Community Forestry Enterprises in Mexico: Sustainability and Competitiveness

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Community-based forest management such as Community Forest Enterprises (CFEs), has potential to generate positive socio-environmental and economic outcomes. We performed a detailed survey of financial and production parameters for 30 of the approximately 992 CFEs in Mexico in order to estimate costs, income, profits, and sustainability of harvest levels for forest management, harvest, and sawmilling. Fourteen of the 30 CFEs harvested more timber than they grew in 2011, suggesting issues with sustainability, but only two of these had harvest far above annual growth, and five of those were only a fraction more than annual growth. All of the 30 CFEs except one made profits in forest management and timber growing. For timber harvesting, 22 of 30 CFEs made profits, but the losses were small for the other CFEs. For the 23 CFEs with sawmills, 18 made profits and 5 had losses; the greatest returns for the CFEs accrued to those with sawmills for lumber production. On average, the CFEs surveyed had high costs of production relative to other countries, but the CFEs were still profitable in national lumber markets. If Mexico were to begin importing large amounts of lumber from lower-cost countries, this could pose a threat to CFE profitability.

KEYWORDS. Community-based forest management; natural forest timber harvesting; financial viability; benchmarking; sawmilling; tropical forestry; Mexico
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INTRODUCTION

The Mexican Context for Sustainable Forest Management

Mexico has a total of 195 million hectares of land, of which 65 million hectares are forests. Ninety five percent of the forested area is natural forest (52% primary and 42% secondary) (FAO, 2010). “Comunidades”, which are indigenous people’s communities that received formal ownership of their traditional or customary lands, and “ejidos”, which are groups of previously landless rural people that received title to land that was expropriated by the state, own more than the half of Mexico’s forests and have relative autonomy to manage them (Kelley 1994)

The modern community forestry movement in Mexico began to emerge in the 1970s and 1980s in response to agrarian reform, the Forestry Law of 1986, and other factors (Bray, Antinori, & Torres-Rojo, 2006; Antinori & Bray, 2005). Before this time, management of forests for timber production was mostly through short-term concessions to private enterprises that were depleting the timber. After the passage of the Forestry Law, comunidades and ejidos started to organize what are now Community Forest Enterprises (CFEs) that harvest and commercialize their timber based on management plans with the assistance of professional foresters (Antinori, 2005). CFEs in Mexico may be governed in a variety of fashions, with more or less control exerted by or independence from the governance structure of the community itself (Bray, Antinori, & Torres-Rojo, 2006).

An estimated 992 CFEs exist throughout Mexico that are categorized according to their capacity and vertical integration as: Type II- communities that own the forests and simply sell concessions to private loggers; Type III- communities that harvest timber themselves and sell it
to private sawmills, and Type IV- communities that harvest and process timber (CONAFOR, 2010). *Comunidades* and *ejidos* that own forest but don’t manage it for income are categorized as Type I. In addition to the commercialization of timber, some enterprises generate income from commercializing Non-Timber Forests Products (NTFP), conducting ecotourism, and recently, an increasing number are earning revenue for the conservation of natural resources under Payment for Environmental Services (PES) schemes.

Sustainable Forest Management (SFM) is widely considered to encompass economic, environmental, and social benefits that are especially important for some countries of Latin America where natural forests are being deforested primarily due to the expansion of agriculture (Geist & Lambin, 2002). Many indigenous communities and rural poor use the forest to supply household needs or as a source of economic income (Forster et al. 2014) Mexico has been a pioneer and model in the effort of supporting a community-based SFM in local *comunidades* and *ejidos* that manage their own natural resources (Asbjornen and Ashton 2008). Despite the potential socio-economic benefits of SFM, there is little scientific literature in Mexico and most of Latin America about the management and economics of native forests by communal landowners, or by small and medium sized entrepreneurs.

Sustainability and Financial Viability of Community Forest Enterprises

“Profit maximization” is not always the main objective of CFEs, although some level profitability should be considered an important one. Profit maximization is a core underlying assumption of the theory of the firm, and Ostrom (1990) clearly rejected the theory of the firm as an underlying model of community-based natural resource management on empirical and theoretical grounds. However, Antinori and Bray (2005) use the theory of the firm as a starting
point, and describe Mexican CFEs as “social firms”. Rather than shareholders or investors, CFEs’ beneficiaries are pre-defined community members. In contrast to profit or return on investment as the single objective, social firms such as CFEs may have numerous objectives, including employment of community members, production of public goods and services, supplying products for household use to community members, as well as profit (Antinori & Bray, 2005). In addition, communities must have good markets to provide an incentive for the development and consolidation of community forestry. Furthermore, communities must have an adequate forest endowment in order become engaged in market insertion, as well community organization (Forster et al. 2014). Thus it is clear that some level of net income generation is required to ensure sustainability, as a money-losing enterprise is not likely to be kept afloat by poor communities. In this sense, it is important that CFEs demonstrate potential for some net income generation and competitiveness with other forest producers.

Certification of SFM by third parties to standards such as the Forest Stewardship Council (FSC) is utilized by some CFEs in Mexico. Certification seeks to encourage SFM by linking enterprises who utilize sustainable practices to consumers who demand them (Markopoulos, 1999). By 2001, only 51 communities worldwide, or “less than one percent of community forests”, had received FSC certification (Molnar, 2003), increasing to 109 by 2014 (FSC 2014). As of 2013, there were 39 FSC certified forests in Mexico (Blackman et al. 2014). Certification provides some evidence of financial viability and sustainability of CFEs, and in some cases may assist in making them so by opening markets and in some rare cases generating price premiums (Humphries & Kainer, 2006), and by reducing costs and improving administrative practices (Anta Fonseca 2006). However, economic benefits have not been as great as hoped, and
certification comes with substantial cost, leading to low numbers of certified communities and a high rate of decertification (Wiersum, Humphries, & van Bommel, 2013; Anta Fonseca 2006).

