TREES FOR GLOBAL BENEFIT PROGRAMME:

TECHNICAL SPECIFICATION: AGROFORESTRY FARMING SYSTEM: MIXED NATIVE AND NATURALIZED TREE SPECIES

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Developed by

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Table of Contents

List of Tables

Table of Figures

Summary

This technical specification has been developed for use in the coffee-banana agro-ecological zones of Uganda for Trees for Global Benefit (TGB) - an afforestation/reforestation carbon management scheme for rural communities currently operating in the Albertine rift (Rubirizi, Mitooma, Kasese, Hoima and Masindi) and Mt.Elgon (Mbale, Manafwa and Bududa districts). Because the TGB encompasses multiple technical specifications, the sections of the Project Design Document (PDD) for the project that specifically discuss this intervention were extracted and presented in this separate document for the purpose of clarity. Nevertheless, they are to be considered an integral part of the PDD and they refer its parts G, H and K.

The main tree species recommended for this system are *Grevillea robusta, Prunus Africana, Mahogany, Croton, Premna, Ficus, Albizia, Cordia, Maesopsis eminii* and fruit trees (*Artocarpus, Persea* and *Mangifera*) under three planting systems: boundary (strip) planting; dispersed interplanting; and woodlots. *Grevillea robusta* and fruit trees are naturalized exotic species while the rest are native to Uganda. This technical specification explores the carbon sequestration potential of various mixed native tree species, as an additional economic benefit, under a given management regimes. The aim of the technical specifications is to provide a justification for the socio-economic and environmental benefits associated with the sustainable management of the land use system. The information used to develop this technical specification came from a number of sources including the National Biomass Study (2003) conducted at the same time as the start of TGB project. In addition, TGB has conducted a baseline assessment as part of the preparations to extend the project to the Mt. Elgon region. In addition, the project has generated real data from farmers that have been growing these trees alongside a single species (*Maesopsis eminii*) system. The project will continue to review and update or develop additional specifications every five years if additional research and monitoring information gathered during project implementation identifies the need to do so.

The main objectives of the land use system are to provide medium to long-term agro-forestry benefits of improved agricultural productivity, shade and wind-breaks for crops and houses as well as providing timber and fuel-wood thus reducing pressure on protected areas. The activities described in the technical specification are only eligible for establishment by smallholder farmers or communities with land where the planting (woodlot, dispersed inter planting and boundary) of trees is possible. The land must be within the project boundary and participating households must demonstrate that the project activities will not conflict with their activities such as subsistence farming. This is a long-term project with carbon credits issued ex-ante over a contracting period of 25 years. The harvesting of the trees is however expected to be spread out to at least 35 years, which is the average rotation period for this system.

The technical specification was developed through a participatory process involving several stakeholders who included the communities as well as technical staff from ECOTRUST, local government and the National Forestry Authority. It was through this consultative process that the tree species and planting methods (including pre-planting, planting, silvicultural practices, maintenance and management activities) were determined.

Calculation of the carbon benefits for the intervention has assumed a baseline of 4.5 t/C/ha (to account for any existing trees on the farmers land). The SHAMBA[1] model has been used to calculate the carbon sequestration rates for the tree species being planted. **Only the carbon pools representing above and below ground tree biomass have been used for the calculations**. A summary of the carbon benefits is shown below in Table 1.

Table 1: Summary of Net tCO_2 and Tradeable tCO_2

Intervention Type	Sink tCO_2/ha	Baseline tCO_2/ha	Net benefits tCO_2/ha	Risk Buffer (10%) tCO_2/ha	Tradeable Carbon tCO_2/ha
Boundary planting	81.95	16.68	65.24	6.52	58.72
Woodlot	255.51	16.68	238.80	23.88	214.92
Dispersed inter-planting	187.10	16.68	170.40	17.04	153.36

A 10% risk buffer has been applied to the net carbon benefits. This is supplemented by an innovative system which relies on a further 10% of the revenue derived from the sales of Plan Vivo Certificates (PVCs) – Tradeable Carbon – being allocated by participating farmers to the Community Carbon Fund (CCF) – see Section H on Risk Management for a description of the Community Carbon Fund.

The monitoring plan for the intervention covered by this technical specification, covering performance monitoring of farmers' planted trees, as well as socio-economic and biodiversity monitoring, has been incorporated.

G Technical Specification

Project Intervention and Activities

This technical specification has been developed for use in the coffee-banana agro-ecological zones of Uganda for Trees for Global Benefit (TGB) - an afforestation/reforestation carbon management scheme for rural communities currently operating in the Albertine Rift (Rubirizi, Mitooma, Kasese, Hoima and Masindi) and Mt. Elgon (Mbale, Manafwa and Bududa districts). The TGB aim is to produce long-term, verifiable voluntary emission reductions by combining carbon sequestration with rural livelihood improvements through small-scale, farmer-led, forestry/agroforestry projects while reducing pressure on natural resources in national parks and forest reserves. Technical specifications are tree or farm management guidelines to ensure that the described activities will deliver the projected carbon sequestration benefits.

The aim of the technical specification is to provide justification for the socio-economic and environmental benefits associated with the sustainable management of the proposed land-use

[1] https://shambatool.wordpress.com/outputs/

system. The activities described here are only eligible for smallholder farmers or communities with land where tree planting (boundary, woodlot or dispersed inter-planting) is possible and the land must be within the project boundary. The project will not involve the clearing of vegetation to plant trees, but rather it seeks to enhance trees on the farm. The cutting of trees for the purposes of planting carbon trees will lead to an automatic disqualification from the project. Participating households must demonstrate that the project activities will not conflict with their subsistence activities, mainly agriculture production. The technical specification will be updated on a regular basis as and when additional monitoring information is gathered during project implementation. The main objectives of the land use-system are to provide medium to long-term agro-forestry benefits of improved agricultural productivity, shade and windbreaks for crops and houses as well as providing timber and fuel-wood thus reducing pressure on protected areas.

Description of the Land-Use System

The agro-forestry system proposed in these technical specifications involves the planting of mixed native and naturalized tree species of long, short and medium rotations alongside other farming activities. The aim of this system is to improve farm productivity and provide multiple benefits such as timber, firewood, and fodder while minimizing land management requirements. This system may also be used on degraded or under-utilised land where in the long term this system may help to re-habilitate degraded lands. The technical specification also provides for various options including block, and boundary planting as well as dispersed inter-planting. Provision has been made for the growing of crops together with the trees in the dispersed inter-planting option. However, crops can also be grown in the woodlot system during the initial years after tree planting and it will be encouraged because it will assist with tree establishment and subsequent maintenance.

Main Tree Species

The main tree species recommended for this system are *Grevillea robusta, Prunus africana, Khaya* spp, *Croton, Premna, Ficus, Albizia, Cordia, Maesopsis eminii* and fruit trees (*Artocarpus, Persea and Mangifera*) under three planting systems: boundary, dispersed inter-planting and woodlot. *Grevillea robusta* and the fruit trees are naturalized exotic species while the rest are native to Uganda. The system will involve a combination of fast/medium and slow-growing species in a ratio of 80:20. Selected tree species are those that perform well with agricultural crops. Annual crops such as beans and maize can be inter-cropped and perennial crops such as bananas, coffee, cocoa, cassava can also inter-cropped with these species up to the rotation period. Species that provide shade to coffee such as *Cordia, Premna*, *Albizia* and *Grevillea* will be prioritized in this coffee/banana agro-ecological zone. After 10 years, when trees are strong enough, domestic animals may be allowed to graze in the woodlot and will then deposit manure to improve soil fertility.

Project Activities

The system involves planting farm land with mixed native tree species at different rotations at spacing of 5x5 m, 7x7 m and 8x8 m for boundary, woodlot and dispersed inter-cropping respectively. These three different systems have been included to cater for differences in landholdings, ensuring that each farmer has enough land for the usual agriculture activities especially food production. Farmers that have relatively small pieces of land will practice boundary planting, those with medium sized plots will practice dispersed inter-cropping while those with larger land holdings will practice woodlots. This is intended to minimize any chance that a farmer will cut down trees existing for the purpose of planting trees for this project. Table 2 summarizes the three main systems.

Table 2 Summary of Activities Covered under this Technical Specification

Technical specification	**Expected Trees at establishment**	**Activities**
Boundary Planting with *mixed native sp.*	80 trees per ha i.e. 400m at a spacing of 5x 5m	Involves planting of *Grevillea robusta* and *Maesopsis eminii* along the farm boundary. The planting consists of single rows on all sides of the cultivated land. Rotation period is 35 years. A farmer may also chose to plant strips of trees within the cultivated land
Dispersed inter-planting with *mixed native sp.*	260 trees at a spacing of 8x8m	Involves planting of various mixed native tree species *Cordia, Premna & Albizia* mixed with crops. Rotation period is 50 years
Woodlot of *mixed native sp.*	310 trees at a spacing of 7x7m	Involves planting woodlots of various mixed native trees species e.g. *Maesopsis, Grevillea, Fantumia, Croton*. Rotation period is 50 years for purposes of generating timber and building poles

Ecology

The tree species can survive in a wide range of ecological types. However, most species prefer deep well-drained and fertile soils. Climate in the target area is classified as bimodal because it is characterized by two rainy seasons. This is suitable for the preferred species. Below is the description of the ecological requirements of each of the species.

(a) Slow Growing spp. for Long Rotations (≥40 years). These include: *Albizia* spp, *Cordia* spp, *Prunus africana, Premna angoloensis, Podocarpus, Fantumia* and should comprise 20% of the farmers' planting target.

Albizia species vary between small shrubs to larger trees. Wood is suitable for general-purpose timber, whereas bark and roots are used for medicinal purposes. Some species roots are used to make soap substitute and bark of some is used for basket weaving while leaves are good for browse. However, its sawdust is irritable to the nose and throat.

Prunus africana is an evergreen tree growing to 10-24 m height. It can grow to a stem diameter of 1m. *Prunus* is a highland forest tree that grows in the humid and semi-humid highlands and humid midlands. The species has a high light requirement and grows best in forest gaps. It grows well at altitudes of 900 to 3,400 m above sea level (asl) and at a mean annual rainfall of 890-1,400 mm. Its reddish brown wood is often used in furniture and leaves are good for browse. However, its sawdust is irritable to the nose and throat

Khaya senegalensis (African mahogany): A deciduous evergreen tree reaching 15-30m high. It can grow in altitude of 0-1,800 m asl and with a mean annual rainfall of between 400-1,750 mm. It tolerates a wide range of soil conditions, from neutral to very strongly acidic and from very well drained, coarse sandy loam to somewhat poorly drained clay. It takes between 50-100 years to harvest for timber.

Entandrophragma spp. (caudatum): This is a large deciduous tree that prefers habitats of rocky hillsides, open woodlands and low-lying river valleys. It will grow up to about 1,400 m asl.

Premna angoloensis: occurs up to 2,100 m altitude, in forest, bush land and grassland. In forest it occurs mainly in margins and clearings.

Podocarpus: *Podocarpus spp.* is adaptable evergreen tree or shrub. It does well in areas with full sun or part shade. It is tolerant to most soil types, but it may become yellow in alkaline, heavy or damp soils.

