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Annual Cash Income from Community Forest Management in the Brazilian Amazon: Challenges for the Future

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Abstract: Community forest management (CFM) is considered an alternative way to protect forests while providing income for smallholders. Since the mid-1990s, the number of CFM projects has rapidly increased in the Brazilian Amazon, although most of them still face several difficulties. In this paper, we discuss the obstacles to the financial viability of CFM in this region and propose some ways to overcome them. Based on evidence from five case studies, we assess the extent to which sustainable forest management for commercial timber production contributes to smallholder income. We show that harvesting timber only provides a limited cash income to smallholders, even though forest covers 80%

of their landholding. Market access to timber is very uncertain and smallholder communities often fail to make a profit from their timber. Minimum remunerative public prices and support for timber marketing are thus needed. Simpler and more flexible procedures are required to reduce the high transaction costs of obtaining a permit and increase smallholder involvement in legal forest management for commercial purposes. Finally, a better assessment of timber potential in smallholder forest reserves through systematic inventories would be useful to avoid arousing false expectations.

Keywords: Brazilian Amazon; community forest management; tropical timber

1. Introduction

Since the mid-1990s, attempts to implement sustainable community forest management (CFM)—defined here as collective forest management involving several households or communities that is undertaken for commercial purposes—have increased worldwide, in part due to the efforts of international donors and environmental non-governmental organizations (NGOs). Several authors have explored some of the conditions that enable or prevent successful outcomes for CFM projects [1–11]. In Central America, particularly in Mexico and Guatemala, many success stories have been reported [2,8,11,12]. However, even in these countries, ongoing initiatives are still facing many difficulties. The main challenges are related to organizational capacity and access to markets. CFM projects are also affected by regulatory frameworks that in many countries are to their disadvantage and greatly reduce their potential profitability. In Africa and Asia, the proportion of household income derived from CFM is low [13], often too low to have an impact on household assets [14].

In the Brazilian Amazon, according to the Forest Code, until 2012, 50% to 80% of all landholdings had to be conserved as forest, where only sustainable management of timber and non-timber forest products is allowed. According to official data, at least 40 million hectares of forests are held by smallholders and communities and could potentially be managed through sustainable forest management (SFM) [15]. In some states, the existing demand for timber may only be met in the future with an expansion of CFM or small-scale SFM [16].

Public incentives to promote CFM in Brazil started in the mid-1990s with the Promanejo Program (support for sustainable forest management in the Amazon), as a component of the “pilot program to conserve the Brazilian rainforest” (PPG7), which supported several so-called “promissory initiatives.” The creation of new settlement models, such as “extractive reserves” (Portuguese acronym RESEX), agro-extractive settlements (Portuguese acronym PAE), or sustainable development settlements (Portuguese acronym PDS), in regions that still have large continuously forested areas has clarified land and resources rights for the communities. The Brazilian forestry law was reformed in 1998 and again in 2006 to create and subsequently to simplify the legal framework regulating CFM [8]. More recently, the legal framework was again reformed to reinforce the fight against illegal schemes involving smallholders with CFM. Since 2010, communities are no longer allowed to subcontract logging operations to a timber company unless they can prove that they themselves do not have sufficient labor to do the work. Moreover, the Normative Instruction No. 5 from the Ministry of

Agrarian Reform and Normative Instruction No. 16 from the Ministry of Environment introduced new institutions for the assessment and approval of CFM plans. The National Land Reform Institute (Portuguese acronym INCRA) for CFM in agrarian settlements, and the Chico Mendes Institute (Portuguese acronym ICMBio) for CFM in conservation units, must not only approve the plan of operation before it is submitted to the environmental authorities but also their annual management plan.

Currently, smallholders in the Amazon still tend to sell timber to loggers and intermediaries both legally, often by acquiring authorization aimed at converting forest to croplands, and illegally, which likely accounts for the largest proportion, to obtain immediate cash [17,18]. According to the most recent official data, 127 timber CFM projects were submitted to environmental public agencies in the Amazon in 2010, 48 in Pará, 36 in Amazonas, 23 in Acre, 16 in Rondônia, and 4 in Amapá. However, most were not approved and only 53 plans were implemented in 2010 [19]. Public or/and private financial support has been provided for the submission of these CFM projects. In the states of Acre and Amazonas, the drafting and submission of CFM plans have been financially supported by public and NGO funds, including the World Wildlife Fund for Nature (WWF) and the International Union for Conservation of Nature (IUCN). In the state of Pará, many CFM plans in agricultural settlements have been submitted through partnerships between communities and private timber companies [20].

Brazilian CFM projects still face many obstacles. In addition to the financial requirements, the long bureaucratic process required to obtain the necessary legal documents is a barrier for many communities [8,21]. Undertaking forestry operations is costly. Until 2010, any community could decide whether to harvest timber on its own or to contract a timber company. Both schemes have advantages and disadvantages. The building and maintenance of physical infrastructure are usually very costly for communities. Forming a partnership with a timber company helps overcome these difficulties but may reduce the economic return for the community. Without subsidies, few plans cover the operational costs with ease and communities barely succeed in becoming self-sufficient, *i.e.*, independent of the support of an external agent [21,22]. Moreover, technologies that comply with legal requirements are often very costly and are not always successful [18,23].

