuttings. - They can be established using containerized seedlings, bare root seedlings or rooted cuttings. -Seedlings should be planted in well-drained light soils, not clay soils, to decrease the incidence of diseases and pests.
<i>Albizia lebbek</i>	It is best established using potted seedlings although bare-rooted seedlings, direct seeding and stump cuttings have all been used successfully

<i>Grevillea robusta</i>	<ul style="list-style-type: none"> - Can be propagated through seed and cuttings. Cuttings can be easily established using shoots from seedlings or saplings, which can also be air-layered. But the use of seedling would be preferred for better establishment - Some control of competing vegetation is required for the 1st 1-2 years after planting.
<i>Acacia polyacantha</i>	It prefers sites with a high groundwater table, indicating eutrophic and fresh soils

2.4.3 Weeding

Weeding should be done twice in the first year and once in the subsequent years until dominance has been achieved by the planted trees. Weeding facilitates the achievement of maximum growth rate. Some grass slashing may also be required for the first three years and occasional uprooting of shrubs. Weeding reduces competition for nutrients and fire risk.

2.4.4 Protection from Hazards

The following measures are recommended to ensure the planted trees are not harmed:

1. Fencing off the planted area is recommended to stop grazing and reduce soil re-compaction by both animal and human activity. However, controlled foot paths should be designated to create access points across the planted area for humans.
2. Fire breaks need to be in place before the onset of the dry spell. Firebreaks are important in halting the spread of fire in case of such an eventuality
3. The boundary forest floor should be kept clean of any potential fire hazards.
4. The farmer should always be on the lookout for any fires.

2.4.5 Maintenance

Table 8: Maintenance operations of species recommended for boundary planting land use system

Species	Maintenance
<i>Markhamia lutea</i>	<ul style="list-style-type: none"> -Trees can be pruned and pollarded to reduce shading and are coppiced when they are about 5 m in height. Should be planted in a deep hole, as the roots are long. The tree coppice and can be coppiced when they are about 8-10 m in height
<i>Maesopsis eminii</i>	-In case of attack by <i>Fusarium solani</i> , selective thinning should be carried out to remove the affected stems.
<i>Casuarina equisetifolia</i>	<ul style="list-style-type: none"> - Weeding is necessary as young trees are susceptible to competition from weeds, especially grasses. - This tree is a poor self-pruner. Pruning is necessary up to m to make plantations accessible for maintenance. - The species is not fire resistant and protection is necessary.
<i>Albizia lebeck</i>	Coppices well, responds to pollarding, pruning and lopping, and will produce root suckers if the roots are exposed. The trees are vulnerable to strong winds and are killed by even light fires, thus requiring clearing of the forest floor and making use of firebreaks
<i>Grevillea robusta</i>	- Pruning and pollarding be carried out repeatedly (every 3. 4 years from age 4.

	<p>6 years onward) to yield wood and to regulate shading and competition with adjacent crops</p> <ul style="list-style-type: none"> - Weeding should be done regularly to avoid competition for nutrients - The surface roots can be pruned by digging with a hoe at a distance of around 30 cm around the trunks of trees growing in and around fields, to reduce competition with adjacent crops - It coppices well after being cut back to ground level at ages of up to 2 years, but coppicing ability declines sharply thereafter, so management on a coppicing rotation is not feasible.
<i>Acacia polyacantha</i>	Fast growing, weeding required

2.4.6 Harvesting

Table 9: Harvesting schedules of species recommended for boundary planting land use system

Species	Harvesting
<i>Markhamia lutea</i>	- Harvesting should be done at age 50
<i>Maesopsis eminii</i>	-Rotations are about 8 years for fuel wood and poles
<i>Casuarina equisetifolia</i>	- Rotation period varies depending on the farmer's need e.g. the rotation period ranges from 7-8 years for fuel wood and 10-15 years for poles but it has a life span of 25-30 years .
<i>Albizia lebeck</i>	- Fuelwood plantations can be clear felled on a 10-year rotation and for timber at age 25
<i>Grevillea robusta</i>	- Rotations of 8 - 12 years for firewood and 15-20 for timber production. A growth reduction after 20 years has been reported
<i>Acacia polyacantha</i>	Can be harvested firewood at age 8 and for timber at age 20.

