

Socioeconomic and environmental impact of forest certification in ejidos and communities of the state of Durango, Mexico

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HIGHLIGHTS

- 48 key forest certification principles, indicators and variables in the Forest Stewardship Council (FSC) forest certification scheme were analyzed systematically in the field with site inspections and personal interviews to determine whether certified firms had improved in these practices.
- 25 principles or practices covered in forest certification are not much different at any significance level between certified and non-certified practices.
- Certified firms have many characteristics that can be considered better than non-certified firms.
- This indicates that current forest certification in Mexico largely appears to be achieving its goals of improved sustainable management.
- Certification is associated with better forest management practices and does help promote a better quality of life for the communities.

SUMMARY

A principal objective of forest certification is to ensure that forest management operations and administration provide opportunities for social, economic and environmental development. This study assessed the implementation of 48 specific forest certification practices through field interviews and site inspections in 13 forest properties certified in Durango according to the Forest Stewardship Council (FSC), and compared them with practices on a pooled set of matching non-certified properties. The results of field observations indicate that forest certification has prompted measurable changes in sustainable forest management practices in Mexico. For 24 identified forest management and environmental certification practices, there were four statistically significant differences at $p < 0.10$, and 7 at $p < 0.25$. Six of 11 forest certification practices were significantly different at $p < 0.10$ for the social component, and 5 of 13 in the economic category. Forest certification in Mexico is related to better forest management practices and as a promoter of a better quality of life for communities. However, it still faces challenges to achieve better prices for certified forest products in the market, but has helped firms enter new market segments.

Keywords: forest certification, forest Stewardship Council, environmental requirements, market based standards

Impact socio-économique et environnemental de la certification forestière dans les ejidos et les communautés de l'État de Durango, Mexique

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L'un des principaux objectifs de la certification forestière est de garantir que les opérations de gestion forestière et l'administration offrent des possibilités de développement social, économique et environnemental. Cette étude a évalué la mise en œuvre de 48 pratiques spécifiques de certification forestière par le biais d'entretiens sur le terrain et d'inspections de sites dans 13 ejidos et communautés forestières du Mexique certifiés par le Forest Stewardship Council (FSC), et les a comparées aux pratiques d'un ensemble de propriétés non certifiées correspondantes. Les résultats des observations sur le terrain indiquent que la certification forestière a entraîné des changements mesurables dans les pratiques de gestion durable des forêts au Mexique. Pour 24 pratiques de gestion forestière et de certification environnementale identifiées, il y avait quatre différences statistiquement significatives à $p < 0,10$, et 7 à $p < 0,25$. Six des 11 pratiques de certification forestière étaient significativement différentes à $p < 0,10$ pour la composante sociale, et 5 sur 13 dans la catégorie économique.

Impacto socioeconómico y ambiental de la certificación forestal en ejidos y comunidades del estado de Durango, México

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Uno de los principales objetivos de la certificación forestal es garantizar que las operaciones y la administración de la gestión forestal ofrezcan oportunidades de desarrollo social, económico y medioambiental. Este estudio evaluó la implementación de 48 prácticas específicas de certificación forestal a través de entrevistas de campo e inspecciones en 13 ejidos y comunidades forestales de México certificadas de acuerdo con el Forest Stewardship Council (FSC), y las comparó con las prácticas de un conjunto de propiedades no certificadas. Los resultados de las observaciones de campo indican que la certificación forestal ha impulsado cambios cuantificables en las prácticas de gestión forestal sostenible en México. Para 24 prácticas de gestión forestal y certificación ambiental identificadas, hubo cuatro diferencias estadísticamente significativas a $p < 0.10$, y 7 a $p < 0.25$. Seis de 11 prácticas de certificación forestal fueron significativamente diferentes a $p < 0.25$. Seis de 11 prácticas de certificación forestal fueron significativamente diferentes a $p < 0.10$ para el componente social, y 5 de 13 en la categoría económica.

INTRODUCTION

Forest certification is a market instrument and a voluntary process that promotes good forest management (Meidinger 2011). It is a mechanism created to highlight good forest management and ensure the sustainability of forests (Basso *et al.* 2018). It has been promoted as a mechanism that regulates trade in timber products in order to protect timber resources and has been widely hailed for its positive impacts on implementing sustainable forest management (Xu and Lu 2021). It is also considered a viable option to increase transparency and accountability in forest management organizations (Cashore *et al.* 2004).

