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Analysis

Are community-based forest enterprises in the tropics financially viable? Case studies from the Brazilian Amazon

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ABSTRACT

Community-based forest management is an integral component of sustainable forest management and conservation in the Brazilian Amazon, where it has been heavily subsidized for the last ten years. Yet knowledge of the financial viability and impact of community-based forest enterprises (CFEs) is lacking. This study evaluates the profitability of three CFEs in the Brazilian Amazon: Ambé, an industrial-scale, upland forest operation producing logs in a national forest, in Pará state; ACAF, a small-scale operation in flooded forests producing boards with a portable sawmill in Amazonas state; and Mamirauá, one of 30 CFEs in a reserve in Amazonas state producing logs and boards in flooded forests. Costs for each CFE were compiled by forest management activity and cost type. Annual total costs were calculated as the sum of fixed and variable costs and then subtracted from total revenue to obtain annual profit. The annual rate of return on investment was calculated by dividing profits by total costs. The Ambé and Mamirauá cases were profitable, demonstrating rates of return of approximately 12% and 2%, respectively; the ACAF case was not profitable. This study illustrates the benefits of cost-sharing among CFEs, and the potential return for investments in small and large-scale community forestry.

1. Introduction

Collective management of forests for commercial purposes provides an alternative paradigm to the traditional model of the firm as a private enterprise, and presents unique institutional and economic challenges (Antinori, 2005). Often termed community-based forest management, this collective model came to the fore in the 1980s (Amaral and Amaral Neto, 2005; Bray et al., 2005; Scherr et al., 2004), and was linked to global concerns and efforts to protect natural tropical forests from deforestation and degradation, to reduce poverty and inequality in rural areas, and to integrate more relevant and just development assistance to communities (Charnley and Poe, 2007). Its rise also coincided with rapid devolution of forested lands to communities (Agrawal and Gibson, 1999; Stone and d' Andrea, 2001), such that nearly one-fourth of the forest estate in developing countries is currently owned and/or controlled by low-income forest communities (White and Martin, 2002). This global trend continues, though with obstacles and at a slower pace (Sunderlin et al., 2005), amidst growing evidence that community forest management plays an important role in limiting deforestation in the tropics (Bray et al., 2008; Ellis and Porter-Bolland, 2008; Nepstad et al., 2006; Porter-Bolland et al., 2012).

Although many community-based forest enterprises (CFEs) are focused on commercial production, they must often still strive to balance social, political, and income motivations, for example the maximization of jobs versus profit. In addition, as CFEs in the tropics also typically operate under conditions of low levels of worker training, inadequate capital, insecure property rights, restricted market access and information, and small scales of production, it is inevitable that financial viability will also be a challenge. Nonetheless, some studies have concluded that CFEs were not only viable, but had rates of return ranging from 20 to 81% (Medina and Pokorny, 2008; Torres-Rojo et al., 2005). However, these studies frequently excluded costs that are typically subsidized, especially technical assistance and machinery costs (Antinori, 2005; Pinho de Sa and de Assis Correa Silva, 2004). Inconsistent methodologies even within studies (e.g., Antinori, 2005) also make it difficult to compare study results. A notable exception is a study by Medina and Pokorny (2008) that occurred concurrent to this one and included two of the same CFEs. While they used consistent methodologies within their study, since these methods were different

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from ours, their results also differed from ours (this is further elaborated in the Discussion section).

Community-based forest enterprises are important actors in sustainable forest management in the Brazilian Amazon, where communities control nearly 60% of the public forests (SFB and MMA, 2009). Successful CFEs could provide multiple benefits to Brazilian society, including a higher standard of living for rural communities, improved governance of natural resources, and conservation of biological diversity. Community forestry in the Amazon was heavily subsidized from the mid 1990s to the late 2000s, but subsidies have been reduced dramatically in recent years in this region and elsewhere in Latin America (e.g., Mexico, Guatemala).

We report on the financial viability of three CFEs in the Brazilian Amazon using a consistent methodology aimed at full cost accounting (i.e., we included all costs, even those normally subsidized). Each CFE had been in operation for at least a couple of years, and as such, each case study captures the accumulated experience of each CFE along a dynamic, but poorly understood, learning curve. Not surprisingly, our full cost accounting methodology resulted in consistently lower profitability estimates than most other studies to date.

2. Community-based Forest Enterprises in the Brazilian Amazon

Community-based forest management projects for timber production in Brazil began in the mid 1990s.[1] In 2000, Amaral and Amaral Neto reported 14 such pilot projects in the legal Brazilian Amazon. In 2006, the number of communities that had submitted timber management plans in the region dramatically rose to 176 (IEB, 2006), although only about one-third followed through with the plans. Several pilot CFEs received financial support from the government program Support for Sustainable Forest Management in the Amazon (ProManejo) from 1999 to 2007 (ProManejo, 2006a).[2] This support was based on the hope that community forest management would provide a higher standard of living for rural communities, improve natural resource governance and biodiversity conservation, and generate sources of wood produced both legally and in a more environmentally sustainable way (Amaral and Amaral Neto, 2000).

CFEs in the region share many challenges, of which securing land tenure is the most fundamental. In 2000, 57% of the pilot CFE projects were on untitled land (Amaral and Amaral Neto, 2000). However, as the area under “community use” has reached nearly 60% of the Amazon's public forests and is expected to increase each year as the federal government parcels out public forests for industrial concessions and community use (SFB and MMA, 2009), tenure should be less of an obstacle and communities are expected to play an increasingly important role as forest managers. Another challenge arises from the typical 3-year project funding cycle — after three years most CFEs are facing first-time harvest and timber sale challenges.[3] In addition, given tight operational time constraints, all-too-common bureaucratic delays have posed an enormous risk for communities and timber buyers. Perhaps because of preoccupations with these difficult conditions, no CFEs have accessed the few affordable credit programs available (Amaral and Amaral Neto, 2000; personal observations), which may be critical sources of capital when subsidies end. Finally, CFEs have difficulty staying informed of the market (market prices and products demanded), and commonly small volumes, low quality products, and isolation make it difficult to access markets that pay higher prices for legal wood from managed sources. Some CFEs have sought to overcome these challenges through collaboration with other CFEs and/or companies, and participation in forest certification systems.

Despite these challenges, the expectation has been that, with donor support and accumulation of experience and knowledge, pilot projects could develop into financially viable CFEs after a few years. To date, however, the pilot projects have had difficulty getting management plans approved (due in large part to bureaucratic holdups) thus delaying timber harvests and sales. Those pilot projects that have completed timber sales have had difficulty competing with both industrial operations (with large volumes and established market networks), as well as illegal operations (whose low costs and market dominance keep prices artificially low). Profitability analyses of CFEs have been limited (Amaral and Amaral Neto, 2000; Sabogal et al., 2008), and differences in methodology and reporting of results make meaningful comparisons of the few existing studies difficult. Since ProManejo ended in 2007 and the Brazilian pilot projects/CFEs face reduced or discontinued subsidies, it is timely to assess financial viability and consider if incomes and profits are sufficient for community-based forest management to become a competitive and compelling land-use.

3. Community-based Forest Enterprise Case Studies

Of the 16 CFEs in the states of Acre, Amazonas, and Pará that had sold wood since 2005, or would be ready to sell by the end of 2008, we chose three for our financial analysis (Fig. 1). These were chosen to capture diversity in scale, production, and location for CFEs (Table 1). While the case studies illustrate diversity among Brazilian CFEs, they are not necessarily representative of all CFEs in the region. Further, although we sought a range of CFEs to study, we were unable to implement a true experimental design. Thus, it was not possible to unambiguously isolate the impacts of various factors on profitability. However, based on our empirical analysis and observations, we summarize the operating conditions that appear to improve or hinder profitability for the cases investigated.