3 Description of the environmental and social benefits that may be derived from this land use system

- 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 . harvesting of incidental moisture and improved water flows which will help to reduce catastrophic flooding (climate change adaptation benefit)
- Biodiversity benefit . through the protection of wildlife habitat (birds, bees).
- NTFP . beekeeping, medicines, fruits etc.
- Shading for humans and livestock
- Pruning material may be used as firewood

4 Description of additionality of community and individual on farm tree planting in Kagera Region, Tanzania

A proof of additionality in this system would be to demonstrate that boundary planting would not have occurred in the absence of the carbon derived finance. The barriers which would be eliminated by this system would be:

- Community mobilisation and participation in planning processes
- Capacity (on improved land use management systems, agriculture and silviculture)
- Awareness (benefits that may be derived from tree planting)
- Raising 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.

5 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 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 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 boundary planting 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).

6 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 tradable 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 woodlots is set out in ~~An~~ Assessment of Net Carbon Benefit Emission Nibwo Bulora project in Kagera, Tanzania (Camco, 2010). Since there is no significant difference between the carbon baseline on cultivated land and that on neglected land a common baseline has been applied for all land

use systems. The carbon baseline is estimated to be 0.06 tC/100m in the absence of project activities (on the assumption that a single 100m line of boundary planting is equivalent to 2.97% of a hectare). Since the baseline per hectare was estimated as 2 tonnes of carbon per hectare, this translates to 0.06tC/100m. A slightly different approach from previous carbon sink calculations has been adopted. In this new approach, the baseline value (i.e. 0.06 tC/ha) was input into the CO₂Fix model, resulting in a marginal increase in the long term carbon sink.

7 Carbon sequestration potential

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 25 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 is calculated using the CO2FIX-V3 model (Mohren et al 2004).
- These model outputs are 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 land use systems is set out in ~~the~~ Assessment of Net Carbon Benefit for Emiti Nibwo Bulora Project in Kagera, Tanzania (Camco, 2010). The potential carbon sink created by this land use system (based on long term average carbon storage over 25 years) is calculated to be 1.5 tonnes of carbon per hectare.

This result is derived from carbon models based on planting tree species in the proportions shown in table 10. Tree growth data was not made available for all the tree species that may be planted by farmers adopting this land use system. Camco have therefore used the available tree growth data to model carbon sequestration potential using information gathered in the field relating to the most likely proportions of different tree species to be planted i.e. models are based on the most representative trees.

Table 10: Species used in carbon modelling		
Technical specification	Species	Proportion (%)
Boundary Planting	<i>Maesopsis eminii</i>	33
	<i>Grevillea robusta</i>	33
	<i>Markhamia lutea</i>	33

8 Risks

The risks involved in relation to this technical specification:

Technical

- Lack of technical skills among farmers and long term extension services from government and NGOs.
- Availability of recommended species of seeds/seedlings is limited and hinders tree planting
- High mortality rates in the plantations due to pest and diseases and/or browsing by animals.
- Improved microclimate resulting from establishment of the system may lead to diversified flora and fauna, that might have negative effect on agricultural production (e.g vermin) leading to negative perception

Social

- Investment cost involved becomes a barrier

- Labour requirement is regarded to high by the farmers for engaging in tree planting activities
- Thefty/illegal cutting of trees for fuelwood, fodder, poles etc without consent of owner of property
- Inadequate knowledge and capacity of the small holder farmers to undertake improved agricultural production may lead to negative perceptions on the system in case of crop failure, similarly the same could be true in case of crop failure due to inability to adapt to climate change in agricultural production
- Possibility for Land relocation as per existing land legislation may affect realising the carbon sink benefits form practicing the system

Market

- If pricing for timber increases it can motivate farmers to cut trees before the optimum rotation age.