Forest certification was motivated by improving sustainable forest management (SFM) in the tropics, but achieved most of its initial diffusion in the temperate and boreal forests of Europe and North America (Cashore *et al.* 2004, Leslie 2004, Ozinga 2004, Siry *et al.* 2005). Much of the early research on certification focused on broader questions such as the consumer response to certified products (Anderson and Hansen 2004, Archer *et al.* 2005, Kozak *et al.* 2004), the costs of forest certification (Estévez Malvar 2013, Gan 2005, Guan and Ip Ping Sheong 2019, Hartsfield and Ostermeier 2003) and the premium prices that forest certification was intended to generate (Gan 2005).

In addition, the reasons that organizations voluntarily seek forest certification and the mechanisms that attract forest enterprises to certification have been examined (Araujo *et al.* 2009). Other research has examined the changes that organizations have made since they obtained forest certification, and different outcomes and impacts between the two dominant systems the Forest Stewardship Council (FSC) and the Programme for Endorsement of Forest Certification (PEFC) (Moore *et al.* 2012, Rotherham 2011). Using forest certifications audit reports and personal interviews, Cubbage *et al.* (2010) found that forest certification prompted many changes in environmental, social and economic practices by forestry firms in Argentina and Chile – including practices required by the certification audits and reports, and practices changed in order to receive forest certification.

Others have compared the FSC standard with their own national certification systems (García-Montiel *et al.* 2017,

Lewis and Davis 2015). Also, it has been evaluated if forest owners' and managers' perceptions of forest certification differ as a tool to support SFM and forest ecosystem services (Paluš *et al.* 2021).

Mexico was among the **first** countries to adopt Forest Stewardship Council (FSC) certification in 1993, and indeed was the world headquarters for FSC from 1993 to 2003, but has seen some decline in enrollment in FSC recently. Despite its role as a global forest certification leader, there are few studies on certification in Mexico (Blackman *et al.* 2017, Blackman 2018, Gerez-Fernández and Alatorre-Guzmán 2007, Klooster 2006). Previous studies such as Blackman *et al.* (2017) performed secondary analyses of FSC corrective action request (CARs) of certified properties before and after certification in Mexico, and found that certification did not promote a large number of changes in environmental practices or forest management changes, and generally consisted of procedural changes that were predominantly social in focus.

Klooster (2006) used conventions analysis and commodity network analysis, and concluded that certification requires forest managers to make substantial improvements to the social and environmental aspects of forest management. According to that early study, forest certification had failed to generate prices that permit forest managers to cover the costs of certification and its required forest management improvements, the instrument imposes requirements on global south producers without rewarding them for their increased efforts. In addition to the equity issues, these features of the commodity network limit the adoption of forest certification and the forest management improvements it generates to only the largest forest management operations in Mexico.

The case of Mexico suggests broader limitations to non-governmental, market-based approaches to environmental governance and development. They need to be more conscious and realistic about the ability of product certification to insert values in markets governed by powerful actors such as retailers. Including rules modeled on Fair Trade will extend their reach, equity and efficacy, nevertheless, voluntary market-based instruments cannot replace a more direct government role in environmental regulation and development projects (Klooster 2006).

Gerez-Fernández and Alatorre-Guzmán (2007) carried out a review of the status of forest certification in Mexico since its inception and the progress that had been made to that date. They concluded that community certification is an important process, but it is immersed in a global, national and local context that demands other options, or modifications to existing options. Certification was not an economically attractive option for most communities. It lacked a strategy of market promotion designed specifically for community forest enterprises (CFEs), and needed information campaigns in national markets, for consumers and for the merchants. Currently, this improved strategy is still incipient in Mexican forest certification. According to Basso *et al.* (2018), in most countries, the internal market does not require forest certification, and often the consumer does not even know what forest certification means or contributes to the environmental improvement of forest management. Gerez-Fernández and Alatorre-Guzmán (2007) suggested that perhaps a gradual implementation mechanism or step by step adoption, with reduced costs, would be better adapted to CFEs and could make certification a more inclusive option. They observed that Mexican forest communities and their CFEs, as well as a number growing communities and indigenous forest companies in the rest of the world, represent a unique contribution to the local and regional forest economy, and to the conservation of these forest ecosystems with its environmental services. This uniqueness needs to be recognized and valued by the market and by the society.

Lewis and Davis (2015) and others contend that the impacts of forest certification on forest management systems are still inadequately studied, and only limited attempts have documented the impacts of forest certification on the overall quality of the operations of a forest management system, and even less limited number of studies were conducted on the enabling conditions of effective forest certification implementation (e.g., Karmann and Smith 2009, Newsom *et al.* 2006, Malek, E.J. 2022). Lewis and Davis (2015) concluded that researchers need to expand their data and statistical methods used in order to determine the overall impacts of forest certification, beyond just using secondary data such as audit reports entities. These secondary data are not always consistent and their compilation is intended for uses other than impact assessment (Karmann and Smith 2009).

