Technical Specification: Reference: MOZ-TS-DIP var. *Faidherbia albida*

Last modified: 5th June 2009

System: Dispersed interplanting
Variation: *Faidherbia albida*

Main tree species

Faidherbia albida	*Faidherbia*	*Faidherbia*

N.B. Although *Faidherbia albida* is a monospecific genus it remains in the Mimosoid legume tribe Acacieae and for practical purposes is still considered an acacia.

Minor tree species

None	None	None

Summary

This system involves the planting of *F. Albida* at a low stocking density throughout the mashamba. Crops can continue to be grown. *F. Albida* is a nitrogen fixing tree which will increase and extend the expected productivity of the mashamba. *Faidherbia* increases soil nitrogen by actively manufacturing nitrogen compounds through symbiotic bacteria located in the roots. Any litter will act as a green manure (organic fertiliser) and the tree roots will also help to preserve the soil structure by retaining moisture and preventing erosion. *Faidherbia albida* is an indigenous tree species to many parts of Africa. According to research carried out by the University of Edinburgh as part of the Nhambita Community project (2007) *Faidherbia albida* is the 16th most commonly found tree in this part of central Mozambique.

Faidherbia is unique amongst acacias in having a reverse phenology – the trees are leafless during the summer (wet) season. Many studies indicate that interplanting of nitrogen fixing trees with crops (e.g. sorghum, maize) will increase crop yields significantly (University of Queensland, 1998) as well as extending the productivity of the mashamba thereby reducing the pressure to clear new areas of forest.

It is also suggested that pigeon peas be planted to further improve soil quality whilst also producing a food / cash crop.

Ecology

Altitudinal range. Faidherbia will adapt to grow at low to medium altitudes (270 - 2700m).
Climatic factors – Plant in areas of low to medium rainfall (250 – 1200 mm/yr). It thrives in climates characterized by long summers, or a dry season with long days. It tolerates seasonal waterlogging and salinity. Mean temperatures from 18^0C to 30^0C.
Habitat requirements. Few limiting factors. Will not tolerate very heavy clayey soils.

Description

Faidherbia is a large spreading, thorny tree which can reach heights of 30 m with a diameter at breast height of 2 m. Its natural habitat is along water courses but it will tolerate a wide range of site conditions. The reverse phenology of *faidherbia* means that it is leafless during the wet season. This allows for more light to reach crops during the growing season whilst also reducing competition for nutrients because the trees are dormant during this period. When the leaves return during the dry season the shade will greatly reduce soil moisture losses through evaporation. The leaves drop at the onset of the wet season so that valuable organic matter is fed into the soil in advance of the sowing of food crops.

Main timber products.

Fuel wood and fodder from thinnings and branches (pruning)
Poles from thinning
Faidherbia can be used to make utensils, canoes, furniture, boxes, drums and oil presses. The wood tends to twist.
Other uses:
Suitable for apiculture. The leaves and pods are palatable to domestic animals and an important source of protein for livestock in the dry season. The plant stems are used as fuelwood. The calorific value is estimated at 19.741 kJ/kg of dry wood. Charcoal yields are as low as 17%.

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	Elevational range and climate Range - 0 - 1500masl Range - 700 – 1500 mm/yr
Sub-optimal	Elevational range and climate Range - >1500 masl Range - <700 mm/yr

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

	High	**Medium**	**Low**
Soil type	Coarse, well textured alluvial soils	Coarse, well textured alluvial soils seasonally waterlogged / some salinity	20-30cm depth, heavy clays

Management objectives

Main management objectives. Plant *faidherbia* trees to improve the soil. The whole area will continue to grow crops. The expected productivity of the site will be extended, which will remove the necessity to change mashamba every three to five years. Regular pruning of *faidherbia* will also provide a source of fuel wood and fodder.

Potential income
Poles may be sold but any additional income from this system is likely to be small.

Costs of implementation
Estimated costs per ha:
Establishment (year 1): 3,500 meticais ($145).
Maintenance (year 2 – 5): 1,500 meticais ($62.5)
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
The farmer must first remove any competing vegetation from the mashamba. All foliage and green waste should be spread on site to break down and enrich the soil. This will also help to retain moisture. The whole site must be turned to a low depth (5 – 10 cm). The farmer will then sow any crops (e.g. maize, sorghum), before planting the trees in small planting pits. Planting should establish 200 trees per hectare at a spacing of **10m x 5m**. Propagation can either be done through potted plants or direct sowing. However, direct seeding is not advisable due to the high failure rates.

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 nursery grown stock:
- 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

It is recommended that this system is combined with pigeon pea planting. This will help to improve soil fertility whilst at the same time producing a food crop.