Like in other countries, one of the main challenges in Brazil is to increase the competitiveness and attractiveness of SFM compared with other land uses [24,25]. Understanding monetary costs and benefits thus plays a central role in developing equitable benefit sharing arrangements and assessing whether the net gains from timber harvesting under CFM are sufficient to encourage a community's long-term commitment to SFM for commercial purposes. To date, few studies have focused on assessing this specific issue. Based on data collected in 2005 and 2006 in four Brazilian CFM plans, Medina *et al.* [22] concluded that none of the case studies they analyzed enabled the communities to derive sound benefits from their forests. More recently, a financial analysis of three CFM projects demonstrated that their financial viability was fragile, and that they needed subsidies or access to credit to cover the fixed costs of salaries [10]. Another recent case study confirmed that potential income from multiple use forest management remains modest and lower than potential agricultural incomes on a per hectare basis [25]. The main limitations of these studies are that the results were based on a one-year assessment and, as pointed out by the authors themselves, costs and benefits can vary greatly from one year to another. Neither do the authors detail and extensively discuss the cash income that communities can expect from CFM on the major part of their landholdings and how to increase this contribution to household income.

It is now quite obvious that the financial viability of CFM in this region remains fragile and that CFM initiatives often depend on external financial support. We do not question the relevance of such subsidies. Rather, our aim is to assess what additional income communities achieved through subsidized CFM initiatives and how this contribution could be increased. To this end, we conducted a detailed analysis of the annual cost and cash income provided by CFM in the Brazilian Amazon. In addition, three of the CFM initiatives presented here were monitored during both the development and exploitation stages. This enabled us to broaden our perspective regarding their economic results and the obstacles to their financial viability, and to make some suggestions on how they can be overcome. We argue that smallholders' income is not guaranteed by SFM for timber production, even though the main part of their landholdings is forested, and that guaranteeing market access at remunerative prices for timber from CFM projects is a priority to ensure their financial viability.

2. Materials and Methods

2.1. Case Studies

This paper focuses on five CFM initiatives, three located in the state of Pará in the eastern Brazilian Amazon and two in the state of Acre in the western Brazilian Amazon (Table 1). Four out of the five cases are official smallholder settlement projects and the other is located in a national forest (FLONAS). The cases selected represent different forest management models and illustrate the diversity of CFM initiatives in the Brazilian Amazon.

Table 1. Main features of the CFM initiatives analyzed.

Characteristics	Chico Mendes	CANOR	Porto Dias	Virola Jatobá	Coomflona
State	Acre	Pará	Acre	Pará	Pará
Land tenure	Concession	Individual	Concession	Concession	Concession in national forest
Number of households	45	6	12	183	180
Area (ha)	12,200	364	3100	26,305	32,000
Area/household involved (ha)	271	61	258	144	178
Annually harvested area (ha)	500	74	120	500–1000	500–1000
Logging intensity (m ³ /ha)	10	15	10	16	12

CFM: Community forest management. CANOR: the Agro-Extractivist Cooperative of Novos Rumos.

The oldest projects are found in Acre. The Porto Dias and Chico Mendes Associations were pioneers in implementing forest management plans. Their members live in settlement models called *Projetos de Assentamento Agro-Extrativistas* (PAE) (Figure 1). In 2007, they joined a cooperative called Cooperfloresta that today manages all CFM projects in Acre.

