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Searching for win-win forest outcomes: Learning-by-doing, financial viability, and income growth for a community-based forest management cooperative in the Brazilian Amazon

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ABSTRACT

After more than two decades of investment by donors and governments in community forest management (CFM) initiatives for timber production from natural tropical forests, also known as community-based forest enterprises (CFEs), the sustainability of this livelihood alternative aimed at improved prosperity remains uncertain. Although many studies have focused on the environmental and social dimensions of CFEs, very little is known about their financial viability and socio-economic impacts, even though these elements are critical to ensuring the broad potential benefits of CFM. Furthermore, the lack of a consistent methodology for financial analyses severely limits the ability to learn from CFE case studies across initiatives and time. In an effort to measure the financial viability and identify critical factors that contribute to the poverty-alleviation potential of CFE timber production, we applied a simplified tool for financial analysis in collaboration with a CFE in the Brazilian Amazon three times over six years. The CFE operates in a national forest and is organized as a cooperative with more than 200 members from local communities experiencing high rates of poverty. We analyzed changes in labor productivity and the growth in incomes generated for seasonal and full-time workers, the value of goods and services purchased from the local economy, profits generated, and the overall financial viability of the timber operation. During the study period, the cooperative: (1) demonstrated substantial gains in efficiency and financial viability due to increasing returns to labor inputs, consistent with a model of learning-by-doing; (2) quadrupled the value of labor payments to local communities; and (3) generated substantial other economic benefits. We discuss strategies used by the CFE to improve its financial viability over time, maximize income opportunities for local residents, and respond to financial, social, and political challenges. Our findings indicate the importance of initial support from governments and other partners for start-up capital, subsidized access to trainings and technical assistance, and navigating complex bureaucratic systems, and the positive effect that improved productivity over time, scale economies, and access to markets can have in influencing the poverty-alleviation potential of CFE timber production initiatives in the tropics.

1. Introduction

Identifying policy and management strategies that might lead to a convergence of tropical forest conservation and poverty alleviation (win-win) outcomes is an ambitious and seemingly elusive goal (Sunderlin et al., 2005; Wunder, 2001). A prominent hypothesis regarding win-win tropical forest outcomes during the past two decades has been that investments by donors and governments in community forest management (CFM) initiatives for timber production from natural tropical forests, also known as community-based forest enterprises (CFEs), will reduce tropical deforestation and degradation while improving prosperity, especially from a financial perspective, for forest-dwelling communities.

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While concern with ecological impacts and sustainability have dominated research and debate on community-based forest management (see Rockwell, Kainer, Staudhammer, & Baraloto, 2007, Ellis & Porter-Bolland, 2008, Porter-Bolland et al., 2012, Hari Pandit, Albano, & Kumar, 2009), far less attention has been paid to the economic sustainability of community forestry enterprises. Indeed, relatively few studies have quantified the economic contribution of family or community timber production to livelihoods (Angelsen & Wunder, 2003; Angelsen et al., 2014; Glasmeier & Farrigan, 2005), and a very limited number have looked at the financial viability of CFEs (Beauchamp & Ingram, 2011; Medina & Pokorny, 2008; Ofoulhast-Othamot, 2014; Teitelbaum, 2014). A near complete lack of studies investigating CFE financial viability after project support ends (Humphries et al., 2012) indicates that knowledge regarding economic sustainability is one of the weakest aspects of CFM initiatives (Baynes, Herbohn, Smith, Fisher, & Bray, 2015; Hajjar, Mcgrath, Kozak, & Innes, 2011). This is a reflection of the lower investment in developing the business capacity of forestry enterprises, despite the fact that poor financial management is, as Radachowsky, Ramos, Mcnab, Baur, and Kazakov (2012) note, one of the greatest threats to the sustainability of CFEs.

With 31% of the forests in developing countries owned or designated for use by communities (RRI, 2012), and CFM increasing in importance as a tool for managing forest resources and generating income for local communities, there is a clear need for studies that evaluate the financial viability of the diverse CFE models that exist and their quantitative contributions to local livelihoods. Furthermore, replicable and comparable studies of financial viability and socio-economic impacts are critical for informing discussions of the effectiveness and efficiency of CFEs in alleviating poverty and conserving forests, justifying their further support, and/or improving related policies.

In this study, we address often neglected areas of financial viability and economic impacts of CFEs with a longitudinal financial analysis of the Mixed Cooperative of the Tapajós National Forest (Coomflona), a cooperative managing areas within a national forest (Flona) for timber production in the Brazilian Amazon. We used a consistent and replicable financial analysis methodology (Humphries & Holmes, 2014) to investigate the following research questions for this cooperative spanning the years 2007 to 2013: 1) what are the costs and revenues related to timber production and sales and 2) how much income was generated for local residents. This methodology has been used to analyze different types and scales of initiatives in the Brazilian Amazon region (Humphries & Holmes, 2015). We then compared the results to other studies of timber producing CFEs.

In addition, we investigated how labor productivity evolved over the study period to determine if, as we suspected, learning-by-doing was contributing to improved financial viability over time. Learning-by-doing has been characterized as improvements in labor productivity attained without increased investments in capital. This phenomenon is sometimes referred to as the "Horndal effect" after a Swedish iron works in which labor productivity increased by about 2% per year despite no new capital investment for a period of 15 years (De Liso, Filatrella, & Weaver, 2001). Innovations leading to greater labor productivity have been argued to reflect the cumulative experience of workers (Nillson, 1995). Thus, learning effects may provide intertemporal externalities in production, and provide a rationale for governments in protecting infant industries (Dasgupta & Stiglitz, 1988). By extension, learning-by-doing may also provide a rationale for government investments in initiating community forestry enterprises, for which capital investments in items such as chainsaws and log-hauling machines generally remain fixed over many periods.

The results reported below provide a detailed look at trends in the costs and productivity of a CFM initiative, the incomes generated through temporary wages, permanent salaries, and the local purchase of goods and services, as well as the viability of the operation (i.e., net income, rate of return). We compare financial results with the initiative's objectives for each year, and discuss the strategies Coomflona has employed to improve its financial viability over time, amplify income opportunities for impoverished local residents, and respond to financial, social, and political challenges, from the time it received the right to manage the forest in 2005 through its recent struggles to maintain forest access.

1.1. Community-based forest management (CFM) in the Brazilian Amazon

As a component of Brazil's response to global concerns in the 1970s and 1980s regarding tropical deforestation, the country launched the Pilot Program to Conserve the Brazilian Rainforests (PPG7) at the Rio Earth Summit (1992). PPG7 ran from 1992 to 2009 with funding from the seven most industrialized countries at the time, plus Holland and the World Bank, and aimed to reduce deforestation in Brazil through innovative strategies for the protection and sustainable use of Amazonian and Atlantic forests while also improving the quality of life for local populations (de Antoni, 2010). Under the PPG7 umbrella, much work was done on improving policies, institutional strengthening, and supporting pilot projects, including community forest management pilot projects through the ProManejo project. The overarching goal of the ProManejo project was to support the adoption in the Amazon of forest management as a tool for forest conservation and sustainable production (da Silva Cruz, 2010b).

During and after PPG7, new laws were passed to strengthen the rights of forest communities and rural families to land and resources, and programs were developed to support their economic development based on the sustainable use of resources. In 2000, the National System of Conservation Units law (Federal law 9.985) created sustainable use conservation units in which communities living in public forests were given rights to reside-in-place while utilizing local natural resources. In 2006, the Public Forests Law (Federal law 11.284) created the Brazilian Forest Service and forest concession system, which exempted local communities living in public forests from paying stumpage fees for the harvest of trees and other resources. Programs created to support families deriving a living from forest products include one for minimum price supports for non-timber forest products - such as natural rubber and Brazil nuts (Decree 5.996) - and another that requires 30% of federal funds for school meals to be spent on products from rural families, including edible forest products (Federal Law 11.947).