3.1. Ambé CFE

Forest management for timber production was first implemented in the Tapajós National Forest from 1999 to 2003, as an experiment supported by the International Tropical Timber Organization (ITTO) to determine if industrial-scale reduced-impact logging in the Amazon could be profitable (the findings are discussed later in this paper) (Caetano Bacha and Estraviz Rodriguez, 2007). In 2001, ProManejo representatives proposed a community-based timber management project in the national forest (Medina and Pokorny, 2008). In 2005, COOMFLONA (Mixed Cooperative of Tapajos Green National Forest) was founded and initiated community-based forest management activities under the auspices of the “Ambé project” (Medina and Pokorny, 2008).

The Ambé project had a large staff and two offices (one in the city of Santarém and a second in the national forest 83 km from Santarém). Many temporary workers employed from local communities had received training through the earlier ITTO study. The Ambé project owned two trucks for transporting staff and workers, and also rented a tractor (D60F), skidder (R-Miller), and loader (Clark R-W 20), which came with operators. A closed bid system was used for timber sales,

[1] While we recognize that community forest management is implemented throughout the region for multiple forest products and services, including non-timber forest products, in this article we use the term to imply management for timber production.

[2] The ProManejo project, funded by the PPG-7 program (Pilot Program for Tropical Forest Protection, funded by Germany, European Union, UK, The Netherlands, USA, France, Italy and Russia) supported 17 community forestry pilot projects from 1999 to 2007 (Promanejo, 2006b). The projects varied greatly in participants and types of ownership, from ranchers on individual private properties, to rubber tappers in federal agro-extractive reserves, to riverside communities living in state sustainable development reserves. Forms of organization also varied, including associations, producer groups, and cooperatives. The scale of production ranged from 4 to 500 ha annual harvest units, with harvest rates between 1 and 15 m^3 per ha (ProManejo, 2006a). At the time of our study, six had sought and achieved Forest Stewardship Council certification for their timber management practices (FSC, 2008).

[3] Amaral and Amaral Neto (2000) assert CFEs need a minimum of five years of funding to become established, in part because long delays in management plan approval and frequent changes to national and state regulations result in delayed harvests. Koury (2007) found that the approval process for ACAF, one of the case studies reported here, took 17 months.

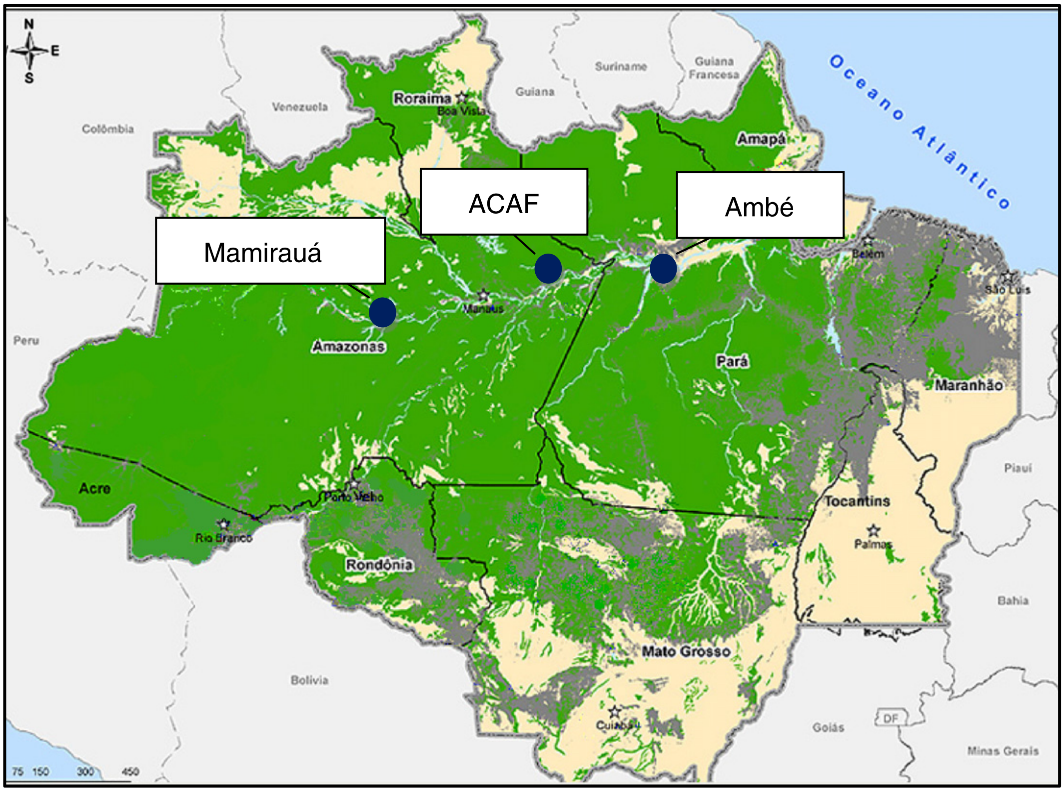

Fig. 1. Locations of the three CFE cases analyzed within Brazil's legally-defined Amazon region.
Adapted from IEB (2006).

Table 1
Summary characteristics for three CFEs in the Brazilian Amazon[a].

Characteristics	Ambé	Mamirauá	ACAF
Organizational structure	A cooperative of 37 members from 18 communities in Tapajos National Forest	30 associations with an average of 5 members each in the Mamirauá Sustainable Development Reserve	An association with 28 members in 3 communities in the Boa Vista do Ramos municipality
Unit of analysis	The cooperative	One hypothetical representative association	The association
Forest type	Upland forest or *terra firme*	Flooded forest or *varzea*	Upland forest or *terra firme*
Timber operation	Industrial-scale	Small-scale	Small-scale
– Annual harvest area	300 ha (30 yr cycle)	18 ha (25 yr cycle)	40 ha[b] (25–50 yr cycle)
– Total annual harvest volume per product	3650 m^3 logs	93 m^3 logs and 97 m^3 boards	20 m^3 boards
– Annual harvest volume of logs ha^{-1}	12.2 m^3	17.2 m^3	1.3 m^3
– Type of extraction	Mechanized (skidder)	Non-mechanized (manual labor)	Mechanized (small tractor)
Workers	7 permanent 40 temporary	7 permanent 5 temporary	21 temporary
Daily wages (USD)	12–17	11	9–18
Forest certification	No	No	Yes

[a] Data presented are based on operational characteristics in 2007 for Ambé, 2007–08 for Mamirauá, and 2006 for ACAF.
[b] ACAF originally planned 80 ha annual harvest units to be managed on a 25-year cycle, but over the last few years it has harvested only half of this area; the area harvested per year will determine the final rotation cycle.

and logs were sold to a local sawmill company (ultimately the only bidder).

3.2. Mamirauá CFE

The Mamirauá Sustainable Development Institute (MSDI) works with community associations in the Mamirauá Sustainable Development Reserve, which constitutes 1,124,000 ha of flooded forest located at the confluence of Solimões, Japurá and Auati-Paraná Rivers (Pires, 2005). The reserve is home to approximately 6000 residents who live in 63 settlements (Pires, 2005). Legal community forest management in the Reserve began with monitoring of traditional extraction methods and participatory mapping in 1993. In 1997, work began with five community associations (a legally registered group of community members), and in 2008, 30 associations participated, each with their own timber management area. Previous logging experience varied among associations, with some older residents having direct experience or secondary knowledge as children of experienced loggers, while others had little to none.