An empirical assessment of financial viability, competitiveness, and sustainability of community forests has been difficult as it ideally utilizes detailed data going back many years, whereas many communities have only incorporated CFEs in recent years and others lack adequate record-keeping systems (Forster et al. 2014). Also, the simplest and most common financial analyses of timber investment returns in Latin America are for even-age stands of planted, fast-growing, monoculture exotic species; whereas common CFE systems of uneven-age, naturally-regenerated, slow-growing, multiple native species introduce numerous uncertainties into the calculation (Cubbage et al. 2007). For this reason, most estimates of CFE profitability have been single case studies, a sample of just a few CFEs, or rely on incomplete or non-standardized data.

Several studies have suggested various levels of profitability with various degrees of confidence (Antonori & Bray 2005). Salafsky et al. (2001), surveyed community-based natural resource enterprises (mostly ecotourism and NTFPs) and found that only 7 of 37 were profitable. Antinori (2005) examined Mexican timber-based CFEs and found high returns on investment (ROI) for temperate natural forest stumpage sales (39%); temperate natural forest logs (48%); temperate forest boards (48%); and temperate forest finished products (32%). However, this was only a “first-order approximation” (quote from Antonori & Bray, 2005), that used differing accounting methods among communities (Humphries et al., 2012). Torres-Rojo, Guevara-Sanginés, & Bray (2005), found ROIs of 20% to 30% for sawn and dried boards in Guerrero State, Mexico, but did not include debt payments, depreciation, or taxes (Humphries et al., 2012).
Elsewhere in Latin America, Humphries, et al. (2012) calculated return on investment for three community forests in the Brazilian Amazon for the entire processing chain from stump to sawmill to lumber manufacture were 12%, 2%, and -48%. They also reviewed other studies of returns to tropical forest management, harvesting, and sawmilling (not all community forests). One of those studies in Brazil had negative ROI of -54%. All the others, however, had positive rates of return ranging from a low of 20% to 30%, up to a high of 81%.

Objectives

The main objective of this study was to assess the financial competitiveness and sustainability of CFEs in Mexico in order to identify strengths, weaknesses and gaps that will guide actions to improve their performance and ensure a sustainable income and biodiversity protection. This was done by: (i) evaluating forest sustainability and its link to the financial performance of the enterprises; (ii) calculating financial variables throughout the vertical integration line: forest management, harvesting, and milling; and (iii) benchmarking CFEs in Mexico with international forestry enterprises.

METHODS

Data Collection and Analysis

The study took place in 12 different states in Mexico including (figure 1): Campeche, Chiapas, Chihuahua, Durango, Guerrero, Jalisco, México, Michoacán, Oaxaca, Puebla, Quintana Roo and Veracruz. Only Type III and IV CFEs were selected to participate in the survey because they were the most likely to have adequate record-keeping systems and because they would be the most comparable with each other and with worldwide forestry enterprises. It is important to note
that this was not a random sample of all CFEs in Mexico, and as such, should not be seen as representing typical or average situations. Among Type III and IV, CFEs to participate were selected through maximum variation purposive sampling. CFEs were selected by a team of knowledgeable informants at the National Forestry Commission of Mexico (CONAFOR) to represent CFEs at various levels of capacity and vertical integration, various scales of production, and various regions throughout Mexico. Feasibility and cost of reaching the CFEs was also a factor, as some regions of Mexico have an unstable security situation.

FIGURE 1

The information about management, harvesting and sawmill activities necessary for calculating the financial variables analyzed in this study was collected in 2012 through a 205 question in-person survey and follow up contacts made to 30 CFEs belonging to Types III and IV. A Spanish-language copy of the survey can be found as an appendix to Cubbage et al. (2013b). Based on our review of the literature, we believe this to be one of the largest samples of CFEs performed to investigate financial profit, competitiveness, and sustainability.

Since performing the study, we found related research that was performed concurrently in Quintana Roo, which also examined factors affecting CFEs and forest market participation (Forster et al. 2014). That study had a larger sample of communities interviewed (53), but only 10 were still actively extracting wood from their forests, and it did not examine costs and returns, but rather compared the forest endowment and community organizational level to assess market participation.
Our survey design was a result of two workshops with the participation of CONAFOR and other stakeholders, and a pilot test in the field. The survey collected information about forest (area, growth rate, species composition, etc); forest management practices and production levels, costs, and revenues; harvesting; and sawmilling in 2011.

The Net Present Value (NPV) based on a 30-year projected rotation and 8% interest rate was calculated to analyze the financial performance of the management of the forest following the methodology in Cubbage et al. (2007, 2013a) and adapted for specific management practices for natural forests in Mexico.

The annual harvest for the CFEs used 2011 survey data as the base year, and the 30-year projections were adjusted based on harvested volumes reported in their forest management plan when the plans were available. Financial variables (costs, revenues, and profits) were calculated for the different stages in the vertical integration: forest management, harvesting and milling. In addition, comparisons of costs of CFEs in Mexico with other forests enterprises in the world allowed analyzing the competitiveness of the CFEs in Mexico.

Measures of Forests and Sustainability

Questions from the survey related to forest ownership size, forest type (species mixture and production versus conservation), timber inventory and harvesting intensity, growth and yield were summarized. Some CFEs had poor timber inventory records, but these estimates were the best available given the limitations. Forster et al. (2014) also examined forest area, species, and inventories in their study to assess market participation.
The sustainability of the forest was analyzed based on the difference between the Mean Annual Increment (MAI) and the harvested volume for a 30-year projected rotation since there is no fixed cutting cycle. If MAI exceeds harvest, timber stocks will increase, in the opposite case, they will decrease. Since sustainability also incorporates the economic, MAI minus harvest was compared to NPV to determine trends.

Vertical Integration

We classified the production activities into three steps: (1) forest management, (2) harvest, and (3) sawmill. Type III CFEs participate in steps 1 and 2, while Type IV CFEs participate in steps 1 through 3. We estimated financial capital budgeting indicators for each of these three steps to determine which steps were the most profitable.

