Small-Scale Natural Forest Management

A new model for small farmers in the Brazilian Amazon

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Converting Cumaru-ferro (Dypterix odorata) *logs to sawnwood in the forest using a chainsaw. Photo: M d'Oliveira.*

The conventional forest management system proposed for the Brazilian Amazon is not widely applied there (Hummel 1996). Problems arise because of the heavy investment and large areas of forest needed to implement the system, and the long period required for the forest to regenerate after harvesting combined with the low price of timber in local markets. As a result, formal forest management is designed for large properties where investment potential is high.

In the Brazilian Amazon, 50 per cent of the area of a property has to be preserved as legal forest reserve and cannot be converted to agriculture or pastures (this has recently been increased to 80 per cent for big properties exceeding 1000 ha). The only legal economic uses of this land are extraction of non-timber forest products (NTFPs) and sustainable forest management. This article reports on research in Acre State, Brazil, which is focusing on small-scale timber production by farmers on this part of their land. A model is proposed for timber production by small farmers which aims to generate a new source of family income by diversification of household economic activity. An additional aim is the maintenance of the structure and biodiversity of the legal forest reserves, which will increase their importance for conservation.

Ecological Basis

The proposal is based on the ecological hypothesis that low-impact disturbance at short intervals, combined with silvicultural treatments, will create an uneven-aged gap mosaic and permit the maintenance of a forest with a similar structure and biodiversity to that of the original forest. The management system has the same theoretical basis as conventional management in the Brazilian Amazon, but additional activities are necessary because of the characteristics of the properties and the proprietors. A short rotation cycle substitutes for the larger impact caused by heavier interventions. Instead of harvesting all trees of commercial size at one time, they are felled over three rotations of approximately ten years each. The outcome, in terms of yield, is equivalent to the standard rotation of 25–30 years established by IBAMA (Brazilian Institute for the Environment and Natural Resources) for high-impact management. It is important to recognise that low-impact harvesting will only work as a silvicultural system (and improve forest characteristics such as growth and composition) if implemented in short cutting cycles. The extraction of small quantities of timber over long cycles would reduce yield to unacceptable levels and would not create suitable conditions for regeneration of some of the most desirable species such as mahogany (*Swietenia macrophylla*).

The conventional exploitation methods create a large number of gaps at one time. Pioneer plants establish and grow rapidly in response to these conditions, but the desirable commercial species are set back in their growth, which imposes a longer cutting cycle and reduces yield. The model suggests that the natural regeneration of desirable species is promoted by distributing the impacts over a longer time period. Reduced competition from pioneer species might lead to a greater net yield of desirable species and lower amounts of damage to the forest ecosystem.

Techniques and Concepts

There is a long history of forest exploitation in the Amazon based on traditional 'low technology' methods. These techniques require low inputs and have a relatively benign environmental impact, but production and profit margins are also low (Oliveira 1996). The model examined here is a formalisation of these traditional methods.

The extraction of timber by small producers is a seasonal activity. This permits them to continue other essential activities (hunting, fishing, harvesting of NTFPs and subsistence agriculture), which makes an integrated management system feasible and furnishes sustainable production without damaging the forest ecosystem (Oliveira 1992).

The legal forest reserve area of the property is considered as the production unit for the preparation and implementation of a management plan, and there a systematic forest inventory is performed within each forest reserve to be managed. The aggregation of producers into larger units by collective or cooperative agreements facilitates the acquisition of new technologies and reduces the costs of overheads such as transport.

The number of annual harvesting coupes is determined on the basis of a minimum felling cycle of ten years and an annual harvest of 5–10 m^3 timber per hectare. Harvesting recommendations were based on a conservative estimate of 1 m^3 ha^{-1} per year (Silva 1989), although it is envisaged that yield predictions may increase in the future following further growth studies on permanent plots. An additional harvesting rule is applied, whereby the maximum felling intensity inside the compartments is equal to the total commercial volume (stems of harvestable species > 50 cm dbh) divided by three. This rule guarantees the first three rotations of the management system, given the tendency for currently lesser-known and lower-value species to become incorporated into the market in the future. The volume of exploited species in these areas is currently around 20–30 m^3 ha^{-1} (see Table 1). The volume of each species to be harvested is determined on the basis of its abundance and distribution in the area, its volume increment and ecological characteristics, such as seed dispersal potential and seedling light demand. Trees are directionally felled to facilitate their transport and minimise damage to the forest. These operations reduce the number of manoeuvres necessary for primary transport (Oliveira and Braz 1995). The logs are converted by chainsaw or one-man sawmills into boards or other products according to the characteristics of the timber and market demand.