Mycorrhizal inoculation

The following simple mycorrhizal inoculation process is recommended as a way of promoting an association between soil borne fungus and the leguminous trees being planted in the mashamba.

1. Collect soil (only top 15 – 20 cm) from under an area of undisturbed vegetation (including non burning in recent years). Either place this soil in a large container or in a ground pit lined with plastic.
2. Plant a mixture of food crops (maize) and leguminous plants (pigeon peas) into this soil. Maintain by watering regularly.
3. After 3 months cut both the food and leguminous crops at ground level. Stop watering.
4. After a further week (with no watering) pull up the roots of the food and leguminous crops and cut into 1 cm sections. Mix the soil and cuttings together. This is the inoculum.
5. The inoculum should be placed around the root ball of the plant when planting out. Alternatively the inoculum is placed in the container in which the seed is sown, a few centimeters below the seed.

Maintenance
Any weeding should be done as required particularly in the first year after planting to ensure successful establishment. It is assumed that extensive weeding will be associated with crop maintenance.
Pruning in the 2nd year to about half the tree height may be needed to control low branching.

For the first two years after planting any dead trees should be replaced at the beginning of the following wet season.
Crops will continue to be grown throughout the mashamba.
There should be **no** burning at any time. Any foliage and green waste should be left on site and worked into the ground. Woody material from pruning / thinning can either be used as fuel wood or for poles etc.

Regular crown pruning is essential to restrict canopy cover and provide a source of fuel wood. During the

early years care should be taken not to remove the leading stem whilst pruning

Thinning and harvest

Thinning may be done according to the following schedule:

Year	% removal	No. of trees remaining on site per hectare (minimum)	No. of trees that may be felled per hectare(maximum)	Recommended tree spacing (meters)
0		200	0	10 x 5
20	50	100	100	10 x 10

Re-establishment

Re-plant 200 trees at year 50 or as required dependent upon tree senility.

Carbon sequestration potential

Carbon sequestration potential over ***100*** years with a crop rotation of ***100*** years on an average quality site with optimal climatic conditions is ***31.9*** tC/ha above an initial vegetation carbon baseline which is assumed to be zero. The Nhambita carbon calculator (ECCM, 2007) 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 above and below ground 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 model is based on current annual increment ranging from 0 – 21 m^3 / ha / year for planted trees (see Table 1. For details of model inputs see appendix 2).

Year	Stocking (number of trees per hectare)	Current annual increment (m^3/ha/yr)
5	200	0.4
10	200	14
15	200	21
20	100	12.2
25	100	12.8
30	100	13.0
35	100	12.9
40	100	12.8
45	100	12.6
50	100	12.3

Table 1. *Faidherbia albida* current annual increment.

N.B. Tree growth rates (MAI & CAI) for *Faidherbia albida* was calculated by collecting tree growth data (height and diameter at breast height) of 134 trees of varying ages (Table 2)managed as part of a dispersed interplanting system in neighbouring Malawi by ECCM in 2008. Specifically tree measurements were made in Neno, Mwanza, Zomba, Blantyre and Lilongwe districts where the climatic and tree growing conditions are considered to be broadly similar to those found in Sofala Province, Mozambique. All of the trees measured are planted and the majority have been managed by pruning. It is noted that the data are consistent with the findings of Takimoto et al (2008), in a similar rainfall regime.

Tree species	Age (years)	Number of trees measured
Faidherbia albida	3 - 10	49
	11 - 20	53
	21 – 30	21
	31 – 40	1
	41 – 50	20
	>50	0

Table 2. Number of trees measured to calculate *Faidherbia albida* growth rate.

N.B.B **31.9 tonnes of carbon** is equivalent to **116.8 tonnes of carbon dioxide**.

Monitoring

Monitoring targets for the first 4 years are based on establishment; the whole plot must be established by the first 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.

