Technical Specification: FOR-ACME-SUBT1

System: Improved Fallow
Variation: Pine/Oak

Summary[1]

The improved fallow system involves the management of secondary pine/oak vegetation for the production of timber, fuelwood and other products through enrichment planting with *Pinus oocarpa* and liberation thinning to encourage the growth of naturally regenerating oak (*Quercus* sp). These areas, unsuited to permanent agriculture, are either periodically cleared for crops or used for grazing and fuelwood collection. Enrichment planting can greatly enhance income generation from otherwise largely unproductive land.

Ecology[2,3,4,5]

Pine/oak forest occurs in temperate to sub-tropical highland regions of Central America. It contains a number of different species of pine and oak and is associated with a number of other species many of which have local uses. The most important commercial pine species is *P. oocarpa. Q. segouiensis* (roble) and *Q. crispipilis* (chicinb) are amongst the most important oak species in the Chuipas region for local use. Much of the pine/oak forest in the Chiapas Highlands has been degraded through years of timber extraction and charcoal production.

Pinus oocarpa is a light demanding species that grows best between 700 and 2000 masl and with 1000-1500 mm rain /yr. It thrives on free draining soils but will tolerate shallow or infertile soils and steep slopes. The mean annual temperature in its natural range is 13-21°C.

Classification of climate/ site productivity

Climate is classed as optimal and sub-optimal based on the conditions where the species exhibits best performance[2] (the use of this system in areas classified as sub-optimal for climatic conditions is not recommended):

Optimal	Subtropical/temperate, sub-humid 700 - 2000 masl 1000 - 2000 mm/yr
Sub-optimal	Tropical, humid <700 or >2000 masl <1000 mm/yr

Site productivity is inferred from locally reported yield of maize and soil conditions for the site[6]. (Exceptions occur on high planes with sandy soils of medium depth medium site productivity may be assumed even if maize yields are low as maize does not grow well at these higher elevations.)

	High	**Medium**	**Low**
Maize yield in a 'good' year with fertilizer	> 2500 kg/ha	1500-2500 kg/ha	< 1500 kg/ha
Soil type	Loamy/sandy soils few stones, >30cm deep	intermediate	Clayey, stoney soils <20cm deep

Management objectives

The objective is to produce timber and other products from otherwise largely unproductive land. *Pinus oocarpa* produces good quality timber, there is a ready market for both round and sawn wood, it is also used locally for house construction. Oak is the preferred species for fuelwood but trees of good form can produce high value timber. Other native species are used for various purposes including poles, stakes, fruits and flowers. Thinning should aim to liberate both the planted pine and oak trees of good form. Regenerating pine/oak forest has a high biodiversity value due to the variety of tree species and other flora and fauna present. Soil conservation is improved on steep slopes.

Potential income – assuming a net value of timber of US$20 /m3 (accounting for harvesting and transportation costs) 200 m3 pine timber /ha would produce a total net income of US$4,000 /ha at the end of the rotation plus additional benefits from fuelwood and other products. (Volume estimated from average reported yield).

Costs of implementation[7] - Estimated costs per ha over the rotation are: establishment US$290, maintenance US$390 and opportunity cost (lost production from land) US$0-1200 depending site quality

Management operations

Establishment

1. Planting lines of 2m width should be cleared through the existing secondary vegetation to reduce competition for light. The planting lines should be cleared of all herbaceous and shrubby vegetation and all overhanging branches cut back; planting lines may be diverted round larger trees to save labour. It is recommended to cut these lines on an east-west axis to maximise the available sunlight.
2. Holes for seedlings should be 30cm depth and 30cm diameter – large holes produce better conditions for root development. The topsoil is more fertile and should be placed in the bottom of the hole for better rooting. Very compact soils holes may be dug after the start of the rains.
3. It is important to obtain good quality planting stock, which should be ready for planting at the beginning of the rainy season. Planting density should be between 5-700 stems /ha (7x2 to 7x3m), The roots of seedlings should be pruned just prior to planting to help root development.