The surveys asked for detailed costs and income using categories based on Cubbage et al. (2013a) and the two stakeholder workshops. Estimates of (1) costs and (2) income and (3) profits were calculated for each of the steps in the value chain (forest management, harvest and sawmill). The cost of harvesting was calculated by adding management costs and harvesting costs and dividing this result by the volume sold (not the volume harvested). The cost at the mill of type IV CFE’s was calculated by adding the price of the timber processed in the mill and the functioning costs and dividing this by the volume of processed timber. Benchmarks of similar measures from forestry operations around the world were used for comparison to determine relative competitiveness of these Mexican CFEs. For comparison with other countries, which are reported mainly in United States Dollars (US$), we used a conversion factor for the year 2011 of 1 US$ = 13 Mexican Pesos (MX$).
“Forest management” consists of the growth of trees up until their harvest, including silvicultural and management activities. Forest management costs were classified as Site preparation, Reforestation, Periodic management, Roads, Fire control, Technical assistance, and Payment to communities. Payments to communities represent financial support from the forest enterprise to the community, and can be considered as a user fee since the forest is owned by the community itself rather than the enterprise. Surveys responses included income from timber, NTFPs, and PES payments.

HARVEST

“Harvest” of the standing timber includes cutting and hauling to roadside. Harvesting costs were classified as Maintenance and Depreciation of Capital, Labor, and Machine operation. Income was the price paid for the logs at the roadside.

SAWMILL

“Sawmilling” is the process of turning roundwood timber into lumber, but also includes including loading and transport from forest roadside to the mill (which was included in the cost of wood purchased by the mill). Sawmill costs were classified as the cost of timber, operation and Maintenance of machines, Depreciation, Indirect labor costs, and Energy. Income was the price paid for sawn lumber, summed across the variety of different lumber products.
RESULTS

Measures of Forests, Sustainability and NPV

The total area of the forests for each community ranged from 151 ha to 62,493 ha, with a mean of 12,269 ha and a median of 6,189 ha. This is a large range, which allowed us to make observations about many different conditions, although the data did have considerable variability. 33% of the CFEs in our sample were certified as sustainable under the FSC standard.

On average, communities categorized 72% of their forests as production forests, and 28% in conservation uses. This varied considerably also, with one community (3% of the sample) categorizing 88% of its forests under conservation, and 13(43%) of CFEs in our sample having less than 15% of their area for conservation. The average size of production forest was 7,717 ha with a median of 4,182.

Ninety percent of the sampled CFEs were located in temperate forests. This kind of forest is a mixed of pines (\textit{Pinus spp.}), fir (\textit{Abies spp.}) and oak (\textit{Quercus spp.}) species from which pine was the most common and commercialized. On average 85% percent of the harvest on these enterprises is pine, 8% fir and 8% oak. Oak is not commercialized but used for household consumption by members of the enterprise. Three enterprises (10%) of our sampled CFEs are located in the south (Peninsula) in the states of Campeche and Quintana Roo where tropical forests are and commercialize common tropical species. The most valuable species in this forest is mahogany (\textit{Swietenia spp.}) that is also commercialized but in a lesser extent. On average 15% of their harvest is mahogany and the rest is common tropical species.
Table 1 summarizes the basic information about average timber inventory per ha, timber harvest volumes for all the CFEs in 2011, total standing volume, and the MAI of the species commercialized in 2011 as reported in the surveys. The average roundwood standing inventory at the start of 2011 was 178 m³/ha, with a range from 21 m³/ha to 450 m³/ha. All but seven (77%) of the CFEs had initial standing inventories of more than 100 m³/ha, which is a substantial volume, indicating a large amount of mature timber that is probably about 50 years old or more, and could be harvested. Six (20%) of CFEs had standing inventories of more than 280 m³/ha, which would indicate that they were more than 100 years old—essentially older growth and very mature timber.

**TABLE 1**

The mean harvested volume per year was 4 m³/ha, with a minimum of 0.03 m³/ha and a maximum of 22 m³/ha. This was greater than the average mean annual increment of 2.8 m³/ha/yr. However, for the median, which discounts a couple of very high CFE harvest volumes per year, the net annual growth was slightly higher than the annual harvest. Fourteen (47%) of the CFEs harvested more timber per ha than they grew in 2011, suggesting some issues with long run sustainability, but only two 7% had harvest far above annual growth, and five of those (17%) had harvests that exceeded annual growth by only a fraction of cubic meter per ha per year.

Figure 2 shows the sustainability (MAI menus harvest in 2011) versus the financial performance of the enterprise represented by their NPV for 30 years. The average NPV for the 30 CFEs was 26,576 MX$/ha (2,044 US$/ha) with a maximum value of 160,309 MX$/ha (12,331 US$/ha) and a minimum of -11 MX$/ha (-1 US$/ha). As figure 2 shows only one enterprise (3%) has a slightly negative NPV and 16 enterprises (53%) showed to be also
sustainable with positive values “MAI minus harvested volume”. Those two enterprises (7%) with the largest NPV are also those that harvest a lot more than what the forest grows (MAI) which make them unsustainable at that rate. Although two or three of the 30 enterprises appear to be unsustainable, with harvests exceeding annual growth by more than 5 cubic meters per ha per year, the amount of overcutting was still relatively small or not a problem for the other 27 (90%) of CFEs in our sample.

FIGURE 2

Vertical Integration

Figure 3 shows the average costs, incomes and profit along the vertical integration. The enterprises analyzed in this study did not sell the standing timber in the forest directly. However income and profit were calculated for the forest management part for comparisons along the steps in the vertical integration supply chain. On average, both the forest management component of the chain and the sawmill component had profits, the latter being more profitable. Harvesting operations were slightly non-profitable on average partly explained by the high labor cost caused mainly by low technology and the proportion of harvested volume that is not sold that increased the cost per m³ (77% of the harvested timber is sold and 23% is waste). The lowest costs are at the stage of forest management, probably as a result of the little management (planting, thinning, and pruning) done by the enterprises.

