

Technical Specification: MOZ-TS-WL

| |
|-------------------------------------|
| System: Woodlot |
| Variation: Timber / Fuelwood |

| Main tree species | | |
|----------------------------------|---------------|--------------|
| Miombo spp. | | |
| <i>Cordia africana</i> | Mutondo | Wild mango |
| <i>Azelia quanzensis</i> | Chamfuta | Pod mahogany |
| <i>Sclerocarya birrea</i> | Amarula | Marula |
| <i>Tamarindus indica</i> | Tamalinoninho | Tamarind |
| <i>Zisiphus mauritania</i> | Massanica | Zisiphus |
| <i>Pterocarpus angolensis</i> | Umbila | Wild teak |
| <i>Millettia stuhlmanii</i> | Panga panga | Panga panga |
| <i>Strychnos innocua</i> | Mutemo | |
| <i>Kigelia africana</i> | Muvunguti | Sausage tree |
| <i>Swartzia madagascariensis</i> | Pau rosa | Rosewood |
| <i>Julbernardia globiflora</i> | Muhimbe | Muhimbe |
| <i>Brachystegia boehmii</i> | Mfuti | Mufuti |
| | | |
| Timber spp. | | |
| <i>Khaya nyasica</i> | Umbaua | Red mahogany |
| | | |
| Fuelwood and poles spp | | |
| <i>Albizia lebbeck</i> | Albizia | |

Summary

This system will be used to re-establish Miombo woodland. In the long term these areas will be managed for the sustainable production of native hard wood timbers. In the short term (where appropriate) these areas will help to meet local demand for fuelwood and building materials. This system can be used to restore degraded areas of forest. This system is the most appropriate to use on old mashambas (i.e. that have been abandoned for many years).

Ecology

Altitudinal range. These species will grow mostly at low to medium altitudes (up to 1,000 m above sea level). Most will grow up to 1,500 – 2,000 m. Amarula will only grow up to 800 m.
Climatic factors – Typically Miombo species are very drought tolerant and frost sensitive. Typically annual precipitation in the range 700 – 2000 mm is required. Amarula, tamarind, zisiphus and mutemo will tolerate drier conditions (as low as 200 mm per year).
Habitat requirements – Typically Miombo species prefer well drained soils. Most of these species are very drought tolerant but will thrive on moist sites.

Growth habit

Most Miombo species are relatively slow growing. Many of these species are deciduous losing their leaves during the long dry spell. Red mahogany is best planted in moist areas where very fast growth rates may be achieved.

Timber products

| | |
|--------------------------|---|
| <i>Cordia africana</i> | Fruit, timber and a good tree for apiculture |
| <i>Azelia quanzensis</i> | Hard timber, easy to work, durable and resistant to termites. Used for construction, boat building, furniture, flooring and |

| | |
|----------------------------------|---|
| | turning |
| <i>Sclerocarya birrea</i> | Light, soft timber suitable for crafts and furniture |
| <i>Tamarindus indica</i> | Very hard durable timber. Will take a fine polish and can be used for general carpentry. |
| <i>Zisiphus mauritania</i> | Medium weight hardwood which is durable but will split easily. Can be used for construction and furniture. Excellent fuelwood |
| <i>Pterocarpus angolensis</i> | High value, very durable timber. Also useful for medicine, apiculture, fodder and tannins. |
| <i>Millettia stuhlmanii</i> | Useful for bee hives and apiculture |
| <i>Strychnos innocua</i> | Use for fuel wood, fodder, food timber and medicine |
| <i>Kigelia africana</i> | |
| <i>Swartzia madagascariensis</i> | Very hard wood |
| <i>Julbernardia globiflora</i> | |
| <i>Brachystegia boehmii</i> | |
| | |
| <i>Albizia lebbeck</i> | Fuel wood and poles |
| <i>Khaya nyasica</i> | Furniture, timber frames, veneer and dugout canoes |

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 – 1,000 masl Range - 700 – 1,500mm/yr |
| Sub-optimal | Description of climate Range - 1,000 – 2,000masl Range - 350 – 2,500 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), stoney, compacted soils or oxidised clays |

Management objectives

Main management objectives. Re-establishment of native woodland species which can be managed in the future for sustainable fuelwood and timber production.