Families and communities living on public lands in the Brazilian Amazon include farmers who reside in public agricultural settlements (usually with up to 100 ha), traditional peoples who reside (often with 100–400 ha) in federal and state conservation units (e.g., extractive reserves, sustainable development reserves), and riverine communities who live near flooded forests on land considered property of the federal government. According to Brazil's Forest Code (Federal Law 12.651/2012), smallholders on certain types of public lands can sell trees legally (with proper permits) from areas being cleared for agriculture or from designated forest management areas. The size of the areas allowed to be cleared for agriculture or managed for timber depends on the land category and land-use regulations for each settlement or conservation unit.

Forest management and timber sale options available to residents depend on the type of landholding in which smallholders live. Smallholders in agricultural settlements can sell timber individually or as part of an association or cooperative. Typically these farmers enter into individual contracts to sell standing trees to loggers who handle all paperwork and operations with minimal farmer oversight. In sustainable use conservation units, residents can only sell timber as part of an association or cooperative. They can autonomously implement forest management and harvesting decisions (either by securing local labor or by paying professional service providers), or they can enter into an agreement with a logging company which will implement operations with association or cooperative oversight. (For studies on community-company partnerships see Amacher, Merry, & Bowman, 2009, Menton et al., 2009, da Silva Cruz, 2010a)

Timber harvesting methods vary considerably throughout the Brazilian Amazon. Timber from areas destined for agricultural conversion is usually clearcut. Timber from forests designated for forest management must be selectively harvested and harvesting methods can be either conducted using industrial technology (as in the case of Coomflona) or using low intensity methods (e.g., animal traction or cables). For the former option, up to 30 m^3/ha can be removed from the forest on a 35-year rotation (lower volumes/ha can justify shorter rotation lengths), and for the latter, up to 10 m^3/ha can be harvested on a minimum 10 year rotation. Forest areas can be divided into smaller annual harvest units and one area can be harvested each year, e.g., 1000 ha could be divided into 35 annual harvest units of 28 ha each for high intensity operations. Or, as is common for smaller forests, the entire area could be selectively harvested once every harvest cycle, e.g., a 10 ha forest could be harvested once every 10 years for low intensity operations.

Forest management led by a community association or cooperative is usually recognized in Brazil as community-based forest management (CFM), as opposed to family or individual forest management. The number of CFM initiatives, or CFEs, with forest management plans in the Brazilian Amazon was 14 in 1998 (Amaral & Amaral Neto, 2000). Two studies that focused on four states in the Brazilian Amazon found this number peaked in 2006 at 142 (IEB, 2006) and fell to 127 by 2010, of which only 53 plans were being implemented (Pinto, Amaral, & Amaral Neto, 2011). A 2017 survey of state agencies and NGOs working with CFM in three states found a total of only 22 active CFEs: three in Acre, one in Amazonas, and 18 in Pará (Roncoletta & Humphries, unpublished).

Of the CFEs identified in 2017, Coomflona is the only one operating in a national forest (Flona). The only other cooperative running a CFE in Brazil is Cooperfloresta in Acre state, which also received support from the ProManejo project and manages forestry operations for associations in three different conservation units in Acre state. Lessons from these two CFEs have been used to inform the development of other larger scale CFEs in Brazil. Notably, technical staff from Coomflona have provided trainings and technical assistance to a new CFE in the Tapajós Arapiuns Extractive Reserve, which is located across the Tapajós River from the Flona Tapajós.

1.2. The Tapajós National Forest and the Mixed Cooperative of the Tapajós National Forest

The Tapajós National Forest (Flona Tapajós) is located in western Pará state on 527,000 ha of mostly dense tropical forest (IBAMA & ProManejo, 2004) along the eastern margin of the lower Tapajós River (Fig. 1). It is home to about 500 indigenous peoples and 5000 traditional peoples (ICMBio, No Date), and located approximately 50 km from the city of Santarém, which has a population of approximately 300,000 people (Wikipedia, No Date). A 2014 survey of Tapajós National Forest residents found families live mostly from agriculture, the extraction of fruits and other products (e.g., Brazil nuts, rubber), and fishing (Leite, Toledo, & Cardoso, unpublished). The two main municipalities in which the national forest is located, Belterra and Aveiro, have low human development index ratings (PNUD, Fundação João Pinheiro, & IPEA, 2010). This is in part a reflection of the high rates of poverty in the municipalities: in 2010, 47% and 66% of residents in Belterra and Aveiro, respectively, were considered "poor" (earning less than R$ 140/month) and 29% and 42% "extremely poor" (PNUD et al., 2010). More recently, in 2014, 19% and 16% of residents in Belterra and Aveiro, respectively, reported income of less than R$77 or USD 23 per month (Leite et al., unpublished). Government programs provide a critical safety net for many residents. In fact, the 2014 survey (Leite et al., unpublished) found 66.84% of national forest residents reported receiving up to one-half of a minimum salary[1] from a government program, such as Bolsa Familia and/or Bolsa Verde.

The Flona Tapajós was established in 1974 and is part of Brazil's system of protected areas. The establishment of the national forest happened without the consultation or consent of indigenous and traditional peoples who had long lived within its perimeter (IBAMA & ProManejo, 2004). When residents realized efforts were underway to expel them from the forest, they organized with the help of the local church and rural workers' union into three intercommunal associations to identify their options and lobby for their rights. In 1998, after years of political gridlock, the communities signed an agreement with the government institution responsible for the national forest, the Brazilian Institute of the Environment and Renewable Resources (IBAMA), to stay in the national forest. In 2000, communities across Brazil received the right to live in public forests with the passage of Brazil's National System of Conservation Units Law (Federal Law 9.985/2000). The issue of the right to commercial management of the forest came to a head in 1999 when community members discovered that a local company had been hired to harvest trees as part of an experimental project funded by the International Tropical Timber Organization (the ITTO project). Local residents began lobbying IBAMA to give communities the right to manage the forest and implement commercial timber harvests.

In 2003, Ordinance 40 granted the three intercommunal associations the right to implement CFM within the national forest on an experimental basis. These associations formed the Federation of Organizations and Traditional Communities of the Tapajós National Forest (Federação das Organizações e Comunidades Tradicionais da Floresta Nacional do Tapajós – FCFT) in 2004. In 2005, the FCFT founded the Mixed Cooperative of the Tapajós National Forest (Coomflona) and the cooperative received a non-onerous (zero-cost) concession for harvesting timber in 2005. The area of forest originally designated for Coomflona's management and sustainable timber production was approximately 33,691 ha (Fig. 1), and in 2015 the cooperative completed its tenth year of forest management.

Early support for Coomflona came from KfW, a German development bank, which channeled funds through the ProManejo project (Medina & Pokorny, 2008). Medina and Pokorny (2008) reported that the total budget for ProManejo's support of Coomflona, including formalizing the cooperative, establishing infrastructure and purchasing equipment, initial external technical support, and three years of full time administrative and technical staff for the cooperative and other costs for three annual harvests from 2005 to 2007, was R$ 1,785,224 (the equivalent of USD 862,427 in 2008); however, the funds ended before the completion of the third harvest (due to delays in the government approval process) and the planned purchase of a sawmill was cancelled. Nonetheless, based on Medina and Pokorny's (2008) detailed estimates of Coomflona's start-up costs (R$ 400,611 for creation of the cooperative, trainings, the forest management plan, infrastructure, equipment) and annual operating costs (R$918.37/ha), the total need for the first three years of operations, 2005–2007, including

[1] The monthly minimum salary in 2014 in Brazil was R$ 724, or USD 308.