Cubbage and Sills (2020) also observed that forest certification research evaluations focused mostly on secondary data from certification reports, and that primary operational, field and empirical data were needed to assess actual impacts. In addition, certification reports alone do not provide a counterfactual of non-certified properties. Primary data from on the ground and managers for both certified and non-certified properties is difficult to obtain because of the considerable effort and expense to visit and measure impacts on the ground, forests grow and change slowly after management, and there is not always a definitive measure of what is the best type of forest management practices for each forest type and situation. As one intermediate research approach, primary interview and management records data could be collected from certified and non-certified forest properties to assess

changes prompted by forest certification. This would lead to an improvement of secondary assessment reports, and would focus questions and responses on specific certification indicators most suitable for evaluation.

Accordingly, this research sought to use more comprehensive approaches to examine the effectiveness of certification compared with similar non-certified properties. In addition to a review of secondary CARs, we also employed direct field visits, in-person interviews with certified owners, and the providers of information the owners of the procedures, such as: the accountant, the members of the board of directors, the treasurer, the provider of technical services, and the president of the ejido, among others.

We used the field inspections and interview procedures with the non-certified properties as well. We identified key principles, criteria and indicators that help determine the impact of forest certification in Mexico, and whether the changes differed significantly between certified and non-certified forest properties.

MATERIALS AND METHODS

Study Area and Sample

The study considered a sample of 13 certified properties including ejidos, communities and private properties, distributed in six municipalities of the State of Durango-Pueblo Nuevo, San Dimas, Tepehuanes, Santiago Papasquiaro, Durango and Topia. The ejido in Mexico is a type of land tenure that belongs to the agrarian social property, the only difference between ejido and community is the legal form in which they are constituted. Ejidos and communities are rural properties that manage their forests with some level of government control, (Lujan-Soto *et al.* 2015). Likewise, the same number of non-certified forest properties was evaluated for comparison purposes, which were selected through a purposeful procedure by a panel of experts who selected ejidos' properties with characteristics similar to those certified in social, economic and environmental terms. These 13 certified properties were compared with a similar pooled group of 13 non-certified properties.

At the time of carrying out this study, in the state of Durango, there were 43 properties with forest certification issued by FSC, without considering if they were also certified by the Mexican Forest Certification System (MFCS). This study considered a random sample of 30% of properties: 2 community, 10 ejidos and 1 private property.

The same number of non-certified forest properties was selected as a pooled comparison considering the following characteristics: same geographical conditions or at least as similar as possible, the non-certified ejidos should have technical services and be lands under forestry exploitation, territorial extension similar to the certified properties, proximity to other developments or settlements and transportation, to be in conditions similar to the certificates and so that access to it was not limiting, and similar accessibility. Finally, they

had to agree to participate in this study, after having an interview with the curator and his surveillance board to access the information. For the non-certified properties 11 are ejidos and 2 are community.

A general description of the evaluated properties is shown in Table 1. Figure 1 illustrates the polygons of the forest properties where the present study was performed.

In order to carry out the evaluation, three separate survey instruments were designed, covering environmental, social and economic criteria within the ten principles of the FSC forest certification scheme (comply with all applicable laws, maintain or improve the social and economic well-being of workers, uphold the rights of indigenous peoples, maintain or improve the social and economic well-being of local communities, manage their products and services in a way that maintains or improves they long-term economic viability, social benefits, and environmental benefits, maintain, conserve, and/or restore the ecosystem services and environmental

TABLE 1 *Properties evaluated for forest management operations in Mexico in 2022*

Status	Name	Hectares	Certified Hectares	Type of property
C	A	2,457	2,307	Ejido
C	B	8,379	1,847	Ejido
C	C	9,442	9,104	Ejido
C	D	12,335	11,328	Ejido
C	E	10,709	9,923	Ejido
C	F	240,588	108,132	Ejido
C	G	153,066	145,347	Comunidad
C	H	14,119	15,212	Particular
C	I	23,446	21,343	Ejido
C	J	60,802	42,480	Ejido
C	K	12,793	11,904	Ejido
C	L	73,287	63,636	Comunidad
C	M	7,816	7,038	Ejido
NC	N	15,556	/	Ejido
NC	O	5,016	/	Ejido
NC	P	7,169	/	Ejido
NC	Q	2,388	/	Comunidad
NC	R	4,763	/	Ejido
NC	S	20,760	/	Ejido
NC	T	13,281	/	Ejido
NC	U	7,608	/	Ejido
NC	V	11,970	/	Ejido
NC	W	1,421	/	Ejido
NC	X	9,266	/	Comunidad
NC	Y	16,806	/	Ejido
NC	Z	3,073	/	Ejido