Potential income

Fuelwood

Poles

Timber

Costs of implementation

Estimated costs per **ha**:

Establishment (year 1): 25,000 Meticais (\$1,100)

Maintenance (year 2 – 5): 10,000 Meticais (\$430)

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

Competing vegetation (**other than trees**) should be cut and the foliage left on site to act as an organic fertilizer, and to conserve soil moisture. Miombo and timber trees should be planted in rows 3 meters apart (1,100 trees / ha). Trees planted for fuel wood, poles and soil improvement (such as albizia) should be planted between timber trees. These trees will be coppiced and thinned out over time.

Any trees that already exist on the site should be left. Plant around these trees.

It is best to plant at the beginning of the wet season to minimize the requirement to water the seedlings. Mulch should be placed around the base of the seedlings to help retain soil moisture whilst also reducing the growth of competing vegetation and adding fertility to the soil.

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
- Plant at the beginning of the rainy season to avoid the need for irrigation.

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 the trees are no longer in competition with weeds).

Prune side branches of timber trees to create clear boles of high value. Offcuts can be used for fuel wood.

No burning is allowed at any time. Any foliage should be left on site. Fire breaks should also be maintained between mashambas.

All seedlings will require protection from goats.

Thinning and harvest

Coppice albizia on 3 – 10 year cycle for fuel wood and poles to be used in construction.

Red mahogany, mbila, amarula and panga panga should be harvested on a 60 cycle.

Other species including muhimbie should be harvested on a 100 year cycle.

Re-establishment

Fuelwood and pole wood species (e.g. albizia) are to be coppiced on a three to ten year rotation for up to 25 years after which no re-establishment will be possible because of excessive shading from other trees.

Miombo and timber tree species should be replaced when felled.

Carbon sequestration potential

Carbon sequestration potential over **100** years on an average quality site with optimal climatic conditions is **50** tC/ha above an initial vegetation carbon baseline of **11.3** 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 carbon sequestration potential of this system has been calculated using the species composition and assumed annual timber production shown in the table below:

| Tree species | Proportion of planting (%) | Mean annual increment (m ³ /ha) | Dry wood density (kg/m ³) | Rotation (no. of years) |
|-----------------------|----------------------------|--|---------------------------------------|-------------------------|
| Albizzia ¹ | 64 | 12.0 | 600 | 25 |
| Red mahogany | 20 | 11.2 | 590 | 60 |
| Amarula | 25 | 5.8 | 590 | 60 |
| Panga panga | 25 | 4.6 | 720 | 60 |
| Mbila | 15 | 5.9 | 640 | 60 |
| Muhimbie | 15 | 1.5 | 780 | 100 |

This species composition is likely to be representative of actual planting and growth data (MAI and CAI) has been obtained for these species which can be used to model carbon sequestration. Pole wood and fuelwood species such as acacia and albizia should be planted throughout where possible and appropriate.

N.B. Stem increment (MAI & CAI) was calculated on the basis of trees measured within the project area. The number of trees measured so far is relatively small. As the project expands and more data becomes available these calculations might be revised and updated.

N.B.B 50 tonnes of carbon is equivalent to 183.3 tonnes of carbon dioxide.

¹ Albizia has been modelled as if coppiced on a five year rotation and assumed not to re-establish after year 25 because of excessive shading from other trees. For the purposes of the calculation of carbon sequestration potential by the Woodlot system an overall stocking density of 1,100 trees has been assumed. The calculations for carbon sequestration potential by timber species (red mahogany, amarula, panga panga, mbila and muhimbie) are based on an assumed stocking density of 400 trees / ha. The calculation for fuel wood species (albizzia) assumes a stocking density of 1,100 trees / ha. For the purposes of these calculations we assume that although 400 timber tree species are planted per ha this is equivalent to 100% of the required stocking density. Planting of fuel wood species in between the timber tree species will make up the difference between 400 trees and 1,100 (i.e. 64%)

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 935 stems /ha) |
| 4 | Whole plot established |
| 5 | Average DBH not less than 6cm |
| 6 | Average DBH not less than 7cm |
| 7 | Average DBH not less than 9cm |
| 10 | Average DBH not less than 13cm |

Additional information

Amarula

Psyllid mites, aphids and wood susceptible to termite and wood borer attack.