Funtumia*: *(bastard wild rubber): A tall tree up to 30 m. It is a medium-sized African rubber tree with glossy leaves, milky sap, and long woody seedpods. It is widespread from Sierra Leone eastward to Kenya, and all the way south to Mozambique and Angola. *Funtumia* has important antioxidant, antifungal, anti-inflammatory, and antibiotic properties. It is traditionally used in its native environment, tropical Africa to treat asthma, allergies, and other respiratory issues as well as malaria.

(b) Fast/Medium Growing spp. These are trees having medium term benefits with a rotation period of approximately 25 years. Examples include, *Maesopsis Spp., Grevillea spp:, Croton,* and *Ficus ssp* as well as fruit trees *P. americana, H. artocarpus, M. indica* and they should represent 80% of the farmers' planting target.

Maesopsis is a large tree found in tropical forest ecosystems of East, Central and West Africa. It can thrive in a wide range of ecological types with an altitudinal range of 700 to 1,500 m asl and mean annual rainfall of 1,200 to 3,000 mm (Katende *et al*., 1995). The species is a light demander and grows up to 30 m high. Prefers a wide range of soil conditions, but it is best on deep moist moderately fertile soils. *Maesopsis* is one of the fastest growing timber trees in Uganda. The rotation is 12-20 years for timber in productive sites. Earlier harvesting at 7-10 years can yield fuel-wood and pulp.

Cordia species grows at an altitudinal range of 550-2,600 m asl and mean annual rainfall of 700-2,000 mm. The tree thrives in dark brown fertile forest soils. Rotation is 25-30 years. This is a shrub or small tree and some species have fruit that are edible. It is a very good as a timber species as well as agroforestry species, in addition to being ornamental.

Grevillea robusta commonly known as Silky Oak or Silver Oak belongs to the plant family Proteaceae. The species thrives well in warm temperate, subtropical and tropical highland regions of many countries. While the species is alien to Uganda, it has been grown in the country for a long period of time and has proved to be an appropriate agroforestry species. It is now a naturalized exotic species without any negative tree-crop interactions reported. It grows within a mean annual precipitation of 700-2,000 mm and mean annual temperature of 15-20°C. *Grevillea robusta* prefers rather fertile soils such as those derived from river alluvia or basalts, but it will grow on shallower less fertile soils derived from sedimentary material. The species tolerates repeated heavy pruning and pollarding, enabling farmers to regulate the degree of competition with adjacent crops. Propagation is usually from seed.

Markhamia lutea is an indigenous tree common in the Lake Victoria belt and highland areas (up to 2,000 m above sea level). It is fast growing and is widely used for agroforestry by farmers. More recently, it is also being planted and considered as one of the most important tree species in this region in almost all configurations, services and products (van Schaik, 1986). It is mainly used for timber, poles, posts, fuel wood, furniture, tool handles, medicine (leaves), bee forage, shade, mulch, ornamental, soil conservation, windbreaks, banana props, and tobacco curing (ICRAF, 1992).

Fruit trees (**mango, jackfruit and avocado)** a few trees are mainly grown in compounds or dispersed on agricultural land. They provide nutritious foods and also play a key role in food security especially in the planting season when the rest of the food crop is still young.

Managing the Intervention

Objectives

The main objectives of the intervention are to provide medium to long-term agro-forestry benefits of improved agricultural productivity, shade and windbreaks for crops and houses. Moreover, it seek to provide timber and fuel-wood thus reducing pressure on protected areas by providing fuel-wood obtained through tree management operations of thinning, pruning pollarding and root pruning. Native species also produce medicinal products, honey, as well as herbaceous fodder for domestic animals growing under trees where possible. Integration of indigenous trees into rural landscapes also provides soil erosion control together with biodiversity conservation benefits. The systems can be used for producing high quality intercrops throughout the rotation period in dispersed inter-planting or during the first three years before competition would affect trees or crops in case of woodlots.

Inputs

Acquisition of Seedlings

Acquisition of seedlings is the main input required for this intervention. There are several sources of seed/seedlings for planting within the targeted agro-ecological zone. The project will provide support to ensure high seedling quality. Individuals can buy seedlings from the local tree nursery or transplant wildlings from good mother trees within their farms. Currently, seedlings of species such as *Grevillea* and *Maesopsis* cost not more than 500 Ugandan Shillings (US$0.20) bringing the total cost for 1 ha of woodlot to US $60 from local commercial tree nurseries. Groups may also seek permission to go to the forest reserve (UWA/NFA) to acquire seedlings, with permission from the Project Coordinator. Individual farmers or groups may also established their own nurseries to supply seedlings to the farmers for cash or using loans that will be payable after carbon payments have been received.

Maintenance

The main costs associated with maintenance include labour costs of tillage operations, tree and crop planting, weeding, harvesting of crops, tree thinning and pruning, crop harvesting, timber harvesting as explained below.

Tillage: This involves removing the weeds that would otherwise compete with the trees.

Planting: Planting holes should be deeper than the root-ball and should be at least three times wider. This creates an opportunity for settling of the root and decreases the chance of root-ball suffocation. Planting stock should come from seeds or wildlings of high quality mother trees. Seedlings should be healthy (not diseased), non-deformed, and of the recommended height of 1 foot (30cm). For this particular technical specification a 7x7m, 8x8m and 5x5m spacing is recommended for woodlot dispersed inter-planting and boundary planting systems respectively.

Beating-up: Replacing dead or poorly performing seedlings is crucial. This should be done between 3-8 months after initial planting, during the next rainy season when trees are established and after assessing the survival rate throughout the dry season.

Weed Control: This is fundamental in tree management especially in the early stages of growth. They are three options for managing weeds on farms including spot weeding, clean weeding and trip slashing. Spot weeding is recommended in the first two years, and then slashing can continue. Clean weeding is necessary especially under the agroforestry planting systems.

Pruning: is a horticultural and silvicultural practice involving the selective removal of parts of a plant, such as branches, buds, or roots. Reasons to prune trees usually include deadwood removal, shaping (by controlling or directing growth), improving or maintaining health, reducing risk from falling branches as well as preparing nursery specimens for transplanting. Early pruning should be done to avoid knot timber/wood. Pruning should be done to only a quarter of the crown height, branches should be cut very close to the stem and a sharp instrument should be used to enable wounds heal faster. Some of the species such as *Maesopsis* are self-pruning and will therefore not require any pruning.

Thinning and Cyclical Harvests: Thinning operations are done with the intention to attain the management objective. As trees increase in girth, the need for growth resources increases and, hence, spacing between the trees must increase otherwise growth will slow down. Thinning artificially reduces the number of trees growing in a stand with the aim of hastening the development of the remainder. The goal of thinning is to control the amount and distribution of available growing space. By altering stand density, farmers can influence the growth, quality, and health of residual trees. It also provides an opportunity to capture mortality and to cull the commercially less desirable, usually smaller and malformed trees. Thinning should be done starting with diseased, stunted and poor-form trees at Year 7, and at Year 10 to retain a stand density of 200 trees ha for woodlots. For dispersed inter-planting, thinning will be done once at Year 10 to leave a density of 100 years for remainder of the rotation period. Tree pruning should be practiced to encourage increase in girth of the trees, hence to provide more timber. The first harvest is recommended at Year 15 while the second should be at Year 20.

Pollarding and Root Pruning: Pollarding is cutting the apical meristem of the growing tree to improve lateral growth and branching of the tree. It is suitable to farmers who need shade for their crops like banana, coffee, cocoa, and so on. Pollarding is usually done at Year 6 when the tree has achieved a reasonable height. Some of the species e.g. *Grevillea robusta* regrow well after complete defoliation following pruning and pollarding, which can be carried out repeatedly to yield wood and to regulate shading and competition with adjacent crops. Root pruning can also be done to reduce root density, and competition for nutrients with the surrounding crops. Surface roots are cut 2m from the tree stem and are used as firewood. Deeper roots and taproots are left for plant's physiological functions.

Data from the field surveys indicated that the prevailing on-farm labour wage for some of these activities was US$ 0.7 per person-day with a person-day being is regarded as 6 hours of work.

Pests and Disease Control
Like any other plant, trees may be attached by pests and disease during growth. For example, *Grevillea robusta* is vulnerable to attack by fungal diseases such as *Corticium salmoniclor*. Fungi such as *Amphichaeta grevilleae*, *Cercospora spp*. and *Phyllostica spp*. have been observed to cause considerable damage to leaves and stems of young *G. robusta* plants particularly if they are overwatered in the nursery. Attack by termites is also a problem when planted in dry areas, as may be the case for Kasese. Young *Maesopsis eminii* are prone to cankers caused by fungi such as *Fusarium solani*. Farmers are encouraged to use organic pesticides for control for example the use of concoction of urine and ash will deter termites.

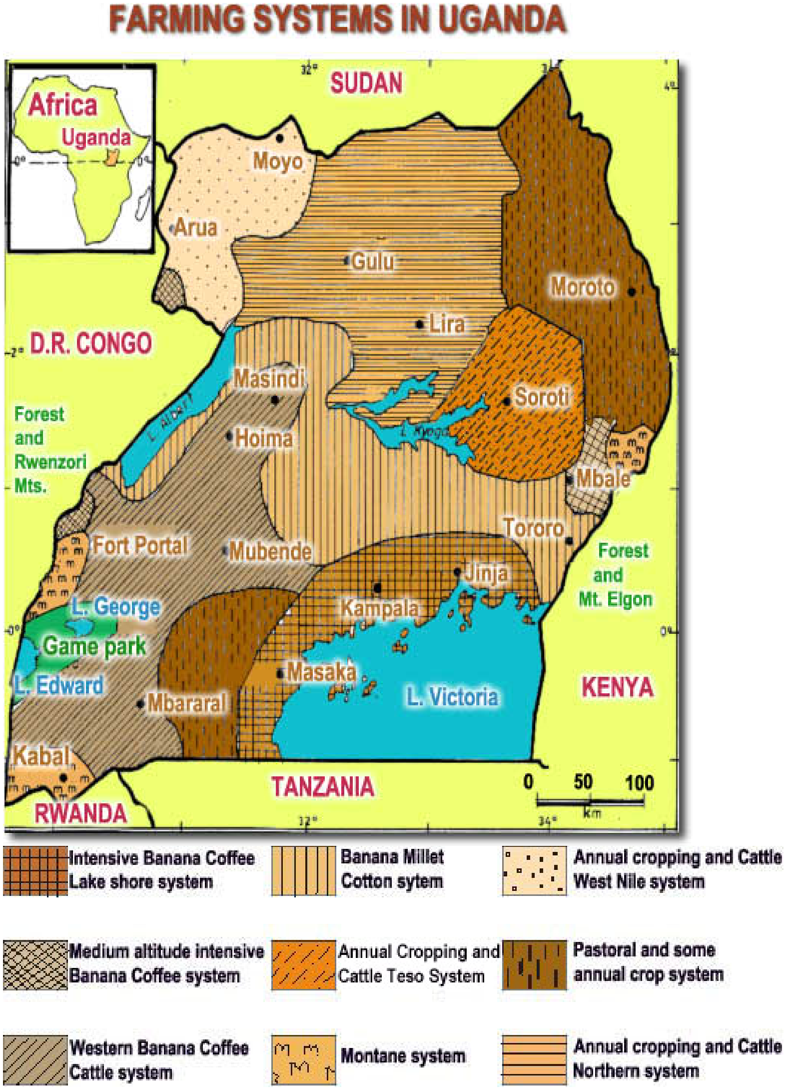
Fire and Drought Management
Fire management is critical woodlots especially after crops harvested. Farmers should consider putting fire-lines while they are lining out before planting. Also farmers can safely guard their gardens by early clean weeding to avoid fires. Trees can be protected from drought by mulching and irrigation.