C= certified, NC= non-certified

values of managed forests, and also avoid, repair, or mitigate negative environmental impacts, establish a management plan that outlines their economic, environmental and social policies and objectives, demonstrate progress toward meeting these objectives, maintain or improve high conservation values, ensure that all management activities comply with FSC principles and criteria), and the nine principles established by the NOM NMX-AA-143-SCFI-2008 for certification of forest management in Mexico.

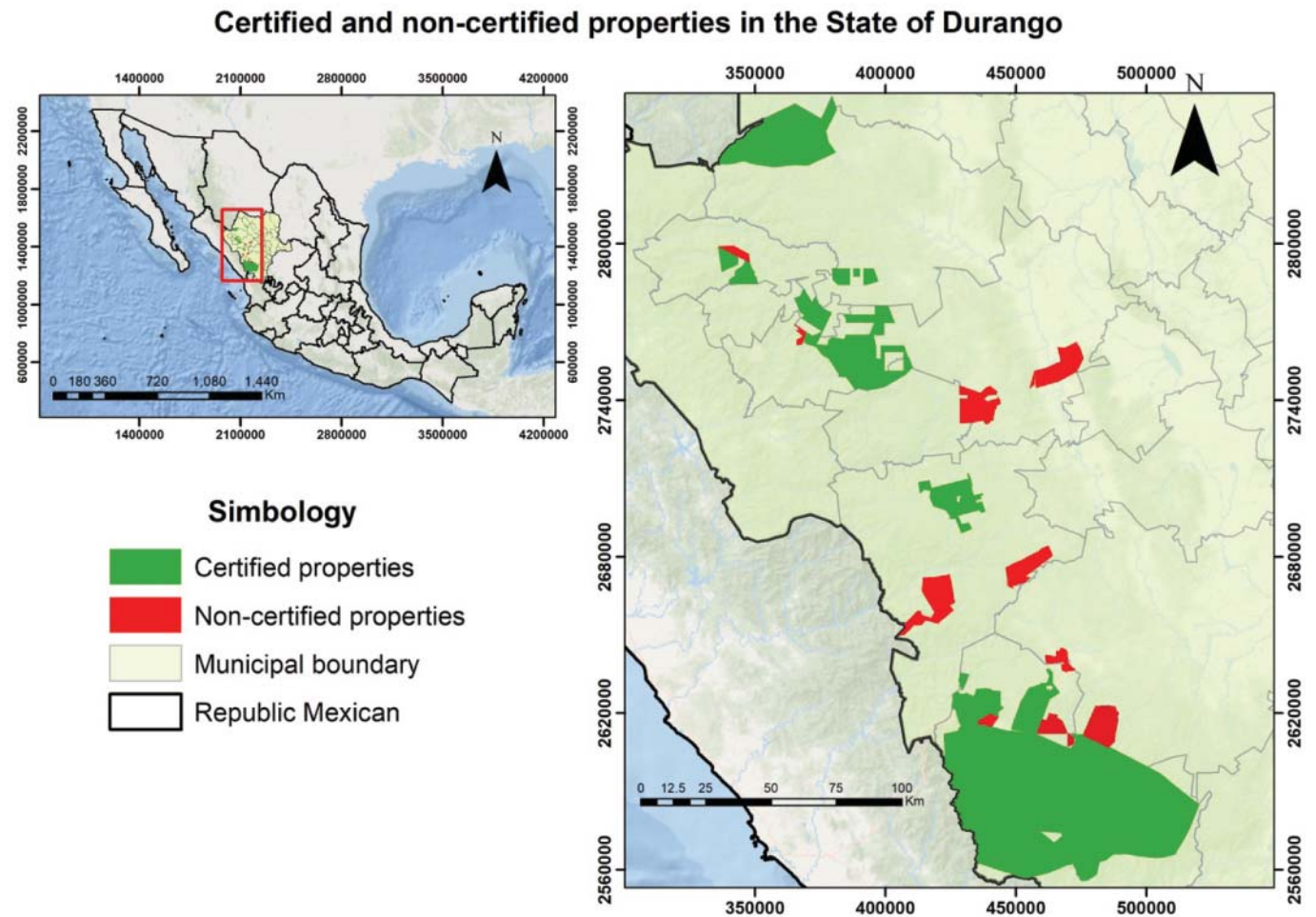
The criteria, indicators and verifiers of the evaluation instruments for each principle were: (a) environmental/forest management: 2 criteria, 4 indicators and 25 verifiers, (b) social: 9 criteria 16 indicators and 49 verifiers, and (c) economic: 5 criteria 22 indicators and 75 verifiers. The environmental instrument was used to assess overall forest management practices. It was developed using Likert scale questions, since there was a continuum of responses about the application of various forest practices and operations. The economic and social questionnaires used binary choice (yes/no) questions about where a particular practice was used, since these were either applied or not.