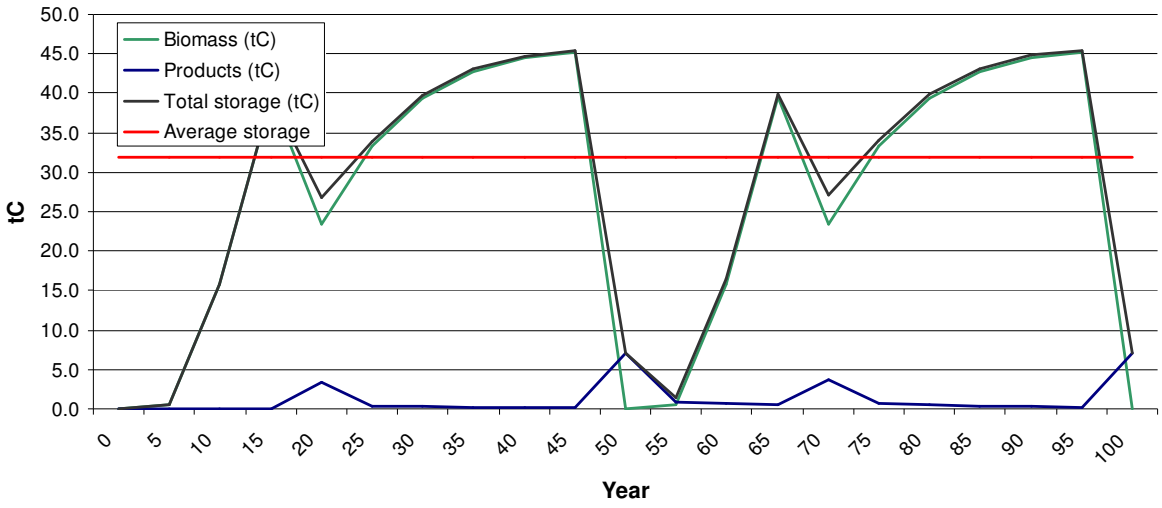
Year	**Indicator**
1	100% plot established. 85% survival.
2	100% plot established
3	100% plot established
4	100% plot established
5	Average DBH not less than 10cm
6	Average DBH not less than 12cm
7	Average DBH not less than 15cm
10	Average DBH not less than 22cm

Information about pests

Ficus thoningii and Taphinanthus dodoneifolius are epiphytes that kill *Faidherbia albida* through strangulation. Nematodes and insect pests include bruchid beetles, which attack the seeds, Kraussiana angulifera and Tylotropidius gracilipes (Orthoptera), which attack young plants, and Cypsotidia angulifera, C. mesonema and C. wollastoni (Lepidoptera), which attack the leaves. (World Agroforestry Centre, 2004).

Appendix 1 Carbon storage figures

Year	Biomass (tC)	Products (tC)	Total storage (tC)
0	0.0	0.0	0.0
5	0.5	0.0	0.5
10	15.8	0.0	15.8
15	39.5	0.0	39.5
20	23.4	3.5	26.8
25	33.4	0.4	33.8
30	39.4	0.3	39.7
35	42.8	0.2	43.0
40	44.6	0.2	44.7
45	45.3	0.1	45.4
50	0.0	7.0	7.0
55	0.5	0.9	1.3
60	15.8	0.6	16.4
65	39.5	0.5	40.0
70	23.4	3.8	27.2
75	33.4	0.7	34.1
80	39.4	0.5	39.9
85	42.8	0.4	43.2
90	44.6	0.3	44.8
95	45.3	0.2	45.5
100	0.0	7.1	7.1



Appendix 2 - CO2Fix Inputs

Stand parameters		
Rotation length (yr)		>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

Tree Growth Table				
Age (yr)	Stem increment CAI (m3/yr)	Dry weight increment relative to stem		
		foliage	branches	roots
0	0.4	0.05	0.2	0.25
5	14			
10	21			
15	12.2			
20	12.8			
25	13.0			
30	12.9			
35	12.8			
40	12.6			
45	12.3			
50	0.4			

Tree species Parameters		
Basic density of stemwood (kg/m3)		560
Carbon content of dry matter		0.5
Turnover of various biomass components (1/yr)	Foliage	1
	Branches	0.05
	Roots	0.05
Mortality as a fraction of trees per year (1/yr)		0.01
Average residence time of carbon in wood products (1/yr)	Dead wood	0
	Energy	0
	Short term products	1
	Medium term products	10
	Long term products	20

Thinning and harvest table						
Thinning age	Fraction stem removed	Dead wood	Energy	Short term products	Medium term products	Long term products
20	0.5	0	0.8	0.04	0	0.16
50	1	0	0.8	0.04	0	0.16

References

Barnes, R.D., and Fagg, C.W. (2003). *Faidherbia Albida*. Monograph and Annotated Bibliography. Tropical Forestry Papers 41. Oxford Forestry Institute.

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.

Takimoto A et al. (2008). Carbon stock and sequestration potential of traditional and improved agroforestry systems in the West African Sahel. Agriculture, Ecosystems and Environment 125, 159-166.

University of Queensland (1998). Forage Tree Legumes in Tropical Agriculture. Published by the Tropical Grassland Society of Autralia Inc.

World Agroforestry Centre (2004). Agroforestry tree database.

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