Maintenance

1. Weeding should be carried twice per year – until canopy closure.
2. Pruning should be carried out when necessary to prevent forking and reduce lateral branching
3. Planting lines should be maintained clear of overhanging branches until the pine trees reach the height of surrounding secondary vegetation.

Thinning and harvest

1. Thinning should take place in year 15, trees of good form should be retained those of poorer form being removed to leave 240-280 stems per ha as the final density (6x7m to 6x6m).
2. The harvest should take place in year 40 when the trees have a diameter of 40cm

Re-establishment

1. Shelterwood: 25 to 30 trees per ha (approx. 20x20m) may be retained as seed trees when the main crop is felled to provide seed for the new crop. Regeneration should be maintained by regular weeding.
2. Re-establishment through the taungya system. An increase in soil fertility may make the plot suitable for replanting with pine seedlings combined with cultivation of maize for the first 3-4 years.

Carbon sequestration potential[8,9]

Carbon sequestration potential over 150 years with a crop rotation of 40 years on an average quality site with optimal climatic conditions is 45.7 tonnes of carbon per ha above an initial soil and vegetation carbon baseline of 181.5 tC/ha.

This includes above and below ground biomass, soil carbon and carbon in products and is based on an assumed annual timber production of 5m3/ha for planted pine trees and 3m3/ha for existing oak vegetation. The baseline is the carbon stock in typical shrub fallow based on the assumption that current land use, involving periodic burning, would continue unchanged and that the long term average carbon storage would be the same as current carbon stock.

Details of the modelling approach and parameters used (initial biomass, maximum potential biomass per ha; species distribution; maximum growth; biomass allocation relative to stem; average annual mortality; wood carbon content; turnover and decomposition factors; product allocation and lifetime) are given in de Jong *et al* 1998. Details of the productivity data are given in de Jong *et al* 1995.

Monitoring[9]

Monitoring targets for the first 3 years are based on establishment; the farmer must have completed planting by the third year. For year 5 the target is based on survival of planted trees. 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 33% plot established
2	At least 66% plot established
3	Whole plot established. At least 475 stems /ha planted
5	85% survival
10	Average DBH not less than 13cm
15	Average DBH not less than 19.5cm At least 240 stems /ha remaining

Additional Information

(Under development)

References

[1] This specification is based on a system used in Chiapas, Mexico

[2] Greaves A. (1982) Pinus oocarpa. [Review Article]. Forestry Abstracts 43(9) 503-526

[3] Webb D.B., Wood P.J., Smith J.P. and Henman G.S. (1984) *A Guide to Species Selection for Tropical and Subtropical Plantations*. Tropical Forestry Paper 15, Oxford, UK

[4] CABI Forestry Compendium

[5] Hellier A., Newton A.C., Ochoa Gaona S. (1999). Use of indigenous knowledge for rapidly assessing trends in biodiversity: a case study from Chiapas, Mexico. *Biodiversity and Conservation* 8: 869-889

[6] Site class characteristics are based on surveys conducted with farmers in the region

[7] Data adapted from Tipper R., de Jong B., Ochoa-Gaona S., Soto-Pinto M., Castillo-Santiago M., Montoya-Gomez G. and March-Mifsut I. (1999) Assessment of the cost of large scale forestry for CO2 sequestration: evidence from Chiapas, Mexico. IEA Greenhouse Gas R&D Programme

[8] de Jong B., Ochoa-Gaona S., Castillo-Santago M., Montoya-Gomez G., March-Mifsut I. And Tipper R. 1998. Modelling forestry and agroforestry opportunities for carbon mitigation at the landscape level. In Nabuurs G., Nuutinen T., Bartelik H. and Korhonen (eds) *Forest Scenario Modelling for Ecosystem Management at Landscape Level*. EFI Proceedings No. 19. pp. 221-238

[9] de Jong B., Montoya-Gomez G., Nelson K., Soto-Pinto L., Taylor J. and Tipper R. (1995) Community forest management and carbon sequestration: a feasibility study from Chiapas, Mexico. *Interciencia* 20(6):409-416