The application of our assessment instrument was carried out personally and directly with each property member who was an expert in the information requested. First, a meeting was held with the representatives of each property and their technical service providers to inform them of the interviews and provide their comments and suggestions. Once the final version of the evaluation instruments was available, appointments were made with each one involved, interviews were made separately. First the social instrument was made attended by the ejidal commissioner, the members of the board of directors and the accountant), then the economic (attended by the accountant and treasurer) one, and then the environmental one attended by the forestry technician and the forestry promoter.

All the certified forest properties were interviewed first, and subsequently the non-certified properties. Most of the properties received the interviewers in their offices for the application of the instruments, in some cases, the personnel designated to attend each interview came to the city of Durango or a city closer to their ejidos and communities to facilitate the process.

Responses were digitized by group of forest properties (certified and non-certified) in a spreadsheet for further analysis. Two statistical analyses were carried out in order to evaluate significant differences in environmental, economic and social verifiers between the two pooled groups of certified and non-certified forest properties. The questions formulated with a binary response (yes/no) to evaluate changes or significant benefits in economic and social aspects as a consequence of the implementation of the forest certification were analyzed with the Wilcoxon nonparametric test (1945) through the NPARIWAY procedure of the statistical system SAS/STAT® (SAS Institute Inc. 2008). To evaluate differences for forest management/environmental factors in the Likert scale response questions (1-5), the non-parametric Wilcoxon median test was used for unrelated samples using the SAS / STAT® NPARIWAY procedure (SAS Institute Inc. 2008).

FIGURE 1 Location of certified forest properties (in red) and non-certified properties (in green color) used in this study, Durango, Mexico in 2022



RESULTS

Changes in forest management practices

Table 2 shows the results of the classification of the 24 benefits (advantages) perceived by the forest management respondents in certified and non-certified forest properties. The range of response varied from 1-6 (1 = not important, 6 = very important). The sample of properties compared was small ($n=13$), so significant differences would be difficult to find regardless. Thus, two levels of significance were indicated, $p < 0.10$ and $p < 0.25$. In 13 of the evaluated benefit variables, there were no significant differences between the certified and non-certified forests properties at either level. These 'similar' practices for all forests included inventory, mapping, monitoring, plantation guidelines, sustained yield, biodiversity, special sites, green-up standards, reforestation, cavity trees retention, harvest clean-up, forest conversions, and invasive control.

The most significant differences were found for 4 of the 24 benefits studied ($p < 0.10$). The best-qualified benefits of respondents on certified sites all had differences indicated in the expected direction, with certified properties being better than non-certified properties. These included forests with

attributes of high conservation value (medians of 5 and 1, for certified and non-certified sites, respectively) and in the diversification of production (medians 2 and 1, for certified and non-certified properties, respectively, and forest health protection (medians of 4 and 2). Seven other factors indicated a moderate level of significance ($p < 0.25$), and all but one of those had the correct anticipated direction of certified properties having better operational practices than non-certified properties. Specifically, at a moderate significance level, certified properties stated that they had better GIS systems and forest planning, forest management program, use and monitoring of BMPs, determination of the maximum harvest area, endangered species protection, and protection of riparian areas and water sources. Interestingly, non-certified properties had a slightly better median score of 2 for stock, growth, and production calculations versus a 1 for certified properties. This exception of non-certified being moderately better than certified properties may indeed prove the rule: all the forest properties appear to manage for markets and profits about the same, but non-certified properties rate it slightly better. But certified properties consistently ranked somewhat higher in the other statistically significant environmental and planning practices.