FIGURE 3
Forest Management

COSTS

Table 2 summarizes different categories of costs in the forest. Costs in the category “Periodic management” include activities as: use of fertilizer, pesticide, controlled fire, pruning, non-commercial thinning and plague prevention and control. “Technical assistance” includes: technical services, consultants and administrative activities. The category with the highest cost is “technical assistance” and the lowest is “site preparation”. Average total costs are 765 MX$/ha (59 US$/ha) and 311 MX$/m3 (24 US$/m3). Most of the CFEs do not spend money on site preparation and reforestation activities since they depend on natural regeneration. Payment to communities is around 13% of the total costs and only 9 (30%) of enterprises did not report a payment to the community. This expenditure has demonstrated to be important for community wellbeing as it helps in the construction of necessary infrastructure such as schools and roads.

TABLE 2

INCOME AND PROFITS

Table 3 presents the income that forests generate by different activities: timber commercialization, non-timber forest product (NTFP) commercialization and payment for environmental services (PES). Total income is 3,111 MX$/ha/yr (239 US$/ha/yr) or 880 MX$/m3 (68 US$/m3). Income from timber accounts for 90% of the total income while NTFPs and PES generate 7% and 3% respectively. Sixteen (53%) of CFEs get income from the commercialization of NTFPs and only 8(27%) from PES. NTFPs included: fuelwood, resins, medicinal, tourism, and employment (from activities different of timber commercialization).
Most of the enterprises (27/90%) reported a benefit from fuelwood; however, only 10 (33%) received income from its commercialization. This indicates that fuelwood is mainly used for household consumption but that there could be a potential product to sell. PES included: prevention of erosion, water conservation and prevention of habitat and biodiversity lost. Six (20%) of CFEs reported income from water conservation and it was the most frequent service enterprises get income from.

TABLE 3

Profits for forest management were on average for 2011 2,345 MX$/ha (180 US$/ha) with a maximum of 15,963 MX$/ha (1,228 US$/ha) and a minimum of -5 MX$/ha (0 US$/ha). Only one CFE had a negative profit which indicates that in general enterprises perform well at the management stage.

BENCHMARKS

Figure 4 compares the Mexican CFEs’ average timber production costs and prices with other countries in the world. The Mexican CFEs grow and harvest mostly pine. Cubbage et al. (2010) calculated total forest management costs for a variety of pine and eucalyptus species in the world in 2008, which was used to calculate a comparable cost per cubic meter to grow wood for a typical plantation rotation without any discounting of costs included. There were three years of difference in the years the costs were estimated, but there was much variation in the costs for Mexico, and not much inflation during this time, so values were not adjusted for inflation to make the comparisons.
These comparisons indicate that Mexico is generally a high cost to very high cost producer of roundwood, depending on the accounting stance taken. In Mexico, the average costs of timber without any payments to the communities was 20 US$/m³ and with payments to communities 23 US$. In contrast the cost of timber in other countries is 2.8 US$/m³ which is around one-eighth the costs in Mexico and includes taxes and administration, or the approximate equivalent of payments to communities for private forests in the other countries.

Regarding the situation for the future costs of roundwood production compounded over the rotation of 30 years, the global benchmarks had a compounded cost of producing wood with an average of 28 US$/m³ while Mexico had an average of 91 US$/m³. Again, some of this may be due to under accounting of administration costs in other countries, or compounding for somewhat longer in Mexico. But the differences are indicative of higher costs of production in Mexico, particularly when carried at the 8% discount rate used. And typical annual discount rates used for CFEs in Mexico are commonly about 12%, which would exacerbate this roundwood production cost disadvantage.

As Figure 4 shows, Mexico had greater prices per m³ for its stumpage prices. These prices were actually relatively uniform in Mexico, with a mean of 51 US$/m³, and a standard deviation of 11 USD $/m³. Global roundwood prices were less on average (39 US$/m³) and a standard deviation of 18 US$/m³. Even when CFEs in Mexico had higher roundwood production costs, they also had higher stumpage prices. This allowed enterprises to generate a profit from forest management from the selling of timber to local markets in Mexico. However these prices would prevent CFEs from competing in export markets, where their production costs would be too high.
compared to other countries, especially low cost producers like Chile and Brazil, or even small private landowners in the U.S. South and Pacific Northwest.

Harvest Costs

Table 4 summarizes the average harvesting costs by different categories. CFEs averaged a harvest of 10,721 m³ per year, with a broad range from 389 to 46,095 m³/yr. The commercial timber volume sold was less, with an average of 8,259 m³. This was about 77% of the total harvest. The total harvest cost per cubic meter was calculated based only on the commercial harvest, since there were not sales of the non-commercial harvest material. Thus those costs might be slightly high considered the amount of wood cut, but using the same metric as commercial timber sold was better for calculating profits.

| Table 4 |

The harvesting costs average was 138 MX$/m³ (11US$/m³) for capital costs; 176 MX$/m³ (14 US$/m³) for operating; and 193 MX$/m³ (15 US$/m³) for labor costs. Most of the equipment consists of old tractors and chainsaws, but there was some purchase and depreciation costs, and certainly some maintenance costs. Operating costs were a slightly smaller share, and labor costs were the largest share of total costs. The overall average costs for harvesting was 506 MX$/m³ (39 US$/m³).

This harvesting cost average is somewhat expensive, but reasonable based on the likely levels of harvest and low-tech equipment used by the CFEs—only chainsaws and tractors in most
cases, and even bulls in a couple of cases. The variation, however, indicates that the costs (and records) varied substantially. The cheapest cases had costs of less than 200 MX$/m³ (15 US$/m³). Several cases were very expensive, at more than 700 MX$/m³ (55 USD $/m³). These costs are possible, and if accurate, would mean that CFEs will produce higher cost wood, or receive less for their derived stumpage prices.

INCOME AND PROFITS

The summary of the calculations for the timber harvesting profitability is presented in Table 5. It was possible to estimate the total amount of the timber sales price “en brecha”—at the roadside—from the survey. The total profit for each community was the price en brecha minus costs of harvesting and management.