Applicability Conditions
This technical specification meets all the necessary applicability conditions under the Plan Vivo Standard including baseline conditions, activities and required inputs and ecosystem services benefits.

This technical specification has been designed to be applicable in the coffee-banana agro-ecological zone of Uganda. This zone is also sometimes referred to as agro-ecological zone 1 – High Altitude Areas (National Biomass Study) of Uganda. Uganda has seven major agro-ecological zones, namely: banana/coffee, banana/millet, montane system, Teso system, Northern system, West Nile system and pastoral system as indicated in Figure 1. The banana/coffee zone has been used to refer to the two specific farming systems: the Western banana coffee cattle system and Medium altitude intensive banana coffee system of Mt. Elgon region.

Communities wishing to participate in the project activities require proof of land ownership that is consistent with the national legislation of the Government of Uganda. Moreover, participating households willing to plant the trees must have land within the project boundary and must demonstrate that the project activities will not conflict their subsistence activities, mainly agriculture production. The activities described herein are only eligible for smallholder farmers or communities with land where tree planting (woodlot or dispersed inter-planting) is possible. Farmers cannot clear forested land to gain eligibility and they must demonstrate proof of land ownership (in the form of land title, purchase agreement, proof of inheritance, customary ownership or any form of acceptable evidence of land ownership from the local leadership) consistent with the national legislations of the Republic of Uganda.

Figure 1: Map Showing Agro-Ecological Zones of Uganda.



Source: arcgis.com

Additionality and Environmental Integrity

Additionality

Comparison with Normal Practice

Prior to TGB activities, there was very limited tree growing in all project areas with deliberate planting of trees being mainly limited to homesteads and along farm boundaries. Even in hilly areas where trees could provide significant benefits, tree growing along contours is not common, with planting of Elephant Grass the more pronounced practice. Some farmers cite the relatively high labour input required by farmers to dig contour bunds as the other major constraint preventing wide use of this practice. Fruit trees are dominant around homesteads where they double as shade trees. Farmers are quite selective about the tree species they retain on their croplands and farm boundaries. The government of Uganda has enacted a number of laws that promote tree growing for example the Forest Act. The government of Uganda, through the Department of Natural Resources at local governments has tried to promote tree growing among communities. However, given the small budget allocations, these activities are very limited in spatial and temporal scale. The very scattered attempts at tree planting have indicated a clear preference among farmers, for fast growing exotics e.g. *Eucalyptus spp.* and *Pinus spp.* It is very unlikely that smallholders will invest in long-term tree planting without this project's intervention.

Loss of Ecosystem Services

This agro-ecological zone (like most zones in Uganda) has experienced noticeable reduction in tree cover and tree species diversity over the years, largely due to increased demands for agricultural land and fuel wood. The continuous use and expansion of land for agriculture is leading to increased loss of vegetation cover. This leaves the ground bare, causing the soil to get exposed to adverse conditions, thus posing a high risk to loss of soil fertility due to run-off. The consequence is that wildlife habitat will be destructed and agricultural productivity will decline. Loss of essential ecosystem services such as provisioning, supporting and regulating will lead to a decline in the quality of life for the communities. Floods and landslide risks are a significant threat to local agricultural livelihoods in this agro-ecological zone particularly in the Mt. Rwenzori and Mt. Elgon landscapes.

Barrier Analysis

The long gestation period of tree enterprises was often cited as a key disincentive for farmers to invest in tree-growing activities (especially indigenous species). In addition, communities lack technical expertise, especially in the production of quality planting materials. This is compounded further by the fact that communities lack disposable income to purchase seedlings as well as to afford extension services from technical experts. Carbon payments present an opportunity for farmers to diversify production strategies by offsetting some of the short-term costs, thus rendering investment in tree growing more attractive. Furthermore, the integration of native trees into agricultural landscapes can have very significant ancillary benefits to the farmers, a fact that the project will have to highlight. In addition, the project will provide the required technical support and training especially in sourcing quality seed and technical skills in collection and handling of the seed to raise good quality seedlings.

After the commercial nurseries have been established, the farmers are then further supported with credit to purchase seedlings and this advance is subtracted from their first payment. Table 3 gives a summary of the barriers that exist and how they are going to be addressed by the project.

Table 3 Barrier Analysis

Barrier	Why barrier exists	Action
Inadequate funding	The government is not putting in much effort to fund a forestation programme and yet the income levels of the communities is low and may not afford the start-up capital	Access to carbon credits will enable financing for the essential requirements of seeds, seedlings, labour requirements, materials and equipment etc.
Inadequate technical expertise	The communities are not skilled, with few experts of forestry in the region. Moreover, the communities are generally too poor to afford hiring of technical expertise	Increase capacity of project participants by engaging the district technical staff to undertake trainings
Inadequate land for project activities	There is a high population density in the project area causing land scarcity and fragmentation	The land use planning approach aims at supporting optimum land utilization A number of land-use options that minimize competitions with crops have been provided appropriate for each household landholding.

Figure 2 shows the land currently under small-scale agriculture accounts for 83% of the total land areas, in the pilot districts of Mt. Elgon and suitable for activities in this technical specification. Table 4 shows the areas under different land uses in the project area. Interventions on the small-scale farmland (the largest area) will impact on adjacent forest areas.

Project Period

This is a long-term project with ex-ante carbon credits, which are calculated over a 25-year period and with payments made over the 15 years of the project from the establishment of any of the planting systems. The payments are made ex-ante mainly to motivate the farmers to grow the trees by providing the required financial and technical resources. Ex-ante payments also enable the farmer to meet their short-term cash and livelihood needs, making it possible to put land aside for tree planting for long-term benefits from materials and income that can be enjoyed in the future. It is anticipated that by Year 10, the farmers would have started benefiting from the thinning (which provides building poles for sale), leaves (which provide fodder) and pruning (which provides fuelwood). The application of this technical specification started in 2012 and is expected to continue until 2037.

Table 5 summarises the crediting period for the technical specification.

Figure 2 Land Use/Land Cover 2005

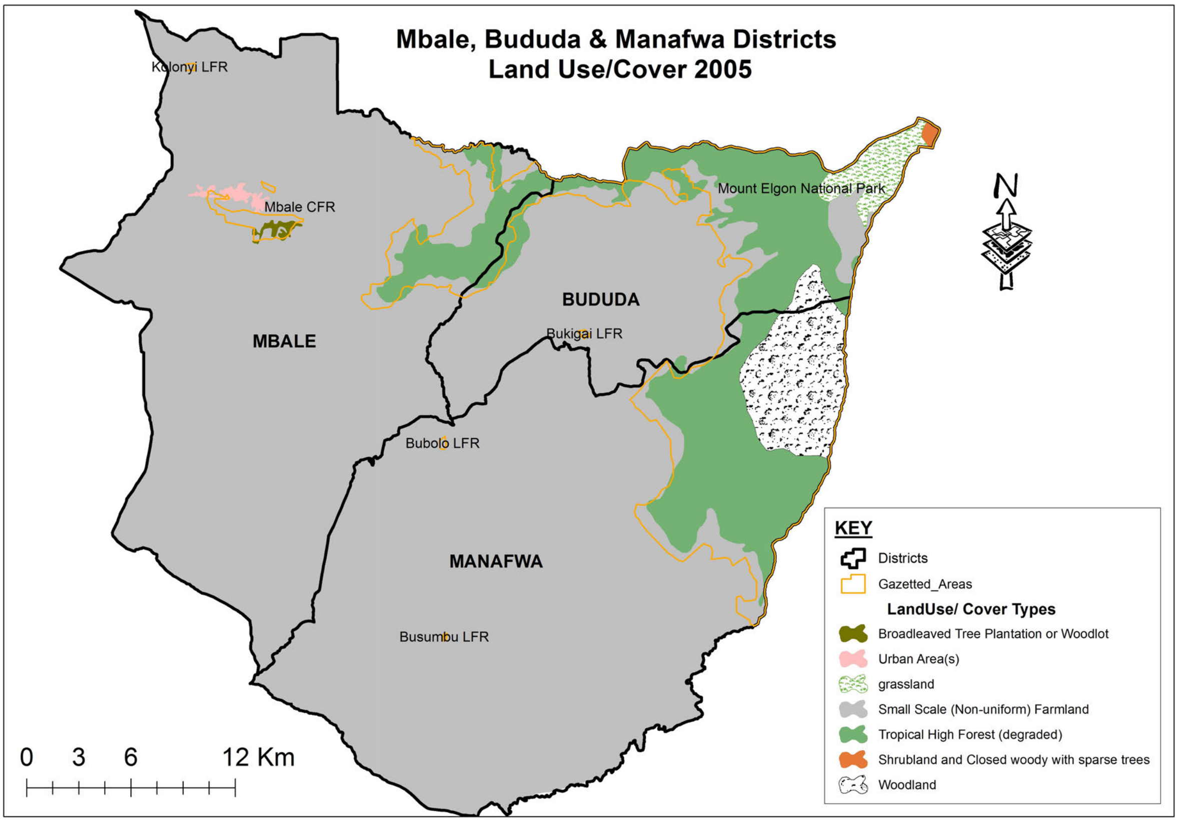


Table 4 Vegetation Classification and Area 2005

Vegetation type/Land Cover Classification-LCC	Area (ha)
Broad leaved tree plantation	150
Urban areas	259
Grassland	1,519
Small scale farmland-non-uniform	113,441
THF-Degraded	16,518
Shrub-land and closed woody vegetation	99
Woodland	4,591

Table 5 Summary of the Crediting Period for Interventions under this Technical Spec.

Intervention	Activities	Crediting Period
Boundary Planting with *mixed native species*	Involves planting of *Grevillea robusta and Maesopsis eminii* along the farm boundary. Rotation period is 25 years	25 years
Dispersed inter-cropping with *mixed native species*	Involves planting of various mixed native *tree species including Maesopsis, Grevillea, Cordia, Premna & Albizia* mixed with crops***:*** Rotation period is 25 to 50 years	25 years
Woodlot *of mixed native species*	Involves planting woodlots of various mixed native *trees species* e.g. *Maesopsis, Grevillea, Fantumia, Croton****:*** Rotation period is 25 to 50 years	25 years

Baseline Scenario

Carbon Pools

The carbon pools that were considered in this carbon assessment and their sources are shown in Table 6. Other pools such as soil carbon were not considered due to variability in spatial soil organic carbon as well as the costs involved in measuring and monitoring.

Table 6 Carbon Pools

Carbon pool	Factors used in the calculation	Source of information
Above ground biomass	Stem growth	Field measurements
	Tree wood density	African tree wood density database
	Carbon fraction	IPCC default values
Below ground biomass		IPCC default values for shoot to root ratios

Baseline Methodology

Data Sources

No publicised tree growth data were available to calculate the carbon sink potential of the project activities, nor is it possible to measure every tree in the project area to determine the carbon baseline. Consequently, project has relied heavily on the information in the National Biomass Study (NBS) exploratory inventory covering the whole of Uganda with systematic sampling at a 5km by 10km grid, coupled with ground truthing in selected sample sites in two (Kasese, Bushenyi & Mt. Elgon) project sites within the agro-ecological zone. In addition, the project referenced with the State of Environment Report produced by the National Environment Management Authority (NEMA 2008). The NBS project was created in 1989 to collect data on biomass resource in Uganda that will be used for planning and sustainable management and use. This was premised on the fact that was/is increasing human population that was exerting pressure on the surrounding land cover through deforestation and forest degradation. Using standard methods, this study generated information on biomass density and standing stock, growth and dynamics among others.