TABLE 2 *Classification of perceived benefits (advantages) of forest certification on land certified and non-certified based on Likert scale responses, Mexico 2022*

Possible benefits (advantages) of forest certification in forest management	Median in certified land	Median in non-certified properties	P value of the paired Wilcoxon test
Forest Inventory for elaborating the management program	2	2	0.9766
Photogrammetric and land use map	2	2	0.6709
Geographical information systems and forest planning	2	2	0.1421*
Forest Management Program	5	4	0.2095
Use and monitoring of best management practices	5	3	0.1586*
Implementation / Efficiency of management monitoring	5	5	0.4227
Determination of maximum harvest area	2	1	0.233*
Comply with guidelines for plantations	2	1	0.9132
Stock, growth and production calculations	1	2	0.1355*
Sustained yield / crop allowed / adjacency constraints	1	2	0.6434
Diversification of production	2	1	0.0103**
Protection of threatened species	5	3	0.1449*
Planning for the conservation of biological diversity	5	4	0.299
Forests or attributes of high conservation value	5	1	0.03765**
Reservations for special sites	3	2	0.5648
Meet "Green-up" standards (habitat connectivity)	4	4	0.8795
Forestry / Reforestation	2	2	0.9568
Chemical Safety / Reduction / Disposal	6	2	0.01259**
Forest health protection	4	2	0.0761**
Maintenance of dry trees with cavities	4	4	0.8947
Protection of riparian ecosystems or water sources	4	2	0.2213*
Cleaning of cutting areas	3	2	0.3616
Decrease forest conversions	1	2	0.3461
Prevention of invasive alien species	1	1	0.9748

** Statistically different mean $\alpha = 0.10$, *Statistically different mean $\alpha = 0.25$

1 = Not important, 2 = Slightly important, 3 = Moderately important, 4 = Important, 5 = Very important.

Changes in social aspects

Table 3 shows the number of changes and percentage of respondents who perceived improvements in social aspects in certified and non-certified properties. Note that in these binary choice models, the different certified and non-certified properties had stronger differences in practices, so the statistical significance level of 0.10 captured almost all of the substantial changes with certification. There were significant differences between the certified and non-certified properties ($p < 0.10$), in six of the eleven aspects evaluated. Compared to non-certified properties, certified properties showed significant changes in the existence of agreements in the FMOs that recognize the legal or traditional rights of communities to own, manage or use forest resources, where workers, including those by contractors, count on and use the necessary personal protective equipment in accordance with their job, the existence of norms that regulate the use of community

services, and the application of norms that regulate the use of services. In addition, the inhabitants of certified forest ejidos have a significantly greater access to middle school and high school education.

Changes in economic aspects

Table 4 shows the number of changes and percentage of respondents who perceive improvements in economic aspects caused by forest certification. As shown in Table 3, significant differences were observed between certified and non-certified properties ($p < 0.10$), in 5 of 13 aspects studied in this component of the study. Compared to non-certified properties, significant changes in budgeting are perceived in certified properties to determine the efficient use of the resource available to the Forest Management Organization (FMO), in estimating costs to maintain certification, in giving the workers the opportunity to organize themselves in any lawful

TABLE 3 Number of changes and percentage of respondents who perceived advantages in social aspects caused by forest certification based on Binary responses, Mexico 2022

Change in the social aspect	Certified properties		Non-certified properties		Pr > Z
	positive responses (No)	%	positive responses (No)	%	
There are agreements between the FMOs (Forest Management Organization) and the communities, ejidos, people, groups, etc. Where customary / traditional legal rights of communities are recognized for owning, managing or using forest resources.	6	33.33	1	6.67	0.0593*
If it exists, the FMO, with the support of the indigenous communities, defines sites of special cultural, ecological, economic or religious significance, And these are clearly identified on maps and in the field, and are protected.	0	0	0	0	1.00
Agreements with indigenous peoples with customary / traditional rights.	0	0	0	0	1.00
In case the indigenous group delegates the forest management to third parties, there are agreements or contracts legally established and freely approved by the assembly of comunitarios or ejidatarios.	0	0	0	0	1.00
All workers, including contractors, count on and use the necessary personal protective equipment in accordance with their job.	13	72.22	3	20	0.0014*
There are regulations governing the use of community services.	8	44.44	15	100	0.0051*
The rules governing the use of services apply.	4	22.22	15	100	0.0002*
Ejidos with kindergarten educational level.	18	100	15	100	1.00
Ejidos with elementary educational level.	18	100	15	100	1.00
Ejidos with middle school educational level.	15	83	7	46	0.0656*
Ejidos with high school educational level.	5	27	0	0	0.0678*
Total positive responses.	87		71		

* Statistically different mean $\alpha = 0.10$.

and legitimate way, in the existence of an accounting system that provides clear and precise information for decision-making in the FME, and in having exclusive forest technical services and the annual employment contracts for forest management workers in timber harvesting.