TABLE 5

Eight (27%) of the 30 CFEs had a loss per m³, indicating that their costs exceeded their incomes. And most of those losses were large, at more than 200 MX$/m³ (15 USD $/m³). On the other hand, 22 (73%) of the CFEs did make a profit on their timber harvesting even when the costs from the forest management part were included. The median case should be more representative since one of the CFEs lost a huge amount (-7,195 MX/m³ or -553 US$/m³). Thus for this case, there was a profit of 243 MX$/m³ (19 US$/m³). Overall, the profitability of the harvesting operations varied widely, but given relatively high product prices at roadside, there appeared to be good opportunity for profits if harvesting costs were not excessive.
For timber harvesting costs, the costs calculated for CFEs were compared with few examples in the U.S. It was expected U.S South costs to be less than other parts of the country, because of the well-managed, high volume production harvesting crews with high levels of mechanization. The harvesting costs for the mountains of the U.S. should be more representative comparison with the Mexican CFEs.

Table 6 summarizes the harvesting cost benchmarks from USA, Argentina, Brazil and Uruguay and CFEs in Mexico. The first value in U.S. South (“Timber Mart-South”, 2011) finds that harvesting costs from the stump-to-loaded on a truck at roadside were 12.17 US$/ton, which is about the same volume as a cubic meter. This is much less than the average costs for the CFEs in Mexico that had an average value of 39 US$/m3. However, the stump-to-loaded on a truck costs cited is an old study in Montana from 1995 for ground based systems in the mountains were much higher, ranging from 37 US$ to 52 US$/m3 (Keegan et al., 1995). These costs, about 16 years ago, were still greater than the Mexican average harvesting costs. The U.S. costs did include loading onto a truck, but this is generally not expensive, perhaps 2-3 US$/m3.

The harvesting costs in Mexico ranged from 8.75 US$/m3 to a more expensive 119 US$/m3. The mean for harvesting operations in Mexico was about 39 US$/m3, and the median 30 US$/m3. There were not many very expensive timber harvesting operations overall, however, there were several that were small, less than 10 US$/m3. Overall, timber harvesting costs appear to be in a reasonable range for typically mountainous conditions found on Mexican CFE.
COSTS

Table 7 summarizes selected sawmill data for total costs, total income, and profits. Note that there were only 23 CFEs that had sawmills (Type IV). The overall average costs for lumber production at sawmills was 2,340 MX$/m³ (180 US$/m³). This was comprised of 1,207 MX$/m³ (93 US$/m³) of wood costs (including loading and transport from road side); 287 MX$/m³ (22 US$/m³) of equipment and operation costs; 638 MX$/m³ (49 US$/m³) of depreciation; and 209 MX$/m³ (16 US$/m³) of indirect labor and energy costs. The cost of timber was the largest.

The variation again indicates that the costs (and records) varied substantially. The cheapest cases had sawmilling costs of less than 1,200 MX$/m³ (92 US$/m³). Only a few CFEs actually had costs per cubic meter greater than the average, which was distorted by the one very expensive enterprise. Without that case, the average sawmilling total costs would fall to 1,676 MX$/m³ (129 US$/m³). This probably is still expensive, but not nearly as costly.

INCOME AND PROFITS

The summary of the calculations for the timber harvesting profitability is presented in Table 8. We estimated the weighted average lumber price by species, and product class ranging from low grade to the highest grade of lumber produced. These were then used to estimate total income, or total sales price. The total profit for each sawmill was the total sales revenue minus the costs lumber production. 22% of the CFE sawmills had a loss per m³, indicating that their lumber
manufacturing and wood purchase costs exceeded their total sales incomes. The rest of the 18 enterprises (78%) did make a lumber manufacturing profit. Average profits were quite large 53 US$/m³ (684 MX$/m³). These profits must reflect high prices for lumber and panel products in Mexico. The profitability of the sawmill operations varied widely, but there was clearly opportunities for profitable sawmilling operations, which indeed extended all the way back through the lumber to timber supply chain.

**TABLE 8**

**BENCHMARKS**

Twenty-three of the CFEs owned sawmills, thus having the complete value chain from forests to sawmills. The mean cost of lumber production for the CFEs was 827 US$ per thousand board feet (MBF), with a large standard deviation of US$1,130. The minimum cost was 340 US$/MBF and; the highest 5,938 US$/MBF; the median cost was 564 US$/MBF.

Random Lengths (2011) reports lumber market prices in the United States, and provides a handy benchmark for Mexican costs (Table 9). It reports sales prices, so would expected to have prices higher than U.S. production costs, but not that much. Margins for manufactured U.S. lumber have reportedly been razor thin, and indeed many sawmills are incurring losses and selling lumber below their costs of production. Thus the Random Lengths (2011) benchmarks should be sufficient given the accuracy of our Mexican data, and the large differences between the prices.

**TABLE 9**

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The weighted average Random Lengths Framing Lumber Composite Price for October 7, 2011 was 263 US$/MBF, and it was 248 US$/MBF in October 2010 (Random Lengths, 2011). Random Lengths reports prices for a wide variety of products and regions in the U.S., f.o.b mill (mill gate price). A few select price comparisons are shown below in Table 9.

For standard 2x4 material, the average production costs for Mexican sawmills are higher than for this most common grade as produced at different regions in the United States. At the high end of the lumber grades, the average Mexican lumber costs would be closer to U.S. costs, but there is not that much wood processed at that grade. However, much of the old growth timber in Mexico still is composed of higher grades, so higher costs would be somewhat more competitive. In addition, prices in Mexico must be high enough for the CFEs to continue to sell their products to markets in the country. But they probably do face considerable pressure from global wood producers, who have a glut of cheap lumber being produced since the recession in 2008.

On the other hand, the returns on investment for the Mexican mills were still generally positive for the entire value chain, based apparently on the relatively high prices for lumber in the Mexican market, where demand must be high. Five of the 23 CFEs had negative ROIs, ranging from -81% to a -2%. Positive ROIs ranged from 3% to 445%. At the very least, the ROI results do indicate that high lumber prices in Mexico have allowed at least the efficient CFEs to make reasonable to quite attractive profits on their overall operations, even including payments to communities.
Measures of Forests, Sustainability and NPV

Community forest enterprises located in temperate forests commercialized mainly pine even though there are other commercial species in the forest such as fir and oak. Enterprises located in the Peninsula (Chiapas and Quintana Roo) commercialized mainly a mix of common tropical tree species and to a lesser extent, mahogany, which is considered a valuable species.