Ground-truthing

The ground-truthing in Mbale involved conducting a biomass survey. Stratified random sampling was used to establish 20x20 m and 50x50m plots for plantations and non-plantations respectively. These plots were systematically placed at 200m intervals in each of the planting systems. The plot reference point was positioned at the South-western corner were the plot distance was measured in the North and eastern directions. A transect was established and straightness was maintained using a compass. All plots established were geo-referenced with Global Positioning System instrument and mapped. In total, the information was generated from 156 plots in Mbale. In Bushenyi, ground-truthing was based on the 135 farmers that had applied to join the project by 2005. This was combined with general observation of the project area using the allometric equation as derived from the National Biomass report for Uganda, 2003.

Estimating the Average Carbon Stock Per Hectare

There are various methods for calculating carbon stock. We adopted a regression model method as used by the National Biomass study for Uganda, 2003, taking into account suggestions made by Knut 1997 to estimate the average carbon stock per hectare and this was done as follows: The results obtained from each plot were determined and standardized to a hectare using an Expansion Factor (EF). EF is obtained by dividing Area of 1ha (10,000m^2)/area of sub-plot in m^2. Using the allometric equation developed by the National Biomass Study (NBS 2003), the above ground biomass was calculated. The general equation for tree size dependent equation is as follows:

ln (PWF) = a + b*ln (D) + c*ln (HT) + d*ln(CR)
Where: ln = natural logarithm
PWF = predicted wet weight of tree
D = diameter at breast height
HT = tree height (from the ground)
CR = crown width

In this equation, constants a, b, c and d are different for two diameter class levels of below 20 cm, and between 20cm and 60cm.

The expansion factor multiplied by the total calculated biomass of trees on the sample sub-plot gave an estimate of the aggregate of all the trees on the hectare of land.

Below Ground Biomass (BGB) was estimated by multiplying the Above Ground Biomass (AGB) by a constant1 (it is estimated that 25% of AGB is root biomass).

Total tree biomass (TB) was calculated by adding Below Ground Biomass to the Above Ground Biomass.

The total tree biomass was converted to total carbon by multiplying the total biomass by the carbon fraction using the IPCC default value (IPCC 2006) as follows: TC = 0.46* TB
For sample plots located on slope > 10%, the slope was measured. The correction was made using the formula: $L = Ls * \cos S$, *where* L is the true horizontal plot radius, $Ls$is the standard radius measured along the slope, S is the slope in degrees, and cos is the cosine of the angle.

Tree Crown Width **(**the distance on the ground covered by the crown of a tree) is another key variable and we used a distance-tape for which the readings were made to the nearest meter. Generally, trees were of irregular crown shapes, therefore, two diagonal readings were taken and the average mean recorded as the crown width. In addition to measuring of tree parameters, other characteristics such as spacing, tree species, and physical status of the trees e.g. those with broken crown, crooked stem etc. were noted. This is because some of these parameters play an important role in determining the growth rates of the trees, hence their total biomass at specific ages.

Baseline carbon stock was estimated based on the on-farm carbon stand in this area and it was based on the farmland of all the farmers that had applied (156 plot in Mbale and 135 in Bushenyi). In each plot tree parameters were measured to obtain single tree weights. These included: diameter at breast height (dbh), bole & tree heights and crown diameter/width. The parameters were used to obtain single tree weights as well as of standing stock of biomass per ha, and ultimately quantification of the total standing biomass stock for the surveyed area. The carbon pools measured as part of the ground-truthing of the baseline carbon stock have mainly included Above Ground Biomass, mainly tree with stems >5cm dbh. However, an IPCC default value was used to determine the root biomass (IPCC 2006). The assessment did not include baseline carbon stocks in leaf litter, dead wood, non-tree vegetation and soil.

Baseline Carbon Stock

During the biomass assessments, farms in Bushenyi especially Kanyabwanga were almost devoid of vegetation. Bitereko, Kichwamba and Ryeru had some trees on farm mainly in pasture land and as boundary markers. These findings are consistent with the information generated by the NBS, which puts the on farm average biomass for Agro-ecological zone 1, i.e. High altitude areas to between 4.8 and 12 tons of air dry weight per ha translating into between 2.4 to 6tons of Carbon. The NBS further gives the average on-farm tree biomass stock in Bushenyi as 5 tones (air-dry) per hectare, which translates to approximately 2.5 tC/ha (NBS data base 1995-1999).

The ground truthing for Mt. Elgon on the other hand gave the standing carbon stocks to be 4.5tC/ha. The mean, Mini, Mode and medium carbon and carbon dioxide values for the Mt. Elgon region are shown in Table 7.[2]

Table 7 Mean, Minimum, Median and Modal Baseline Values

	tonnes in 50 by 50 m plot		**tonnes per ha**	
	Total carbon	**Total CO_2**	**C per ha**	**CO_2 per ha**
Mean	1.14	4.17	4.55	16.68
Min	0.00	0.01	0.01	0.044
Median	0.47	1.74	1.90	6.96
Mode	0.79	2.89	3.15	11.56

Baseline Project Scenario

To predict the without-project scenario, the project conducted an assessment of vegetation changes over time using arc view to generate land-use maps over the years in one of the project sites. Land use/cover was delineated to estimate changes between the years 1996, 2000 and 2005. The overall percentage land-use change in Mt. Elgon for the 10-year period, from 1996 to 2005 is shown in Table 8 while the forest cover change in Hoima-Masindi is in Table 9.

[2] Raw data and calculations for the mean, Mini, Mode and medium carbon as well as carbon dioxide values for Mt. Elgon are available on request. Please, contact the Plan Vivo Secretariat.

Table 8 Mt. Elgon Change in Vegetation over 10 Year Period (1996-2005)

Vegetation type-Land Cover Classification	Area (ha) 1996	Area (ha) 2005	Change (ha)	% Change
Broad leaved tree plantation	253	150	(103)	(41)
Grassland	5,413	1,519	(3,894)	(72)
Small scale farmland-non-uniform	103,534	113,441	9,906	10
Woodland	12,402	4,591	(7,811)	(63)

Source: *Analysis of Landsat images*

Table 9 Forest Cover Change in Masindi & Hoima Districts 1990-2005

District	1990 Forest Cover (ha)	2005 Forest Cover (ha)	2005 forest Area outside Pas	Annual Change (%)	Annual Forest area Change (ha)	Maximum Annual Change outside PAs (%)
Hoima	75.14	58.89	23.14	-1.44%	-1.08	-2.75%
Masindi	36.37	31.93	2.48	-0.81%	-296	-4.28%
Total	**111.52**	**90.82**	**25.62**	**-1.23%**	**-7.13**	**-3.58%**

Source: Adapted from NEMA 2008

The analysis shows that there has been a noticeable decline in the tree cover in the Mt. Elgon area with a loss of 41%, 72% and 63% in broad-leaved tree plantations, grassland and woodland respectively in Mt Elgon in the ten years. In addition, land under agriculture in the same region, has increased by 9,906 ha. This is slightly less than the land lost from woodland and grassland over the same period.

The land cover/land use change analysis for Hoima and Masindi based on information from the National Environment Management Authority shows similar trends with an annual loss of 2.75% and 4.28% outside the protected areas in Hoima and Masindi. The primary proximate drivers of deforestation over the past years have been conversion to small and medium-scale agriculture for commercial production and small-scale subsistence farming. Among commercial uses, in Masindi District the expansion of sugar cane plantations in particular has consumed large areas of forest. In Hoima, tobacco plantations have played a similar role.

With the increasing population resulting in a search for more land for agricultural activities and settlement, the current trend is likely to continue. Moreover, except for the Farm Income Enhancement and Forest Conservation (FIEFOC) project, promoting *Eucalyptus grandis* and *Pinus caribaea,* there is no known major intervention expected to promote tree planting in the project area. Since the FIEFOC ended, it is very unlikely that smallholders will invest in long-term tree planning without the project's intervention.

Baseline Carbon Emissions

The project is targeting tree planting on pieces of land that are currently almost devoid of trees. For each individual farm application, any area that is already tree covered will be left out of the project. Although the project only recruits land that has no trees, and although farms in some of the project sites are almost devoid of trees, the project has applied the average baseline carbon figure of **4.55tC/ha**, which is the average value calculated from the sites with the highest biomass within the project area (Mt. Elgon). The figure of 4.55 tC/ha is consistent with the NBS, which puts the on-farm average biomass for Agro-ecological zone 1, i.e. High altitude areas, as between 4.8 and 12 tonnes of air dry weight per ha translating into 2.4 to 6 tonnes of carbon/ha. The NBS also gives the average on farm tree biomass stock in Bushenyi as 5 tonnes (air-dry) per ha which translates to approximately 2.5 tonnes carbon per ha (NBS data base 1995-1999). Furthermore, the project has assumed a static baseline scenario even though there is no indication that farmers were planning to increase or introduce the number of trees on farm. These assumptions in the calculations of baseline carbon stock and baseline emissions will therefore contribute to conservative calculations of carbon sequestration rates for the with-project scenario.

Ecosystem Service Benefits

Current Biodiversity Status

The Mount Elgon area is an ecologically valuable region in light of its ecological goods and services that include food, water, wood, fuel, nutrient recycling and climate amelioration. The Mt. Elgon caldera has small lakes and moraine ridges, which are indicative of glaciations that occurred about 1.5 m years ago. These subsequently cut low through the caldera as the melting waters heat at the streambeds of the weak volcanic ash, giving rise to various physical features e.g. the caldera. The key values of the region are its natural heritage, biodiversity, water catchment, agricultural base and tourism. It is in light of these that Mount Elgon is being considered for nomination under the World Convention on Heritage Sites (Lake Victoria Basin Commission, 2009). In addition, the region contains habitats that support unique and diverse fauna and flora and it is home to many rare species of extreme conservation importance. The world conservation union (IUCN) has listed 37 fauna species in the area as globally threatened (i.e. 22 mammals, 2 insects and 13 bird species) of which 9 species are endemic (IUCN, 1995). Owing to the rarity of some of its bird species, the region has been given the status of an Important Bird Area (IBA). It is also one of very few locations worldwide, where the Elgon Teak (*Oleacapensis*) is found.

The Albertine Rift forms the epicentre of Africa’s montane rainforest with exceptional faunal and moderate floral endemism. These mountains also support the Mountain gorilla (*Gorilla beringei*), which is one of the most charismatic flagship species in Africa, and an effective target for much of the current conservation investment in the area. There are a number of National Parks and Forest Reserves in this rift, providing the local communities with a lot of ecosystem services similar to those in the Mount Elgon area.

However, both the Mount Elgon area and the Albertine rift are mountainous regions characterized by very high human population density that exert pressure on the remaining forest resources and converting forest areas outside reserves into farmland.