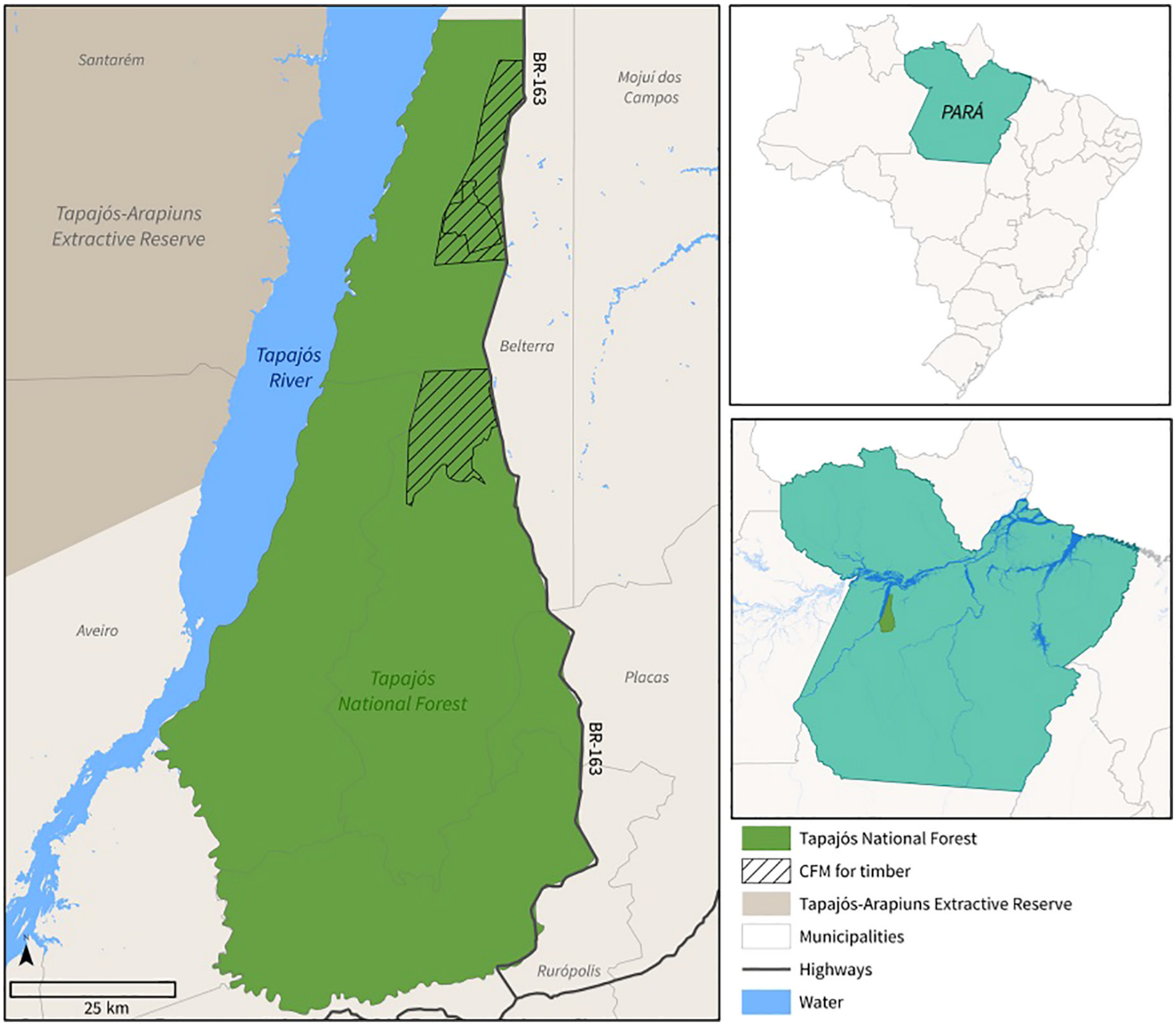

Fig. 1. Map of the Tapajós National Forest (Flona Tapajós) and the area of Coomflona's original timber concession (source: Earth Innovation Institute and ICMBio).

a harvest of 100 ha in 2005/2006, a harvest of 300 ha in 2007, and 500 ha in 2007/2008 would have been only R$ 1,227,144 (the equivalent of USD 593,110 in 2008).

The original business plan for Coomflona included mechanisms through which it would accumulate sufficient capital from its timber sales in the first three years, 2005–2007, to cover its future operating costs without the need for outside assistance. However, due to inefficient financial management and the cancellation of a sales contract in the third year, Coomflona was unable to accumulate the operating capital needed to sustain operations through annual harvests (Humphries, McGrath, & Andrade, 2015). Thus in 2008, another federally funded but smaller project, Floresta em Pé, stepped in to help fund the cooperative. Changes to leadership and efforts to cut costs allowed the cooperative to operate with financial independence as of 2009. Nonetheless, the cooperative continued to receive targeted support from various Brazilian NGOs over the years through, for example, subsidized trainings and help paying the costs of forest certification.

The number of cooperative members has grown each year, depending on the need for new workers. In 2014 there were 212 members from 21 communities in the Flona Tapajós. Requirements for membership included being from a community in the Flona and a member of one of the intercommunal associations. Coomflona is run almost exclusively by these members: in 2014 only 6 of 31 Administrative staff were not members, and all its 57 temporary field workers were members.

Coomflona originally received permission to manage an area of 33,691 ha, comprised of two units of almost 19,000 ha each, less areas used for research and preservation. The proposal was for Coomflona to begin in one of these units with an annual harvest area of 100 ha and incrementally increase the area over time to 1000 ha per year, for a cutting cycle of 30 years (Fig. 2). The total volume harvested each year also grew as, in addition to an increase in the harvest area, the average harvest rate per ha grew from 15.45 m^3 in 2005 to 22.03 m^3 in 2013 (4–7 trees per ha).[2] The gaps between the total volumes authorized versus harvested, and between the volumes harvested versus sold also narrowed (Fig. 2). The species sold included more valuable tropical hardwoods often processed and sold as furniture and flooring in national and export markets, and less valuable lighter woods, usually destined for domestic markets for construction.

In 2012, the recognition of indigenous territories within the Flona led to the removal of 20,691 ha from a northeast section of the Flona, which significantly overlapped with Coomflona's timber production area. Coomflona and the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the government institution that manages activities in the national forest, initiated the process of obtaining authorization for the timber production area to be

[2] The actual volume to be removed is specified in the legal authorization from the government based on an annual operating plan submitted by Coomflona each year, which in turn is based on the detailed inventory for the harvest unit.