The MSDI employed a professional forester and several technicians to provide training and technical and commercialization assistance; funding was provided by various grants. Typically, once forest inventories were completed, association representatives met with timber buyers (usually intermediaries from the state capital of Manaus) to set minimum prices and collectively negotiate timber sales. Each year as the river began to rise (four to five months after buyer's advance payments were received), association members began felling trees. Associations with access to a portable sawmill (four at the time of our study used a Lucas Mill 827) also produced boards and other milled products. Once the river rose, motorized canoes and manual labor were used to move logs and milled products into streams, float them to lakes, and then form log rafts. Buyers then floated the rafts to Manaus for processing.

3.3. ACAF (Community Agriculture and Forest Extraction Association) CFE

ACAF (Community Agriculture and Forest Extraction Association) was initiated by IMAFLORA (a Brazilian forest certification organization) and the Boa Vista do Ramos municipal government as a pilot project for reduced impact logging, community development, and a test of forest certification for CFEs (Koury, 2007). The municipality is located on a branch of the Amazon River 367 km downriver from Manaus.

ACAF was founded in 1999 with 28 members from three communities. From 1999 to 2004, ACAF conducted 10 small harvesting operations (i.e., harvested several times a year within the same harvest unit while respecting volume limits) in a municipal timber concession. Its first two annual harvest units were 50 ha, which then increased to 80 ha. In 2005, ACAF obtained Forest Stewardship Council (FSC) certification. ACAF's equipment included two chainsaws, a portable sawmill (Lucas Mill 827), a mini-tractor (Agralle 4100) with an attachable cart, and a boat with a 114 hp engine (Koury, 2007). In 2006, 12 members of ACAF chose to work in timber management; other community members were hired to meet labor requirements as needed. ACAF received free technical assistance from a professional forester and a forest technician.

In the ACAF CFE, trees were typically felled in the forest and sawn in situ with the portable sawmill. Boards were then transported by a tractor-pulled cart to the river port (an average of 3 km), then by boat to the community, and finally sent on commercial boat to the buyer. ACAF negotiated two timber sales in 2006 with buyers seeking FSC certified wood.

4. Methods

Both participatory and observational methods were used to collect production cost and revenue data for one year of timber harvesting operations. Data collection was structured so that analyses could be undertaken using computerized spreadsheets within a consistent framework, allowing meaningful comparisons to be made across the case studies.[4]

4.1. Data Collection

Field data for the ACAF case study were collected from March 2006 to February 2007 (Koury, 2007). Data were obtained from input and production monitoring sheets, observations, and cash box receipts. Also, on-site interviews with key informants were conducted to identify challenges faced by the Association in production and marketing of wood products.

Data for the Ambé and Mamirauá cases were collected in November 2007 and February 2008, respectively, using a participatory research framework with staff from each CFE. The framework was structured around workshops which combined training in basic timber production cost and profitability calculations with data collection and analysis.

4.1.1. Cost Categories

Cost data were organized by activity (Table 2) and input-category (labor, machinery/equipment, and materials/services). Input costs omitted in Table 2 (e.g., sales negotiations) were either subsumed under other cost categories (e.g., administration) or not incurred in that particular CFE production model (e.g., skidding and transport for the Mamirauá CFE).[5] All variable and fixed costs associated with each activity were included in analyses (even if they were usually subsidized), and the analytical timeframe spanned one operational year or harvest cycle (which could cover two calendar years). When possible, costs were based on field monitoring data. Otherwise, conservative estimates of production rates and costs were made based on expert opinion provided by CFE forest engineers and technicians.

[4] Although the commonly-used RILSIM data management program was designed to facilitate collection and analysis of data for industrial tropical forestry operations (see http://www.blueoxforestry.com/RILSIM/), it was not used for this study because its data requirements and assumptions were ill-suited to CFE models.

Table 2
Input cost categories included for each CFE case study.

Activity	Ambé	Mamirauá	ACAF
Inventory and planning	√	√	√
Sales negotiations		√	
Tree harvest	√	√	√
Skidding	√		√
Product measurement	√	√	√
Transport			√
Permanent plots	√		
Administrative costs	√	√	√
Certification			√

4.1.2. Timber Revenue

Timber production revenues were computed using timber sale data for Ambé and ACAF. For Mamirauá, timber production revenue was estimated based on average harvest volume by timber value class from 2000 to 2006, and 2008 prices.

4.2. CFE Analyses

A one-year production scenario was developed for each CFE using the best information available. These scenarios were developed to include all costs to better serve as references for other small and medium sized forest enterprises, some of which are paying for technical and administrative assistance (e.g., *ejidos* in Mexico, associations in southern Germany) (e.g., see Lutze, 2010; Stoian and Donovan, 2008). Nonetheless, we recognize that these particular scenarios are not necessarily broadly representative of CFEs around the globe. Although costs and production may vary by year, and technical and economic efficiency of CFEs may increase over time as they gain experience, no attempt was made to address these sources of variation within our one-year analyses.

4.2.1. Production Scenarios

For Ambé, the analysis reported here is based on the CFE's second year of production (2007–2008) on 300 ha (Table 1). This production year was chosen because there was monitoring data available, and we also assumed it would more indicative of financial viability as the operation increased efficiencies and harvest levels. The 300 ha harvest area represents an increase over the initial 2007 area (100 ha), and less than the projected 2009 area (500 ha). Harvest intensity for 2007–2008 was 12.2 $m^3\ ha^{-1}$.

The Mamirauá CFE's scenario was based on log production data for all associations from 2000 to 2006, and one year's data for milling with the portable sawmill.[6] Although output levels per association can vary year to year, we assumed output was relatively stable over this time period. On average, the Mamirauá associations harvested 17 $m^3\ ha^{-1}$ from roughly 18 ha, of which 93 m^3 was sold as logs, and 97 m^3 was sold as boards. Mamirauá associations did not typically maintain cost monitoring records, and thus the MSDI staff

[5] For all three case studies, machinery and equipment were purchased with funds from donors (although Ambé rented the necessary large machinery). Materials and supplies were purchased with advances from buyers. All of these costs are charged to the CFEs in this study.

[6] Production parameters for the conversion of logs to boards were based on field observations by MSDI staff. The conversion rate for Mamirauá was 45% (e.g., 2.2 m^3 of logs = 1 m^3 of boards). Average daily productivity was 3.0 m^3 of boards.

combined discussions with association members with their own personal observations to estimate productivity and cost parameters.

For the ACAF CFE, 2006 monitoring data were used for the sale of boards.[7] This is the only year of production data available. The cost and production parameters from each harvest were averaged to create a scenario representing 1.3 m^3 ha^{-1} harvested over 40 ha, which was used to produce 20 m^3 of boards.[8]

4.2.2. Temporary Labor

Each CFE used a different method to compute labor costs for temporary workers. The Ambé CFE paid a monthly salary, the Mamirauá CFE only disbursed profits, and the ACAF CFE paid a daily wage. To facilitate comparison, a daily wage was computed for each CFE as follows: for Ambé, average daily wages for team leaders and other workers were calculated (monthly wages divided by 25-day work month); for Mamirauá, the minimum daily wage in the region was used; and for ACAF, the actual daily wage rates for association members and non-members were used. Finally, total labor costs were based on actual or estimated days (not months or weeks) worked.[9]

4.2.3. Machinery/Equipment and Materials/Services

Expenditures related to machinery/equipment (e.g., helmets, chainsaws) and materials/services (e.g., gasoline, maintenance) were estimated for most items since these costs were infrequently documented. First, quantities of items needed per activity were estimated. Then, total quantity of items needed for the harvest cycle was calculated.[10] Finally, cost of each item was recorded based on receipts or estimates from staff members who assisted the CFEs.