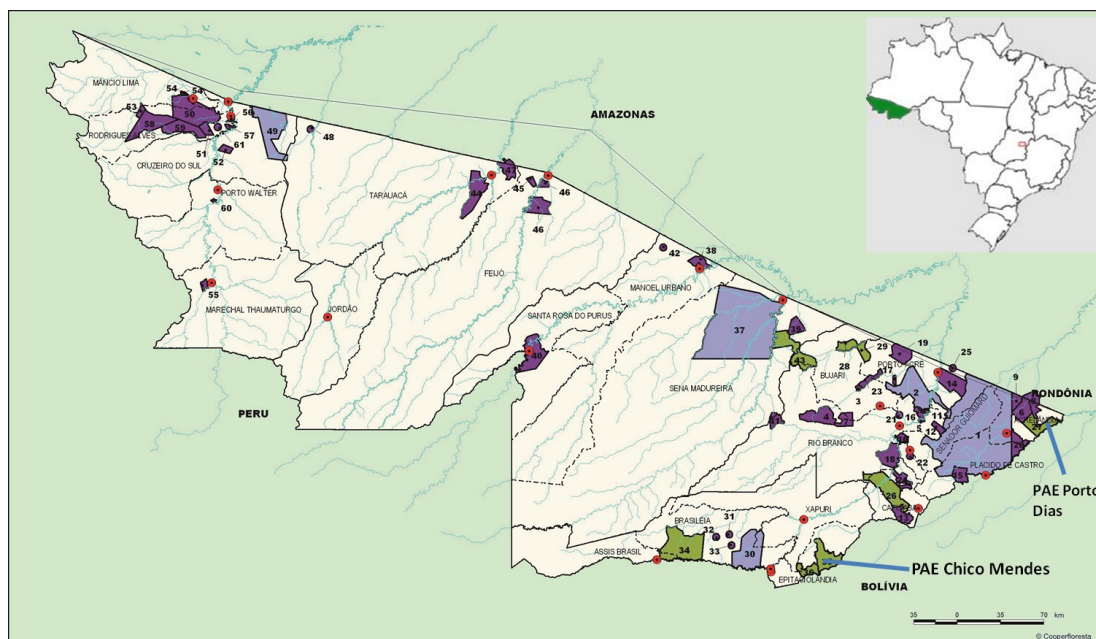


Figure 1. Location of the case studies in Acre.

In Pará, the Agro-Extractivist Cooperative of Novos Rumos (CANOR) is a cooperative of smallholders who settled in the municipality of Uruará in the Transamazon region at the beginning of the 1970s (Figure 2). These smallholders hold plots that average 100 ha, for which they have individual tenure rights, although many have not yet received a formal title. Until 2012, the Brazilian Forest Law required that these smallholders maintain 80% of their plots as legal forest reserves. They can extract the timber and non-timber forest products from the reserves under an approved forest management plan. On the remaining 20% of the land, cattle ranching is the main source of income, but farmers also grow corn and rice.

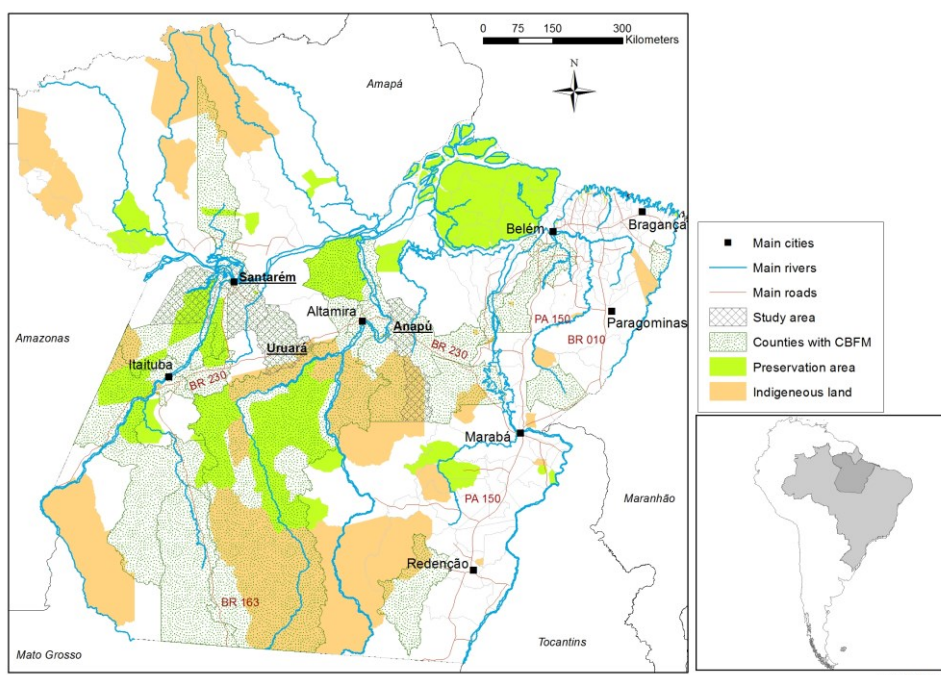


Figure 2. Location of the case studies in Pará.

The second case study in Pará is the Virola Jatobá Association initiative. The Virola Jatobá is a special category of settlement known as a PDS (sustainable development settlement), located in the municipality of Anapu in the Transamazon region (Figure 2). The settlement was created in 2003 and covers 37,000 ha [26]. The legal forest reserve is a continuous area that is accessed collectively. The remaining area is divided into individual plots each averaging 20 ha, where farmers can raise cattle and grow crops. The settlers do not have individual land titles because the association signed a concession contract with the government. The contract guarantees long-term user rights over land and forests under specific rules. Another distinctive feature is that—with the support of the local Rural Union, the Pastoral Land Commission, and NGOs—the association has invested in building a community-company partnership. In 2007, it signed a contract with a tropical wood flooring firm, located in Belém, the capital of the state.

The third case study in Pará is located in the Tapajos National Forest, in the Santarem municipality (Figure 2). In 2005, a cooperative named Coomflona was created to manage the CFM project. The cooperative has 180 members, who are local farmers. The plan received support from the Brazilian Forest Service (Portuguese acronym SFB) and international funds from *Fond Français pour l'Environnement Mondial* (FFEM) [27]. Most forestry operations are carried out by members of the cooperative.