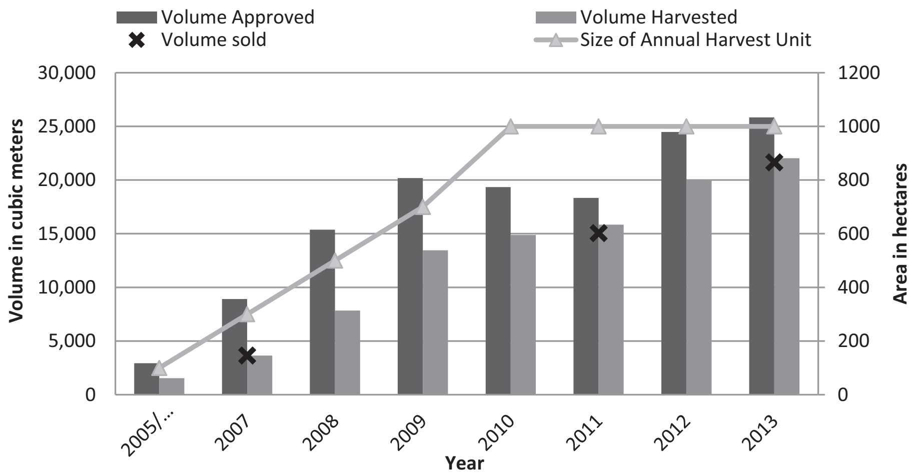

Fig. 2. Information on annual harvest area and volume for Coomflona from 2007 to 2013 (source: ICMBio, Coomflona).

shifted to two potential new areas in the Flona. The proposal was to increase Coomflona's annual harvest unit in the new area to 2000 ha. To avoid jumping straight from 1000 ha to 2000 ha, Coomflona was granted permission to harvest approximately 1600 ha per year for the final two harvests in the original forest management area.

Coomflona manages the preparation and submission of annual operating plans and other legal documentation, as well as all field operations, from the initial planning and forest inventory, through harvesting, to transporting logs to a central patio or holding area where they are retrieved by buyers. Coomflona implements reduced impact harvesting techniques and worked for several years to obtain Forest Stewardship Council (FSC) forest certification, which was achieved in late 2013. It hires local service providers for heavy machinery and operators as follows: a tractor for road construction; a skidder to remove trees from the forest; a loader and truck to move logs from the forest to a central patio; and a loader to unload logs in the central patio. In 2013 it had a total of two skidders in operation (one leased and one rented).

Until 2014, Coomflona received sealed bids from buyers for its logs. Due to the strict requirements for purchasing logs from a public forest (e.g., business license, no citations for illegal behavior, proof of payment of all taxes), very few buyers submitted bids over the years. With the exception of 2012, the same buyer purchased all of Coomflona's timber. In 2012, an additional buyer purchased part of the timber.

Coomflona has supported other productive activities in the national forest as well, which are not included in the analyses reported here, e.g., the production and sale of several non-timber forest products (natural latex from rubber trees, medicinal oils, timber species seeds, artisan crafts), the production and sale of finished wood products made from the large branches and other logging residues in several small carpentry shops in the national forest, and the sale of rustic furniture made in several communities in the national forest. Coomflona is also working with the US Forest Service and ICMBio to develop ecotourism within the national forest.

2. Methods

The Green Value tool for simplified financial analysis of forest-based initiatives provides a consistent and replicable method to organize, understand, and present financial information needed to make informed and transparent decisions, allows initiatives to measure results against objectives, and facilitates comparisons of results across time and initiatives. The Green Value tool consists of a User's Guide and a series of inter-linked spreadsheets that allow users to record and analyze financial cost and income data. The results identify the costliest activities and types of inputs, and provide indicators of the viability of the enterprise, which allow reflection on how to reduce costs, increase income (especially regarding price negotiations), and strengthen short and long-term viability.

In addition to providing critical information for decision-making, the results can also be used to demonstrate impacts. The Green Value tool can be used to measure the financial contributions of CFM in terms of direct payments (salaries, daily wages) and indirect payments (purchase of materials and services, investment of profits in other activities and in communities). This information is key for determining and facilitating discussion of the impact of investments by the initiative and others, e.g., critical reflection on the importance of start-up capital for new CFEs to become viable as they learn-by-doing and how benefits are distributed. Having information collected and reported in a consistent manner also enables researchers to more easily aggregate and compare results among initiatives.

Some aspects of the Green Value tool methodology differ from other cost-benefit analyses. First, users are encouraged to include all production costs related to the product or service being analyzed, including subsidized services, like technical assistance and expensive machinery and equipment. The tool is also set up to analyze one productive period at a time, which is defined by the user and can range from one week to one year. Costs which are incurred for inputs (e.g., training, management plans, machinery and equipment) that have a useful life greater than one productive period should be divided over the useful life. For machinery and equipment,[3] the Green Value tool uses a linear depreciation calculation and encourages users to define a useful life based on their experience rather than manufacturers' recommendations. In addition, the tool's definition of administrative costs is broad and includes, in addition to typical administrative staff, all full-time workers and other workers not assigned to specific productive activities, such as cooks and drivers. This can lead to proportionally higher than anticipated administrative costs. Finally, the calculation of cost per cubic meter of timber is based on the volume of timber sold, not the volume harvested, as the former is a more realistic indicator for determining if prices received are sufficient to cover costs.

[3] An item is classified as "machinery" or "equipment" if it has a useful life longer than one productive period; otherwise it is classified as a "material".

Table 1
The six step method for using the Green Value tool.

Steps	*Description*
Step 1. Plan	Enter general information about the product, the producer, the period of time (production period) to be analyzed, the producer's goals, the principal activities to be monitored, and the responsibilities for monitoring. Also note any assumptions used in the financial analysis.
Step 2. Collect	Collect cost and income data and record it in written form using printed worksheets for each type of input (labor, materials and services, and machinery and equipment). *This step can be combined with Step 3.*
Step 3. Enter	Enter the collected data in digital form in worksheets using a computer.
Step 4. Compile	Calculate subtotals per type of input and per activity.
Step 5. Analyze	Present the costs per activity and per input type, and calculate total income, net income, and rate of return. Illustrate results using graphs and charts.
Step 6. Discuss	Register the main points from the discussion of the results.

Source: Humphries and Holmes (2014).

Coomflona's timber harvesting initiative was first analyzed by Humphries and Holmes in 2007 as part of research to measure the potential financial viability of two pilot CFM projects in the Brazilian Amazon that had been supported by the ProManejo project (Humphries et al., 2012). The spreadsheets they developed to use with pilot project staff to organize and analyze cost and income data were developed into the Green Value tool over the next six years (Humphries and Holmes 2014). Subsequent analyses were implemented in 2012 and 2014 for the 2011 (Humphries et al., unpublished) and 2013 harvests.

For each of the analyses, a small group of staff and representatives from Coomflona's partner organizations worked with an instructor to use the Green Value tool as they organized and analyzed cost and income data for one harvest period (Table 1). For the 2007 harvest, the workshop was four days; the subsequent workshops were three days each. Cost data were organized by major productive and administrative activities, as well as by input type: (1) labor; (2) materials and services; and (3) machinery and equipment. Financial results included cost per activity by input type, total cost per input type, total cost per activity, total cost, cost per unit sold, total income, net income, and rate of return. The results of each analysis were discussed with participants to verify their validity and to identify ways to strengthen the short and long-term viability of the operation. Several assumptions were made in our analyses to facilitate comparison of the three years (Annex).

The costs and revenues for each period were then compared, and the evolution of labor productivity over time was measured to determine if in this case, given a fixed production technology, labor productivity increased as worker experience accumulated. To test this hypothesis, following De Liso et al. (2001), we specify an index of experience (Z_t) computed as the labor/output elasticity:

$$Z_t = \frac{L_t}{Y_t}\frac{\partial Y_t}{\partial L_t} \quad (1)$$

where L is the labor input (i.e., number of workers), Y is the product output, and t is the time period. This expression for Z_t is derived from a Cobb-Douglas production function in which output is the product of fixed factors of production (representing constant production technology) and labor inputs. Notably, values of Z_t greater than 1 indicate increasing returns to scale (e.g., an *x* percent increase in labor results in a greater than *x* percent increase in output) and signifies that worker learning occurred during the production period.

For comparison studies we decided to focus on initiatives similar to Coomflona in terms of community management of field operations (i.e., either hiring service providers to do the work or hiring workers directly) for production cost data, but to also include some other models to have a broader comparison of costs and net financial and other types of benefits to families and communities. We also present and contrast results from unpublished studies in which the Green Value tool was used for one productive period with other community-based forest initiatives in the Amazon region.