Description of Environmental Benefits

Small-scale production of fuel wood and timber is expected to lead to a reduction of pressure on nearby forest reserves and national parks as well as contributing to habitat restoration and helping communities adapt to climate change. The project area is located in close proximity to several protected areas in the form of forest reserves (e.g. Kasyoha – Kitomi, Kalinzu, and Maramagambo in Bushenyi, Bugoma in Hoima and Budongo in Masindi) and as communal forests, which are the main source of hard wood timber in Uganda. These forests are under tremendous degradation pressure due to the over exploitation of their resources. It is therefore intended that increasing tree cover in this area will contribute to relieving pressure on these forests and thus to improving their conservation.

The project area is of international conservation significance with several Important Bird Areas, Man and Biosphere reserves, World Heritage Site and so on. Conservation of these mostly riverine forests therefore contributes to the maintenance of their several ecological functions (e.g. carbon sequestration, biodiversity, watershed etc.). As a result of their position in the landscape, riverine forests play a critical role in the ecosystem, disproportionately large for their sizes in buffering potential impacts on water quality of rivers from disturbance in upland ecosystems and as wildlife corridors that enhance sustenance of species. The targeted forests for example offer protection to many local streams, rivers, and lakes (including two Ramsar sites of Rwenzori Mountains and Lake George) and reduce siltation of major water ways (which in turn protects important lake fisheries). Table 10 outlines the key impacts.

Table 10 Ecosystem and Biodiversity Impacts

Ecosystem & Biodiversity Impacts			
Intervention	***Agroforestry farming system – mixed native and natural tree species***		
Biodiversity	**Water/watersheds**	**Soil productivity/conse rvation**	**Others**
Maintaining connectivity between protected areas (corridors)	Water purification	Reducing soil erosion and sedimentation	Regulation of micro-climate
Conservation of indigenous tree species	Regulating water flow by reducing runoff	Soil stabilisation and soil retention on slopes	Support community-based ecosystem-based adaptation
Restoration, protection and management of degraded and threatened ecosystems	Reduced flood and landslide/mudslide risks		
Improved protection of protected areas by reducing local pressures	Improved wetland conservation and management (Ramsar sites)		

Estimating Tree Growth Rates

The methods used to calculate the growth rates were based on the SHAMBA Model[3] shows the dataset that was used to estimate CAI. This data was generated by the farmers that are currently participating in TGB – therefore it is very location-specific under on-farm conditions. The tree growth assumptions used in the carbon modeling have been based on tree parameters of age, DBH, crop cover and general crop management for boundary

[3] The SHAMBA model is an approach to calculating carbon sequestration rates for small-holder tree planting interventions developed by researchers from the University of Edinburgh. The results of the model calculations are available on request. Please contact the Plan Vivo Secretariat.

planting, dispersed inter-planting and woodlots. The assumption on tree species combinations in the various systems are shown in Table 11. The initial stocking density values as well as survival and thinning regimes are based on current practices that have been used in the modeling.

Table 11 Stocking and Wood Density Assumptions Used in Carbon Modelling

Scientific name	Common name	Wood density (g/cm^3)	Stocking density			Reference for mean growth rate for SHAMBA
			Boundary	Dispersed Inter-planting	Wood -lot	
Grevillea robusta,	Silky Oak, Silver Oak	0.54	40	70	80	Tree inventory of 46 trees in Bushenyi in March 2015 gave rate of 2.4cm/yr at 10 years. See SMSPES DBH data Excel document.
Maesopsis eminii	Maesopsis	0.46	40	50	60	Tree inventory of 38 trees in Bushenyi March 2015 gave rate of 1.8cm/yr at 10 years. See SMSPES DBH data Excel document.
Funtumia		0.45	0	35	40	Tree inventory of 14 trees in Bushenyi March 2015 gave rate of 1.4cm/yr at 10 years. See SMSPES DBH data Excel document.
Croton macrostachyus		0.50	0	35	40	Tree inventory of 19 trees in Bushenyi March 2015 gave rate of 1.6cm/yr at 10 years. See SMSPES DBH data Excel document.
Persea americana	Avocado	0.55	0	5	20	Tree inventory of 2 trees in Bushenyi March 2015 gave rate of 2.1cm/yr at 10 years. Tree inventory of 2 trees in Bushenyi March 2015 gave rate of 2.2cm/yr at 6 years. See SMSPES DBH data Excel document.
Toona serrata	Omunyamazi	0.48	0	15	20	Tree inventory of 17 trees in Bushenyi March 2015 gave rate of 1.2cm/yr at 10 years. See SMSPES DBH data Excel document.
Mangifera indica	Mango	0.55	0	5	12	No growth data from field studies or literature review. Assumed to be similar to other fruit trees. Jackfruit used to be conservative.
Terminalia spp	Umbrella	0.60	0	15	20	Tree inventory of 20 trees in Bushenyi March 2015 gave rate of 2.7cm/yr at 10 years. See SMSPES DBH data Excel document.
Artocarpus	Jackfruit	0.60	0	5	8	Tree inventory of 12 trees in Bushenyi March 2015 gave rate of 1.3cm/yr at 6 years. See SMSPES DBH data Excel document.
Markhamia lutea	Markhamia	0.55	0	15	0	

Cordia millenii	Cordia	0.50	0	15	8	Tree inventory of 4 trees in Bushenyi March 2015 gave rate of 1.9cm/yr at 10 years. See SMSPES DBH data Excel document.
Prunus Africana,	Prunus	0.69	0	30	40	Tree inventory of 24 trees in Bushenyi March 2015 gave rate of 1.4cm/yr at 10 years. See SMSPES DBH data Excel document.
Khaya anthotheca	Mahogany	0.60	0	10	32	Tree inventory of 27 trees in Bushenyi March 2015 gave rate of 1.4cm/yr at 11 years. See SMSPES DBH data Excel document.
Fagara	Omurema Nkobe	0.69	0	10	20	Tree inventory of 18 trees in Bushenyi March 2015 gave rate of 1.2cm/yr at 10 years. See SMSPES DBH data Excel document.
Total			**80**	**310**	**400**	

Stocking, Survival and Thinning Regimes

Farmers are required to plant at least 50% of the trees in the first year and 100% by the second year. It is assumed that at least 20% of the planted trees will die by the third year of planting. In addition, farmers are also required to practice thinning with the intention to attain the management objective. The management model for all systems is summarized in Table 12.

Table 12 Thinning Regimes

Land use system	Species	Activity	Age	Stand density (stems/ha)
Dispersed inter planting	*Grevillea robusta, Maesopsis Premna Cordia & Albizia*	Establishment-initial planting		310
		Thinning 1	7 years	233
		Thinning 2	10 years	210
		1st Harvest	20 years	73
		2nd Harvest	35 years	0
Boundary Planting	50% *Grevillea robusta* and 50% *Maesopsis eminii*	Establishment-initial planting		80
		1st Harvest		
		2nd Harvest		
Woodlot	40% *Maesopsis*, 40% *Grevillea*, 10% *Fantumia*, & 10% Croton	Establishment-initial planting		400
		Thinning 1	7 years	300
		Thinning 2	10 years	270
		1st Harvest	20 years	92
		2nd Harvest	35 years	0

Carbon Benefits

The net carbon benefits for the intervention was estimated using the SHAMBA Model. Although these technical specifications **only consider tree carbon pools**, an assessment of the likely impact of the system on other carbon pools below and above ground was also been conducted using SHAMBA. Table 13 shows the model for the estimated long-term average carbon storage in tCO_2 for the land-use systems covered in this intervention.

Table 13 Mean Long-Term (25 yr) CO_2 Storage Benefits

System	Baseline ($t/CO_2/ha$)	Intervention ($t/CO_2/ha$)	Net benefits ($t/CO_2/ha$)
Boundary planting	47.81	-28.42	-76.23
Woodlot	47.81	-219.10	-266.92
Dispersed inter-planting	47.81	-144.96	-192.78

Separating the different carbon pools to establish the contribution of tree planting to each pool for the three planting systems is shown in Table 14.

Table 14 SHAMBA Estimates for Net Contribution to Different Carbon Pools over 25years

System	Tree contribution net ($t/CO_2/ha$)	Soil contribution net ($t/CO_2/ha$)	Crop contribution net ($t/CO_2/ha$)
Boundary planting	-65.24	-21.60	0.00
Woodlot	-238.80	-38.72	7.95
Dispersed inter-planting	-170.40	-32.98	7.95

The SHAMBA results **focus on the contribution of trees planted only** and therefore assumes that the existing tree biomass on the plots would remain under both the baseline scenario and under the project intervention scenario. In this case, the net difference from existing trees would be zero. However, for purposes of these technical specifications, the project has applied the published baseline for this agro-ecological zone, which has also been confirmed by ground truthing. Table 15 shows the summary of the Net Carbon Benefits for the intervention.

Table 15 Summary of Net Carbon Benefits and Tradeable Carbon for the Intervention

System	Sink (tC/ha)	Baseline (tC/ha)	Net C benefit		Risk Buffer (10%)		Tradeable Carbon	
			tCO_2/ha	tC/ha	tCO_2/ha	tC/ha	tCO_2/ha	tC/ha
Boundary planting	22.33	4.55	65.24	17.78	6.52	1.78	58.72	16.00
Woodlot	69.62	4.55	238.80	65.07	23.88	6.50	214.92	58.56
Dispersed inter-planting	50.98	4.55	170.40	46.43	17.04	4.64	153.36	41.79

The carbon (tC) is converted into carbon dioxide (tCO_2) by multiplying the ratio (3.67) of the molecular weight of CO_2 (44) by that of carbon (12)[4]. The net benefit is the difference between the carbon sink and the calculated baseline and the 10% risk buffer.

[4] 44/12=3.67

Leakage and Uncertainty

Risk of Leakage
Leakage is unintended loss of carbon stocks outside the boundaries of the project resulting directly from project activity. The project is working with smallholders and indeed land shortage is one of the challenges identified to be preventing the setting aside of land exclusively for trees. It is therefore important that activities be planned to minimize the risk of any negative leakage. The main potential source of leakage envisaged in this project is displacement of agricultural activity (small scale for subsistence and commercial purposes). However considering that we have provided options for the different sizes of land holdings, we estimate that the leakage will be very minimal and it has thus been discounted from the calculations of the carbon benefits.

Managing Leakage

The project will work with project participants, supporting them to develop land-use plans, which ensure that the project activities will not conflict their subsistence activities, mainly agriculture production. The recommended species are agroforestry tree species providing optimal conditions for crop growth. Moreover, the technical specifications have been developed to enable optimum utilization of land, expected to result into improved agricultural productivity. Furthermore, the specifications allow for different systems i.e. boundary, woodlot or dispersed inter-planting to cater for different land sizes.

In addition, the project works with participating communities to form communal land associations that develop community level adaptation plans that among other objectives seek to work towards the improved management of pockets of private forest outside the Protected Area System. Through the Communal Land Associations, the communities are supported to maintain boundaries of these forests, ensuring that there is further deforestation in these forests.