2.2. Economic Assessment Methodology

In Pará, the annual production costs supported by the communities, sales negotiations, and profits obtained were monitored in 2007, 2008, and 2009 as part of two research and development projects financed by international funds (European Fund and FFEM). In Acre, we used Cooperfloresta financial reports including annual costs and gross receipts since 2007, when this cooperative was put in charge of the forestry projects. Additional interviews were conducted with association leaders in 2010, 2011, and 2015 to enable a qualitative assessment of ongoing projects.

The annual costs reported are only those that accrue to the communities. The costs paid by development projects and public funds are not included because (1) it was not possible to obtain reliable data for all the contributions from different sources at the different periods; and (2) in this paper, the focus is on estimating costs paid by members of the communities and additional income generated by CFM including such external supports—not to question the relevance of such supports. Since each plan has its own specificities and has benefited from different types of external support, caution should be used when comparing each category of costs. In addition, in two case studies, the timber was sold as standing trees and the harvesting costs of the timber company were not included as they did not accrue to the community. The detailed production costs are consequently only presented for three case studies. Costs are distributed among (1) administrative costs; (2) the pre-harvest stage, which includes license fees and procedures, inventory, and opening a road and log landing for the parcel to be harvested during the year; (3) the harvesting stage, which includes equipment rentals or depreciation and labor costs for logging, skidding, cubage, and technical assistance; and (4) transport costs to the mill, again only when these accrue to the community. Certification costs are included when they accrue to the community.

Information concerning the potential household income derived from each project comes from two main sources: (1) the net benefits of timber production (*i.e.*, gross annual benefits from timber sales minus the annual production costs paid by the community); and (2) salaries for community members involved in administration or forest management operations. The distribution of benefits among the community members varies with the scheme. In some cases, e.g., in Virola Jatobá or Chico Mendes, the benefits are not distributed but instead are invested in collective goods. However, we decided to distribute the net benefits among all the households involved in order to fully discuss the cash income a family might expect from a CFM plan. As most of the data were collected in 2008, 2009, and 2010, we adjusted the 2008 and 2009 values with the observed IPC (Consumer Price Index) to 2010 (5.9% between 2009 and 2010 and 10% between 2008 and 2010) to correct for inflation. For all the calculations, the following exchange rate was used: US\$1/R\$1.72 in 2010.

3. Results

3.1. Background and Trajectories of the Case Studies

According to official data, around 160 families live in the Porto Dias and Chico Mendes settlements in Acre. There are two types of families: traditional rubber tappers and formerly landless farmers who moved here from different parts of Brazil. The two settlements cover relatively large areas: the Porto Dias settlement covers 24,349 ha and the Chico Mendes settlement 24,098 ha. Each family holds about 300 ha of land, but they do not have private property rights over the land. The whole area belongs to the federal government.

Family incomes depend mainly on rubber tapping and harvesting Brazil nuts. Agriculture is mostly for subsistence. Cattle ranching is a secondary source of income. When the CFM initiatives were launched in 1996, rubber tappers were suffering from a significant drop in income from Brazil nuts as well as a decline in rubber prices that shrunk cash income from forest-based activities. To counterbalance the risk of the expansion of cattle ranching, NGOs started to promote and support forest timber management inside extractive reserves and PAE.

The history of CFM in Acre can be divided into two periods: before and after the foundation of Cooperfloresta. During the first period (between 2000 and 2006), the forest producers in the Porto Dias and Chico Mendes settlements were supported by the *Centro dos Trabalhadores da Amazônia* (CTA), a local NGO, and WWF. They provided support for the preparation of forest management plans and for certification. The objective was to prepare community members to perform all forestry activities: settlers were trained on subjects ranging from logging to selling processed timber. Subsequently, the Porto Dias association purchased an old-fashioned sawmill, whereas the Chico Mendes settlers tried to contract out to external sawmills. However, this operational model did not survive. As the settler associations had difficulty negotiating their contracts, they joined the group of forest producers of Acre (GPFAC), an action sponsored by WWF. The aim of this informal organization was to find buyers and act as middlemen in contracts to sell timber from the CFM areas in Acre. In 2006, this informal group was dissolved, and a single cooperative (Cooperfloresta) was established to assist existing CFM projects in the different stages of forest management.

The creation of Cooperfloresta represents a new stage in the development of CFM initiatives in Acre. Since 2007, the cooperative has been in charge of planning, monitoring, transporting, sawing, and trading all the timber produced by all the CFM projects in the entire state. Nonetheless, the production models have changed significantly over time based on decisions made by the associations and negotiations with partner timber companies. Until 2008, the community members were still in charge of certain forestry activities, such as felling the trees, but other services were already contracted out, including transport of the timber. Between 2009 and 2010, both associations decided to subcontract timber harvesting and transport to a timber company. After 2010, Cooperfloresta carried out logging activities with its own team of members of the communities. Some services requiring heavy equipment such as skidders, tractors, and trucks continued to be outsourced.