3. Results and discussion

3.1. Costs

Between 2007 and 2011, the total costs of timber production by Coomflona grew rapidly (Table 2), along with the harvest area and volume sold (Fig. 3). All costs are for the year of harvest except

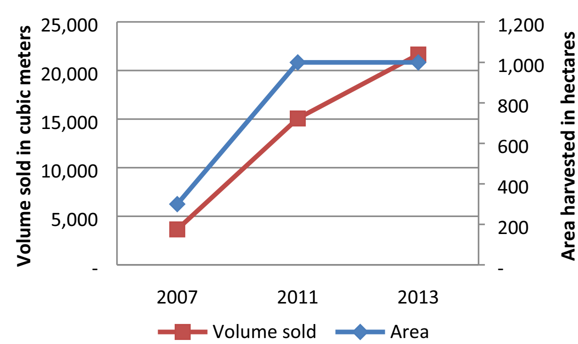

Fig. 3. Area of annual harvest unit and volume sold per year.

Table 2
Costs per year of timber production for Coomflona (Real values in USD for 2015).

Activity	2007			2011			2013		
	Total cost	Cost/m^3	% of total cost	Total cost	Cost/m^3	% of total cost	Total cost	Cost/m^3	% of total cost
Planning and inventory	23,993	6.57	9%	68,280	4.53	11%	161,331	7.45	19%
Felling	11,357	3.11	4%	39,018	2.59	6%	62,765	2.90	7%
Skidding (included loading for '07)	40,509	11.10	15%	81,215	5.39	13%	84,285	3.89	10%
Measurement	3916	1.07	1%	53,697	3.56	8%	63,260	2.92	8%
Loading		–		93,628	6.22	15%	114,086	5.27	14%
Administration	197,212	54.03	71%	309,829	20.57	48%	356,754	16.48	42%
Total	276,988	75.89	100%	645,668	42.86	100%	842,481	38.92	100%

Planning and inventory activities which are performed the year prior to harvest. Administrative costs consistently accounted for the largest share, followed by costs associated with heavy equipment rentals (especially for skidding and loading). Expansion of harvest areas and volumes led to increases in the number of workers, equipment purchases, and quantities of materials and services (Fig. 4).

During this period of harvest expansion, the efficiency of timber harvest operations increased substantially. Average costs of producing the volume of timber sold decreased from $76/m^3 in 2007 to $42/m^3 in 2011, and to $39/m^3 in 2013 (Fig. 5). This is largely due to economies of scale – the fixed costs of Administration were spread over a larger volume of timber (Fig. 6).

In terms of inputs, Labor and Materials and services together accounted for 88% of costs in 2007 and 95% in 2011 and 2013 (Table 3). Machinery and equipment costs were relatively low due to the fact that Coomflona rented or leased all the heavy machinery it used in its field operations, the costs for which were categorized as a service.

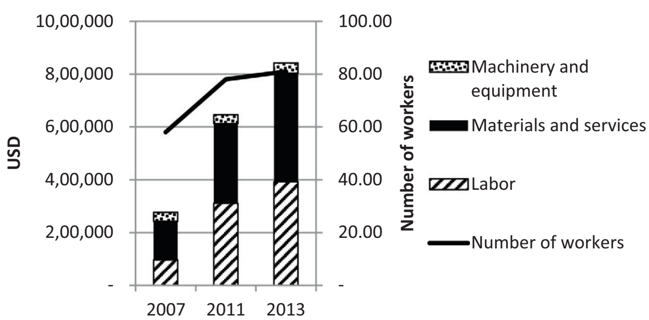

Fig. 4. Cost by input type and number of workers per year (USD).

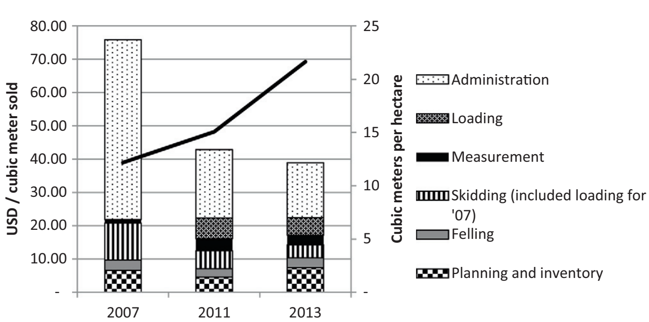

Fig. 5. Cost per unit sold by activity and volume sold per hectare (USD).

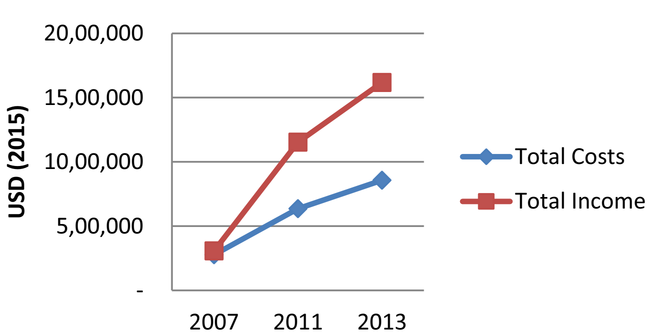

Fig. 6. Total cost and income for three study years for Coomflona (USD).

3.1.1. Labor

The most significant labor cost all three years was for Administration. Indeed, Administrative labor costs consistently accounted for 28–29% of *total cost* for all three study years. As mentioned, administrative labor included permanent staff who worked full time for 12 months (professional foresters, forest technicians, accountants, clerical staff, professional drivers), and part-time employees who worked on administrative issues. In addition, those whose work was not directly related to a specific field activity (e.g., cooks, security guards) were categorized as Administrative staff, as were three audit committee members who received a small monthly wage. While the number of Administrative staff, in addition to the three audit committee members, increased from 15 (8 full time, 7 part time) in 2007 to 31 in 2013 (23 full time, 8 part time), the average cost (or cost/m^3) of administrative labor decreased by half from $21.48/m^3 in 2007 to $10.76/m^3 in 2013.

Overall, the average cost (or cost/m^3) of labor for productive activities (field labor) increased from $5.12/m^3 in 2007 to $8.10/m^3 in 2011, but then dropped to $7.40/m^3 in 2013 even as the total number of field workers increased. Variation in the average cost of field labor was likely due to the interaction of several factors including vagaries in weather, terrain, timber stocking, and field team experience. We note that Coomflona's leadership reported satisfaction with the results of its 2009 decision to pay most temporary workers based on production, rather than time in the field[4], in order to encourage them to be more efficient with their time and to save on other related costs (e.g., machinery rental).

While these results provide an indication that workers learned how to improve the efficiency of these activities, we can summarize dynamic changes in worker productivity for the entire CFE using Eq. (1). The overall index of learning, which is simply the output elasticity of labor, was computed to be 9.07 for the 2007–2011 period and increased to 11.36 for the 2011–2013 period.[5] These results indicate strongly increasing returns to labor inputs and that an x percent increase in CFE labor during the 2007–2011 period resulted in roughly a 10x percent increase in timber production. While some proportion of this increase may be simply due to speeding up production among field crews, reflecting a change in wage-based production incentives, the results further suggest that labor-based innovations improved efficiencies throughout several components of CFE activities (including the Administrative functions).

3.1.2. Materials and services

Overall, the average cost of materials and services decreased by half from $39.98/m^3 2007 to $19.95/m^3 in 2011, and by a further 5% to $18.98/m^3 in 2013. Among the most significant costs in this category were machinery and equipment rental (including operators), fuel, and lubricants for field operations.