Sustainability was measured by asking the CFEs how much total timber inventory and harvest they made in 2011, the area of their production forests, and what their average growth rates per ha were for their forests. Based on this, an average removal rate per ha was calculated, and compared with the average growth rate per ha. Growth rates per ha exceeding removal rates per ha indicated sustainable harvests, and vice versa.

Fourteen (47%) of the CFEs were harvesting more than their annual growth rate in 2011, although most of these CFEs with excess harvests over growth had higher standing inventories of older growth forests as their base. Two of the CFEs (7%) had harvests that greatly exceeded growth, at 19 m3/ha/yr more, which clearly would not be sustainable for long, although these were compared to the largest standing inventory base of old growth timber volume per ha of more than 360 and 450 m3/ha. Six (20%) were harvesting about 2 m3/ha/yr more than the growth, but this could be continued for decades without seriously depleting the base volume, which ranged from 80 m3/ha to 300 m3/ha for the relevant CFEs. In addition, the harvests may decrease in years after 2011 for those CFEs, and in fact, the forest management plans for all CFEs indicated that they should be sustainable over the next decade, if they followed the plans.
In general, CFE are performing well as the average NPV shows (2,044 US$/ha) for the management of the forest. Twenty nine (97%) of the 30 CFEs considered in this study have positive NPV for a 30 year rotation and 16 (53%) are also doing a sustainable harvesting as the volume harvested is lower than the MAI. In general, this is a positive result which shows that enterprises are profitable and sustainable at the same time. The remaining 14 enterprises (47%) harvest more than the MAI but in general the difference was small. Only two enterprises (7%) had a severe overharvesting volume in comparison to the MAI, and they also were the ones showing the largest NPV values, but were working on the high standing inventory base. They probably would decrease harvests once the large old growth forest base was harvested and they converted to younger forest estates. Monitoring still should be necessary to ensure that CFEs that harvesting more than annual growth do not continue that pattern for so long that the long term harvest is not sustainable.

Forest Management

The cost-benefit analysis showed that all but one enterprise was profitable for its forest management. This result could be attributed to the low costs reported. These low costs of the management activities may be partially explained by the low investment that the enterprises put on site preparation and regeneration activities. There are many cases with no cost in these two categories which shows that the enterprises rely mainly on natural regeneration. Costs could be even lower if CFEs spent less than the average 13% on investments for the community such as schools and roads, but this is not an excessive amount given the importance of the forestry enterprise to sustainable livelihoods in the comunidades and ejidos. The largest cost category was technical assistance; this cost could be reduced if community members were trained to do
the technical activities for which they currently have to pay. However, the growth rates for Mexican forests were quite low, at an average of 2.8 m3/ha/yr, so the average forest management costs per cubic meter were still greater than for exotic fast plantations grown in other countries.

On average only 7% and 3% of the income of the forest management income for CFEs came from commercializing NTFPs and from implementing PES schemes, 90% came from timber sales. NTFPs and PESs may have more potential to increase the income and profitability of the enterprises, but do need market development.

Harvest

The results from the timber harvesting analysis and profitability indicate that those costs were moderately expensive. The mean of 506 MX$/m3 (38 US$/m3) or the median of 397 MX$/m3 (30 US$/m3) are more expensive than in some countries, considering that is just the cost to cut and haul the timber from the forest to the roadside. Several CFEs were more efficient, with costs of less than 200 MX$/m3 (15 US$/m3). This timber, however, would require transport costs to the mill as well, which would add another 235 MX$/m3 (18 US$/m3) on average. The majority of CFEs—22 of 30 (73%)—were profitable in their harvesting operations, but a few had very high costs.

Not all the volume that is harvested is for commercial sales. On average, CFEs sold 77% of their timber harvest, and the rest was considered waste or is use for household consumption. The harvesting includes mainly pine, fir and oak—pine accounts for 85% of the harvest on average while 8% is fir and 8% oak.
Sawmill

The mean cost of lumber production was 2,340 MX$/m³ (180 US$/m³) and the median cost was 1,503 MX$/m³ (116 US$/m³). The product mix on average for the CFE was: 43% of Mill Run, 9% of Grade 1, 6% of Grade 2, 16% of Grade 3, 15% of Grade 4, and 11% of Grade 5. The more any individual sawmill produced large, high grade, high value lumber, the more it could justify higher costs.

The Mexican sawmills were generally profitable, with five exceptions, with a median excess of sales prices over manufacturing costs of about 483 MX$/m³ (37 US$/m³). This represents about a 30% profit margin, which is attractive for any business.

Benchmarks

Benchmarks from other studies of community forests indicate that our survey and analysis results were both more variable, and more optimistic in its ROIs and profits, despite relatively high costs. Still, the international competitiveness of Mexican CFEs is challenging. At least two-thirds of the CFEs examined had costs of forestry, harvesting, and sawmilling that were higher than the costs reported in other countries producing pine. The slow growth of native forests makes wood production costs high in any species and country, and Mexico cannot escape this adage. Logging on land with steep slopes is expensive, but small-scale systems in Mexico may fare quite well in this regard, and certainly are intensive labor systems and processors can be good jobs. Sawmills appear to have substantial production capacity, but have low levels of annual production. This leads to high lumber production costs, at almost double the costs in neighboring U.S. or in Southern Cone countries.
The large national demand for forest products and solid wood products has allowed the CFEs to have positive net profits despite high average production costs. This supports financial sustainability in Mexico at this time. Other countries can produce cheaper wood but need to seek markets while facing depressed markets in the U.S. and Europe. Thus, the financial sustainability of communities may require policy interventions—incentives, tariffs, subsidies or other—in the long run, and/or need to improve the competitiveness of the local production compared to international markets.

CONCLUSIONS

This paper presents an extensive study of the value chain for a sample of CFEs in Mexico. The sample included 30 Type III and IV CFEs, which are those that generally have the highest human capacity and best management. There are 992 CFEs in Mexico, with a wide range of sizes and manufacturing capacity. The sample for estimating the sustainability and profitability of the Mexican CFEs was relatively large; the sample includes about 3% of all Mexican CFEs and about 10% of the total CFEs belonging to categories III and IV (291), which represents one of the largest studies of community forestry to date, extended throughout the entire value chain from forest management to lumber manufacturing. Characteristics of the CFEs sampled varied considerably, but this could be expected for a study spanning 12 states and 30 CFEs across a large country, and given the challenges of collecting sensitive production and cost data from a variety of communities.