In Pará, CANOR was created at the end of the 1990s to implement CFM initially in the legal forest reserves of its 42 members. The proposal received financial support from the Promanejo program in 2004. However, the forest management plan finally submitted in 2006 only involved six members. The other members could not participate either because less than 80% of their landholdings were in forest reserves, or because their forest reserves were inside a demarcated indigenous reserve. CANOR's members originally intended to saw all the timber harvested themselves; to this end, they purchased a portable sawmill with public funds from the Ministry of Agrarian Development (Portuguese acronym MDA). For the transport of the sawn wood out of the forest, they decided to combine animal traction and tractors. Sawn wood had to be transported to buyers in rented trucks since the original idea was to sell all the sawn timber on local and regional markets.

However, these initial plans had to be revised for several reasons. First, the forest management plan was only approved in 2008. From then on, with the technical support of the Floresta and Agricultura (FLOAGRI) project [28], they decided to shift to a more prudent scenario and harvest only 15 m³/ha instead of 29 m³/ha. They also partially abandoned the idea of selling all the timber as sawn wood; only the three most valuable species were to be sawn after a subcontract was negotiated with an industrial sawmill. After the first year of logging, the cooperative stopped operating.

In the case of the Virola-Jatobá CFM, the contract with the tropical wood company was initially intended to last 15 years (2008–2023). During this period, the company was supposed to be in charge of all production activities and to support all logging costs. The price per cubic meter for each species was previously negotiated between the company and the association. The Virola-Jatobá association, with the assistance of its sponsors, negotiated other social and economic clauses to enhance the benefits to the community. One of the contract clauses stated that the enterprise had to employ some community members. The firm had also to maintain the roads within the settlement. Despite these rather positive clauses in the contract, after the first year of exploration, the relationship between the community and the company progressively deteriorated because the company did not comply with many of the clauses. In addition, the company had financial problems and became subordinate to stronger financial partners with fewer social and environmental commitments [26]. The company was responsible for several management irregularities. The contract was finally cancelled in 2012 following Normative Instruction No.5 (see above), and logging stopped until 2014.

In the case of Coomflona, the forest management for timber production started in 1999 as a project supported by the International Tropical Timber Organization (ITTO) aimed at assessing whether reduced-impact industrial logging could be profitable. Some communities that were established around

this project claimed that they could sustainably manage the forest. In 2001, the Promanejo program proposed a CFM plan. Coomflona was created in 2005 and brought together members of different communities to implement the CFM plan. The management model was based on the one implemented by the former project timber company and benefited from the infrastructure that had already been built and from the training that had been provided at that time. From 2010 to 2014, 1000 hectares were cut annually. In 2014, the cooperative succeeded in obtaining the Forest Stewardship Council (FSC) certification. It also increased logging intensity to reach 24 m³/ hectare in 2014. However, Normative Instruction No. 16 from the Ministry of Environment prevented logging in 2015 because ICMBio was unable to assess and approve the annual operations plan in time.

3.2. Production Costs

Total production costs covered by the communities ranged from US\$48/m³ harvested to US\$118/m³ (Table 2). Two main reasons explain the difference. The Porto Dias community subcontracted log harvesting and transport to a timber company. The negotiation concerning harvesting was not favorable for the community since the company quoted US\$53,983 to harvest, or almost US\$41/m³, whereas the cost was much lower for Coomflona and CANOR. In addition, the technical assistance provided by Cooperfloresta during exploitation was included in this harvesting cost as it was paid for by the members of the community, whereas in the other two cases technical assistance was financed through external funds. For CANOR and Coomflona, skidding was the largest share of the harvesting cost. Skidders were rented in both cases and the rental alone amounted to 70% of the skidding costs.

Table 2. Production costs paid by the communities in Coomflona, Porto Dias, and CANOR.

Activity	Coomflona (2008 *)		CANOR (2008 *)		Porto Dias (2010)	
	US\$	US\$/m ³	US\$	US\$/m ³	US\$	US\$/m ³
Administration	130,038	16	10,552	10	31,758	24
Pre-harvesting	78,324	10	2974	3	12,149	9
Harvesting	85,637	11	8476	8	70,965	54
Skidding	74,378	9	6044	6		
Transport	85,695	11	39067	37	34,813	26
Certification					4585	3
Association					2846	2
Total	379,694	48	61,069	58	157,116	118
m ³ harvested	7843		1048		1326	

* cost in 2008 adjusted by the inflation rate between 2008 and 2010 (10%).

The significant variations in the share of pre-harvesting costs, particularly between Coomflona and CANOR, were linked to the fact that, for Coomflona, they covered trail and log landing opening, inventorying, and the drafting and submitting of the annual harvesting plan. In the case of CANOR, the costs of inventorying and drafting and submitting the annual operational plan were fully covered by external funds.