Tamarind

Scale insects, mealy bugs and borers

Ziziphus

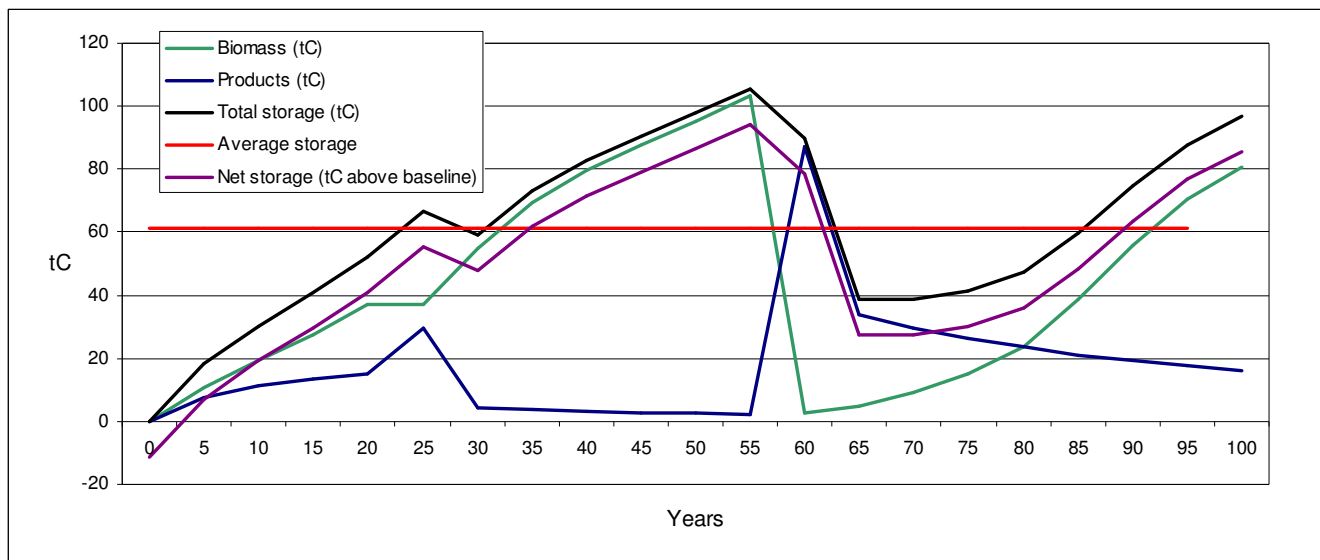
Fruit flies can be a major cause of crop loss

Red mahogany

Shoot borer (will damage leading stem and reduce timber quality)

Appendix 1 Carbon storage figures

| Year | Biomass (tC) | Products (tC) | Total storage (tC) | Net storage (tC above baseline) | Accumulated tCyr |
|------|--------------|---------------|--------------------|---------------------------------|------------------|
| 0 | 0 | 0 | 0 | -11.3 | |
| 5 | 10.9592 | 7.264 | 18.2 | 6.9 | 58.4 |
| 10 | 19.1967 | 11.1488 | 30.3 | 19.0 | 177.0 |
| 15 | 27.5341 | 13.4912 | 41.0 | 29.7 | 346.0 |
| 20 | 37.229 | 15.0144 | 52.2 | 40.9 | 567.3 |
| 25 | 37.3225 | 29.44 | 66.8 | 55.5 | 854.6 |
| 30 | 54.743 | 4.4224 | 59.2 | 47.9 | 1118.6 |
| 35 | 69.555 | 3.6544 | 73.2 | 61.9 | 1457.8 |
| 40 | 79.6785 | 3.104 | 82.8 | 71.5 | 1854.7 |
| 45 | 87.6215 | 2.7072 | 90.3 | 79.0 | 2291.2 |
| 50 | 95.4055 | 2.4128 | 97.8 | 86.5 | 2765.4 |
| 55 | 103.3305 | 2.2016 | 105.5 | 94.2 | 3277.5 |
| 60 | 2.794 | 86.9297 | 89.7 | 78.4 | 3805.2 |
| 65 | 4.918 | 33.9372 | 38.9 | 27.6 | 4026.4 |
| 70 | 8.9675 | 29.6202 | 38.6 | 27.3 | 4218.4 |
| 75 | 15.1235 | 26.3045 | 41.4 | 30.1 | 4418.7 |
| 80 | 23.68 | 23.5146 | 47.2 | 35.9 | 4642.0 |
| 85 | 38.4495 | 21.157 | 59.6 | 48.3 | 4911.7 |
| 90 | 55.75 | 19.1518 | 74.9 | 63.6 | 5256.0 |
| 95 | 70.515 | 17.4395 | 88.0 | 76.7 | 5670.8 |
| 100 | 80.6125 | 15.9662 | 96.6 | 85.3 | 6138.6 |