The method used for hauling the sawn timber from the forest to the trailhead is animal traction. This phase is the most expensive and labour-intensive component of the entire system. Haulage by animals has the advantage of generating less soil compaction and modification, and less damage to residual trees, than traditional skidding equipment (Dykstra and Heinrich 1996). Transport of the wood is by trucks from the trailhead to the processing centres or directly to the customer.

Table 1: Distribution of Commercial Tree Species Exploited in Pedro Peixoto Settlement Project (number of seedlings/trees >10 cm dbh ha^{-1}, volume of trees >10cm dbh m^3 ha^{-1})

Species	Regeneration (seedlings ha^{-1})	Tree density (trees ha^{-1})	Total volume (m^3 ha^{-1})
Aspidosperma sp	256.8	3.7	1.3
Protium apiculatum	505.1	13.9	7.3
Cedrela fissilis	13.7	0.9	0.6
Torresia acreana	0.0	0.3	0.5
Dipteryx odorata	91.8	1.5	3.0
Hymineae sp	106.5	0.8	0.9
Manilkara huberi	17.2	0.8	0.9
Couratari spp	387.0	3.1	4.1
Peltogine paniculata	117.8	3.8	3.9
All exploited species		28.9	21.6
All commercial species		61.5	39.9
Total for the area		**375.5**	**73.1**

From Oliveira, 1996

Silvicultural treatments are performed by the farmers. One year before felling, vine-cutting is carried out in the compartments to be harvested. Where appropriate after logging, selective cleaning and weeding is implemented to maximise the development of natural regeneration, but artificial regeneration is carried out by transplanting seedlings of desirable or valuable species with natural regeneration problems (Oliveira 1994). Long-term changes in forest floristic composition, tree growth and natural regeneration will be monitored using permanent sample plots in managed forest.

Preliminary Results

The Small-Farm Forest Management Project is being executed by CPAF-ACRE (Agroforestry Research Center for the State of Acre), and the following data were obtained during field work from the Pedro Peixoto Settlement Project, over the period 1994–1997.

Forest structure

The forest possessed a total volume of 180 m^3 ha^{-1} in trees (>10 cm dbh), and an average of 375 trees ha^{-1}. A high volume of commercial species (40 m^3 ha^{-1}) was present. This volume is composed of hardwood species used in construction, such as *Dipterix odorata* and *Hymenaea courbaril*, and species with an intermediate commercial value, such as *Aspidosperma* sp., *Protium apiculatum*, and *Peltogine paniculata*. Highly desirable species such as *Cedrela odorata* and *Torresia acreana* are also present but with low volume (Table 1).

Around 20 per cent of the trees in the forest have a commercial value. The protected species, the Brazil nut (*Bertholetia excelsa*) and rubber (*Hevea brasiliensis*) were not considered, because their exploitation is forbidden. Similarly, species which produce plywood and veneer were not considered because of the low prices that the local market pays for this kind of wood.

With the exception of *Torresia acreana*, all commercial species were found among the natural regeneration (seedlings > 1 m height and < 10 cm dbh), which was abundant in these areas. These data and the volume of trees suggest that the yield will increase in future rotations (Table 1).

Forest exploitation

(a) Tree-felling and conversion of logs to sawnwood: The efficiency of conversion (in volume terms) of logs to sawnwood was between 61 per cent and 41 per cent for the biggest and smallest trees respectively, with an average of around 50 per cent. The total time to convert 1m^3 was one hour 40 minutes. For a six-hour working day a team of three people was able to produce 3.6 m^3 of sawn timber, which represents a very low productivity even when compared with a small sawmill (around 10 m^3 per day). On the other hand, as the annual potential production of these farms is only about 40 m^3 (10 m^3 ha^{-1} x 4 ha $year^{-1}$), the maximum annual labour requirement is therefore only about six days to convert these logs into about 20 m^3 of boards.

(b) Hauling the lumber: Two methods of hauling were compared. The first was a combination of mechanised and animal hauling, in which oxen were used from the forest management area to the forest boundary, and a small tractor (pulling a wagon with 3 m^3 wood capacity) completed the transportation as far as the secondary road.