In all the cases, log transport cost (including loading the logs) represented a major share of the production costs; this share was largest in CANOR (64% of the total cost). The unit log transport cost ranged from US\$11/m³ in Coomflona to US\$37/m³ in CANOR. In CANOR and Porto Dias, log

transport and loading were contracted out at an average price of US\$37/m³ and US\$26/m³, respectively. In Coomflona, a loader and a truck were rented. The loader rental accounted for the largest share of log transport costs (US\$10/m³) and the transport costs only covered transport of the logs to the log landing.

Administration costs were substantial in Coomflona and Porto Dias because they covered the salaries of the team responsible for plans, all the procedures, paying taxes/fees, sales negotiations, and accounting, as well as the running costs of the building and equipment (trucks, chainsaws) belonging to the association and the cooperative. In CANOR, until 2009, the plan benefited from the support of an external team financed by an external project, but in practice only one person, the association president, was in charge of plan management. Even in the latter case, the administration cost was substantial, covering several trips to the state capital (Belém) made by the manager to formalize the plan and the association, as well as to pay the annual taxes/fees.

In 2014, we were only able to obtain comparable data for production costs for the Porto Dias case study. The data show that the distribution of production costs was almost the same as in 2010 and that the total production cost per cubic meter had decreased slightly.

One major cost, not included in Table 2, was the cost of drafting and submitting the management plan. Initial costs were mainly funded by the Promanejo program (CANOR, Virola Jatobá, Porto Dias, Chico Mendes) or by an external funding agency such as ITTO, in Coomflona. It was very difficult to obtain data on the cost of this initial stage. However, we did get a general idea of the cost in our interviews and from the data we collected for two of our case studies. CANOR received US\$265,116 from Promanejo in 2004 and about 50% of this amount (US\$132,558) was used to pay for the delimitation and forest inventory of the 24 blocks (a prerequisite for preparation of a technical forest management plan) and the drawing up of the forest management plan and of the first operational plan by a forest engineer. The same level (US\$136,364) was reported by the Virola-Jatobá Association.

3.3. Benefits and Income

Table 3 shows the total benefits for each plan, the annual benefits for each cubic meter harvested, and the annual benefits obtained per household, based on the assumption that the total benefits were distributed among all the households that belonged to the association holding the plan. As mentioned previously, each community itself decided to distribute all or part of the profits obtained or to invest in collective goods. Only CANOR and Porto Dias distributed all the total benefits among all the households holding the plan.

In the end, all the plans made a net benefit, *i.e.*, they succeeded in selling timber at a higher average unit price than the average unit production cost paid by the community. The lowest benefit per cubic meter was obtained by CANOR. In fact, the situation remained critical until the end of 2010 because the total volume of timber sold up to 2010 was only 551 m³ (gross sales: US\$40,517) so the cooperative had a negative balance for some time. A survey carried out on behalf of SFB in 2011 reported that the community finally succeeded in selling the remaining harvested timber [20]. The lowest net benefit per household was calculated for Virola-Jatobá. The yield of timber was lower than expected: instead of harvesting 8000 m³ from 500 ha, the enterprise in fact harvested only 4054 m³ of round timber because the timber potential had been overestimated in the previous forest inventory.

Some trees that had been marked for cutting were located in preservation areas and consequently could not be removed and more trees were hollow than estimated.

Table 3. Benefits from CFM in the five case studies (US\$ and US\$/m³ harvested).

US\$	Coomflona 2008 **	Canor 2008 **	Porto Dias 2010	Virola Jatobá 2008 **	Chico Mendes 2009 ***
Total cost	379,694	61,069	157,116	27,014	108,713
Sales	693,224	77,090	192,794	139,794	203,848
Additional subsidy			17 811		53,095
Net benefit	313,530	16,021	54,070	112,780	148,230
Net benefit/Household	1742	2670	4506	616	3294
US\$/m ³ harvested *	Coomflona 2008 **	Canor 2008 **	Porto Dias 2010	Virola Jatobá 2008 **	Chico Mendes 2009 ***
Total cost	48	58	118	7	23
Sales	88	74	145	35	43
Additional subsidy			14		11
Net benefit	40	16	41	28	31

* For Coomflona the volume harvested was higher than the volume sold. ** As for the production cost, all values for 2008 have been adjusted by the inflation rate between 2008 and 2010 (10%). *** All values for 2009 have been adjusted by the inflation rate between 2009 and 2010 (5.9%).

The highest net benefit per cubic meter harvested was calculated for Coomflona and Porto Dias, despite their relatively high production costs. The high sales prices they negotiated explain their positive results. Coomflona and Porto Dias succeeded in negotiating prices of US\$122/m³ and US\$145/m³ (including transport costs), respectively, whereas the sales price negotiated by CANOR was US\$74/m³. Moreover, the Porto Dias and Chico Mendes settlements benefited from a significant additional subsidy from the state government of Acre. Coomflona benefits could have been even higher because they harvested 7843 m³ but only succeeded in selling 5704 m³ of round logs in 2008.