9 Buffer

20% of all VER_¢ 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_¢ will return to the farmer.

10 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 land use system (technical specifications) is presented in the table below:

Table 10: The net carbon benefit and tradable carbon offset for the boundary land use system

Technical Specification	Sink (tC/100m)	Baseline (tC/100m)	Net benefit (tC/100m)	Buffer (%)	Tradeable (tC/100m)	Tradeable (tCO ₂ /100m)
Boundary	2	0.06	1.9	20	1.5	5.6 ²

The figure below shows the long-term average carbon sink over the simulation period (25 years).

² 1 decimal place maintained for tradeable tCO₂ under this land use system because net carbon gain is relatively low and rounding down would result in significant decrease in carbon offsets by >10%.

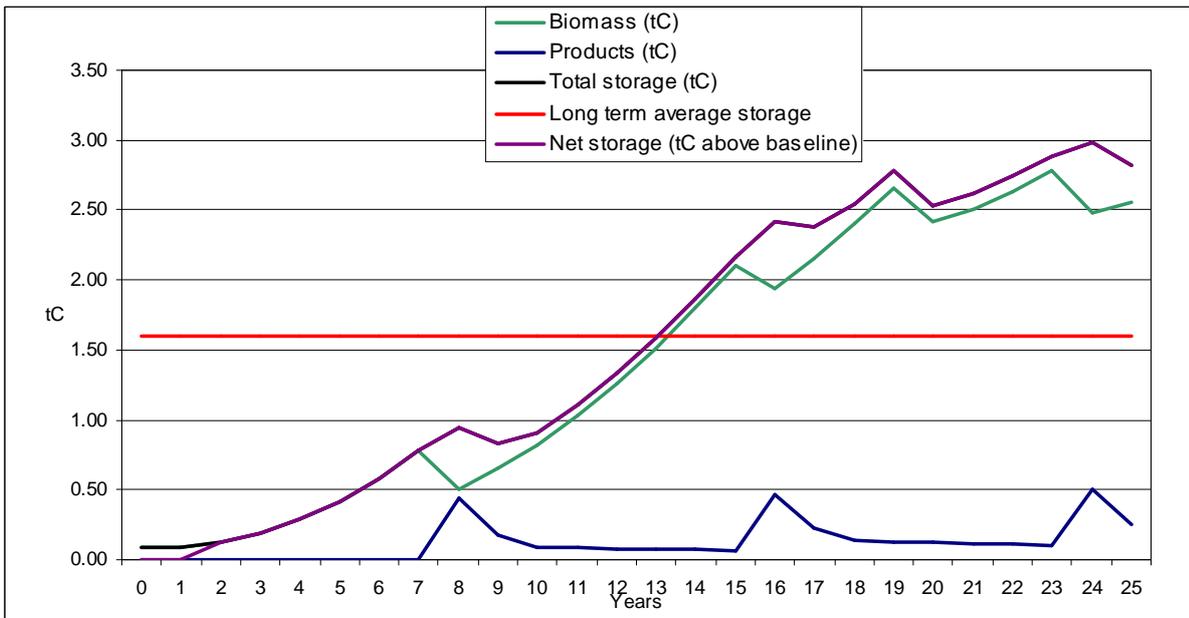


Figure 2: Carbon sequestration potential for boundary land use system technical specification over 25 years

11 Monitoring

Monitoring targets for the first 4 years are based on establishment; the whole plot must be established by the second year with at least 90% 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.

Table 12: Monitoring indicators for species recommended for boundary planting land use system

Year	Indicator
1	At least 50% plot established
2	Whole plot established, 90% survival (at least 29 stems / 100 m surviving)
3	Whole plot established , 90% survival
4	Whole plot established
5	Whole plot established and average DBH not less than 8 cm
6	Whole plot established and average DBH not less than 11 cm
7	Whole plot established and average DBH not less than 13 cm
10	Whole plot established and average DBH not less than 19 cm

12 References

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