At the Mamirauá CFE, the portable sawmill was shared by four associations. Thus, to construct a representative CFE, the total cost of the portable sawmill was divided by four.

4.2.4. Technical Assistance and Administration

To fully account for all costs, estimates of technical assistance and administrative costs were included in each analysis. At the Ambé CFE, technical assistance was provided by a full-time forest engineer and a forestry technician. Salaries were also included for a mix of temporary and permanent personnel associated with administering the forestry activities for the cooperative (seven personnel), the cooperative leadership (five personnel), two drivers, and two cooks.

At the Mamirauá CFE, technical assistance was provided by a full-time coordinator, forest technician, researcher, research assistant, and community liaison specialist. Auxiliary costs were included for a variety of temporary personnel including consultants, cooks, and boat drivers. As these technical assistance and administrative costs at MSDI encompassed costs for all of the forestry associations in the reserve (30 associations), the total cost was divided by 30 to estimate the cost for a single CFE.

At the ACAF CFE, technical assistance was provided, at no cost to the CFE, by a professional forester and forest technician. To reflect the value of the services provided by these personnel, a portion of their salary costs were included in the analysis.[11]

4.2.5. Fees, Taxes, Interest, and Depreciation

Various types of fees were incurred. These included annual registration fees for the associations and annual operating plan fees. However, no stumpage fees or royalties (i.e., costs of standing timber) were charged due to the fact these community-based operations are not required to pay such fees on publicly owned land.

At the Ambé and Mamirauá CFEs, the wood product purchasing firms were assumed to pay sales taxes (ICMS), as they had in previous years. However, the ACAF CFE paid the out-of-state 12% sales tax rate on one sale and the in-state rate of 17% on the other — we used an average rate of 14.5%.

None of the CFEs studied received interest-bearing loans — thus the time cost of money was not included in our calculations. However, as an additional analysis, we calculated the amount of capital needed to meet cash flow requirements for one year, and included 5% annual interest on the cost of capital in this scenario.

A challenging aspect of the cost analyses was the determination of a relevant rate of depreciation. Operating conditions for equipment used by tropical CFEs – such as high humidity, inadequate storage infrastructure, and limited availability of maintenance skills and replacement parts – are generally not conducive to optimal productive life. Further, little is known about the useful life of equipment, such as chainsaws or portable mills, as actually used by CFEs. Thus, it was necessary to simplify and modify the standard formula for computing depreciation.[12]

The first modification was, for most equipment, exclusion of a resale value in the formula based on the assumption that equipment was used until it was no longer operable.[13] Second, useful life was specified as the number of harvest cycles each asset would remain productive (rather than as the number of hours the asset could be used based on the manufacturers' estimates of productivity), as estimated by staff based on their field experience with their respective CFEs. The resulting estimates were more conservative than the useful life estimates provided by equipment manufacturers.

The following equation was used to determine the depreciated value of machinery/equipment:

$$D_i = \frac{\mathrm{P_i} \times \mathrm{Q_i}}{\mathrm{L_i}} \tag{1}$$

where D_i is the annual depreciated value, $\mathrm{P_i}$ is price, $\mathrm{Q_i}$ is quantity, $\mathrm{L_i}$ is the estimated useful life in terms of the number of annual harvest cycles, and i indexes the specific item of machinery/equipment. To compute the depreciation value of each item by activity (D_{ij}), the depreciation value for the item is multiplied by the ratio of days item i was used for activity j (a_{ij}) over the total days item i was used for all activities in one annual harvest cycle (b_i):

$$D_{ij} = D_i \times \frac{a_{ij}}{b_i}. \tag{2}$$

[7] During our study period, ACAF, unable to find a buyer for its entire approved volume before the harvesting period, received orders at two different times, which resulted in two small harvests.

[8] Production parameters for the conversion of logs to boards were based on field observations. The conversion rate for ACAF was 39% (e.g., 2.6 m^3 of logs = 1 m^3 of boards). Average daily productivity was 1.2 m^3 of boards (Koury, 2007).

[9] For the Ambé CFE, the total labor cost reflects the fact that, on several days, work was not performed due to weather and/or machinery problems, and therefore costs were not included for these days.

[10] Calculations were based on whether activities were carried out simultaneously or not. At the Ambé CFE, several work teams implemented different activities concurrently, and each team needed its own equipment and materials. Thus, the quantities of equipment and materials needed per activity were summed across the number of work teams. For the Mamirauá and ACAF CFEs, one small team implemented all activities sequentially, so only one set of each equipment item was needed. Finally, the cost of each item was recorded based on receipts or estimates from staff members who assisted the CFEs.

[11] It was assumed that the forester and forest technician contributed 20% and 50% of their time, respectively, to the ACAF CFE.

[12] Depreciation per hour or production unit is usually calculated by taking the price of an asset, subtracting its resale value, and dividing the difference by the total number of hours it can be used or units it can produce during its useful life. Then the depreciation cost for a given year is calculated by multiplying the per hour cost or per unit cost by the number of hours worked or units produced in a given year. These costs are often graduated for present value calculations; for our study we did not graduate the costs.

[13] The only exceptions to this rule were for the two vehicles used by the Ambé CFE which could be sold for parts at an assumed rate of 10% of the total value in the nearby city.

Then, the following equation was used to calculate the total depreciation cost per activity (D_j) of all machinery or equipment (i) used in activity (j):

$$D_j = \sum_{i=1}^{n} D_{ij} \quad (3)$$

where j indexes the activity, and n is the total number of items of equipment or machinery used in activity j.[14]

4.2.6. Rate of Return

Total costs (TC) were computed by summing all variable and fixed costs by cost category and activity. Total revenue (TR) was calculated by summing the revenue per timber value class (high, medium, and low) per product. The arithmetic rate of return reflects the amount of profit made on an initial investment and was computed as the ratio of net revenue (TR–TC) to total cost. For the ACAF and Ambé CFEs, values in Brazilian Reais (R$) were adjusted for inflation to the year 2008. Then values for the three cases were converted to US Dollars ($) using the average exchange rate during February 2008 (Mamirauá CFE data were collected in February 2008).

5. Results

5.1. Costs

Administrative costs, including technical assistance and licensing fees, were the most costly expenditures for the Ambé and ACAF CFEs, and second highest for the Mamirauá CFE (Table 3, Fig. 2). Notably for the Ambé CFE, administrative costs accounted for 73% of total costs. Labor costs associated with administration (mainly technical assistance) comprised high proportions of total costs: 30% for the Ambé CFE, 19% for the Mamirauá CFE, and 18% for the ACAF CFE.[15,16] Processing costs were the largest expenditure for the Mamirauá CFE (44% of total cost) and the second highest expenditure for the ACAF CFE (20% of total cost). Overall, the Mamirauá CFE had the lowest log and board production costs per unit (Fig. 3).

Cost allocation between labor, machinery, and materials were similar for the three case studies (Fig. 4). Nonetheless, a notable difference was that the Ambé CFE paid a rental fee for its large machinery/equipment (e.g., skidder), while the other two operations paid the depreciated annual value of their machinery/equipment.

5.2. Revenue

Revenues varied based on prices received and volumes sold (Table 4, Fig. 5). The product prices varied first by forest type (upland versus flooded forest) and then by species, which were divided into three value classes. Upland species commanded higher prices than flooded forest species across all value classes. Certification also positively affected the price ACAF received for its boards.