We were able to collect more recent quantitative data for Porto Dias and Chico Mendes comparable with the data collected concerning 2009 and 2010. These data show that Cooperfloresta succeeded in guaranteeing an annual benefit for the families involved in the management plan that was almost the same as the amount they received in 2009 and 2010.

Some additional income goes to households with members involved in administering the plan or in forest management operations, which was the case in some of the case studies in the state of Pará (Table 4). In the Chico Mendes and Porto Dias case studies, at that time, no community members were employed by the timber companies in charge of the harvesting phase, and the plan was exclusively administered by Cooperfloresta. For the other initiatives, Table 4 shows that the additional income was quite substantial for households with a member involved in administration or forest operations and often surpassed what might be expected from the distribution of net benefits made by the plan.

Table 4. Total income per household including salaries (US\$).

Characteristics	Number of Households	Net Benefit per Household	Salary	Total Income per Household
Coomflona				
Households with a member involved in administration	10	1742	3605	5347
Households with a member involved in forest management	42	1742	3000	4742
Virola-Jatobá				
Households with a member who was a permanent employee of the timber company	2	616	2895	3511
Households with a member who was a temporary employee of the timber company	10	616	3837	4453
CANOR				
Households with a member involved in forest management	4	2,670	469	3139

4. Discussion

Despite the fact that there has been significant improvement in legal community access to large areas of forest, particularly through the expansion of RESEX, PDS, and PAE, this does not necessarily ensure substantial additional income for the families. The Brazilian minimum salary in 2010 was US\$297/month distributed over 13 months, or US\$3861 annually. In our case studies (see Tables 3 and 4), only 74 households (over 426 households involved) could have gained an additional annual income higher than one minimum salary. It is not negligible but it is a relatively small amount when one considers that 80% of each household's land cannot be converted to other uses. In the state of Pará, some authors showed that on a per-hectare basis, income from agriculture is often higher than income from harvesting timber [16,28]. Moreover, incomes from CFM are not always sustained each year. A look at the history of some of the case studies reveals several years without exploration following plan approval: four years for CANOR and Virola-Jatobá; three years for Porto Dias and Chico Mendes. The reasons are the difficulties involved in beginning forestry operations and market uncertainty. Sometimes it is not possible to reach an agreement on timber sales, in which case harvesting becomes very risky, especially when the community lacks the necessary capital to cover pre-harvesting and harvesting costs.

Market conditions are still unfavorable for CFM projects that lack support for the marketing stage. Despite the federal government's effort to fight illegal logging, local sawmills are still supplied by illegal sources. Timber from indigenous lands and settlement areas continue to supply many sawmills with or without the cooperation of the indigenous people and settlers, thereby pushing timber prices down.

The case of CANOR is a good illustration of this situation. Several attempts were made to negotiate and sign a sales contract with various timber companies before harvesting, but not even an oral agreement was reached. The cooperative only succeeded in selling its timber after harvesting at a lower price than in the other case studies. The sales price was not lower because CANOR sold mainly

less-valuable species: 51% of the timber sold by CANOR was from the most valuable species, compared to 52% sold by Porto Dias. Intermediation by Cooperfloresta and the fact that the Porto Dias plan was certified by FSC clearly made a difference during sales negotiations.

Reaching national or international markets remains a challenge for communities. The buyers in Brazil's central (Brasilia) and southeastern (São Paulo) regions demand processed wood that is costly and risky to produce. They are very strict about timber quality and the communities are not equipped or prepared to produce high-quality processed timber.

Even with strong support for marketing, it is often difficult to sell the entire harvest at a profit. The legal requirements of the forest management plan forbid harvesting the same parcel twice without waiting for the legal rotation period. Communities often prefer to harvest all species even if they have not yet found a buyer for some of them. Thus, significant quantities of timber may remain unsold, significantly reducing the final benefit, which was the case for Coomflona. Community–company partnerships may help reduce such risks, as timber companies are more skilled at processing logs and finding suitable markets for end products. However, a community member of the Virola-Jatobá Association claimed the company tried to harvest the most valuable species to the detriment of other species that the community was interested in selling.

Securing market access at prices that make CFM plans financially viable may thus be the first step to increase the potential of CFM in the Amazon and allow for more efficient use of public funds. For example, when the local or regional governments need to buy timber to build schools, medical centers, public housing, and other projects, they could preferentially buy it from areas with CFM plans at guaranteed prices. The current procurement mechanisms do not allow this because the supplier who is chosen is usually the one offering the timber at the lowest price. In Brazil, a system of minimum guaranteed price already exists for smallholders' agricultural products. Establishing an official list of minimum prices for timber from CFM projects may help CFM managers reduce speculation while negotiating with buyers. Public bidding systems, such as in Coomflona, could also provide a mechanism for improving market access.