DISCUSSION

This research found that for 24 identified forest management field practices, there were four large and seven moderately significant changes or benefits in most of the evaluated management practices. For forest monitoring, forest protection, reduction of the use of chemicals and conservation of biodiversity, a significantly higher amount of performance that met the FSC forest certification standards was obtained on certified properties in comparison to the non-certified ones. Other planning, forest management program, BMP, harvest area, endangered species, and riparian practices were somewhat different and better on certified properties. For the social aspects, superior practices were observed in 57% of the indicators and verifiers evaluated on certified properties. In economic aspects, significant changes were found in certified properties in the existence of program budgets, the efficient

use of resources, the freedom of workers to organize, the existence of an accounting system, and year-round contracts.

The results of this study are consistent with other studies that suggest that forest certification has led to changes or the use of good forest management practices (Newsom *et al.* 2005) as well as social and economic aspects when the certificate is provided by the FSC (Auld *et al.* 2008), although in the case of Durango, the economic benefits are related to the administration and not to an increase in the price of the wood. They also found more changes in all three components of forest certification in Mexico than the study by Blackman *et al.* (2017).

According to Newsom and Hewitt (2005), the main changes brought by forest certification were in the following aspects: management plan, monitoring, communication and conflict resolution with stakeholders, neighbors and communities, training, chain of custody, aquatic and riparian areas, sensitive sites and high conservation value forests, threatened and endangered species, roads and skid trails and worker safety.

Auld *et al.* (2008), concludes that certification schemes have emerged in recent years to become a significant and innovative venue for standard setting and governance in the environmental realm, examinations of corrective action

TABLE 4 Number of changes and percentage of respondents who perceived advantages in economic aspects caused by forest certification, based on Binary responses, Mexico 2022

Change in the economic aspect	Certified properties		Non-certified properties		Pr > Z
	positive responses (No)	(%)	positive responses (No)	(%)	
There is the preparation of budgets to determine the efficient use of the resource available to the FME	6	33.33	0	0	0.0678
Market study of wood	1	5.56	0	0	0.3352
Have costs been estimated to maintain certification?	18	100	0	0	<.0001*
Were new staff employed to work following the implementation of forest certification?	2	11.11	0	0	1
The workers are given freedom to organize themselves in any lawful and legitimate way	16	88.89	0	0	<.0001*
It has an action plan to find customers in international markets	3	16.67	0	0	0.1490
There is an accounting system that provides clear and accurate information for decision making in the FME	17	94.44	2	13.13	<.0001*
The forest estate has exclusive forestry technical services	9	50	0	0	0.0006*
There is currently an organization and / or union formed by workers	1	5.56	0	0	0.3352
Annual seasonality of forestry jobs in extraction and supply	15	83.33	2	13.13	0.0134*
The techniques of utilization and transformation used avoid the breakage of trees	17	94.44	14	93.33	0.3352
Total positive responses	107		18		

* Statistically different mean $\alpha = 0.10$

requirements (CARs) issued by certification bodies indicate that forestry practices are changing as a consequence of forest management auditing as well.

These findings are affected by various issues with ejidos in Mexico. Some of the ejidos that were not certified had a greater problem in the organization of ejidatarios, and it was more complicated to organize to work as an ejido. There were other cases where the ejidos cooperated for timber harvests by the buyer (Ejido 1010 and Antonio Molina Déras). Some ejidos have had conflicts with the use of resources and accountability, and distrust has been generated towards the board. This has led to a halt in timber harvesting operations and lack of timber stumpage sales, causing a lag in the generation of jobs. Some ejidos that were not certified did not have good cost or financial information. There may not be an accountant who is in charge of the registration of the operations, so hand worksheets are used.

Some non-certified ejidos are looking for forest certification in order to meet the government's requirement as a condition to receive support, but not from their own motivation. In other ejidos and communities, the lack of awareness regarding the care of the environment and continuous improvement caused the lack of interest in the acquisition of the FSC green seal.

The surveys and interviews examined prices for wood and financial benefits for certification. The price of timber was uncertain, but estimated to range from \$ 1,150.00–\$ 1,200.00 pesos per m³, based largely on the size and quality of the

wood – not derived from the certification. For comparison, CONAFOR (2022) reported national level average prices for timber stumpage (madera en pie) and processed wood products where pine roundwood had a comparable average of \$1,210 pesos per m³ in 2022. For some surveyed forestry companies, certification allowed them to enter new markets. For example, some forestry companies have gained access to the market for molding, where it is a requirement to be certified.

The accountants who responded to the questions stated that prices depend almost entirely on sale negotiations; the best bargainers will obtain greater profits. They stated that certification had not brought increases in the price, as corroborated by the CONAFOR data. However, it did not appear to cause stumpage prices to decrease due to increased environmental compliance requirements, suggesting better practices could be considered a net welfare improvement.

