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Article

Retos ambientales, económicos y sociales, en la cadena de valor del sector maderero de Puebla

Environmental, economic and social challenges in the value chain of the timber sector of Puebla State

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Abstract

The Mexican forest sector faces overexploitation, illegal logging, deforestation, lack of government subsidies, and irregular agricultural growth, all of which reduces its competitiveness. This study analyzes the capacity of forestry businesses to adapt to environmental, economic, and social challenges in district VII of *Tehuacán* and *Sierra Negra*, in the state of *Puebla.* A mixed approach was used, with an exploratory scope and a cross-section design. In 2021, 16 timber producers (sawmills), 12 traders (timber companies), and 38 final consumers (construction companies-carpentries) were selected for convenience. A structured survey was applied with demographic data, environmental and sustainable management perceptions (the reference was the Sustainable Development Goals of the United Nations), organizational, legal, and socioeconomic data. Results showed that the most benefited agent during COVID-19 was the sawmill (44 %), which, together with the timber companies, are family businesses (75 % and 92 %, respectively). Respondents are willing to adapt to economic challenges, however, their ability to cope with environmental and economic development will be long-term. Sawmills try to protect and maintain forested areas but lack external support. In the social aspect, the participation of men prevails. The final consumer is more interested in wood price (58 %) than in its legal origin (42 %). Future research could increase the sample size, apply random sampling, and include other regions both within and outside Mexico.

Keywords: Competitiveness, soil degradation, family businesses, innovation, Sustainable Development Goals, social responsibility.

Resumen

El sector forestal mexicano enfrenta sobreexplotación, tala ilegal, deforestación, falta de subsidios gubernamentales y crecimiento agrícola irregular, lo que reduce su competitividad. Este estudio analiza la capacidad de las empresas forestales para adaptarse a los desafíos ambientales, económicos y sociales en el distrito VII de Tehuacán y Sierra Negra del estado de Puebla. Se utilizó un enfoque mixto, de alcance exploratorio y diseño transversal. En 2021, se seleccionaron por conveniencia a 16 productores de madera (aserraderos), 12 comercializadores (madererías) y 38 consumidores finales (constructoras-carpinterías). Se

aplicó una encuesta estructurada con datos demográficos, percepciones ambientales y de manejo sustentable (la referencia fueron los Objetivos del Desarrollo Sostenible de la Organización de las Naciones Unidas), organizacionales, legales y socioeconómicos. Los resultados demostraron que el agente más beneficiado durante el COVID-19 fue el aserradero (44 %) que, junto con las madererías, son empresas familiares (75 % y 92 %, respectivamente). Los encuestados están dispuestos a adaptarse a los desafíos económicos, aunque su capacidad para enfrentar el desarrollo ambiental y económico será a largo plazo. Los aserraderos intentan proteger y mantener las zonas boscosas, pero carecen de apoyo externo. En el aspecto social, prevalece la participación de los hombres. El consumidor final tiene un mayor interés en el precio de la madera (58 %) que en su origen legal (42 %). En futuras investigaciones se podría aumentar el tamaño de muestra, aplicar un muestreo aleatorio e incluir otras regiones dentro y fuera de México.

Palabras clave: Competitividad, degradación del suelo, empresas familiares, innovación, Objetivos del Desarrollo Sostenible, responsabilidad social.

Introduction

The forest, as the world's main ecosystem, is strategic for the economy and the environment; it covers 31 % of the earth's surface, with 4 060 million hectares (mha), of these, more than 54 % are in the Russian Federation (815 mha), Brazil (497 mha), Canada (347 mha), the United States of America (310 mha), and China (220 mha) (FAO, 2020).

Globally, the forest sector faces overexploitation and irregular agricultural expansion (FAO and PNUMA, 2020). In this regard, globalization is an opportunity, since it eliminates trade barriers and improves trade-friendly policies, but it is also a challenge due to the lack of capacity to compete in foreign markets, to measure the impact on the well-being of the population, and to use natural resources, as well as to the corresponding legislation (Luján *et al.*, 2016). Because there is little

organization for forest production, which affects both the environment and the community in general.