3.1.3. Machinery and equipment

Overall, the total cost of annual depreciation of machinery and equipment owned by Coomflona varied little over time while the average cost dropped by 78% from $9.31/m^3 in 2007 to $2.22/m^3 in 2011, and then by 11% to $1.79/m^3 in 2013. The majority of machinery and equipment cost was for Administration, and included one truck, one car, one industrial stove, and computers. Items were included in this category if they were used for administrative purposes or for a mix of field activities and administrative purposes.

[4] An example of paying a worker based on production is to pay chainsaw operators working in felling a certain amount per cubic meter of trees felled. In 2013, the only temporary worker who was paid based on time was the tractor operator assistant who received a set amount per month.

[5] For the years 2007–2011, $\frac{L_t}{Y_t}\frac{\partial Y_t}{\partial L_t} = \frac{58}{3650} * \frac{(15064-3650)}{(78-58)} = 9.07$. For the years 2011–2013, $\frac{L_t}{Y_t}\frac{\partial Y_t}{\partial L_t} = \frac{78}{15{,}064} * \frac{(21{,}644-15{,}064)}{(81-78)} = 11.36$.

Table 3
Cost per input type per year (USD).

Cost by input	2007		2011		2013	
Labor	97,070	35%	311,691	48%	392,997	47%
Materials & Services	145,923	53%	300,527	47%	410,706	49%
Machinery & Equipment	33,995	12%	33,450	5%	38,778	5%
Total	276,988		645,668		842,481	

3.1.4. Cost comparisons with other studies

Although it is difficult to make direct comparisons of production costs with other studies of CFM initiatives due to significant differences in methods and reporting, a very relevant comparison is to Medina and Pokorny's (2008) study of Coomflona (Table 4). They collected cost and income data for the 2007 harvest on 300 ha and, using the average cost per hectare, extrapolated costs for a 1000 ha harvest. Their finding of USD 48.56/m^3 was much lower than our finding for the 2007 harvest, but close to our findings for the 2011 and 2013 harvests (based on 1000 ha) although the actual volume harvested (21.6 m^3/ha) was much higher than the estimate they used (9.19 m^3/ha). Drigo and Sist (2013) studied a much smaller operation also in Pará state in 2007–2009. They found a similar average cost of timber sold but did not include many significant subsidized costs. Two unpublished studies of CFM initiatives in Bolivia which used the Green Value tool found costs per cubic meter of timber sold much lower than the Brazil estimates (Humphries et al., unpublished-b, Humphries et al., unpublished-a). This may be due to better access to roads and better stocking of commercial timber species, among other factors.

As Coomflona has moved into a scale of production considered industrial for the region, we also compared its cost per cubic meter sold in 2013 of $39 to those of company-run forest management operations, which were consistently lower than Coomflona's. Caetano Baucha and Estraviz Rodriguez's (2007) study of reduced impact logging operations in the Flona Tapajós implemented by a company from 1999 to 2003 (under the ITTO project), found an average cost per cubic meter of USD 30.26 over four annual harvests, which is 29% lower than Coomflona's. Pokorny and Steinbrenner (2005) cited values of USD 17–37/m^3 (in 1991–2004 USD) for a variety of types of industrial operations (conventional and reduced impact logging) for which data was collected using different approaches (surveys, experiments, and case studies). Given the variations in research and logging methods and time frames for these studies, it is difficult to gauge real differences in costs and to speculate on their causes.

3.2. Income

3.2.1. Net income and viability

Gross and net income rose significantly for Coomflona over the study period. Net income (profit) rose by 1627% from 2007 to 2011, and then by a further 47% from 2011 to 2013 (Fig. 6). Prices received per cubic meter of timber, in real terms (USD 2015) varied from $52 in 2007 (the average price for three species categories) to $76.51 in 2011 and to $74.72 in 2013.[6,7]

Of course, the big question is whether the cooperative could be financially viable based on income from timber alone. Although the financial viability of Coomflona was marginal early on (Humphries et al., 2012), in subsequent years the CFE proved to be running a very profitable timber business, with rates of return of 79% and 92% in 2011 and 2013 respectively.

Unlike private concessions, Coomflona is exempt from paying royalties for standing timber due to its non-onerous concession status. As a point of reference, in the logging experiment implemented in the Flona Tapajós from 1999 to 2003, the logging company was charged a stumpage fee per cubic meter of wood harvested based on three timber class prices: USD 1.15/m^3–USD 4.14/m^3 (Bacha & Rodriguez, 2007); these amounts would have had a small impact on Coomflona's overall average cost or profitability. We note that technical services are provided by two local universities to conduct analyses of permanent plot data from within the forest management area and periodic training of field workers. These subsidies are not included in our analysis because they are expected to be permanent (unlike temporary assistance provided by short term projects).

3.2.2. Income generation for local residents

In 2013 Coomflona generated over $1.5 million in wages for workers, profit (or net income) which was used for various purposes, and expenditures on materials and services (Table 5, Fig. 7). Disaggregating this income for 2013, the total income from wages was $392,997, 53% of which went to full time administrative staff and 40% went to temporary field workers.

Wages were well over the legal minimum salary, which was $238 per month (equivalent to $10.81/day or $2763/year) in 2013.[8] The average permanent full time employee made 3.2 times the minimum and the average temporary field worker made 1.2 times the annual minimum, but only worked 4–8 months. The part time permanent staff was paid 1.6–1.9 times the minimum per month and the wages to the audit committee were token payments for their contributions when needed. It is notable, referring back to Table 3, that the total income generated by Coomflona for local workers quadrupled over the six-year study period as it increased the scale of its operations.

Given that a 2014 census of residents in the national forest found high rates of poverty, with 21.5% making up to one-half of a minimum salary per month and 41.2% making between one-half to one minimum salary per month (Leite et al., unpublished), and the scarcity of opportunities for paid wages in the Flona and surrounding areas, these opportunities for employment comprise important contributions to local livelihoods and poverty reduction for both unskilled workers and young professionals from the Flona. These jobs allow them to stay relatively close to home while also working for the benefit of their communities. An additional significant benefit for all workers not included in Table 1 is the meals they receive each day they work for Coomflona, which value USD 7.83 (or R$ 30) per day.

The generation of indirect income benefits for local residents is also important. The total amount in 2013 injected into local and regional economies from the purchase of materials and services was USD 410,706. These funds went to local businesses, which pay their own local staff, buy local inputs from farmers, and pay taxes. The net income or profit from the sale of timber that entered into the Cooperative's income stream in 2013 was USD 774,805. These funds were merged with additional income sources

[6] Coomflona runs scenarios each year to determine if it is to their advantage to sell their timber at different prices by groups of species or at a lump price.

[7] In nominal terms, the price increased from R$ 198 in 2011 to R$ 220 in 2013.

[8] Values are in USD. The monthly minimum salary for Brazil in 2013 was R$678, or USD 238.

Table 4
Other studies on community-based forest enterprises producing logs in tropical countries.