In comparison, Frey *et al.* (2019) used an instrumental variable approach to examine the effect of forest certification and government capacity development programs for CFEs in pine forests of Mexico. They found that the two programs jointly increase productivity of timber harvest and also increase community income. This augments the findings by Blackman *et al.* (2017) that certification had larger social and economic components than for to environmental considerations.

Interviews and field observations indicated that non-certified ejidos showed a lack of business discipline in many cases. They fail to work fixed schedules, lack a culture of teamwork, lack awareness in the care and sanitation of the

forest regarding waste disposal, and have little training. In addition, they are not likely to have training in various topics of culture and education, social integration is less than in certified ejidos, and workers do not have safety equipment in any of their areas. This study supports the need to have data on the impacts of forest certification of cases of a specific territory in order to be compared with regional scales as recommended by Wolff and Schweinle (2022).

CONCLUSIONS

This research collected and analyzed primary data from two groups of properties, certified and non-certified, in order to include better specific empirical data and improve comparisons. This paired comparison approach and direct collection of primary data from both certified and non-certified properties provides a robust approach to forest certification evaluation.

For the 24 environmental / forest management indicators, as indicated by a Likert scale ranking, 4 practices differed at the $p < 0.10$ level, and 7 at the $p < 0.25$ level. Many important forest management and environmental practices were found to be strongly or moderately significant and better on certified forest properties. For the binary social and economic questions and a level of $p < 0.10$, 6 of 11, social practices were different. Of the economic questions, 6 of 10 questions were different. In both cases, the tenets that were significant reflect improved social and economic principles and practices, confirming the merits of certification.

There were about 25 of 48 principles or practices covered in forest certification that did not show difference at any significance level between certified and non-certified practices. However, there is no suggestion that the certification process should consider dropping or eliminating particular questions. It simply indicates that all forest properties can be similar in many ways. Having a complete set of indicators and standards in forest certification makes for a thorough and credible approach and if many of the practices are already similar, it also suggests that conforming with forest certification may not be that burdensome, and more easily attained than critics of its difficulties or large costs might suggest.

In addition, our research can provide a new perspective on the common issues of greater certification costs without increased financial returns. Forest certification did not appear to generate higher timber prices, but on the other hand, it brought a number of new benefits from environmental, social and economic to the CFEs that used certification. And timber prices did not decrease due to higher compliance costs, so there could be a net welfare gain. Some prior studies of certification audit reports have found that audits focus more on social capacity building and economic and management system components than on environmental standards. Frey *et al.* (2019) found that this capacity building could be a positive outcome as well, by increasing timber harvest productivity and community income. Our observations that certification was associated with better training, team building, and organizational spirit reinforces the merits of social and planning standards in forest certification.

For the basis of these comparisons among firms, matches for the non-certified firms were made by a panel of academic, state and national CONAFOR experts. While these matches seemed similar, our subsequent surveys indicated that the nature of the non-certified firms was often different, which then contributed to their poor performance on the SFM certification indicators. This finding does not resolve whether certification was effective at improving ejidos/firms, or if it was just that the best firms were the ones who became certified. However, it does provide a much more robust empirical and counterfactual outcome than prior reviews of certification reports, finding that certified firms do have many characteristics that can be considered better than non-certified firms.

Nonetheless, our rigorous experts pooled matching approach and our primary data collection research does indicate that the certified ejidos appear to be better at achieving environmental, social and economic principles and indicators as selected and implemented in the FSC system in Mexico. Certification is associated with better forest management practices, and does help promote a better quality of life for the communities.

Further research might determine if it is certification or superior management that drives these improved sustainable forest management results, but they are clearly intertwined. Furthermore, the reasonable similarity between certified and non-certified properties in many aspects suggests that achieving certification is not an insurmountable task for other forest properties. Not only more research, but more government funding and extension could be used to help achieve this laudable goal to improve sustainable forest management.

Overall, based in primary interviews and field visits, FSC market-based forest certification lead to improved forest management, social and economic practices among matched pools of certified and non-certified properties. This indicates that current forest certification in Mexico largely appears to be achieving its goals of improved sustainable management. These findings, based on current research with primary data, show more success than previous studies based on secondary data, and that a moderate number of important forest management and environmental practices are included in these improvements. This suggests that certification in native forests in Mexico, and perhaps Latin America in general, has evolved and improved.

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DECLARATION OF INTEREST

The authors report no conflict of interest. The authors alone are responsible for the content and writing of this article.

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