5.3. Profit, Rate of Return, and Labor Income

Ambé and Mamirauá were profitable enterprises with rates of return of 12% and 2%, respectively, while the rate of return at ACAF was −48% (Fig. 6, Table 5). Ambé and ACAF had products for which average production cost was greater than price received (Figs. 3 and 5). For Ambé, the class 3 log price of $58 m^{-3} was much lower than the average costs of producing the logs, $91 m^{-3}. For ACAF, the cost of producing boards ($1023 m^{-3}) was 76% higher than the highest board price received ($581 m^{-3}).

In addition to profits, labor income generated was a significant benefit for CFE participants. For our Mamirauá CFE scenario, log production generated 32 labor days per person and sawing generated an additional 33 labor days per person over three months, resulting in an average total income per worker of $688. At the Ambé CFE, the average total income per worker actually paid was much higher: $2307–$3460 for eight months (depending on job type). For ACAF, because subsidies covered its total operating costs, workers received an average total of $175 for 15 days spread over two months (daily wage depended on membership in ACAF and days worked per person varied).[17]

6. Discussion

Our finding that two of the three CFEs studied had profitable annual harvests illustrates that long-term community-based forest management may be financially viable under certain conditions. However, profitability for these two CFEs appears to be quite fragile, and using a one-year timescale is a limitation of our study. For Mamirauá, a decrease in the number of associations that shared costs of technical services and/or the portable sawmill would jeopardize model viability. At Ambé, if monthly salaries for temporary workers were included, instead of wages based on days worked, the operation's profitability would drop to −10%. Nonetheless, it is anticipated that as Ambé simultaneously increases harvest unit size (from 300 to 1000 ha), total harvest volume, and production efficiency, its fixed costs per m^3 will decrease and profitability should increase, even while paying monthly salaries. ACAF, in comparison, will need major increases in product volume and production efficiency to overcome its high fixed costs, especially for machinery.[18] Finally, all three case studies will need new subsidies or better access to credit if their operations are to continue, as the advances they receive from buyers are not enough to cover fixed costs of salaries and equipment.

6.1. What Factors Make Community Timber Production So Expensive?

Administrative costs, including technical assistance and training, were the largest expenditure for Ambé and ACAF, and second largest expenditure for Mamirauá. While Brazil's Public Forest Management Law (PFML, Law 11.284) simplified the management plan requirements for small scale operations, document preparation and processing still require much technical assistance, and training in reduced impact logging and other techniques is quite expensive. These fixed costs would be more manageable for Ambé and ACAF if spread over a larger product volume or among multiple CFEs, especially where several CFEs operate in geographic clusters, as for Mamirauá.

The Mamirauá CFE, despite its poor economies of scale, was able to keep its per unit production costs relatively low. Mamirauá's average cost per cubic meter of producing logs was approximately one-fourth ($24 m^{-3}) the cost for the industrial scale Ambé CFE ($91 m^{-3}) due to cost sharing of technical assistance with other associations within the Reserve, and reliance on manual transportation of logs via waterways. Similarly, cost per cubic meter of producing boards for the Mamirauá CFE ($112 m^{-3}) was nearly one-tenth the cost for ACAF ($1023 m^{-3}), the other small-scale operation. Factors that affected

[14] Since ACAF conducted two harvests in one year of 20 m^3 boards each, we calculated average operating expenses by halving total annual depreciation costs for machinery and equipment and the total costs for materials and services.

[15] The Ambé CFE administrative labor costs included eleven Cooperative leaders that received a 12- or 7-month salary.

[16] It is common for CFE financial viability studies to exclude administrative costs, which are typically subsidized, and thus to provide incomplete results.

[17] Labor income computed for the case studies exceeded the 2007 national minimum of $219/month (R$380) or $9.95/day (based on a 22-day work month). Furthermore, in isolated forested areas it is uncommon for workers to receive the full minimum wage amount. Ambé paid its workers a monthly salary 32% to 98% more, and Mamirauá and ACAF, respectively, paid daily wages 5% and 84% more than the minimum (although ACAF paid non-members of its association 8% less).

[18] ACAF could offset the depreciation cost of its machinery (i.e., boat, tractor) by renting it out.

Table 3
Annual costs for each CFE case study by activity and type (USD, February 2008).

Activity	Ambé					Mamirauá					ACAF				
	Labor	Machinery	Materials	Subtotals	%	Labor	Machinery	Materials	Subtotals	%	Labor	Machinery	Materials	Subtotals	%
Inventory and planning	5513	20,261	1830	27,604	8%	320	154	178	653	5%	647	708	125	1481	7%
Felling	2511	2447	1213	6171	2%	171	409	226	806	6%	854	596	366	1816	9%
Skidding	2130	37,257	9487	48,874	15%	256	190	206	652	5%	–	–	–	–	0%
Processing	–	–	–	–	0%	1735	1653	2375	5763	44%	1037	2573	446	4056	20%
Product measurement	3748	490	487	4725	1%	160	234	311	705	5%	–	–	–	–	0%
Commercialization	–	–	–	–	0%	811	–	62	873	7%	–	–	–	–	0%
Transport	–	–	–	–	0%	–	–	–	–	0%	1147	1383	641	3171	15%
Permanent plots	1098	244	–	1343	0%	–	–	–	–	0%	–	–	–	–	0%
Administration	98,661	35,594	107,759	242,014	73%	2516	249	959	3724	28%	3661	292	4459	8412	41%
Certification	–	–	–	–	0%	–	–	–	–	0%	–	–	1530	1530	7%
Subtotals	113,661	96,293	120,776	330,731		5970	2889	4317	13,176		7346	5553	7567	20,465	
%	34%	29%	37%			45%	22%	33%			36%	27%	37%		

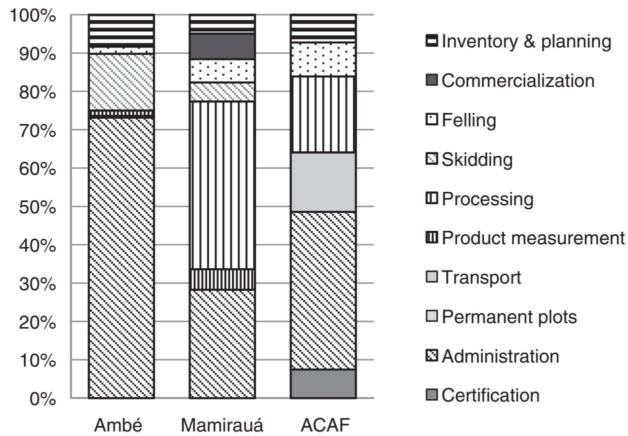

Fig. 2. Annual cost by forest management activity (as proportion of total) for three CFEs in the Brazilian Amazon.

ACAF's higher cost were: lower harvest volume, lower production efficiency, and greater reliance on expensive machinery (Fig. 4).

Processing boards from logs accounted for a large proportion of total expenditures for both the Mamirauá and ACAF CFEs. For Mamirauá, the \$60 m^{-3} difference in income from selling one cubic meter of boards versus the equivalent volume in logs barely exceeded the \$59 m^{-3} processing cost. Yet, processing tripled the amount of daily wages paid. For ACAF, in comparison, the \$136 m^{-3} difference in income from selling one cubic meter of boards versus the equivalent in logs is much less than the \$200 m^{-3} processing cost.[19]

The rate of processing also affected costs, with low productivity per day resulting in high total labor costs. The average productivity range for the operations' Lucas Mill portable sawmills is 2 to 8 m^3 of boards per day, depending on the size of the trees (with higher daily production for larger trees) (Andreas Nagl, *personal communication*). The Mamirauá CFE processed approximately 3 m^3 of boards per day, whereas ACAF processed half of that — both on the low end of the range. Mamirauá's processing efficiency was also higher than ACAF's (2.2 m^3 versus 2.6 m^3 of logs for 1 m^3 of boards).

