Technical Specification: MOZ-TS-HP

System: Homestead Planting

Main tree species

Mangifera indica	Mangueira	Mango
Anacardium accidentale	Cajueiro	Cashew

Minor tree species

Psidium guajava	Goiabeira	Guava
Citrus sinensis	Laranjeira	Orange
Citrus limon	Limoeiro	Lemon
Tamarindus Indica	Tamarineiro	Tamarind
Persea spp.	Abacateira	Avocado
Ziziphus mauritania	Massanica	Ziziphus

Other tree species

Albizia lebbeck	Albizia lebbeck	Albizzia lebbeck
Sclerocarya birrea	Amarula	Marula
Morus alba	Amorereira	Mulberry
Calliandra calothyrsus	Calliandra	Calliandra
Afzelia quanzensis	Chamfuta	Pod mahogany
Gliricidia sepium	Gliricidia	Gliricidia
Spirostachys africana	Mecunite	Tamboti
Brachystegia boehmii	Mfuti	Mufuti
Brachystegia spiciformis	Msasa	Msasa
Julbernadia globiflora	Muhimbie	Muhimbe
Swartzia madagascariensis	Pau rosa	Rosewood
Pterocarpus angolensis	Umbila	Rhodesian teak
Sesbania sesbans	Sesbania	Sesbania
Khaya nyasica	Umbaua	Red mahogany

Summary

This land use system involves the planting of trees around the house primarily to create shade and to produce fruits for sale and domestic consumption. The main tree species are likely to be mango and/or cashew. However under this system it is expected that a wide variety of species will be planted (see list of minor and other tree species above). The area of planting under this system is likely to be small (<0.5 ha).

Ecology

Altitudinal range. All of these tree species will adapt to grow at most altitudes from sea level up to 1500m above sea level. The optimum range for cashew is up to 800 m and up to 600 m for mango.

Climatic factors – The optimum temperature range is from 20°C to 35°C. Zisiphus and tamarind will tolerate higher temperatures. Optimum precipitation is between 1,000 – 2,000 mm / year. Zisiphus, tamarind and avocado will tolerate drier conditions (as low as 300 mm / year).

Habitat requirements. Cashew will not grow on pure clays but is very tolerant of degraded soils. Mango will grow on most soils and will tolerate drought and occasional flooding. The minor species will tolerate most soil types. Avocado should not be planted in areas that are prone to waterlogging. Guava is best grown on clays. Orange, lemon, tamarind and zisiphus prefer well drained soils.

Description

Cashew, mango, tamarind and avocado are all medium to large size trees which can reach up to 15 – 20 m in height. Ziziphus is a medium sized tree which will grow fast in the early years on well aerated soils. Guava, orange and lemon are small trees which are unlikely to exceed 10 m.

Main products
Fruit, nuts and medicine
Fuel wood from branches
Other tree species might be planted for fuelwood, poles and timber.

Classification of climate/ site productivity

Climate is classed as optimal and sub-optimal based on available ecological information and experiences within the project. (The use of this system in areas classified as sub-optimal for climatic conditions is not recommended.)

Optimal	Description of climate Range - 0 - 1000masl Range - 1000 – 2000 mm/yr
Sub-optimal	Description of climate Range - 1000 – 2000 masl Range - 500 – 2500 mm/yr

Site productivity is inferred from locally reported soil conditions for the site

	High	**Medium**	**Low**
Soil type	Deep (>30cm), well drained, brown-black, few stones	20-30cm depth, heavy clays or sandy	Thin (<20cm), stony, compacted soils or oxidised clays

Management objectives

To provide shade around the house and supply fruit for domestic consumption. Any excess fruit can be traded or sold. A huge range of other tree species might be planted as part of this system. The other tree species might be managed for fuel wood, poles for building houses and timber for other purposes.

Potential income

Any additional income is likely to be small and will depend on trees planted. The current market price (2005) is 12 Mts per kg for cashews and 5 Mts per kg for mango.