It is also important to improve the communities' knowledge of the market value of timber stocks in their legal forest reserve areas. In general, supported by donors, each community manages to inventory the first parcel to be harvested. However, an extensive inventory of the entire forest reserve might avoid raising false expectations regarding potential benefits and prevent the community from investing in a plan with limited financial viability. A full forest inventory would enable settlers and communities to better plan future timber sales and would better guide logging operations. Moreover, markets need to be developed for the many less valuable species that are always difficult to sell, since the timber companies, who are the main direct buyers, are not interested in these species.

Securing market access and value for timber from CFM is all the more necessary as not many options exist to reduce production costs.

The initial costs (*i.e.*, inventory, preparation of forest management plans and annual operational plans, starting the bureaucratic process of approval, and follow-up) are prohibitive for the communities. Although community members may be betrayed by unethical professionals who overcharge for their services, particularly once they know that public funds are available, it is also true that contracting the services needed to draw up a forest management plan in the Amazon region is expensive. There are few forestry engineers and technicians available and their fees are usually high.

In addition to having to pay for such services, the community members incur costs for travel to register documents in the state capital. For the elaboration and submission of the Virola-Jatobá plan, travel expenses amounted to US\$9,800 and taxes/fees to US\$10,900. Unfortunately, in Brazil, insufficient data exist on the cost of drawing up a forest management plan, even for private companies [29]. The smaller the volumes available for harvesting, the greater the weight of this fixed initial cost.

Such initial costs could be reduced through a more efficient administrative system and the possibility of registering forest management plans without having to travel to the state capital. As this stage is systematically financed by public funds, a public institution or an organization directly paid by a public institution could be entirely in charge of drafting and submitting CFM plans. For example, in Acre, the state government implemented a bidding system to contract forestry services to draw up, submit, and monitor CFM plans.

In some cases of community–company partnerships, the timber company supports the cost of formalizing the forest management plan. However, such cases can be expected to remain limited to communities with large forest reserves or, as in some cases, when the timber company plans to obtain legal access to the timber for the first harvest without being responsible for post-silvicultural treatments [20]. In any case, this alternative is now more difficult because of Normative Instruction No. 5 from the Ministry of Agrarian Development.

Pre-harvesting and harvesting costs are substantial and there is little room to reduce such costs, except perhaps by investing in skidding equipment. Santos Melo *et al.* (2011) estimated that Coomflona could decrease skidding costs by 30% by investing in a skidder, which would also provide more flexibility for this stage and could be rented out to other communities [30].

The poor condition of internal settlement roads and external roads increases transport costs. The case of CANOR is critical, but the situation may be the same for all smallholders with separate plots willing to invest in CFM. Improving roads may help but will not substantially reduce the cost of transport in the short term, because the major share of these costs is renting transport and loading equipment.

Just after 2010, all initiatives (except CANOR) succeeded in renewing their forest operations, highlighting the importance of internal organization schemes (such as Coomflona and Cooperfloresta) and/or partnerships with a private timber company, even though this may appear somewhat costlier in the short term. Having a full team dedicated to management and operational planning from one year to another makes the difference because annual operational plans, harvest planning, sales negotiations, payment of taxes, contracting services, *etc.* are difficult for one person to manage. Institutional organization also makes the difference: in the state of Para, almost all CFM activities stopped in 2012 because local institutions did not succeed in performing the CFM plan assessment required by the new Normative Instructions in time. This was not the case in the state of Acre.

5. Conclusions

Community forest management for timber production could be financially viable in the Brazilian Amazon with significant public financial support and/or partnerships with private companies. However, the annual cash income a smallholder can expect from 80% of his land area is not sufficient to sustain the family's livelihood. Improving smallholders' incomes from their landholdings—while

preserving the forest—requires investment in research and development to support the implementation of sustainable cattle ranching and agricultural activities in the limited area allowed to be deforested or to find a way to increase SFM profitability. Many other benefits may be obtained from SFM (e.g., creation of employment, income diversification, environmental amenities), but these were not the focus of this study. A major barrier threatening financial viability is insecure market access and poorly remunerative timber prices. Once this barrier is overcome, even with high and incompressible production costs, CFM can succeed in producing net benefits. Today, however, many communities are not in this situation. As it exists for some agricultural products produced by smallholders, a public policy guaranteeing minimum remunerative prices for timber from CFM should be a priority to reduce the risk of failure. Moreover, a better assessment of timber potential in smallholdings is required through systematic inventory, given the large initial fixed cost of drawing up, submitting, and starting a CFM. Finally, the current legal framework could be simplified and should keep a certain level of flexibility to enhance smallholder investment in SFM for timber production.

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Author Contributions

Marie-Gabrielle Piketty and Isabel Drigo designed and performed the research; Evandro Araujo and Driss Pena provided some data; Marie-Gabrielle Piketty, Isabel Drigo, and Plinio Sist analyzed the data and wrote the paper.

Conflicts of Interest

The authors declare no conflict of interest.

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