Overall, the study indicates that while there is considerable variability in Mexican CFEs, they are mostly sustainable in the long run, and most of their operations in the forest management to lumber manufacturing value chain are profitable. Two of the CFEs were harvesting far more than
a sustained yield level, but both had extremely large base inventories, so could probably taper off the timber harvests as inventories declined. The other CFEs either had a moderate base inventory, or were actually harvesting less than they were growing in 2011. Their harvests of relatively rich natural forest estates almost always made forest management for the CFEs profitable, except in one case. Still, the CFEs could not exploit their rich natural forests excessively or indefinitely, especially those that were harvesting substantially or slightly more than they were growing. Otherwise, they would become unsustainable from all three financial, environmental, and social perspectives.

It is interesting to revisit the findings from the concurrent Forster et al. (2014) study, which found that only 10 of 53 interviewed community forests in Quintana Roo were currently marketing timber, although 29 had at one time harvested timber, and 14 never had. That study concluded that the forest inventory, better species, and community organization were keys in determining if communities were still harvesting timber. Perhaps this might imply that communities that harvest too much timber also could stop being sustainable, and have to cease market participation, although the authors lacked adequate inventory volumes per ha to be able to empirically test this relationship (Forster et al. 2014).

The CFEs of this study also were fairly sophisticated in their management, as indicated by the fact that all had forest management plans to complement their land ownership and most had timber processing all the way through the forest value chain. Most CFEs also made profits on timber harvesting and lumber production, but there were more firms that lost money on these operations. It is important to note that this study was restricted to Type III and IV CFEs; the level of management and profitability is likely much different for Types I and II.
The profitability of the CFEs was encouraging, but was based on high prices for timber from forestry, high harvesting prices paid, and high lumber prices. These high lumber prices and high costs could be a threat by inviting cheaper wood to be imported, and from not so far away—the U.S. South or Chile. Thus increased efficiency throughout the value chain could be more important in the future. Continued adaptations and improvements in their operations will be required for CFEs to prosper with global competition, but they do have a good forest resource and evidenced reasonable management skills and experience to recognize and make such improvements, with capacity building, the technical assistance from government organizations and continued financial assistance. It is important to consider that many CFEs obtain government subsidies and it would be interesting for future studies to analyze the effect these have on the financial performance and sustainability of CFEs operations. The CFEs also may be to expand income from NTFPs and PES, which are still minor contributor to income on average, and explore the commercialization of the 23% of the wood that is wasted during harvesting as some other CFEs in Mexico not included in this study.
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Figure 1. Map of the states included in the study
Table 1. Timber Growth and Harvest per Hectare for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th></th>
<th>Standing volume m3/ha</th>
<th>Total harvest 2011 m3/yr</th>
<th>Mean annual increment (MAI) m3/ha/yr</th>
<th>MAI minus harvest 2011 m3/ha/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>178</td>
<td>11,393</td>
<td>4.04</td>
<td>2.83</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>106</td>
<td>11,264</td>
<td>5.38</td>
<td>1.98</td>
</tr>
<tr>
<td>Maximum</td>
<td>450</td>
<td>46,095</td>
<td>22.12</td>
<td>8.82</td>
</tr>
<tr>
<td>Minimum</td>
<td>21</td>
<td>389</td>
<td>0.03</td>
<td>0.70</td>
</tr>
<tr>
<td>Median</td>
<td>153</td>
<td>6,265</td>
<td>2.32</td>
<td>2.50</td>
</tr>
</tbody>
</table>


Figure 2. Sustainability (MAI minus harvested volume 2011) versus Net Present Value
Figure 3. Average costs, incomes and profits along the vertical integration
Table 2. Forest management cost categories for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th></th>
<th>Site preparation</th>
<th>Reforestation</th>
<th>Periodic management</th>
<th>Roads</th>
<th>Fire control</th>
<th>Technical assistance</th>
<th>Payment to communities</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MX$/ha</td>
<td>MX$/m3</td>
<td>MX$/ha</td>
<td>MX$/m3</td>
<td>MX$/ha</td>
<td>MX$/m3</td>
<td>MX$/ha</td>
<td>MX$/m3</td>
</tr>
<tr>
<td>Average</td>
<td>27</td>
<td>15</td>
<td>162</td>
<td>10</td>
<td>27</td>
<td>87</td>
<td>51</td>
<td>54</td>
</tr>
<tr>
<td>Maximum</td>
<td>150</td>
<td>225</td>
<td>4,503</td>
<td>211</td>
<td>193</td>
<td>563</td>
<td>792</td>
<td>375</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>30</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>
Table 3. Income from forest management activities for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th></th>
<th>Timber</th>
<th>NTFPs(^1)</th>
<th>PES(^2)</th>
<th>Total income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MX$/ha</td>
<td>MX$/m3</td>
<td>MX$/ha</td>
<td>MX$/ha</td>
</tr>
<tr>
<td>Average</td>
<td>2,796</td>
<td>661</td>
<td>206</td>
<td>108</td>
</tr>
<tr>
<td>Maximum</td>
<td>17,083</td>
<td>1,037</td>
<td>3,331</td>
<td>1,904</td>
</tr>
<tr>
<td>Minimum</td>
<td>18</td>
<td>369</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>1,198</td>
<td>679</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\) Non-Timber Forest Products  
\(^2\) Payments for Environmental Services
Figure 4. Average costs and prices of forest management activities of 30 CFEs in Mexico versus other countries.