Costs of implementation

Estimated costs per ha:
Establishment (year 1): 11,500 Meticais ($480)
Maintenance (year 2 – 5): 5,000 Meticais ($200)
Opportunity cost (lost production from land): N/A

N.B. The above costs include values for the purchase of seedlings and for time that the farmer would spend on establishment and maintenance of the trees. However, in the first years of the project (during the Pilot Phase) seedlings are supplied at no cost to the farmer and most farmers will plant and maintain their own trees so this is not actually a cost that will be incurred.

Management operations

Establishment

All competing vegetation should be removed and the foliage left on site to act as an organic fertilizer, and to conserve soil moisture. Trees should be planted at a distance of 4m x 4m for larger tree species (mango, cashew, tamarind, avocado and ziziphus) and 3m x 3m for smaller tree species (such as orange, lemon and guava).

It is best to plant at the beginning of the wet season to minimize the requirement to water the seedlings. Mulch (in the form of organic green material from e.g. competing vegetation) should be placed around the base of the seedlings to help retain soil moisture whilst also reducing the growth of competing vegetation and adding fertility to the soil.

- Care should be taken handling plants not to cause damage to shoots, buds or bark
- Only remove plastic from around root-ball at the time of planting. Care should be taken to remove all the plastic
- Prune back roots (especially any circular roots) at the time of planting to stimulate new root growth once in the ground
- Plant to depth of root collar (i.e., for bagged plants, to level of existing soil). Never plant deeper than in nursery leaving no roots exposed.
- Ensure that soil is replaced firmly around trees (i.e., well heeled in). Put top soil back in planting hole first

Maintenance

The removal of all competing vegetation will be required twice a year for the first three years after planting, or until the trees have reached a height of 1.5 - 2 m.

Weeding intensity can be reduced to once per year after the third year until approximately the sixth year (or once canopy closure is achieved). No pruning is required but some lower side branches may be removed to allow for access to trees. Offcuts can be used for fuel wood. No burning is allowed at any time. Any foliage should be worked into the soil. Fire breaks should also be maintained between machambas. All seedlings will require protection from goats.
Thinning and harvest No thinning required unless polewood / fuelwood species are planted in between the main homestead fruit tree species. Trees (cashew, mango and ziziphus) should be replaced when fruit production begins to decrease at approximately year 50.
Re-establishment The majority of species will require replanting at approximately year 50. The harvest cycle will continue on this basis. Tamarind is likely to be grown on a cycle of 100 years (+).

Carbon sequestration potential

Carbon sequestration potential over ***100*** years with a crop rotation of ***60*** years (100 years for tamarind) on an average quality site with optimal climatic conditions is **42.05** tC/ha above an initial vegetation carbon baseline which is assumed to be zero. The Nhambita carbon calculator (ECCM, 2005) should be used to calculate the number of saleable carbon credits based on the land use system and area planted.

Carbon sequestration potential is based on average net carbon storage in biomass and forest products. Carbon storage is calculated using the CO2FIX-V3 model (Mohren et al 2004). Details of the parameters used (basic wood carbon content; timber production; total tree increment relative to timber production; product allocation for thinnings and expected lifetime of products) are given below.

The carbon sequestration potential of this system has been calculated using the following species composition:

Tree species	Proportion of planting (%)
Cashew	40
Mango	40
Zisiphus	10
Tamarind	10

This species composition is likely to be representative of actual planting and reasonable growth data has been obtained for these species which can be used

to model carbon sequestration. In reality, it is likely that a much wider range of tree species will be planted by farmers using this system.

The model uses current annual increment (for details of model inputs see appendix 2). As more data becomes available the species composition of the planting may be modified and the models used to calculate carbon sequestration potential will be updated.

N.B. Stem increment (CAI) was calculated on the basis of trees measured within the project area. A relatively large sample of mango trees (>80) of a known age were measured. The mango trees measured ranged in age from 7 to 50 years. The sample size for ziziphus and cashew ranged between 10 and 20, the majority of which were young trees (<15 years old). The sample size for tamarind was less than than 10. However, as the project expands and more data becomes available these calculations can be revised and updated if required.

N.B.B. **42.05 tonnes of carbon** is equivalent to **154.18 tonnes of carbon dioxide**.