In 2019, the main timber consumers in the world were China (27 %), the United States of America (USA) (21 %), Germany (4 %), and Canada (3 %); while China (18 %), USA (17 %), Canada (9 %) and the Russian Federation (9 %) stood out among the producers. In Latin America, only the following stood out Chile for pulp for paper (3 %), and Brazil for industrial roundwood (8 %), wood charcoal (12 %), wood pellets and chipboard (6 %) (FAO, 2019).

The American continent has a high percentage of forested areas and large forest producers; in 2015, it had 39 % (945 mha) of the world's forested area, of this, 59 % was concentrated in Latin America and the Caribbean. In 2020, it decreased to 932 mha; the five countries with the highest forest cover in that region were Brazil (497 mha), Peru (72.3 mha), Mexico (65.6 mha), Colombia (59.1 mha), and Bolivia (50.8 mha) (Cepal, 2020). Although Mexico is among the five countries with the highest forest cover in the continent, it is not among the nations with the potential to stand out in this sector.

On the other hand, two thirds of the world's biodiversity are located in 12 countries known as megadiverse. Mexico stands out as the fourth nation in terms of species richness, this implies a potential for sustainable development which requires solid knowledge, and the development of capacities for its management (Sarukhán *et al.*, 2017). Furthermore, 70% of Mexico's surface area (137.8 mha) is forest land, 47.7 % is wooded area (65.7 mha), and, of this, 52 % is forest (Conafor, 2021).

Puebla was one of the 10 states with the highest fluctuation in timber production in the period from 2003 to 2017. The states with the highest forest production

between 2009 and 2019 were *Oaxaca* (1), *Durango* (2) and *Michoacán* (3), while the state of *Puebla* occupied the seventh place (Semarnat, 2020).

In *Puebla*'s primary sector, agriculture is the most important; however, the forestry sector is the second largest producer of fir logs (Inegi, 2021). Region I of the Northern *Sierra* of *Puebla* (*Huachinango-Chignahuapan-Zacatlán*), located in the northwest of the state, is made up of 35 municipalities and currently has sustainable forest management with the highest production volume and forestry certifications (Inegi, 2017; CCMSS, 2020). However, the area that was reforested in 2013 amounted to 6.2 %, and in 2018 it decreased to 3.6 % (Conafor, 2020). For example, the volume of forest production authorized for 2016 in Region VII of the state of *Puebla* (*Tehuacán* and *Sierra Negra*) was less than 1 % of the state's total; this region is located in the southwest of the state and includes 21 municipalities, among them *Nicolás Bravo* and *Vicente Guerrer*o, with pine and oak trees. With respect to the products obtained, both municipalities contributed less than 1 % of timber and firewood; *Vicente Guerrero* stands out with 25 % of the state's total production of charcoal, but there is no mention of its contribution to non-timber production. Of the 233 authorizations granted by the Ministry of the Environment and Natural Resources for timber harvesting, only one was for *Nicolás Bravo*, and four for *Vicente Guerrero* (Inegi, 2017).

The forest value chain is composed mainly of two sectors: primary and industrial activities. Primary forest includes the production of plants or clones, planting (a key link in the chain, since this is where the raw material is generated), and forest management, which includes various silvicultural practices, harvesting, and log

cutting. In industrial activity, solid wood (sawmill and plywood mill) and cellulose (production of cellulose and wood chips) chains stand out (Morales, 2021).

Despite Mexico's great natural attributes, the forest sector has been experiencing several problems for decades. The reassessment of the forest sector in 2019 recognized the lack of competitiveness of forest activities, inefficient value chains and low levels of integration, insufficient forestry production to meet national consumption, low private investment and financing for its development, deforestation and degradation due to legal and illegal land use changes, fires, pests, and diseases, illegal logging and intervention by organized crime, insufficient alignment of policies, programs, and subsidies in rural areas, lack of support and local technical assistance, insecurity in rural areas, complex legal and administrative framework that hinders forest development, and insufficient fiscal budget, with a downward trend, among others (Conafor, 2021).

In Region VII, the main sources of income for the population are free logging (without a permit) with overexploitation of the forest and labor migration; there is also self-consumption agriculture on forest and rainfed land with an unfavorable climate (Ávalos *et al.*, 2007).