Costs are the total costs in 30 years (without discounting or compounding), divided the total volume harvested during 30 years. Other countries include: USA, Chile, Brazil, Argentina, Uruguay, New Zealand, South Africa, Colombia, Venezuela and Paraguay, taken from Cubbage et al., 2010.
Table 4. Harvesting costs by different categories in 2011

<table>
<thead>
<tr>
<th></th>
<th>Total harvest</th>
<th>Commercialized volume</th>
<th>Capital: maintenance and depreciation</th>
<th>Labor</th>
<th>Machine operation</th>
<th>Total costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/yr</td>
<td>m³/yr</td>
<td>MX$/yr</td>
<td>MX$/m³</td>
<td>MX$/yr</td>
<td>MX$/m³</td>
</tr>
<tr>
<td>Average</td>
<td>10,721</td>
<td>8,259</td>
<td>961,783</td>
<td>138</td>
<td>889,755</td>
<td>193</td>
</tr>
<tr>
<td>Maximum</td>
<td>46,095</td>
<td>39,181</td>
<td>4,897,940</td>
<td>519</td>
<td>5,172,160</td>
<td>1,189</td>
</tr>
<tr>
<td>Minimum</td>
<td>389</td>
<td>195</td>
<td>10,400</td>
<td>5</td>
<td>36,000</td>
<td>9</td>
</tr>
<tr>
<td>Median</td>
<td>6,182</td>
<td>5,254</td>
<td>440,279</td>
<td>109</td>
<td>558,750</td>
<td>99</td>
</tr>
</tbody>
</table>
Table 5. Harvesting Costs, Income, and Profits for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th></th>
<th>Commercialized volume</th>
<th>Total harvesting costs</th>
<th>Management and harvesting costs</th>
<th>Income at roadside</th>
<th>Profit at roadside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m3/yr</td>
<td>MX$/yr</td>
<td>MX$/m3</td>
<td>MX$/m3</td>
<td>MX$/m3</td>
</tr>
<tr>
<td>Average</td>
<td>8,259</td>
<td>2,992,645</td>
<td>506</td>
<td>997</td>
<td>922</td>
</tr>
<tr>
<td>Maximum</td>
<td>39,181</td>
<td>12,674,374</td>
<td>1,550</td>
<td>7895</td>
<td>1794</td>
</tr>
<tr>
<td>Minimum</td>
<td>195</td>
<td>206,200</td>
<td>114</td>
<td>187</td>
<td>524</td>
</tr>
<tr>
<td>Median</td>
<td>5,254</td>
<td>2,304,408</td>
<td>397</td>
<td>645</td>
<td>866</td>
</tr>
</tbody>
</table>
Table 6: Harvesting Benchmarks for Timber Harvesting Costs

<table>
<thead>
<tr>
<th>Region</th>
<th>Average cost (US$/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South USA (Timber Mart-South, 2011)</td>
<td>12.17</td>
</tr>
<tr>
<td>USA Mountains (Montana 1995)</td>
<td>37-52</td>
</tr>
<tr>
<td>Argentina, Brazil, Uruguay (Patricio MacDonagh, Pers. Comm. 2013)</td>
<td>7.41-14.82</td>
</tr>
<tr>
<td>Mexico CFEs</td>
<td>39</td>
</tr>
</tbody>
</table>
Table 7: Sawmill costs for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th>Cost of timber</th>
<th>Cost of machines: operation and maintenance</th>
<th>Depreciation</th>
<th>Indirect labor costs and energy</th>
<th>Total cost sawmill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MX$/y</td>
<td>MX$/m3</td>
<td>MX$/y</td>
<td>MX$/m3</td>
</tr>
<tr>
<td>Average</td>
<td>9,147,155</td>
<td>1,207</td>
<td>1,221,347</td>
<td>287</td>
</tr>
<tr>
<td>Maximum</td>
<td>24,436,416</td>
<td>2,865</td>
<td>2,926,106</td>
<td>2,433</td>
</tr>
<tr>
<td>Minimum</td>
<td>13,346</td>
<td>695</td>
<td>25,000</td>
<td>18</td>
</tr>
<tr>
<td>Median</td>
<td>8,038,742</td>
<td>1,035</td>
<td>981,135</td>
<td>101</td>
</tr>
</tbody>
</table>
Table 8. Sawmill costs, income and profit for CFEs in Mexico, 2011

<table>
<thead>
<tr>
<th></th>
<th>Volume processed</th>
<th>Total cost</th>
<th>Total income</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/y</td>
<td>board ft/y</td>
<td>MX$\text{/y}$</td>
<td>MX$\text{/m}³$</td>
</tr>
<tr>
<td>Average</td>
<td>8,556</td>
<td>1,819,903</td>
<td>12,350,147</td>
<td>2,340</td>
</tr>
<tr>
<td>Maximum</td>
<td>27,187</td>
<td>5,760,000</td>
<td>30,242,979</td>
<td>16,968</td>
</tr>
<tr>
<td>Minimum</td>
<td>10</td>
<td>2,259</td>
<td>174,346</td>
<td>941</td>
</tr>
<tr>
<td>Median</td>
<td>7,200</td>
<td>1,452,000</td>
<td>9,921,971</td>
<td>1,503</td>
</tr>
</tbody>
</table>
Table 9. Select Random Lengths Lumber Prices, October 2012

<table>
<thead>
<tr>
<th>Product/Species</th>
<th>Southern Pine Central</th>
<th>Douglas Fir</th>
<th>Western Spruce-Pine-Fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiln Dried Dimension (2x4 #2&amp;better)</td>
<td>263 US$/MBF</td>
<td>285 US$/MBF</td>
<td>308 US$/MBF</td>
</tr>
<tr>
<td>Kiln Dried Framing (2x8 12')</td>
<td>275 US$/MBF</td>
<td>270 (green) US$/MBF</td>
<td>290 US$/MBF</td>
</tr>
<tr>
<td>Selects &amp; Commons (#2&amp;better, 1x8)</td>
<td>365 US$/MBF</td>
<td>335 (green 1x6) US$/MBF</td>
<td>445 US$/MBF</td>
</tr>
<tr>
<td>Selects &amp; Commons (D, 1x8)</td>
<td>720 US$/MBF</td>
<td></td>
<td>930 US$/MBF</td>
</tr>
</tbody>
</table>

Average Cost Mexico CFE (2011): $827 USD/MBF