Technical Specification: AF-CERVI-SUBT1

System: Live Fence
Variation: *Pinus oocarpa* (pino) and *Juniperus lucitanica* (cipres)

Summary[1]
Live fences may be established by planting trees around the edge of arable fields or areas of pasture. The trees produce timber and other products and if correctly managed crop yields will not be significantly affected by competition for light or water. This a useful system where land is scarce as crops are not displace by tree planting as the trees are planted on the field boundary.

Ecology[2,3,4]
P.oocarpa and *J.lucitanica* grow naturally in the pine/oak forest in highland regions of Central America, which contains various species of pine, oak and associated species, many of which have local uses. 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 occurs over a wide range of altitude, 250-2500 masl, and rainfall, 700-3000 mm/yr. It grows best between 700 and 2000 masl and with 1000-1500 mm rain /yr on free draining soils[2] and will tolerate shallow or infertile soils and steep slopes. The mean annual temperature in its natural range is 13-21°C.

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

Optimal	700 - 2000 masl 1000 - 2000 mm/yr
Sub-optimal	<700 or >2000 masl <1000 mm/yr

Site productivity is classified by the locally reported yield of maize and soil conditions for the site[5]. (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 of this system is to provide additional products (including timber, poles and fuelwood) from what would otherwise be unproductive ground round the field edge. *Pinus oocarpa* produces good quality timber and there is a ready market for both round and sawn wood. *P.oocarpa* and *J.lucitanica* are used locally for house construction. A live fence may provide increased protection form winds that can damage the maize crop (the fence must also retain its original function of protecting the field from stock). The inclusion of trees in agricultural areas can also provide soil erosion and biodiversity benefits

Potential income – assuming a net value of timber of US$20 /m3 (accounting for harvesting and transportation costs) 100 m3 pine timber /ha would produce a total net income of US$2,000 /ha at the end of the rotation. (Volume estimated from average reported yield).

Costs of implementation[6]- Estimated costs per ha over the rotation are: establishment US$30, maintenance US$26 and opportunity cost (lost production from land) US$0-195 depending site quality.

Management operations

Establishment

1. Although these techniques vary with location the following activities are carried out:

1.1 Clearing weeds

1.2 Making holes for seedlings – large holes 30cm diameter and depth produce better conditions for root development, the topsoil is more fertile and should be placed in the bottom of the hole for better rooting. In very compact soils holes may be dug after the start of the rains.

2. It is important to obtain good quality planting stock, which should be ready for planting at the beginning of the rainy season.

2.1 Planting spacing should be every 3m, representing 133 trees around a 1 ha field.

2.2 The roots of seedlings should be pruned just prior to planting to help root development

Maintenance

1. Weeding should be carried out at the same time as the crops in the field are maintained each year for at least the first 5 years.
2. Pruning should be carried out when necessary to prevent forking and reduce lateral branching

Thinning and harvest

1. No thinning.
2. The harvest should take place in year 40

Re-establishment

1. Re-establishment will involve re-planting after harvest.

Carbon sequestration potential[7,8]

Carbon sequestration potential over 150 years with a crop rotation of 40 years on an average quality site with optimal climatic conditions is 27.9 tonnes of carbon per ha above an initial soil and vegetation carbon baseline of 133 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. The baseline is the carbon stock in typical arable field based on the assumption that current land use 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[8]

Monitoring targets for the first 3 years are based on establishment; all the trees must be planted by the third year with at least 85% survival. 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% trees planted
2	At least 66% trees planted
3	All trees planted (at least 133 stems /ha)
5	85% survival
10	Average DBH not less than 13cm
15	Average DBH not less than 19.5cm

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

[6] 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

[7] 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

[8] 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