Based on the above, the general objective of this study was to analyze the capacity of timber sector companies to adapt to environmental challenges in accordance with four of the Sustainable Development Goals (SDGs) of the United Nations (UN): number 5, equitable participation of women and men, and gender equity; number 8, on decent work and economic growth; number 12, on responsible production and consumption; and number 15, on life in terrestrial ecosystems. An additional objective was to analyze internal organizational changes and the adoption of new

technologies, as well as demonstrate the knowledge of fiscal, legal, and financial strategies by forestry producers in Region VII.

Materials and Methods

Type of study

The present research had a mixed approach, exploratory scope and non-experimental cross-sectional design (Hernández-Sampieri and Mendoza, 2018). In order to obtain the primary information, a structured survey of 23 to 38 items was prepared, depending on the subject of study. The type of responses included multiple choice and dichotomous responses; demographic information and perceptions of environmental, organizational, economic, and social areas were requested. The participants were selected for convenience.

Study region, analysis unit and study subject

Region VII: *Tehuacán* and *Sierra Negra*, was chosen because of its lack of notoriety in the state's forest area, despite being a forested area and the fact that timber harvesting is one of the main sources of income of its inhabitants (Gobierno del Estado de Puebla, 2009). It was selected also because of the accessibility to the study subjects in *Nicolás Bravo*, *Vicente Guerrero* and *Tehuacán* municipalities, *Puebla.* Thirty-five sawmills and 15 timber companies were identified, of these, some have ceased operating because the report is almost 10 years old. The study subjects were the owner(s) or the person designated by the owners of the sawmills, the timber companies, and the end consumers (construction and carpentry companies). 16 sawmills, 12 timber companies, and 38 final consumers, all legally constituted, were selected.

Data analysis

Statistical analysis was performed in SPSS IBM® Statistics, Version 26. Frequencies, percentages, and the Shapiro-Wilk normality test were included with a significance level of $p<0.05$, allowing to contrast the normality of a set of data,

which were nonparametric. The analysis was completed with Kendall's Tau-b correlation coefficient with a significance level of $p<0.05$ in order to test the statistical hypotheses.

Results

In the forestry sector, the presence of men prevails (67 %), except in the timber industry. The range of schooling was varied greatly, ranging from junior high school to university, with a predominance of secondary and high school education. More than 93 % of all companies surveyed are registered with the Tax Administration Service (SAT) as natural persons and have existed for more than 10 years (Table 1).

Table 1. Demographic data of study participants (percentages).

Variable	Answer	S(*n*=16)	TC(*n*=12)	EC(*n*=38)
Schooling	Elementary school	0	0	16
	Secondary school	50	25	34
	High school	19	25	26
	University	31	50	24
Gender	Female	6	33	3
	Male	94	67	97
Age	20-30 years	0	16	5

	30-40 years	37	67	47
	40-50 years	13	17	32
	More than 50 years	50	0	16
Position	Owner	75	42	100
	Manager	25	58	0
Type of business	Natural person	87	100	92
	Legal entity	13	0	8
Age of the company	Less than 10 years	25	17	26
	10-20 years	31	42	24
	20-30 years	38	8	24
	More than 30 years	6	33	26

SPSS descriptive statistical analysis of frequencies of applied instruments.

S = Sawmill; TC = Timber company; EC = End consumer.

Regarding legislation in the forest sector and knowledge of the SDGs, more than 69 % of sawmills and timber companies stated that they were aware of Mexican laws in the forestry sector, less than 16 % of sawmills and final consumers are aware of the 17 UN SDGs, and 50 % of timber mills claim to be aware of them.

Among the respondents, more than 82 % favor sustainable forest management. 75 % of the sawmills even own forest land that has no governmental support, of these, 67 % carry out reforestation actions. The other sawmills have agroforestry systems under management and cover their operating expenses —maintenance of fences, retentions, gullies, and pruning— with their own resources.

Timber companies and the end consumers carry out activities in favor of the environment, among which the separation of waste predominates (45 %). The

majority of the three groups surveyed (88 %) support sustained economic growth guaranteeing sustainable consumption and production patterns.