The sales (ICMS) taxes were burdensome for ACAF (buyers paid these costs for the other case studies). The tax structure (17% for local sales and 12% for out-of-state sales) favors larger producers with better market access.

[19] However, the ACAF production model required the processing of boards so that they could be transported to the river side using an agricultural tractor and wagon. Logs were too large to transport with the mini-tractor.

6.2. What Factors Affect Revenues and Profits?

Prices varied greatly among species within and across forest types, and even across states for the same species (Lentini et al., 2005) (there was little overlap in species sold for our cases) (Table 4; Table A.1). The differences in class 2 log prices between Ambé and Mamirauá (\$105 m^{-3} vs. \$26 m^{-3}, respectively) and class 1 board prices between ACAF and Mamirauá (\$581 m^{-3} vs. \$112 m^{-3}, respectively) were related to higher market prices for upland forest species relative to flooded forest species, and ACAF's certified status. Although MSDI staff attributed lower prices for flooded forest timber to a lack of commercial knowledge of these species, Arima and Veríssimo (2002) cited abundance of flooded forest timber resources and high costs of transportation to processing facilities.

Value added through processing was also reflected in CFE prices received. The price of class 1 boards for Mamirauá was 2.7 times higher than for class 1 logs. However as mentioned above, due to small production volumes and low efficiency, the price differential of added value versus cost for processed boards was small for Mamirauá and not nearly sufficient for ACAF. Nonetheless, one could argue that the additional daily wages generated from processing is sufficient reason to subsidize processing, or at least continue training to increase efficiencies and processing viability. Gretzinger (1998), for example, found that a CFE in the Maya Biosphere Reserve increased profitability through processing with portable sawmills.

While all three CFEs cited low prices as a problem, in general, they obtained prices much higher than recently reported state averages (Lentini et al., 2005) and the ITTO-reported domestic prices for a few species (ITTO, 2008), perhaps because of their legal status and/or innovative commercialization strategies. The Ambé CFE used a closed bid system (as required in national forests), which aimed to encourage higher prices and yet was uncommon in the industry.

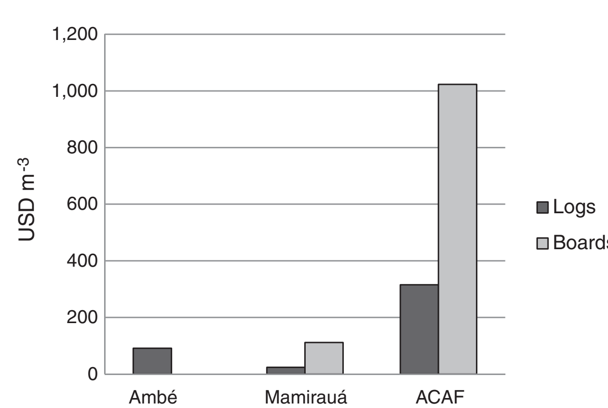

Fig. 3. Annual cost of production per unit for three CFEs in the Brazilian Amazon.

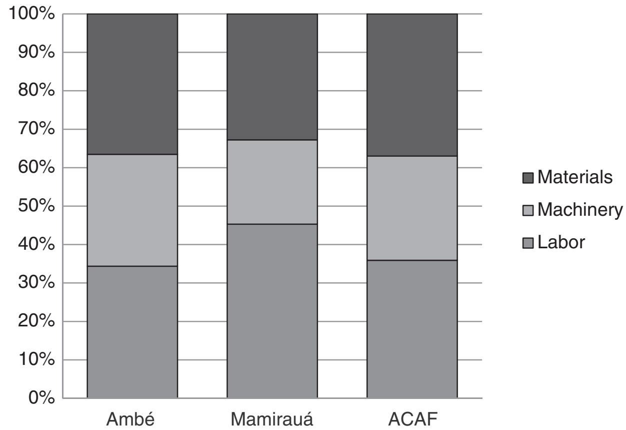

Fig. 4. Cost by category (as proportion of total) for three CFEs in the Brazilian Amazon.

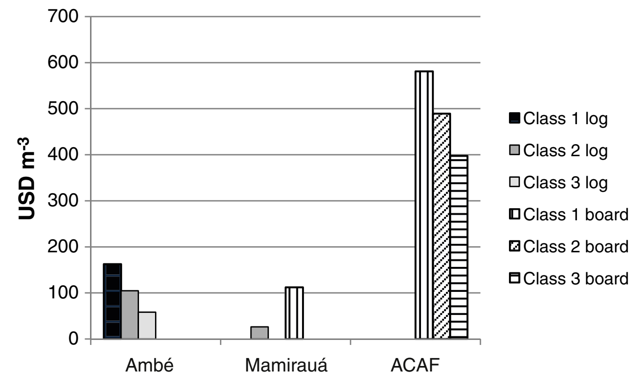

Fig. 5. Price received per unit of product for three CFEs in the Brazilian Amazon.

However, bid system participation rules (e.g., no outstanding taxes or loan defaults) may have excluded some potential buyers, as only one bid was received. Mamirauá associations collectively determined minimum prices and negotiated joint sales with buyers, and their prices have steadily increased (Kibler, 2008). ACAF used its certified producers' group membership to access the national market and negotiate better prices. These CFEs would benefit from local price reporting; data are available for some species in Pará and São Paulo (CEPEA, 2009), but provide limited reference for isolated CFEs.

Location likely affected sales. The Ambé CFE had the advantage of proximity to a major city and good access to roads and rivers. By comparison, CFEs in the Mamirauá Reserve are on average five hours by boat from the nearest city and quite distant from the closest major market; ACAF is also quite distant from all major markets. In addition, the strong governmental presence near Ambé and Mamirauá may have encouraged buyers to purchase legally-produced wood. In contrast, Koury (2007) reported that ACAF members perceived a lack of government oversight and control, and a plethora of regionally-available illegal, cheap wood as major challenges for commercialization.

Total revenue could have been much higher if the CFEs had harvested their total approved volumes. Ambé harvested 91% of its approved volume. ACAF harvested only 8% of its approved volume per hectare (2.6 of 29.5 m^3), due to long approval process delays and difficulty finding buyers for its relatively small volume. ACAF's two small harvests were more expensive and less efficient than a single harvest would have been, although this reduced risk and perhaps waste. ACAF would need to increase board production by 215% in one harvest (assuming same efficiency and productivity rates) to break even (Fig. 7). In the case of Mamirauá, both natural (low river level) and human factors (labor deficiencies) led to harvests of only half the approved volume, even when the entire volume was contractually obligated to buyers. Medina and Pokorny (2008) found that, relative to industrial operations, small and large-scale Amazonian CFEs were 75% and 25% less productive, respectively. They associated this result with CFE participants' general preference for maximizing labor income over profits, high value for free time, and involvement in other important productive activities such as agriculture. Additionally, leaving standing trees in the forest may allow CFEs to capture more value in future harvests, especially as they improve administrative, technical, and business skills.

Table 4
Annual income data for each CFE case study (USD, February 2008).