The project recognizes that poorly designed carbon schemes may lead to loss of critically important ecosystem services. For example, conversion of forested land (albeit degraded) into large-scale monoculture plantations, could negatively impact watersheds and biodiversity. To prevent this, the project activities under this technical specification are only applicable on farmland currently under crop (mostly annual) production. The cutting down of trees for purposes of planting project trees leads to an automatic disqualification. The recruitment process requires that every applicant’s land is inspected to ensure that there is sufficient land for tree planting. Figure 2 (page 15) shows the land currently under small-scale agriculture accounts for 83% of the total land areas, in the pilot districts of Mt. Elgon and suitable for activities in these technical specifications.

The project also recognizes that there may be several other tree planting initiatives and would not want to claim the efforts of these interventions. However, most of these initiatives support the growing of exotic tree species such as Pine and Eucalyptus. Moreover in these situations support does not usually go beyond provision of seedlings.

To protect against the selling of carbon credits by farmers under this technical specification, the project engages with stakeholders at local government level to inform them of the project activities and boundary. Table 16 highlights of potential leakage risks and describes how the project will address them.

Table 16 Assessment of Leakage

Leakage risks	Level of risk	Management measures
Displacement of small scale subsistence agricultural activity	Low	Each farmer will develop a land-use plan demonstrating that s/he is not going to displace agricultural activities Each farmer will include improved agricultural productivity as one of the management objectives for tree planting Periodic land cover surveys and analysis using satellite imagery to see if there has been any leakage Various land use options depending on the landholding of each household Monitoring farmers' *plan vivos* to ensure adherence to the plan Continuous community sensitization to ensure there is no displacement of agricultural activity
Raising opportunity costs due Commercial Agriculture	Medium	Empowering smallholders to have control over their land through security of land and tree tenure as well as access to sustainable markets for tree – based enterprises. Making tree planting more lucrative through the carbon payments and access to markets Raising community awareness to role of environmental services to their own livelihoods
Carbon emissions resulting from project management and travel during monitoring activities	Low	Generally, this is expected to be negligible since farmer recruitment, capacity building and monitoring are conducted cooperatively.

Monitoring Leakage

The expansion of their agricultural lands (the main threat to leakage), both for subsistence and commercial production (e.g. tobacco), by communities is limited to the forests on their property, and they do not usually colonize or exploit lands elsewhere. The project will ensure that no land that has evidence of tree cutting in the last ten years will be recruited into the project. The farmers will be required to develop a *plan vivo*, which, amongst other things, indicate the area where trees exist on land prior to project intervention. Farmers will be monitored to ensure that they are not cutting down tree for purposes of shifting agricultural activities due the project intervention.

H Risk Management

The project employs a multi-pronged risk management approach that combines measures for risk assessment, risk mitigation through the implementation of best practices, risk avoidance and risk transference through a buffer of unsold carbon as well as a financial buffer. This section describes the risks and the measures taken by the project to minimise and/or mitigate them.

Identification of Risk Areas

Risks to Permanence

The main risks to permanence faced by the project include pests and diseases, fires, natural disasters such as floods and drought as well as raising land opportunity costs. To minimize these risks, the project will invest in building the capacity of the participants through training in general agroforestry practices. In the event that some farmers have been disproportionately affected by natural disasters (e.g. floods), the project will use the Carbon Community Fund to support replacement of their lost trees. The Carbon Community Fund has been established as a self-managed risk fund to guard against loss due to natural disasters. Table 18 describes the risks to permanence in more detail and outlines the measures taken for each to manage them.

Risk Management Measures

Capacity-Building

The project implements a technical assistance and outreach package that combines the training of farmers in seedling handling, fire and pest management practices. This capacity building focuses on transforming the farmers' investment horizons by using part of their land to develop assets (trees) that not only provide short-term cash and needed livelihood inputs, but also long-term benefits from materials and income that can be enjoyed in the future. Coupled with careful selection of tree species that suit local conditions, this capacity building helps the management of risks to non-permanence. In addition, the project builds capacity for farmers to develop strategies that will reduce on the labour demands. For example, farmers are encouraged to grow food crops on the same piece of land with trees, so that during the early years when the trees require weeding, the same labour used to weed the trees is the same for weeding other crops.

Tree Planting as a Livelihoods Strategy

As a long-term forestation/reforestation project, long-term risk management is incorporated throughout the life span of the project. Participation by the producers and later on their successors throughout the life of the project is critical for the project's success. The project employs a number of risk management strategies that include consultations with local communities to design activities in order to fit into and enhance the existing livelihood strategies. The project intervention covered in this technical specification is designed around making tree planting a viable livelihood option and around promoting trees that are well adapted to both the local environment and local livelihood strategies. The structure of payments allows farmers to meet their short term needs while the multiple objectives allow the farmers to enjoy medium term benefits in form of honey, fruits, medicinal extracts, fuelwood from pruning, fodder for animals and the building of poles from thinning. Moreover, adapting the technical specification to people's livelihoods will ensure that the interventions can be implemented with the minimal levels of skill that is available at household level.

Whole Household, Whole Community Approach
The project is based on both a community and a household approach for the recruitment of farmers and for benefit-sharing. For example, the project is introduced as part of a collaborative forest management process in which the entire community is consulted during the design of the project activities. This ensures that the project activities fit into the overall development plan of the area. At household level, the project demands that both spouses and some of the older sons and daughters participate in the land-use planning as well as to the project capacity building activities. The relationship between the project and achievement of household needs (of food security, fuel wood, income etc.) is emphasized during the project's awareness activities. This ensures ownership of the project by the whole household, contributing to the integration of tree planting as a livelihood strategy. There have been incidences where the original applicant has passed on and the project activities have been consequently transferred to the surviving members of the family. In addition, the farmers are allowed to sell the land under the project. However, it is made very clear in the contract and in the awareness meetings that the contract is with the land. Transferring land rights automatically transfers the carbon rights and obligations. The awareness meetings target the entire community to include both participating and non-participating farmers.

Sustainability of the Project Co-ordinator
ECOTRUST, the project coordinator, is a well-established and financially stable Ugandan Environmental Trust, established with the goal to "*Provide long-term sustained funding for the conservation of biodiversity and environmental management in Uganda*". ECOTRUST has, over the years, established a very valuable niche in conservation finance supporting natural resource management initiatives countrywide and has a proved long history of effective project and programme management. ECOTRUST is actively involved in collaborative forest management with the project at grass roots level. This enables it to be closely involved with farmer recruitment, capacity building, monitoring and delivery of performance-based payments.

ECOTRUST's corporate governance structures are well established with a dedicated highly technical secretariat supervised by a committed nine-member Board of Trustees selected from among Uganda's most respected conservationists from different walks of lives. The Executive Director heads the secretariat with support from skilled technical advisers and associated professional consultants on short and medium - term assignments. Guided by its mission, ECOTRUST strives to combine the conservation of natural resources and livelihoods improvement. The organisation has established an Endowment Fund, to enable it to support conservation activities in perpetuity and to hire and retain a team of highly motivated staff having the diversity of technical expertise required by the project. This will ensure continued existence of the project.

The project has also established two specific funds within its Endowment Fund structure, with a specific focus on supporting the initiatives promoted under these technical specifications. These are (i) Carbon Community Fund and (ii) PES Fund. The Carbon Community Fund supports the provision of climate services, while the PES fund supports other environmental services especially those that related to Ecosystem-based adaptation to climate change. These funds are intended to guard against market failure.

Community Carbon Fund
The project has established a Carbon Community Fund (CCF), which is a self-managed risk fund to replace lost carbon and is directly financed by cash derived from the sales of carbon credits generated by the project. More specifically, the project withholds 10% of the cash due

to each participating farmer and transfers it to the CCF so that, effectively, the risk of non-delivery is minimised by being spread across several thousands of project participants.

The CCF has two main functions:

- To serve as a community-based support mechanism established by TGB to address the risk of non-delivery of carbon benefits associated with the project activities
- To share the benefits generated by the sales of carbon credits with the wider community by providing grants for community projects

In practice, 70% of the 10% contributed by all farmers to the CCF supports any replacement of lost carbon due to external threats (drought, floods, pests or fire) that have destroyed the plots where the trees have been planted. CCF (which has been active since 2010) provides farmers with new seedlings at no extra cost in order to make up for the loss carbon that they have incurred. The CCF never gives cash directly to the famers, but rather it focuses on providing them with the means to replace the lost carbon.

Similarly, the CCF deals with the occurrences of reallocation - that is when ex-ante carbon is reallocated from one farmer who has exited the project to a new farmer who will then be able to compensate for the lost carbon. For example, if a specific farmer exits the project because he/she has not managed the plots correctly or because of external factors such as land disputes or landslides, new farmers will be given seedlings paid by the CCF in order to compensate for the gap in carbon incurred by the project. The new farmers will be specifically recruited by the CCF for that purpose.

As a consequence, thanks to the CCF, the project is able to internally address the risk of non-delivery organically and efficiently so as to be able to sustain natural (fire, droughts, flood) and external risks (e.g. land disputes) associated with the project activities.

The remaining 30% of the 10% withheld by the CCF is used to fund community-based projects such as the building of a school, roads, tree nurseries and so on. These funds are considered grants and the each project is decided by participating farmers in a participatory manner. This allows the project to share the benefits generated by the sales of carbon credits with the wider community, even those not directly involved in the project.

Performance-Based Payments

Although awareness raising and capacity building are done cooperatively, each farmer will be rewarded according to their individual performance. The payment at each stage will be tagged to attainment of the agreed milestone. This will motivate farmers to take good care of their trees. A breakdown of the payments and how they relate to performance is provided in Table 21. The skill level required coupled with multiple incentives for farmer participation as well as strict rules to govern the performance payments, increases survival of the trees.

Risk Avoidance

The project avoids the inclusion of high risk sites such as those with unclear tenure or those that are known to be prone to natural disasters such as landslides, seasonal floods etc. The technical specifications are applied to private smallholdings, where the farmers have clear tenure, in accordance with Uganda's the Land Act. The project uses locally acceptable means of verification using for instance purchase agreements, land titles or letters from clan heads. The local leaders that usually witness these land transactions are part of the verification process as they will be required to give their approval on land ownership.

Risk Buffer

It is anticipated that there may be external risks that are not within the producers' control that may affect the performance of the project. In order to account for such externalities, a combination of a pool of unsold carbon that has been included in the carbon benefits calculations and set aside as a risk buffer with a self-managed risk fund (CCF) has been envisioned for this project.

The risk buffer allows for the insurance of project activities against such risks. According to the risk assessment (Table 17) the project has a risk for this intervention equivalent to a score of 10% and therefore a risk buffer of 10% of unsold carbon is proposed. In addition, the Community Carbon Fund (Page 28) acts as reserve funds representing a further 10% of the value of sold Plan Vivo Certificates to account for internal risks that can be managed by the project.