According to the statistical tests, there is no significant correlation between known forest regulatory information and the acceptance of sustainable economies: Timber company's correlation coefficient [*CC*]=0.522, significance = 0.083; Sawmill's *CC*=0.153, significance= 0.554 (Table 2). That is, the behavior of one variable is not related to the behavior of the other variable.

Table 2. Opinion of study subjects regarding legal and environmental issues.

Variable	Answer	S(%)	TC(%)	EC(%)
Are you familiar with the laws that regulate the forestry sector at the national level?	Yes	69	75	-
	No	31	25	
Do you agree to manage forests sustainably?	Yes	100	100	82
	No	0	0	18
Are you familiar with any of the 17 sustainable development goals of the UN Agenda 2030?	Yes	12	50	16
	No	88	50	84
Do you agree with sustainable and inclusive economic growth?	Yes	88	92	95
	No	12	8	5
Do you support or carry out any activity in favor of the environment?	Yes	94	83	92
	No	6	17	8
Which?	Reusable products	0	0	17
	Separation of waste	0	45	46

Composting	0	22	11
Planting trees	93	22	26
Other	7	11	0

S = Sawmill; TC = Timber company; EC = End consumer. * The correlation is not significant between any of the variables.

In the last five years there has been an increase (42 %) in wood consumption by the end consumers; 87 % of these indicated that their strategic planning includes the environment, but when they buy wood their priority is the price (58 %), and that it is a legally established place (42 %) (Table 3).

Table 3. Final consumer's opinion regarding consumption and preferences of forest inputs.

Variable	Answer	Percentages
Over the last five years, your timber consumption has	Increased	42
	Diminished	24
	Remained the same	34
When buying wood, what is your number 1 priority?	Legally established place	42
	Price	58
Does your strategic planning contemplate the environment?	No	13
	Yes	87

SPSS descriptive statistical analysis of frequencies of applied instruments.

Regarding organizational issues, 50 % of the sawmills and 83 % of the timber companies have an idea of their organizational structure and use a strategy to guarantee the supply of their material during the year; more than 81 % and 83 % use incentives for their personnel, among which bonuses vary from 50 to 62 %.

The end consumer's staff are more willing to use new technology and materials (97 %). While for the timber companies, the percentage was 75 %, and in sawmills it was 56 %, which represents a little more resistance to change. It should be noted that more than 75 % of both sawmills and timber companies are family businesses, and more than 70 % are owner-managed.

Sawmills and timber companies do not have, nor are they in the process of obtaining any certification; and more than 50 % of timber companies buy their products from non-certified sources, and 75 % of sawmills buy their products from established but not certified sources.

In sawmills there is a moderate correlation between the use of some incentive to encourage their staff to adapt to new technology or material quickly (*CC*=0.545*, significance=0.035); this is related to the use of some strategy to guarantee the supply of material (*CC*=A 0.630*, significance=0.015). That is to say, incentivizing personnel is linked to their acceptance of new technologies, through the integration of tactics for the supply of inputs to continue working.

There is a moderate correlation between being certified and buying from a certified business (*CC*=M 0.707*, significance=0.019). In turn, in the end consumer, there is a weak correlation between personnel adapting to the use of a new technology or material quickly and buying in certified places (*CC*=0.346*, significance=0.033) (Table 4).

Table 4. Opinion of the subjects of the study on organizational design.

Variable	Answer	S(%)	TC(%)	EC(%)	CC	Sign.*
Who runs the organization?	Owner	81	73	-	NA	
	Manager	19	27	-		
Does the company have an organizational structure?	Yes	50	83	-	-	-
	No	50	17	-		
Do you use any incentives to encourage your staff?	Yes	81	83	-	S 0.545*	0.035
	No	19	17	-	-	-
Which?	Bonus	62	50	-		
	Cash	0	50	-	NA	
	Food	38	0	-		
Do you have any certification or are you in management?	Yes	0	0	-	LC 0.707*	0.019
	No	100	100	-		
Do the companies where you buy have some certification?	Yes	0	50	Confusion between legally established and certified	LC 0.707*	0.019
	No	100	50		EC 0.346*	0.033
Do you use any strategy to guarantee material supply?	Yes	50	83	-	S 0.630*	0.015
	No	50	17	-		
Do the staff adapt quickly to the use of new technology or material?	Yes	56	75	97	S 0.545*	0.035
					S 0.630*	0.015
	No	44	25	3	EC 0.346*	0.033

