Technical Specification: MOZ-NHA-FO-CASHEW-draft

System: Fruit orchard
Variation: Cashew

Main tree species

Anacardium occidentale	Cashew	Cajueiro / Castanha de caju

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Minor tree species

Citrus sinensis	Laranjeira	Orange
Carica papaya	Papayeira	Papaya
Morus alba	Amorereira	Mulberry
Psidium guajava	Guaveira	Guava
Zisiphus mauritania	Massanica	Zisiphus

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Summary

Under this land use system more than 80% of the area is planted with cashew trees which will be managed in the future for commercial production of nuts. Any remaining area can be with other fruit and / or fuelwood species for domestic consumption.

Ecology

Altitudinal range: Cashew will grow from sea level up to 1,000 m above sea level

Climatic factors: Optimum temperature range for cashew is 20°C to 37°C. It is not tolerant to frost. Cashew can adapt to constant dry conditions and indeed, for high quality nut yields dry conditions during flowering and fruiting are ideal.

Habitat requirements: Cashew will grow well on sandy soils where all competing vegetation has been removed. Will not grow on pure clays. Cashew is very tolerant of degraded conditions and can be planted to help combat soil erosion.

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 - 800masl Range - 1000 – 2500 mm/yr
Sub-optimal	Description of climate Range - 800 – 1200 masl

	Range - 500 – 3500 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
Commercial cashew nut production. Surplus nuts can be sold locally or used for household consumption. In addition to the nut, the cashew fruit can also be consumed. The timber is quite hard and is used for furniture or building.

Potential income

Maximum production will be achieved starting in year 10. Up to 23 kg can be produced per tree each year. The current market value for cashews is 12,000 Mts per kg.

Costs of implementation

Estimated costs per ha:
Establishment (year 1): 11,500,000 Meticais ($480)
Maintenance (year 2 – 5): 5,000,000 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 in rows at a distance of 5m x 3m (666 tree/ha). Crops may be grown between the trees during the first years until canopy closure. In the first year these crops should be planted after the trees have been planted.

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 or interplanting) should be placed around the base of the seedlings to help retain soil moisture whilst also reducing the growth of competing vegetation and adding fertility to the soil.

When planting:

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

Maintenance

The removal of all competing vegetation will be required twice a year for the first three years after planting, or until the cashew 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. Trees should be replaced when fruit production begins to decrease at approximately year 50.
Re-establishment The whole site should be re-planted at year 50.

Carbon sequestration potential
Carbon sequestration potential over ***100*** years with a rotation of ***60*** years on an average quality site with optimal climatic conditions is ***37.4*** tC/ha above an initial vegetation carbon baseline of **2.8** tC/ha (Sambane, 2005). 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; turnover rate; product allocation for thinnings and expected lifetime of products) are given below. The model uses current annual increment for planted trees. (For details of model inputs see appendix 2). At this stage the carbon sequestration has been modelled as if 100% of the area is planted with cashew (i.e. this does not include other species such as orange, mulberry, guava, zisiphus and papaya). As more data becomes available these species might be included in the calculation of the carbon sequestration potential of this system.

N.B. Stem increment (CAI) was calculated on the basis of trees measured within the project area. The number of trees measured was small and the majority of these trees were relatively young (<10 yrs). As the project expands and more data becomes available these calculations should be revised and updated.

N.B.B. **37.4 tonnes of carbon** is equivalent to **136.9 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.