Table 17 Risks to Permanence, Risk Mitigation Measures and Risk Score

Risk type	Description	Management & Mitigation Measures	Severity (impact after management)	Score
Environmental Risks: Risk level = low				
Fire incidences	Fire is a key threat to tree planting. Slash and burn practices are conducted mainly on the sugarcane farms as well as by encroachers in protected areas but rarely on the smallholdings, which are used predominantly for food production. In addition, controlled fires are applied as a management tool in savannah national parks. Some of the communities in the Masindi and in Rubirizi live in close proximity to sugar farms, and savannah National Parks respectively.	One of the objectives of the project is to reduce threats to deforestation and forest degradation. Joining the project is a form of reward for the reduction in forest encroachment and thus reduction in forest fires. The project trains farmers in fire management techniques such as the use of fire lines, planting of fire resistant trees on the perimeter of *plan vivos* so as to minimise the extent of destruction. The food crops intercropped within the tree farms also form fire lines for scattered smallholdings. In addition, the project has a Carbon Community Fund, which is a self-managed risk fund used to support farmers affected by fires with the aim of providing seedlings to replace the lost trees.	TGB is now in its 10th year of operations and, on average, less than ten (10) farmers a year typically claim support to replace lost trees due to fire. Probability of this threat after management is therefore low.	0.05
Land and mudslides	Participating communities in one of the Bududa District are prone to landslides. These landslides take place during extreme weather conditions, which are now occurring more frequently than in the past. While no landslide has yet to affect the farmers involved in this project, it is likely that a landslide might take place every 2 to 3 years. The Government has been trying to relocate farmers living the most landslide-prone areas.	Planting trees will only take place in less fragile sites (which have been not earmarked for relocation), where trees are planted as a soil stabilisation management action, making the communities less prone to the landslides. If the risk potential increases, these sites will be eliminated from the project, but tree-planting activities in these sites will continue with the support from the Carbon Community	The likelihood of the occurrence of landslides still exists and its impact will be severe for those few affected farmers. However, considering the small percentage of people likely to be affected, the cautious approach taken by the project make this a low risk	0.10

		Fund as an adaptation strategy. The lost farms will be replaced with other farms from less prone areas, thus replacing the lost carbon.		
Pests and diseases	Pests and diseases are consistently present on tree farms. The main threat this project has experienced in its 12 years of operations has been the die back due to viral infections and termites. However, farmers are supported in the assessment and selection of quality seeds and seedlings that can resist insect/pest attack. This specific threat can generally been observed in only about 10 out of the 2,000 or so farms monitored per year.	The planting of indigenous trees adapted to local conditions coupled with the application of proper silvicultural practices in pruning, applications of local organic concoctions as well as the planting of mixed native species has assisted in containing this threat.	Experience acquired over ten years of growing-trees activities among these communities suggests that the impact of pests and diseases on the project is very low.	0.05
Drought	With changing weather patterns, the threat of drought is likely especially in the long-term. In fact, the planting of trees on farms is partly a strategy to make these farms more resilient to extreme conditions such as drought, by improving soil water retention.	Farmers are required to plant trees at the beginning of the rainy season to maximise benefits of the rains. The project ensures that all the training, recruitment, nursery and field preparations take place well before the rains. In addition, performance-based payments require the farmers to replant the trees affected by drought. Farmers use year 2 as a gap-filling year and, if they do not achieve the 80% survival rate by the third year as indicated in the technical specifications, they are not paid. The Community Carbon Fund (CCF) is also available to support farmers that may be disproportionately affected by prolonged droughts.	The real data used in the estimates includes information collected directly from farmers - some of whom have been occasionally affected by drought. The effect of drought is therefore included in the model and its associated risk is medium.	0.10
Floods	A very limited fraction of the project sites (parts of Rwenzori) is occasionally affected by floods. This is usually caused by excessive rainfall that causes River Nyamwamba to overflow and to destroy entire plots.	The Community Carbon Fund (CCF) is also available to support farmers that may be disproportionately affected by floods. Sometimes however, the land becomes filled with debris (rocks) after the floods, making it impossible to replant the lost trees. In this case, alternative land is recruited to replace the lost carbon using the CCF.	The likelihood of occurrence still exists and impact will be severe to those few affected farmers. However, considering the small percentage of people likely to be affected, the ability of the project to replace the lost carbon using the CCF makes this a low risk.	0.10
Socio – Economic Risks: Risk Level = Low				
Social unrest	Since this is a land use project, failure to include people with small landholdings may widen the gap between the participating and non-participating farmers, therefore causing friction among community members.	The management activities are designed through an inclusive process that ensures that all community members are informed and consulted to incorporate their views. Technical specifications have been designed to accommodate even those with the smallest of land. The project also involves members of participating communities that are landless in other income generating activities e.g. nursery activities	Very low risk.	0.05

		casual labour (slashing, weeding of fire lines, boundary maintenance etc.). Additional land is also available in the deforested areas within the Forest Reserves and has been allocated to landless households under the Collaborative Forest Management. The CCF also supports projects that benefit the entire community e.g. the building of bridges on roads, the support to community schools and health centres, improving access to clean water.		
Raising opportunity costs	The improved forest management is likely to result in reduced resource use activities, which may lead to loss of livelihoods. Other opportunity costs may be the reduced support from donors and aid agencies due to income from PES.	The project seeks to integrate tree planting as a livelihood strategy complimentary to other land use options. A financial analysis of project interventions shows that carbon payments and the multiple short, medium and long-term benefits enable tree planting to compete favourably. TGB actively mobilises support from other development partners by raising the visibility of participating communities. In addition to the payments to producers, the project is designed to incentivise highly valued products in the form of fuelwood and timber.	Project interventions raise income opportunities and allow tree planting to be a viable livelihood venture competing favourably with other options. The risk associated with opportunity costs is therefore low.	0.05
Financial / Economic Risks: Risk Level = Low				
Failure to Match Supply with Demand	It takes a year to generate a carbon credit as described in the project's technical specifications. It is not easy to forecast how farmers are going to respond to the recruitment in a given year or how favourable the rains are going to be.	The performance of the first planting season, which is in March before any buyer's contract is signed, gives an indication on how good the overall performance that year is likely to be. The project will only accept purchases that are likely to be met. In addition, the project has established a revolving fund that is used to purchase some of the credits from farmers in advance of finding buyers. This has enabled the project to match supply with demand.	Low risk.	0.05
Weaknesses in Financial Systems	Farmer payments are done through savings and loans associations. These are institutions governed by farmers and any weakness in the governance structure is likely to affect the farmers' payments.	As part of financial benefit sharing of the project, farmers are trained in the identification of credible SACCOs while leaders are trained to enable these SACCOs to be sustainable. Checks include regular communication with farmers' leaders as well as site visits to the SACCOs to establish whether there may have been any problems compromising the farmer's funds.	The likelihood exists but the project has checks and balances to detect problems and to take mitigation measures. In the ten years of project existence, SACCOs have closed, but farmers have never lost their funds. Low risk.	0.10
Market failure risk: Risk Level = Low				
Failure of farmers to honour	Some farmers may fail to continue with the contract either by selling the land or by simply losing interest.	The farmers' payments are performance-based and, if a farmer consistently fails to progress from	Low risk.	0.10

contracts		the YR 0 targets, their contracts can be revised to reduce those expected targets. The project then combines the remaining farmer payments and CCF will then identify additional farmers to replace the carbon that was not be attained.		
Failure for buyers to honour contracts	TGB is located in Uganda and thus geographically removed from the main carbon market. If buyers for one reason or another fail to honour their contracts, it is difficult for ECOTRUST to seek legal redress.	Carbon credits are issued and sold ex-ante. The project uses the Plan Vivo Escrow facility, through which buyers are able to deposit funds as soon as purchase agreements are concluded. These funds are only transferred to the Project Account after certificates have been issued.	The systems designed to match supply with demand are effective and the use of the Escrow facility has been successful in getting buyers to honour contracts. No risk.	0
Technical Risk: Risk Level = low				
Growth of planted trees is less than calculated	Project growth rates of planted trees are estimated to calculate carbon benefits.	Trees being planted are well known in the project area. The past performance of planted trees has been used in the SHAMBA model to project future growth. In all cases, conservative figures have been used to calculate carbon benefits e.g. soil carbon has not be accounted. Regular verification will provide an opportunity to recalibrate the model for local environment situation.	Considering the longevity of the project and the familiarity of farmers with the trees being planted, there are enough mechanisms designed to ensure that trees will perform as expected and that carbon-benefits are not over-estimated.	0.05
Administrative risk: Risk Level = low				
Project coordinator unable to manage the project effectively	Without an effective and committed project coordinator, project monitoring will be at risk.	ECOTRUST is a long established organization in Uganda and the TGB project has also been effectively operating for many years. The project coordinator therefore has a strong track record of effective project management and has high levels of governance standards to ensure that it delivers the project in an accountable and transparent way.	Considering the past experiences of TGB, there is very little risk of the project coordinator failing to provide effective project administrative services.	0.10
Overall score (highest risk)				0.10
Suggested risk buffer				**10%**

K Monitoring

Ecosystem Services Benefits

Performance Monitoring

Performance monitoring for this technical specification is activity-based (ex-ante) in which simple models are used to predict the expected carbon benefits. The assumption made is that carrying out these activities will result in the projected environmental services. Activities therefore include: number of trees planted, area of land managed, type of tree species planted, and survival rates. The plots used for the collection of baseline data were not established to be permanent plots – hence project monitoring is based on monitoring information collected from individual farms.

Each carbon farmer recruited is required to draw a *plan vivo* of the entire piece of land owned by the farmer, indicating exactly where the project trees are going to be located and also if there are any existing trees on farm. During the review of the *plan vivos*, the technician will verify if the *plan vivo* is a true representation of the baseline status of the land and will propose adjustments where necessary. The technician will record the observations on the review form including if there were trees or bushes covering the area where the new trees were to be planted. This information for every farm will be entered in a form that will be signed and dated. Although the *plan vivos* cover the entire land owned by the farmer, the carbon pools in the farmer contract only include the planted trees on land under other crops.

The inclusion of the total land owned in the *plan vivo* map helps to keep track of changes in carbon stocks over time on both the areas planted with trees and the rest of the farmer's land. Farmers that cut trees for the purpose of planting project trees will be disqualified from participating in the project. The project monitors the performance of each individual farm throughout the project lifecycle. Each participating farmer will have an individual contract with a monitoring plan specifying the expected milestones based on the growth rates in the carbon model used in this technical specification. The resources needed to undertake monitoring include: GPS, clinometers, data sheets, digital camera, clipboard, pen/pencil, measuring tape, spray paint, callipers, DBH tape and trained personnel who are competent to use this equipment.

Table 18 Performance Monitoring Plan

Time of measurement (yr)	Milestone	Means of measurement	Objectives
0	At least 50% of the planned Number of trees planted	Physical counting of all trees planted by a farmer and measuring the their spacing	To establish the acreage under improved management and whether the number of approved trees has been achieved
1	100% of the planned Number of trees planted	Physical counting of all trees planted by a farmer	Same as above
3	At least 85% of the planted trees surviving	Physical counting of all the surviving trees	To establish whether the targeted percentage of surviving trees has been achieved
5	An average DBH of at least 10cm	DBH & tree height measurements. Sample plots are established by stratified random sampling, to select 15-25m radius plots, or targeting 10% of the targeted (planted) number of trees by the farmers	To establish if the targeted average size of trees planted has been achieved. Growth rates provide an indication on amount of carbon stored
7	An average DBH of at least 14cm	Same as above	Same as above
10	An average DBH of at least 20cm	Same as above	Same as above

Table 19 Performance Monitoring Variables

Variable	Instrument	Reason for observation/measurement
Species	Field observation	Assess if the approved tree species are those planted in the *plan vivo*
Number of trees	Field observation and physical tree count	Assess the stand density/trees planted and estimate capacity requirements from nurseries for the mortality
Diameter at breast height	Callipers and diameter tapes	Used to assess growth and yield (current and mean annual increments)
Tree height	Suunto clinometers and hypsometers	Used for growth and yield information
Tree condition	Observations	Assess tree health, as poor health will affect the achievement of milestones in particular years- this may lead to non-payment

NB: *These variables will measured at the times prescribed in the Plan Vivo cycle*

Every year, the project visits farmers that are due for monitoring at the different stages of the project. Each individual farmer is visited and observations made in Years 0, 1, 3, 5, 7 and 10 correspond with those in Table 19. Data on the number of trees planted and their spacing, number and size of surviving trees is documented and used in progressive monitoring reports to provide an indicative amount of the carbon sequestered.