Monitoring

Monitoring targets for the first 4 years are based on establishment; the whole plot must be established by the third year with at least 85% survival of seedlings. Thereafter monitoring targets are based on DBH, the expected DBH at the time of monitoring is based on a predicted mean annual diameter increment on which carbon sequestration estimates are based.

Year	Indicator
1	At least 35% plot established
2	At least 70% plot established
3	Whole plot established, 85% survival At least ***530***. stems /ha surviving
4	Whole plot established
5	Average DBH not less than 7cm
6	Average DBH not less than 8.5cm
7	Average DBH not less than 10cm
10	Average DBH not less than 16cm

Information about pests

Cashew

Important pests to cashew trees include sucking bugs (*Helopeltis schoutedeni* and *H. anacardii*), the theraptus bug (*Pseudotheraptus wayi*), thripts (*Selenothrips rubrocinctus*), bark borers (*Mecocorynus loripes*) and the defoliating caterpillar (*Nudaurelia bellina*) (World Agroforestry Centre, 2004).

Common diseases include die-back or pink disease (*Corticium salminicola*), damping-off of seedlings (*Phytophthora palmivora*); anthracnose disease

(*Collectotrichum gleosporioides*), leaf spots, shoot-rot and leaf fall. A combination spray of BHC and a copper fungicide like Blitox at the time of emergence of new flush has been found an effective prophylactic measure (World Agroforestry Centre, 2004).

Mango

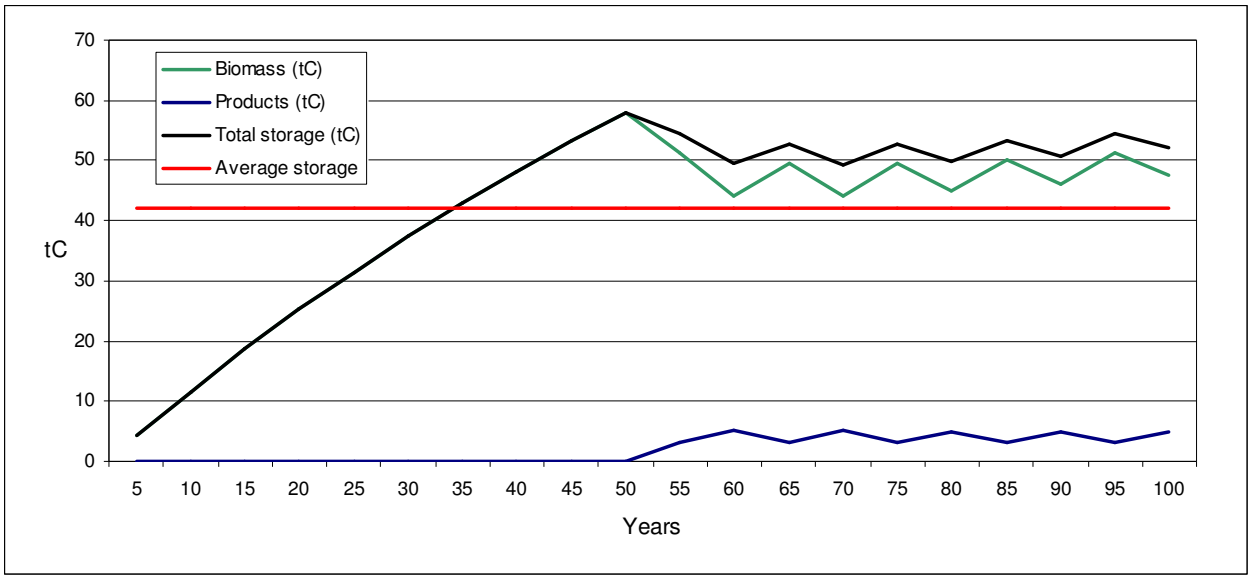
Anthracnose (*Glomerella cingulata*, conidial stage *Colletotrichum gloeosporioides*) distorts and turns developing leaves black and disfigures developing fruit. May be controlled by use of copper based fungicide.