Author	Location	Product	Size of operation	Cost/m^3 (USD)	Rate of return	Income to families/community (USD)	Study limitations
Medina and Pokorny (2008)	Pará State, Brazil	Tropical natural forest – logs transported to patios in the forest	1000 ha per year	48.56[1]	81%	Total: 540,164[1] Wages: 182,940 Profit: 357,224	Took average costs for one 100 ha unit and scaled up
Drigo and Sist (2013)	Pará State, Brazil	Tropical natural forest – logs delivered to mill	74 ha per year	47	23%	Total: 16,014 Wages: 4,476 (373/person) Profit: 11,538 in profit (1,921 per family)	Excluded inventory, management plan, and depreciation of equipment
Humphries et al. (unpublished-b)	Santa Cruz, Bolivia	Tropical natural forest – logs in forest	364 ha per year	11.88	84%	Total: 57,145.08 Wages: 14,007 Profits: 26,713 Materials/Services: 16,425	
Humphries et al. (unpublished-a)	Pando, Bolivia	Tropical natural forest – logs in forest	500 ha per year	9.84	150%	Total: 54,869 Wages: 13,992 Profits: 33,674 Materials/Services: 7203	
Beauchamp and Ingram (2011)	GIC Doh, Cameroon	Tropical natural forest – logs in forest	4738 ha over 25 years[2]	–	1133%[3]	Profit: 34,198[4] used to support community projects	Does not include some subsidies
Ofoulhast-Othamot (2014)	Cameroon	Tropical natural forest – logs in forest	16,240 over 25 years[2]	–	31%[4]	Profit: 151,574[5], 50% designated for local development and socio-economic projects	–

[1] Nominal value in 2015 USD converted from the value reported by the author in another currency. Other values were reported by authors in USD.
[2] Annual harvest unit size was not specified.
[3] Based on the net present values of the total costs and the total income over 25 years at a 5% discount rate.
[4] Annual average over 25 years.
[5] Annual average over six years.

(e.g., project funds from different sources) and used to cover the cooperative's other costs, such as supporting other productive activities. Then, the net annual income for the cooperative as a whole is typically allocated among five funds as follows: reserve 10%; technical assistance, education and social issues 5%; investment fund 45%; community assistance 15%; health 5%; and disbursed to members 20%. While the community investment fund is often used to maintain roads in the national forest so that buses can pass for the benefit of all residents, the health and education funds mostly benefit cooperative members and their families (e.g., to help pay for technical courses, expensive surgeries).

3.2.3. Income comparisons with other studies

When rates of return (RR) are compared with those of other CFE studies, the larger operations in Brazil and Bolivia have greater rates of return (Table 4). The predicted rate of return by Medina and Pokorny (2008) for 1000 ha was exactly what we estimated for 2011 and very close for 2013 (despite the fact that their estimated timber harvest per ha was much lower than the actual volume harvested). The smaller operation in Uruará, Pará (Drigo & Sist, 2013) had a low RR, and if all subsidized costs had been included it probably would have been negative. The RR for the Beauchamp and Ingram (2011) seems extremely high, even knowing some subsidies were omitted. Analyses with Green Value of other timber operations with associations on indigenous lands in Bolivia found RRs from 84% to 150%; these operations were also largely financially autonomous.

The total amounts of money generated by the CFM initiatives in Table 4 are impressive. Coomflona's wages for local workers and profits were much higher than the other studies, and its scale of production is also much greater. Medina and Pokorny's (2008) estimates of wages paid and profit were much lower than our findings for 2011 and 2013. Again, these discrepancies are likely due to their low estimate of timber harvested per ha (9.19 m^3 instead of the 21.6 m^3 harvested in 2013).

A comparison of Coomflona's RR for 2013 (92%) with that of other companies shows that Coomflona had a higher RR even though its costs per m^3 were higher. Caetano Baucha and Estraviz Rodriguez's (2007) average RR estimate for the ITTO project that ran for four years in the Flona Tapajos was 36%, less than half that of Coomflona. This is likely due to the facts that Coomflona sold more timber (21,644 m^3) than was sold under the ITTO project (annual average of 15,848 m^3) and at higher average prices (USD 74.72/m^3 versus USD 41/m^3). Holmes et al. (2002) found quite high rates of return, 63% for conventional logging and 84% for reduced impact logging in the eastern Amazon, despite using a much lower weighted average price of USD 25.50/m^3 sold.

3.2.4. Coomflona results and goals

As mentioned, the Green Value tool is designed to allow users to measure results against goals for the productive period. Coomflona's targets for 2011 and 2013[9] (Table 6) included the number of people employed (both years), as well as the total net income for 2011, and the RR and cost per cubic meter of timber for determining the minimum prices for 2013. The results were used to help facilitate reflection on how well the cooperative performed and what could be improved in the following years. Though Coomflona is not independently using the Green Value tool, the cooperative staff reported that it helped identify costs that were higher than expected, underscoring the importance of monitoring costs for all activities (the cooperative has its own system), and helped them realize that

[9] The methodology used in 2007 did not include setting goals before the analysis was performed.

Table 5
Income for local workers generated by Coomflona in 2013.

Type	Number of months/year	Number of staff	Total (USD)	Range per person (USD)	Average per person (USD)
Wages					
Permanent – full time	12	23	210,842	4483–18,491	8821
Permanent – part time	2–9	8	14,639	747–3973	1830
Audit committee	12	3	7336	2445	2445
Temporary field workers	4–8	47	160,179	*	3408
Materials and services			410,706		
Profit			774,805		
Total			1,571,171		

* It is difficult to estimate how much each temporary field worker makes.

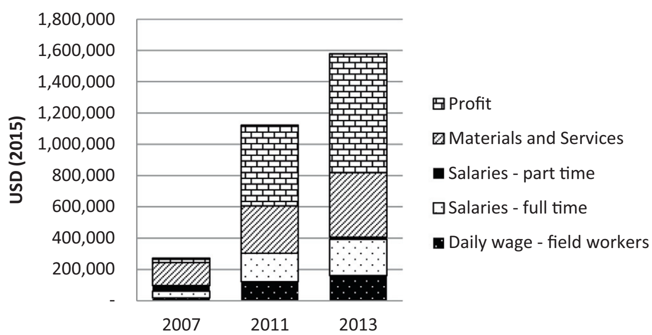

Fig. 7. Income generated by Coomflona for local residents and businesses.

Table 6
Coomflona's goals and results for 2011 and 2013.

Indicator	Goal	Result
2011		
Number of people employed	70	67
Net income (USD, to use for building an office)	115,924	516,823
2013		
Number of people employed	150	81
Rate of return (see if increased from 2011)	79%	92%
Determine the minimum break-even price per cubic meter of timber	–	yes

they could analyze the potential financial impact of changes before making decisions (Batista Dantas, unpublished).

3.2.5. Other benefits

Coomflona has a policy of using the net income from timber to support other productive activities in the national forest with the aim of expanding income generation opportunities for residents who do not work in logging. For example, the cooperative pays two coordinators of non-timber forest products who work with local residents to improve the production and marketing of these products (e.g., latex, medicinal tree oils, timber seeds). Many of the non-timber forest products are made by women's groups in the Flona. Timber income was also used in recent years to fund four carpentry workshops in the Flona producing doors, windows, and other products from the residues of harvested trees (e.g., large branches). Coomflona has also used timber profits to invest in the cooperative's infrastructure, e.g., in 2012 it built a new permanent office in the city of Santarém as well as an eco- store ("Ecoloja") to sell products from the Flona, including wooden furniture, windows, and doors from the carpentry workshops, and crafts made from non-timber forest products (including natural latex and seeds).