Product and value class	Ambé			Mamirauá			ACAF		
Log	Price	Volume	Value	Price	Volume	Value	Price	Volume	Value
Class 1	163	735	119,600	40	–	–	–	–	–
Class 2	105	1747	182,747	26	93	2456	–	–	–
Class 3	58	1169	67,936	22	–	–	–	–	–
Board	Price	Volume	Value	Price	Volume	Value	Price	Volume	Value
Class 1	–	–	–	112	97.65	10,972	581	5	2907
Class 2	–	–	–	–	–	–	490	7.5	3671
Class 3	–	–	–	–	–	–	398	7.5	2.983
Total Income	370,282			13,428			9561		

6.3. How Do These Case Studies Compare to Other Studies of Community-based Forest Enterprises?

In an independent study of CFEs in Brazil, Medina and Pokorny (2008) found similar results for the ACAF CFE. For Ambé, however, they found a much higher rate of return than reported here (Table 6). In their analysis, average costs for a 100 ha harvest unit were scaled up to 1000 ha (the expected total area in 2010), whereas we used actual costs, to the extent possible, for a 300 ha harvest. Apparently the economies of scale they anticipated by harvesting 1000 ha had not materialized at the 300 ha scale. For Mamirauá, they studied two different cases for log and board production and found only logs profitable. Their estimate for income from the sale of boards relied on a smaller production volume than we used, and thus did not cover the higher machinery and labor costs for primary processing (i.e., higher fixed costs per unit, Table 6).

The profitability and rate of return on investment for the Ambé CFE, as reported here, was lower than for the industrial ITTO experiment (36%), which ran from 1999 to 2003 (Caetano Bacha and Estraviz Rodriguez, 2007). Both projects operated in the Tapajós National Forest, so forest type, stocking, and market access were very similar. The greater profitability of the ITTO experiment is likely

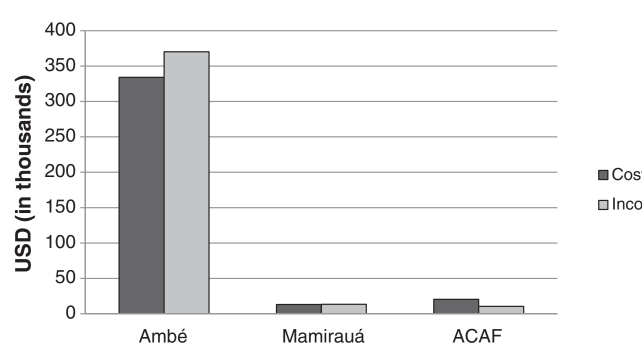

Fig. 6. Total annual production costs and timber sale revenues for three CFEs in the Brazilian Amazon.

Table 5
Annual costs, income, and profit for the three CFE case studies (USD, February 2008).

	Ambé	Mamirauá	ACAF
Total costs	334,183	13,176	20,465
Income	370,282	13,428	10,593 [a]
Profit	39,560	252	−9872
Rate of return	12%	2%	−48%

[a] This is the average income from the two sales (total income/2); in table 4 the total income is based on average prices and an estimate of volume per product based on the two sales.

due to the larger scale of production and higher level of experience of its workers.

Pedro Peixoto, another small-scale CFE in Brazil that produced boards with a portable sawmill, was found to have a rate of return of 63% (Table 6) (Pinho de Sa and de Assis Correa Silva, 2004). However, it is not clear that the full costs of technical assistance, including transportation costs (e.g., vehicles, fuel) and infrastructure (e.g., computers), were included in the analysis. Other CFE studies in Mexico, Guatemala, and Cameroon show profitability for a range of products (Table 6). However, the exclusion of potentially large costs (e.g., administration and machinery depreciation, which were among the highest costs for our cases) and differences in cost accounting methods make it difficult to compare these results and draw conclusions.[20] Failure to account for all costs may cause some CFEs to appear financially viable when, in fact, the results are biased. The rates of return we report (based on full cost accounting) are more modest than most reported in the literature. Nonetheless, these cases illustrate that community-based forest enterprises are operating with the help of subsidies, managing forests, producing timber products, and generating locally-rare opportunities for wages and profits for local populations.

6.4. Methodological Innovations and Limitations

The participatory research method used in this study, combining data collection and analysis with training, allowed staff for the Ambé and Mamirauá CFEs to effectively contribute their expertise, thereby ensuring greater accuracy of data and results and facilitating valuable discussion of conclusions. This training also prepared staff for continued monitoring and evaluation of costs and income.

The procedures used in this study also revealed limitations to be addressed in future research. First, our analysis was based on a single operating year. Not only will costs and revenue vary annually – reflecting differences in biophysical factors such as weather and timber species stocking – but, in addition, the technical and economic efficiency of CFEs are anticipated to increase over time as production experience is gained (which could reduce labor and machinery costs). On the other hand, the analyses reported here are based on first harvest entries into timber stands, as are most tropical timber harvesting studies (Boltz et al., 2003). It is doubtful that future harvests in the same stands will produce similar rates of return due to slower than anticipated growth rates and/or the incursion of illegal logging. A long-term analysis of the net present value of community forestry for these and other CFEs would shed light on their ultimate financial sustainability.

6.5. Future Funding for CFEs in Brazil

Community forestry is an expensive endeavor, and it is unclear where required capital will come from to keep existing CFEs in operation post-subsidies (i.e., cover operating costs and replace machinery and equipment as necessary) and/or to replicate these pilot projects.

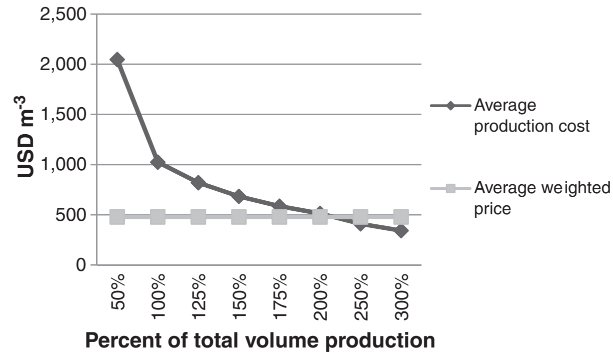

Fig. 7. Per unit annual production costs for ACAF and average weighted price received[a] as a function of total volume produced, relative to actual volume produced (100%). [a]Average weighted price received was calculated based on the volume sold per price class as a percent of the total volume sold.

Medina and Pokorny (2008) estimated start-up costs ranged from $22,400 to $348,000 (not adjusted for inflation) for eight Brazilian Amazonian CFEs, including the ones in this study. The annual operating costs for our case studies ranged from $13,176 to $330,731. Furthermore, all three cases had insufficient profits to cover subsequent year operating expenses, and depended on subsidies, advance payments by buyers, and, frequently, loans from buyers to cover costs. With termination of the ProManejo program in December 2007, continued operation of some CFEs seems uncertain. The new Fundo Amazônia, a Brazilian program whose goal is to compile funds and distribute them to projects aimed at reducing greenhouse gas emissions related to deforestation and forest degradation (http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site_pt), represents a potentially important new source of project-based funding support for community forestry (Tasso de Azevedo, *personal communication*).

Utilizing loans from banks (instead of buyers) to finance cash flow for CFEs would increase total costs, but may be necessary if subsidies end. Although some credit lines were available to CFEs, including a new credit line from Banco da Amazonia and federal and state credit programs, to our knowledge not a single CFE in the Brazilian Amazon accessed these for timber production in 2007.[21] To provide some idea of the scope of the problem, we estimated that Mamirauá and Ambé would need loans to cover operating costs of $9750 and $245,000, respectively, in addition to buyer cash advances.[22] These loan amounts represent 73% of operating costs in both cases, and the 5% interest rate (offered by Banco da Amazonia) would reduce profitability to zero for Mamirauá and 10% for Ambé. Nonetheless, the financial freedom could help CFEs negotiate better prices and access different markets. Mamirauá Sustainable Development Institute notably set up a micro-credit loan program for the forestry associations in 2000, but in 2004 low river levels inhibited log removal, associations were unable to pay back loans, and the program was discontinued. Similar problems have led to recurring debt with buyers who provide loans, complicating efforts to negotiate prices.