The other technique was to use oxen for the whole job. The number of boards transported varied between one and four per ox per trip, according to their shape and weight. The load therefore varied from around 0.19 m^3 (*Dipteryx odorata*) to 0.39m^3 (*Couratari tauari*) with an average of 0.28 m^3. The pace of the oxen was approximately 4 km per hour, and was kept constant even when the distance increased from 200 to 1200 m. However, when the distance increased to 1400 m the time required to load and unload the 'zorra' (a wooden appliance used with oxen to haul the lumber) was not long enough to rest the animals for continuous operation. The total volume transported in one day by a team of two men and one ox varied according to haulage distances, from 1.14 m^3 (1400 m) to 3.36 m^3 (250 m).

General Costs

The production costs were about US$34.5m^3 of sawnwood before transport to the market. Even including transportation costs, the total costs would be around US$50 m^{-3}. The market price for this kind of wood in Rio Branco today varies between US$100 and US$150 m^{-3} according to species and the quality of the lumber. Therefore, even with the low-level of technology and experience available to the farmers for this activity, it was possible to achieve ratio of benefits to costs of around 2:1 (Table 2).

Table 2: Costs of Each Phase of the Forest Management (US$) per cubic metre

Phase	Animal Haulage	Mixed Haulage (Ox and Tractor)
Trails opening	4.20	4.20
Prospective inventory	1.36	1.36
Silvicultural treatment	0.80	0.80
Harvesting and converting logs to boards	14.23	
Haulage		9.70
Distance: 200m	4.57	
1300m	10.60	
Average cost	7.05	
Chainsaw maintenance	5.70	5.70
Transportation of logs	15.00	15.00
Total	**48.34**	**50.46**

Conclusions

- Small-scale forest management for small farmers provides an opportunity to fill a seasonal lull in their work schedule, allowing them to use the forest reserves in an economic and sustainable way. It will help maintain these reserves as forests, in the presence of strong pressure to convert them to pastures and shifting cultivation.
- Projected yields were very conservative in order to promote biodiversity and the ecosystem processes as a whole. In the future when more information about the forest responses is available, new silvicultural techniques should be applied to maximise the yield.
- The introduction of new species (and products) to the market will decrease pressure on the few currently exploited species and the risks of biodiversity loss and genetic erosion. Therefore the current standing stock of timber represents an investment rather like a savings account.
- Investments in training for the farmers and more studies of time and work rationalisation are required through monitoring of all activities involved in forest management.
- In order to avoid loss of profits to third parties, it is desirable that all activities are performed by the farmers either individually or collectively.
- Some outstanding problems, such as the lack of control of the trade in illegal timber, and the entrance of royalty-free timber from areas being converted from forest to agriculture, make it difficult for legally-produced timber to compete on an equal basis. In order to consolidate this system across a large area, some changes in the forest legislation will be necessary and polices will be needed to implement them.

References

Braz, E M and Oliveira, M V N d'. 1994. Manejo Florestal para áreas com Populações Tradicionais. 3° Simpósio Internacional de Estudos Ambientais sobre Eossistemas Florestais. Porto Alegre, Brasil.

Braz, E M and Oliveira, M V N d'. 1996. Planning to reduce damage. *Tropical Forest Update*. Vol 6, no 3. 1996/3. ITTO, Yokohama

Dykstra, D P and Heinrich, R. 1996. Codigo Modelo de Praticas de Aprovechamiento Forestal da FAO.

Hummel, A C. 1996. Aspectos gerais do controle da atividade madeireira na Amazonia brasileira. Universidade Federal do Amazonas – Faculdade de direito. Monografia.

Oliveira, M V N d'. 1994. Regeneração Artificial de Mogno (*Swietenia macrophylla* King.), em Clareiras e Trilhas de Arraste de Exploração Florestal Mecanizada. II Congresso Internacional de Compensado e Madeira Tropical. Belem, Brasil.

Oliveira, M V N d'. 1992. Exploração de madeira em várzea pelo método tradicional no paraná Abufari no médio rio Púrus. EMBRAPA - CPAF-Acre. Boletim de Pesquisa, 7. Rio Branco, Brasil.

Oliveira, M V N d' and Braz, E M. 1995. Reduction of damage to tropical moist forest through planned harvesting. *Commonwealth Forestry Review* 74(3). Oxford Forestry Institute.

Oliveira, M V N d'. 1996. Manejo Florestal em Regime de Rendimeto Sustentado, para Pequenas Propriedades rurais. In Simposio internacional sobre ecossistemas Florestais. Belo horizonte, Brasil.

Silva, J N M. 1989. The behaviour of the tropical rain forest of the Brazilian Amazon after logging. PhD Thesis. Oxford Forestry Institute. Oxford. Unpublished.