A mealybug, *Rastrococcus invadens*, can cause serious damage to mango and other crops. In the greenhouse, thrips often turn leaves rusty brown. Malathion is the conventional spray for insect pests; sulphur works on mites. A long-horn beetle (*Rhytidodera simulans*) bores into the trunk and thick branches; branches may be killed but the whole tree retains its viability. The larvae of the mango weevil (*Cryptorrhynchus mangiferae*) feed on the pulp and damage the fruit.

Other diseases include the flower malformation caused by *Fusarium moniliforme* and spread by mites, bacterial canker which is becoming a pressing disease problem and *Oidium mangiferae*, a powdery mildew that affects flowers, young fruit and leaves. Can be controlled by spraying powdered kelp, sodium bicarbonate and fungicide sprays.

Appendix 1 Carbon storage figures

Year	Biomass (tC)	Products (tC)	Total storage (tC)	Accumulated tCyr
5	4.255	0	4.3	10.8
10	11.385	0	11.4	52.7
15	18.633	0	18.6	131.6
20	25.292	0	25.3	245.0
25	31.518	0	31.5	390.3
30	37.39	0	37.4	565.6
35	42.895	0	42.9	769.2
40	48.187	0	48.2	999.6
45	53.231	0	53.2	1255.8
50	57.938	0	57.9	1536.2
55	51.29	3.289	54.6	1810.1
60	44.162	5.304	49.5	2085.5
65	49.502	3.247	52.7	2340.3
70	44.072	5.082	49.2	2609.4
75	49.404	3.24	52.6	2863.4
80	44.803	4.914	49.7	3132.7
85	50.086	3.233	53.3	3390.2
90	45.983	4.816	50.8	3663.2
95	51.193	3.256	54.4	3926.4
100	47.389	4.777	52.2	4205.2



Appendix 2 - CO2Fix Inputs

Stand parameters		
Rotation length (yr)		Cashew,, mango & ziziphus: 60 Tamarind: 100
Number of rotations		2
Adjustment of assimilate to account for non-optimal site conditions	Foliage	1
	Branches	1
	roots	1
Initial biomass (Mg/ha)*	Foliage	0
	Roots	0
	Litter	0
	Branches	0
	Stems	0
	Deadwood	0

*The initial biomass (baseline) will be subtracted by the project staff on a case by case basis.

Stem increment **CAI** (m3/ha/yr)

Year	Cashew	Mango	Tamarind	Ziziphus
5	4.1	.7	0.3	3.9
10	4.1	4.6	0.3	6.4
15	5.0	4.5	0.7	
20	5.0	4.4	1.4	
25	4.9	4.3	2.7	
30	4.9	4.2	2.6	
35	4.8	4.0	4.5	
40	4.8	3.9	5.8	
45	4.7	3.8	6.4	
50		3.7	6.5	
55			5.9	
60			4.7	

Dry weight increment relative to stem

foliage	branches	roots
0.35	0.2	0.25

Tree species Parameters		
Basic density of stemwood (kg/m3)		Cashew: 520 Mango: 520 Tamarind: 750 Ziziphus: 760
Carbon content of dry matter		0.5
Turnover of various biomass components (1/yr)	Foliage	1
	Branches	0.05
	Roots	0.07
Mortality as a fraction of trees per year (1/yr)		0.0
Average residence time of carbon in wood products (1/yr)	Dead wood	10
	Energy	1
	Packing	5
	Construction	25

Thinning and harvest table						
Species	Thinning age	Fraction stem removed	Dead wood	Energy	Packing	Construction
Cashew / Mango	60	0.25	0.0	0.75	0.0	0.25
	70	0.25	0.0	0.75	0.0	0.25
	80	0.25	0.0	0.75	0.0	0.25
	90	0.25	0.0	0.75	0.0	0.25
	100	0.25	0.0	0.75	0.0	0.25
Zisiphus	60	1.00	0.0	0.30	0.0	0.70
Tamarind	100	1.00	0.0	0.30	0.0	0.70

References

ECCM (2005). Nhambita carbon calculator

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Sambane, E (2005). Above ground biomass accumulation in fallow fields at the Nhambita Community, Mozambique. A dissertation presented for the degree of Master of Science, University of Edinburgh, 2005.

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