3.2.6. Equity of benefits distribution

Who benefits and how CFM benefits are distributed have been the topics of several studies (Bhattacharya, Pradhan, & Yadav, 2010; Ofoulhast-Othamot, 2014; Rahut, Ali, & Behera, 2015; Schusser et al., 2015). The most direct benefit of Coomflona's timber operation is income to employees. Most workers, except for about 20% of the permanent full-time staff and some heavy equipment operators, are members of the cooperative. The pool of members has expanded each year although the number working at any one time depends on operational requirements. To become a member, one must be a resident of one of the 21 communities located within the Flona Tapajos, must be considered a traditional person (i.e., having grown up within the traditional livelihood culture of the local communities), be a member of one of the two intra-communal associations in the Flona,[10] and pass a written test about cooperatives.[11]

The cooperative has rules in place aimed at ensuring equity in job distribution among cooperative members. For example, the cooperative's leaders meet at the beginning of each work season to evenly distribute temporary work opportunities among the two inter-communal associations. Permanent posts are also given with the objective of sharing full time employment between the associations' members. Andrade et al. (2014) estimate the cooperative is generating income for 25% of the national forest's population. While jobs are widely distributed, one of the policies has the unintended consequence of limiting the number of women who work in the timber operation: when multiple household members are eligible to work with the cooperative, they must choose only one person among them to work. Often the husband or son will be chosen as their earning potential is higher than that of mothers and daughters.

Women have had a much smaller role than men in the cooperative and in 2014 they comprised only 14% of cooperative membership and 17% of the work force (Humphries et al., 2015). The most common job for women is as cooks. Three women have served as forestry technicians; later, one of them became the assistant coordinator of non-timber forest products and another assumed a director role as Secretary of the cooperative. More efforts are being invested in work with NTFPs precisely to increase benefits for women artisans, though many men work with NTFPs, as well.

3.3. Factors in Coomflona's financial success

Close partnerships with government agencies were critical to helping Coomflona launch the timber operation in 2005, and to maintaining its financial resilience in spite of mismanagement in its early years (Humphries et al., 2015). Recently, its close relation-

[10] One intercommunal association was removed from the Federation when the communities its members hailed from were excised from the national forest in 2012.
[11] The illiteracy rate among national forest residents has decreased from 24.4% in 2007 (IBAMA 2007) to around 17% in 2014 (ICMBio unpublished).

ship with ICMBio, the agency now in charge of the Flona, has been essential in dealing with the loss of 55% of its forest management concession to an indigenous reserve. ICMBio is working closely with Coomflona to identify and receive authorization for a new concession within the Flona. ICMBio also works with Coomflona to negotiate the complex bureaucratic process for securing annual authorization for timber harvesting and transport.

As previously mentioned, partnerships with national and international NGOs have also helped reduce costs and strengthen Coomflona's business model. Coomflona has worked closely with the Tropical Forest Institute (Instituto Florestal Tropical - IFT) for training throughout the last ten years, and most recently IFT leased a skidder to Coomflona at a very low rate. As mentioned earlier, two local universities provide continued training through a long-term agreement with Coomflona, and students often intern at the cooperative. The Amazon Alternative (TAA), based in the Netherlands, provided information and funds to help Coomflona prepare and pay for its initial FSC certification, and the FSC Brazil office has promoted Coomflona's products to national and international buyers. In addition, the Brazil National Education Institute (Instituto Internacional de Educação do Brasil - IEB), the Amazon Environmental Research Institute (Instituto de Pesquisa Ambiental da Amazônia - IPAM), and Earth Innovation Institute have provided capacity-building support for business management, among other areas.

Having high value timber species and good access to a significant timber processing hub and markets are also important factors in the cooperative's financial success (Humphries et al., 2015). Due to its designation as a national forest in 1974, the Flona Tapajos, unlike many forests in the region, was not heavily exploited for commercial timber over the last 40 years. Santarém, which is approximately 50 km via paved roads from the entrance to the Flona, has been a significant timber processing center and market for the state of Pará, which supplied 33% of Brazil's tropical timber in 2011 (SFB, 2013).

Finally, transparent and accurate financial reporting and management are critical to financial viability as well as to maintaining public support for the cooperative's leadership and its mission (Humphries et al., 2015). A financial report is delivered each year at the general assembly of cooperative members, and members can ask to examine the financial records at any time. The perception of the fair distribution of benefits is also important for public support. Coomflona strives to sustain community support by maintaining roads in the national forest (this is typical for forestry operations in the region) and investing in other productive activities in order to provide benefits to as many people as possible. Elite capture and/or inequitable distribution of benefits, cited as criticisms or weaknesses of CFM initiatives around the globe (Nuesiri, 2014; Schusser et al., 2015), do not seem to be a problem thus far for Coomflona.

4. Conclusions and policy recommendations

This longitudinal study of a CFE sustainably managing 33,691 ha of Brazilian national forest that went from receiving large subsidies during its first four years to a highly profitable enterprise providing substantial financial benefits for local people – generating in 2013 over USD 1.5 million in income for workers and local businesses and auxiliary social benefits for impoverished Flona residents, presents a rare example of the potential for CFEs to contribute financially to improved livelihoods and overall prosperity of forest-dependent people. It provides a success story from the perspective of government and civil society's efforts to support community forest management as a way to promote rural economic development, poverty alleviation, and a reduction in the rate of tropical deforestation. It also highlights the need for and benefits of using consistently applied research instruments to investigate the financial viability and contributions of CFEs. Looking ahead, recent FSC certification of the CFE, anticipated increases in annual timber harvest volumes, and the increased pressure on international timber importers to buy legal tropical timber (Greenpeace, 2014; Lerer & Marquesini, 2005) are expected to improve forthcoming prices and profits for Coomflona, and thus benefits for local people.

In terms of the broader impacts of this case study for CFM, governmental and non-governmental institutions that have worked with Coomflona since its inception (ICMBio, IFT, IEB, and IMAFLORA) are drawing upon their experiences with and the financial analyses of the cooperative (in which these organizations participated) to work with other CFM initiatives around the country. In addition, as mentioned, Coomflona's own technical staff is helping a new CFM initiative in a nearby extractive reserve prepare for and initiate forest management activities and is considering expanding its services into nearby colonist settlements where it would compete directly with commercial loggers.

While many might hope to replicate Coomflona's accomplishments, important factors in its success include community members and leaders dedicated to securing the right to manage their local forest resources and continuously improving their management skills, and strong partnerships with NGOs and government agencies who provided essential start-up capital, aligned their strategies to work in concert with Coomflona, and helped the cooperative with marketing and bureaucratic challenges. In addition, certainly the dramatic gains observed in reduced average costs and labor productivity from learning-by-doing and scale economies were enhanced by the training opportunities provided by various outside institutions. Finally, it is important to note that access to well-stocked forests and nearby timber markets have also been critical to the CFE's success.

To facilitate additional success stories of rural economic development and poverty alleviation through CFM, our research suggests it is critical for governments and/or other partners to provide initial subsidies to CFEs to cover technical assistance and other start-up capital costs (e.g., rentals of machinery and equipment). This approach should also include a business plan that provides a realistic road map for generating the capital for operations and equipment that is essential to financial autonomy, as well as consistent financial monitoring. Financial risk for CFEs could also be reduced by simpler requirements and shorter processing times for timber harvesting permits, as forest operations are restricted to dry periods and delays in permitting often result in missing annual harvest opportunities and consequently to accumulating debts.

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Annex

The following assumptions were made to facilitate the comparison of the results for the three study years:

- For the 2007 analysis, machinery and equipment that were rented were moved to "Materials and Services" –this changed the distribution of costs a bit from Humphries et al.'s (2012) study.
- For the 2007 analysis, we assumed temporary workers were paid based on the number of days worked, rather than the

actual payment structure of a set salary per month. This reduced labor costs for the field activities by 39%. Coomflona switched to paying temporary workers based on units of production in year 2009.

- For the 2007 analysis, costs associated with permanent plots were included in Planning and inventory activity.
- For the 2011 and 2013 analyses, we included costs associated with vine cutting and road construction and maintenance under the Planning and inventory activity.
- For the 2011 analysis, we include Sales and marketing in Administrative costs.

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