Appendix 2 - CO2Fix Inputs

| Stand parameters | | |
|---|---------------------|---------------------------------|
| Rotation length (yr) | Tree species | Rotation length |
| | Red mahogany | 60 |
| | Amarula | 60 |
| | Panga panga | 60 |
| | Mbila | 60 |
| | Muhimbie | 100 |
| | Albizia | 25 |
| Number of rotations | | 2 (only 1 rotation for albizia) |
| 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 |

| Stem increment CAI (m ³ /ha/yr) | | | | | | | Dry weight increment relative to stem | | |
|---|---------|--------------|---------|-------------|----------|-------|---------------------------------------|----------|-------|
| | | | | | | | foliage | branches | roots |
| Year | Albizia | Red mahogany | Amarula | Panga panga | Muhimbie | Mbila | 0.35 | 0.2 | 0.25 |
| 5 | 12.0 | 2.3 | 0.5 | 1.7 | 2.4 | 0.6 | | | |
| 10 | | 2.3 | 0.5 | 3.5 | 2.4 | | | | |
| 15 | | 4.6 | 1.0 | 6.9 | 1.1 | 1.3 | | | |
| 20 | | 9.1 | 1.9 | 6.2 | | 2.6 | | | |
| 25 | | 23.0 | 4.9 | 5.4 | | 3.8 | | | |
| 30 | | 24.0 | 5.5 | 4.6 | | 5.1 | | | |
| 35 | | 20.8 | 6.1 | 3.9 | 1.1 | 6.3 | | | |
| 40 | | 13.2 | 6.8 | 3.1 | | 7.6 | | | |
| 45 | | | 7.4 | 2.3 | | 8.9 | | | |
| 50 | | | | 1.6 | | 10.1 | | | |
| 55 | | | | | | 11.4 | | | |
| 60 | | | | | | 12.6 | | | |

| Tree species Parameters | | |
|---|---------------------|-------------------------|
| Basic density of stemwood (kg/m ³) | Tree species | Kg/m³ |
| | Red mahogany | 590 |
| | Amarula | 590 |
| | Panga panga | 720 |
| | Mbila | 640 |
| | Muhimbie | 780 |
| | Albizia | 600 |
| 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 (Yr) | Species | Fraction stem removed | Dead wood | Energy | Packing | Construction |
| 5 | Albizia | 50 | 0.0 | 0.8 | 0 | 0.2 |
| 10 | Albizia | 50 | 0.0 | 0.8 | 0 | 0.2 |
| 15 | Albizia | 50 | 0.0 | 0.8 | 0 | 0.2 |
| 20 | Albizia | 50 | 0.0 | 0.8 | 0 | 0.2 |
| 25 | Albizia | 100 | 0.0 | 0.8 | 0 | 0.2 |
| 60 | Red mahogany, amarula, mbila & panga panga | 100 | 0.0 | 0.3 | 0 | 0.7 |
| 100 | Muhimbie | 100 | 0.0 | 0.3 | 0 | 0.7 |

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.
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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).