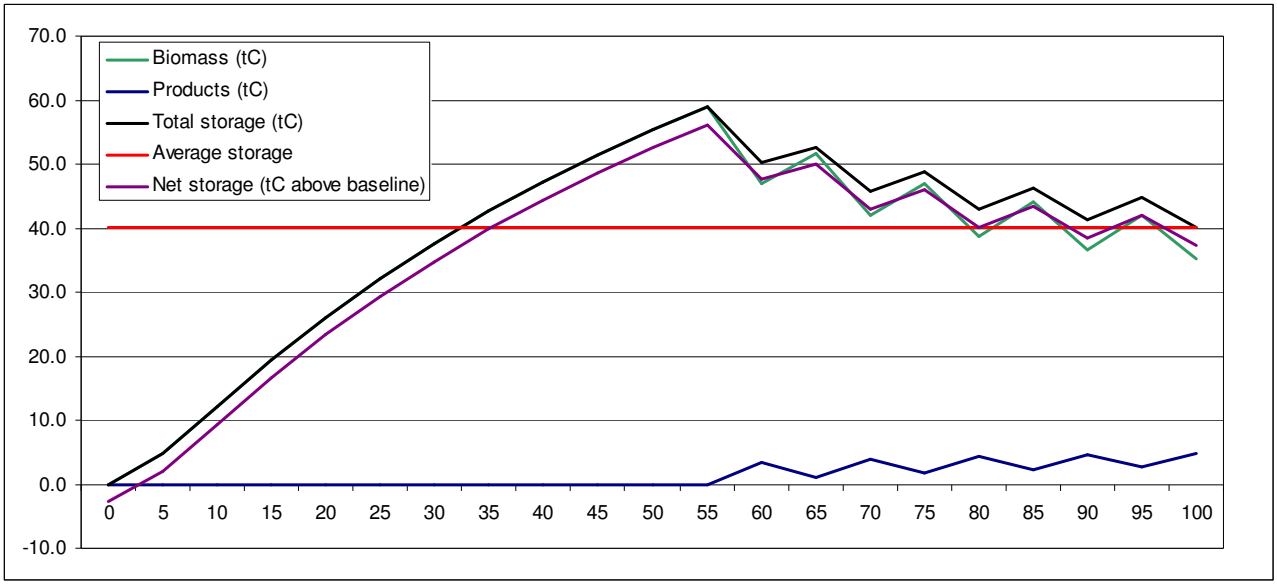
Year	Indicator
1	At least 35% plot established
2	At least 70% plot established
3	Whole plot established, 85% survival At least ***566***. stems /ha surviving
4	Whole plot established
5	Average DBH not less than 7cm
6	Average DBH not less than 8.5cm
7	Average DBH not less than 10cm
10	Average DBH not less than 16cm

Information about pests
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).

Appendix 1 Carbon storage figures

Year	Biomass (tC)	Products (tC)	Total storage (tC)	Net storage (tC above baseline)	Accumulated tCyr
0	0.0	0.0	0	-2.8	
5	4.8	0.0	4.8	2.0	11.6
10	12.1	0.0	12.1	9.3	57.7
15	19.4	0.0	19.4	16.6	140.0
20	26.1	0.0	26.1	23.3	257.4
25	32.1	0.0	32.1	29.3	406.3
30	37.6	0.0	37.6	34.8	583.6
35	42.6	0.0	42.6	39.8	786.7
40	47.2	0.0	47.2	44.4	1013.5
45	51.4	0.0	51.4	48.6	1262.0
50	55.3	0.0	55.3	52.5	1530.8
55	59.0	0.0	59.0	56.2	1818.5
60	46.9	3.4	50.3	47.5	2112.1
65	51.6	1.1	52.7	49.9	2367.3
70	41.9	3.9	45.8	43.0	2632.2
75	47.0	1.7	48.8	46.0	2867.1
80	38.7	4.3	43.0	40.2	3114.1
85	44.1	2.2	46.3	43.5	3336.2
90	36.6	4.6	41.2	38.4	3571.8
95	42.1	2.7	44.7	41.9	3785.8
100	35.2	4.9	40.1	37.3	4014.2



Appendix 2 - CO2Fix Inputs

Stand parameters		
Rotation length (yr)		60
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.

Tree Growth Table				
Age (yr)	Stem increment **CAI** (m3/ha/yr)	Dry weight increment relative to stem		
		foliage	branches	roots
5	4.1	0.35	0.2	0.25
10	4.1			
15	5.0			
20	5.0			
25	4.9			
30	4.9			
35	4.8			
40	4.8			
45	4.7			

Tree species Parameters		
Basic density of stemwood (kg/m^3)		520
Carbon content of dry matter (proportion of dry weight)		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					
Thinning age	Fraction stem removed	Dead wood	Energy	Packing	Construction
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

References

ECCM (2005). Nhambita carbon calculator

Mohren, F., van Esch, P., Vodde, F., Knippers, T., Schelhaas, M., Nabuurs, G., Masera, O., de Jong, B., Pedroni, L., Vallejo, A.., Kanninen, M., Lindner, M., Karjalainen, T., Liski, J., Vilen, T., Palosuo, T. (2004). CO2FIX-V3

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.

World Agroforestry Centre (2004). Agroforestry tree database.

Acknowledgement

This work undertaken by ECCM as part of the Miombo Community Land Use and Carbon Project has only been possible because of the financial support received from the European Commission (Environment budget).