During Years 0, 1 and 3 the project conducts a physical count of all the trees that have been planted and/or are still surviving on each individual farm. Each of the respective years has different targets as follows: for the first monitoring, which is in Year 0 (within a year of signing the agreement), the farmer's target is to plant at least 50% of the expected number of trees. The farmer is expected to have completed the planting by end of Year 1, which is the second year after signing the agreement. In Year 3, the project measures how many of the planted trees are surviving and the expected number is 85%.

The project measures tree growth in year 5 and year 10 of each individual farmer and it is during this period that the project measures the carbon intake The measurements in years 5, 7 and 10 include Diameter at Breast Height (DBH i.e. 1.3m) above the ground level using a diameter tape or distance tape as well as Height of the trees from the ground to the tip using clinometer's or the stick/halving method. At this stage in monitoring, since the number of parameters to be measured has increased data is only collected from a representative sample of the trees. Using 15-25m radius plots, or targeting 10% of the targeted (planted) number of trees by the farmers during year 5 and year 10, data will be recorded from 4 established sample plots (of 15metre radius) per hectare. Ten trees in every plot will be measured. Thus, in 1 ha with an effective tree population of 310, a sample of 31 trees will be measured. The sample plots will be established using stratified sampling. This is important to be able to get a representative sample of all the trees in the garden, since the different sections of the garden may have trees of varying sizes due to physical factors, spatial effect (e.g. valleys, shallow soils, etc.) and planting the various sections during different seasons.

Farmer Payments

The monitoring indicators are the basis of making payments. Payments are issued to the producers according to predetermined milestones. Producers who do not meet the targets have their payments differed until corrective actions are implemented. Table 20 describes the milestones in the first 10 years of the project.

Table 20 Payment Breakdown

Year	Basis of payment	Target	% of total Payment per ha
0	Number planted	At least 50% plot established	20%
1	Number planted	Whole plot established, with 100%	20%
3	Percentage survival	70% survival	20%
5	Girth of stem/ diameter of the trees planted	Average DBH of at least 10cm	10 %
7	Girth of stem/ diameter of the trees planted	Average DBH of at least 14cm	10%
10	Girth of stem/ diameter of the trees planted	Average DBH of at least 20cm	20%

Updating the Technical Specifications

The technical specification will be updated every five years when sufficient additional information is gathered during project implementation. This information will be obtained from the standard monitoring tool that has been developed. The project starts collecting data on the parameters required for carbon modelling (DBH and Height) at Year 5. However, the need for modifications in this technical specification can also be as a result of the changing or the emerging of farmer needs, necessitating the development of new technical specifications to suit the new environment.

Socio-Economic Impacts

Description of Social Benefits

The contribution of trees and tree products to the livelihoods of farmers cannot be overemphasized. While working towards the establishment of tree stands for carbon sequestration, trees will also provide multiple products for farmers thereby improving their food, incomes and livelihood security. Small-scale, farmer-led, forestry/agroforestry projects will contribute to rural livelihood improvements. The selected trees grow well in the region on suitable sites and can be well integrated with agricultural crops without significantly affecting their yield.

This project intervention covered by this technical specification is designed to make tree planting a viable livelihoods option and it promotes trees that are well adapted to the local environment and local livelihood strategies. The proposed agroforestry farming system will lead to increased farmer incomes from the sale of timber (see Table 21 for the costs of timber), and other forestry products such as fuelwood, medicinal extracts and so on. In addition, project activities (e.g. nursery management site preparation, planting etc.) will provide employment. Moreover, trees on farms will lead to improved agricultural production through increased water holding capacity of soils. Trees also act as wind breaks to protect crops and houses. Furthermore, trees also support other enterprises such as apiary and provision of fodder for livestock. Although it was not previously part of the system, livestock are now an integral part of agriculture in most of Uganda and production systems have evolved over time to suit the agro ecological zones and the socio-economic setting. The main livestock production systems in the targeted agro-ecological zone include tethering where livestock are restrained by ropes around intensively cultivated areas and where herd sizes are small (1 - 5 animals). This is a direct response to the declining area of natural pastures (Tabuti & Lye, 2009). The production of fodder on farms will therefore increase livestock productivity.

Table 21 Potential Income Based on the Timber Prices in Ugandan Shillings

Tree species	Timber size									
	6x1	4x2	4x3	6x2	8x2	8x1	9x1	10x1	12x2	15x1
Mahogany		11,500		16,500	23,000			23,000	33,000	
Milicia excelsis		9,000		14,000	18,000			18,000	28,000	25-35,000
Albizia spp		4,500		9,000	9,000			9,000	18,000	12-15,000
Maesopsis emnii		3,500		5,000				9,000		
Cupressus spp	6,000	5,500	7,000	12,000		9,000	15,000	25,000		
Chrysophylum albidum		6,000	1,000	1,000	1,000	1,200		12,000	20,000	

Note: Prices are expressed in Ug.Sh per m^3 with marketable volume of 30% and includes estimated costs of harvesting and transportation.

Table 22 summarises the socio-economic benefits for this intervention.

Table 22 Socio-Economic Benefits

Socio-economic Benefits							
Intervention		***Agroforestry farming system – mixed native and natural tree species***					
Food and agricultural production	**Financial assets and incomes**	**Environ-mental services (water, soil, etc.)**	**Energy**	**Timber & non-timber forest products (incl. forest food)**	**Land & tenure security**	**Use-rights to natural resources**	**Social and cultural assets**
Increasing yields	PES payments	Improved soil management	Fuel wood production	Timber production	Ownership Documentation	Access rights to Protected Areas	Effective social institutions
Diversification of food types	Financial inclusion – savings & Access to credit	Improved water retention	Renewable energy	Fruit production	Communal Land Associations		Social Cohesion
Land use planning	Access to markets	Slowed runoff	Improved cook stoves	Honey production	Titles of Communal Ownership		Increased visibility
	Employment	Soil stabilization		Medicinal extracts	Live Boundary markers		

Negative Socio-Economic Impacts and Mitigation Strategies

TGB is a pro-poor cooperative carbon-offsetting scheme that needs to ensure that it has no negative socio-economic impacts. In addition, TGB is designed to be inclusive, providing an opportunity for as many marginalized households as possible to participate. Table 23 identifies any potential negative impacts that would limit the ability to achieve the desired socio-economic impacts and describes the mitigation measures that will be used to control these.

Table 23 Potential Negative Social Impacts and How They Can Be Controlled

Potential Risk	Description	Control
Opportunity Cost	Tree planting may reduce land available for agriculture, resulting into reduced food security and incomes. This is very important for sites with the average to small landholdings e.g. Mt. Elgon	Integrate these activities as a livelihood strategy (e.g. fruit trees, medicinal extracts, fodder for animals Various options to accommodate households with different landholdings Recruit in groups so people do not have to give up much land to
Increased competition and/or loss of land rights	Success with PES could attract speculative investors, which could in turn squeeze out indigenous landowners, especially where low levels of tenure security exist.	Security of tenure should be one of the PES objectives and or expected benefit for the community
Unfair outcomes	Unfair sharing of net revenues between communities & business entities mainly due to asymmetrical information. Due to land tenure, some gender groups may be disadvantaged	Proper consultations Rules to guide benefit sharing Benefits shared with general community Include provisions for marginalized groups
Loss of control and flexibility over local development options and directions	Poorly designed Parish Adaptation Plans can limit land management activities to a narrow range of alternatives, which could cost community residents their rights to exercise certain options for managing their land.	The limitations will be carefully scrutinized in light of potential future options that sellers of ecosystem services wish to keep open

Considering that socio-economic impact assessments are some of the actions required to develop technical specifications, then monitoring of our projects will be based on the baseline surveys. It is anticipated that, in addition to offsetting CO_2, this intervention will have a range of socio-economic impacts for participating farmers including: improved incomes, increased access to fuelwood and building materials, reduced deforestation pressures on nearby forest reserve and national park resource. Furthermore, participants will gain access to local and national markets for timber, pole wood and fuel wood, fruit and fodder. Nursery establishment and production of seedlings will also provide additional income to rural communities. These are some of the indicators that the project will be documenting at Years 1, 3, 5 and post-10 years of the carbon payment period. The socio-economic impact monitoring plan is shown in Table 24. All these indicators will be monitored by project field technicians at the intervals specified through the participatory methods indicated.

Table 24 Socio-Economic Monitoring

Social Dimension	Indicator	Monitoring method	Frequency & responsibility
Livelihoods	Number of households with increased income	Project annual report and project financial records	Annually
Jobs	Number of employees, hired by the project-supported enterprises (men/women)	Summary of annual reports from project-supported enterprises	Every 5 Years
Gender Equity	Number of women participating actively in the programme; number of women-owned enterprises	Activity (meetings, workshops, etc.) reports data summarised in the annual report	Annually
Tenure security	Number of project households with documented ownership; Number of communal ownership titles and area covered by theses	Project/household records	Annually
Social capital	No. of farmer groups supported by the project; No. of farmers participating in group activities (men/women)	Activity (meetings, workshops, etc.) reports data summarised in the annual report	Annually
Well-being	% of participating households in each of 4 well-being classes; % of households that have moved from the lowest class to the next highest class	Participatory well-being ranking (PRA tool)	Every 5 years - facilitated by the project

Environmental and Biodiversity Impacts

Every year, the project visits farmers that are due for monitoring at the different stages of the project. Each individual farmer is visited and observations made in Years 0, 1, 3, 5 and 10. The data on the number of trees planted, their spacing, number and size of surviving trees is documented and used in progressive monitoring reports to provide an indicative amount of the carbon sequestered. During these visits, information is also collected on species of trees planted. This will provide information on number and diversity of threatened indigenous species that have been domesticated. The provision of timber and fuel wood will be used as a proxy for reduction of threats to the protected areas within the project area. Where possible, the project will invest in structured biodiversity and watershed surveys to assess the impact of the project on these environmental services. In addition, biodiversity assessments will be conducted by various researchers including PhD students.

Table 25 Biodiversity Monitoring

Dimension	Indicator	Monitoring method	Frequency	Responsibility
Drivers of Deforestation	% change in the amount of fuel wood collected in protected areas	Survey of participating households	Annually	Project Technicians
Biodiversity conservation	% of indigenous tree species planted (as opposed to naturalized species)	Species list recorded on annual basis from monitoring information and presented in the annual report	Annually	Project Technicians
Protected areas conservation	No of protected areas covered by project	Information recorded in the annual report	Annually	Project Technicians
Catchment condition	List of catchments improved by the programme	Fixed point photographs (from vantage points) taken in different seasons	Annually	Project Technicians
Climate resilience	No of HH with improved adaptation strategies	Plan Vivo review and activity monitoring annual report	Annually	Project Technicians

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