7. Conclusions

As evidenced by the history of tropical forest exploitation, implementation of economically and ecologically sustainable methods for tropical timber production presents many challenges for forest enterprises (Jenkins and Smith, 1999). Still, during the past decade,

[20] This is exemplified within the Antinori (2005) study, in which different accounting methods are used within a single study.

[21] See Amaral and Amaral Neto (2005) for a critique of current credit programs available to CFEs.

[22] Buyers paid 25% and 10% of total sale amount in advance, respectively, for Mamirauá and Ambé.

Table 6
Financial case studies of CFEs.

Author	Location	Product	Size of operation	Rate of return	Study limitations
Medina and Pokorny (2008)	Mamirauá, Amazonas State, Brazil	Tropical natural forest — logs	22 ha per year	55%	
		Tropical natural forest — boards sawn with a portable sawmill	10 ha per year	−54%	
Medina and Pokorny (2008)	Ambé, Pará State, Brazil	Tropical natural forest — logs	1000 ha per year	81%	Took average costs for one 100 ha unit and scaled up
Caetano Baucha and Estraviz Rodriguez (2007)	ITTO project, Pará State, Brazil	Tropical natural forest — logs	693 ha per year	36%	
Pinho de Sa and Assis Correa Silva (2004)	Pedro Peixoto, Acre State, Brazil	Tropical natural forest — logs	4 ha per year	63%	
Torres-Rojo et al. (2005)	El Balcon, Guerrero State, Mexico	Temperate natural forest of mixed conifers and hardwoods, and planted pine — Sawn and dried boards	Total area was 15,190 ha natural forest, 163 ha pine plantation	20–30%	Did not include debt payments, depreciation or taxes
Antinori (2005)	45 CFEs, Oaxaca State, Mexico	Temperate natural forest — Stumpage (standing trees)	Size varied	Averages: 39%	Accounting methods differed among communities
		Temperate natural forest — Logs		48%	
		Temperate natural forest — Boards		54%	
		Temperate natural forest — Finished products		32%	
Gómez and Ramírez (1998) (see also Ammour et al., 1995 in Gretzinger, 1998)	San Miguel, Petén State, Guatemala	Tropical natural forest — boards sawn with a portable sawmill	128 ha per year	46%	Excluded concession fees and administrative costs
Ezzine de Blas et al. (2009)	20 communities, Cameroon	Humid natural forest — logs under company management[a]	General total range reported as 3000 ha to 4500 ha	63%	Excluded demarcation of harvest units, forest inventories, and machinery
		Humid natural forest — logs under self management		58%[b]	

[a] The communities were given two timber production options: 1) enter into an agreement with a company which would incur all costs; or 2) self-management, in which the community incurred all costs. Four chose self-management.
[b] Ezzine de Blas et al. (2009) also report that the communities' total benefits per harvested unit for the self-management option (€129.2/m^3) was on average twice the company agreement option (€64.4) due to the labor income for the former.

advances have been made in developing reduced impact logging (RIL) guidelines for tropical forests (Dykstra and Heinrich, 1996), and it has been demonstrated for industrial scale operations that RIL can be both profitable and economically competitive with conventional logging, while reducing the ecological impacts of timber harvesting (Barreto et al., 1998; Holmes et al., 2002; Pokorny and Steinbrenner, 2005). CFEs, with lower economies of scale and less access to resources, are also expected to implement RIL techniques, but until now little effort has been made to assess RIL fit for community operations (although see Rockwell et al., 2007) and to determine if this could be financially viable for them.

Our study provides important insights for Brazil, where community forest management is a key component of national resource policy, as well as for other tropical countries where land devolution and community forestry are increasing. The Ambé CFE demonstrated the potential profitability of large-scale operations that sell logs. The Mamirauá CFE illustrated that small, vertically integrated operations can be profitable when the substantial costs of technical assistance and primary processing are shared with nearby CFEs. The same case also illustrated the value of joint negotiations and sales among CFEs. The ACAF CFE showed that small, isolated operations with very small production volumes cannot afford to pay full costs of technical assistance and machinery, and that primary processing is not necessarily profitable. In conclusion, geographically clustered CFEs stand to benefit from cooperatives and producer groups that facilitate cost sharing and collective negotiations, while isolated, small CFEs will have a harder time benefitting from these groups.

For all three cases, wage opportunities were rare and wages received for timber production represented significant cash income. The generation of daily wages could be sufficient justification to continue low profit margin, value-added activities, such as primary processing, certainly from the association members' perspective. Indeed, it is not clear that CFEs are, or should be, profit maximizing enterprises, and income generation, subject to a satisfactory level of profit, may provide a more appropriate analytical framework.[23]

As Brazil's community forestry pilot projects transition into forest-based businesses, they face decreased direct subsidies. They would benefit greatly from continued indirect subsidies. Subsidized technical assistance (one of the largest costs) through government extension services would provide a huge boon to CFE viability. In addition, improved access to low interest loans would help CFEs cover costs, decrease dependence on buyer financing, and perhaps improve prices received. Improved skills and technologies would increase productivity, which would decrease costs and improve viability. CFEs would also benefit from reduced bureaucratic delays and expenses, which could be ameliorated by further decentralization and special tax rates for CFEs, and a decrease in illegally-sourced timber, which continues to make up at least 40% of the national harvested volume (although estimates vary widely, see Brito and Barreto, 2006; Zarin et al., 2007). Finally, certification, while it represents a significant cost, can help CFEs obtain higher prices and access to the national market (as in the case of ACAF).

Community-based forestry presents many opportunities for forest management and economic development, and CFEs would greatly benefit from policies that address the myriad challenges they face. We recommend further research on the financial benefits of cost sharing and collective sales with cooperatives and producer groups, the benefits of company–community relationships, and other innovative ways to reduce costs and maximize income for communities.

[23] Herbert Simon (1956) suggested that firms attempt to “satisfice” (seek satisfactory outcomes) rather than maximize profits.

Acknowledgments

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Appendix A

Table A.1
Commercial timbers (common names) and prices per value class ($).

Value class	Ambé	Mamirauá	ACAF
High — Class 1	Price: \$163 m^{-3} log (in the log deck in the forest)	Price: \$40 m^{-3} log Price: \$112 m^{-3} board (at meeting place on river)	Price: \$581 m^{-3} log (in municipal port)
	Angelim Pedra Cedro Rosa Ipé Roxo Ipé Amarelo Jatoba Louro Preto Muiracatiara Muirapiranga	Capitari Faveira Gitó Louro abacate Louro amarelo Louro chumbo Louro inamuí Louro preto Maparajuba Mulateiro Perereca Pipinho Piranheira Tanimbuca	Ipê Muiracatiara Pau D'árco Sucupira
Medium — Class 2	Price: \$105 m^{-3} log	Price: \$26 m^{-3} log	Price: \$490 m^{-3} boards
	Cedrorana Currupixá Garapeira Itaúba Maçaranduba Sapulcaia Tatajuba Tauari	Abiorana Arapari Araparirana Assacu Biribarana Castanharana Caxinguba Cedrinho Macacaricuia Mangarana Muiratinga Munguba Mungubarana Mututi Paricarana Tacacazeiro Ucuúba	Pau-ferro Piquiarana
Low — Class 3	Price: \$58 m^{-3} log	Price: \$22 m^{-3} log	Price: \$397 m^{-3} boards
	Jutai-Mirim Fava Vermelho Goiabão Jarana Louro-rosa Louro Vermelho Quaraba-Cedro Virola	Murupita Seringa barriguda	Marupá Louro faia

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