Family-owned business	Yes	75	92	-	NA
	No	25	8	-	

S = Sawmill; TC = Timber company; EC = End consumer; NA = Does not apply; $p<0.05$; *CC* = Correlation coefficient; Sig. = Significance. * The correlation is significant at the 0.05 level (bilateral). ** The correlation is significant at the 0.01 level (bilateral).

On the commercial side, the participants stated that timber sales were their investment priority (92 % for timber companies and 69 % for sawmills). For sawmills, the largest consumer are the timber companies (94 %), their market is construction (58 %) and carpentry (42 %). Of the three groups surveyed, in addition to dimension timber, the sawmill (63 %) does not process any other timber product; the other two groups (over 92 %) process plywood. Regarding non-timber forest products, sawmills (100 %) and timber companies (93 %) do not consider them, while the final consumer includes resin (53 %).

In regard to economic issues, the main financial source of timber companies comes from suppliers (57 %); all the timber companies and sawmills are aware of the profit margin, but not the final consumer (37 %). During COVID-19, 44 % of sawmills indicate that they benefited from the increase in the price of timber, as before the pandemic the price of it was undervalued. For 31 % of sawmills, the negative facet of the pandemic was that the processing of felling permits was delayed and the price of logs increased. Timber companies and end consumers also report being affected by the pandemic (60 % and 42 %, respectively) due to the increase in the prices of materials (Table 5).

Table 5. Opinions on the economic and commercial performance of the participating companies.

Variable	Answer	S(%)	LM(%)	RC(%)
Is the company clear about its objectives?	Yes	75	75	-
	No	25	25	-
Is a periodic review of business management carried out?	Yes	69	67	-
	No	31	33	-
Timber product, other than squared timber - Which?	Firewood	25	0	-
	None	63	0	-
	Other	12	0	5
	Plywood	0	92	95
	Charcoal	0	8	-
Non-timber forest product -Which one?	None	100	91	-
	Organic fertilizer	0	9	-
	Living plants	0	0	16
	Fruits and seeds	0	0	31
	Resins	0	0	53
Priority number 1 investment timber	Yes	69	92	-
	No	31	8	-
What is your largest consumer of timber?	Timber company	94	-	-
	Construction company	0	58	-
	Carpentry	0	42	-
	Artisans	6	-	-
Is financing available?	Yes	12	58	13
	No	88	42	87

Which?	Banking Institution	0	29	40
	Finance Company	50	14	20
	Moneylender	50	0	40
	Supplier	0	57	0
Profit margin	Yes	100	100	63
	No	0	0	37
Pandemic impact	Positively	44	20	16
	No impact	25	20	39
	Negatively	31	60	42
	I am not familiar with the subject	0	0	3

S = Sawmill; TC = Timber company; EC = End consumer. * The correlation is not significant between any of the variables.

Among sawmill personnel, 75 % know their sawmilling coefficient (m^3 obtained from logs), however, only 50 % own a sawmill to retail their material. Results also showed that about 62 % of the squared timber is marketed within the state of *Puebla*, followed by *Veracruz* (31 %) and Mexico City (6 %). Most timber companies (83 %) sell non-wood materials such as Medium Density Fibreboard (MDF) and Melanin. For 42 % of the end consumers, wood is a priority for their activity, 84 % buy products such as MDF (54 %), Melanin (24 %), and Drywall (22 %).

About social issues (Table 6), more than 88 % respondents support gender equality and the number of employees from the region is more than 91 %.

Table 6. Opinion of study subjects on certain variables of a social nature (percentages).

[a] Variable	Answer	S	LM	EC
Do you believe in gender equality?	Yes	88	92	95
	No	12	8	5
Female and male staff	Female	7	23	11
	Male	93	77	89
Staff in the region	Region	91	94	97
	Foreign	9	6	3

[a] SPSS descriptive statistical analysis of frequencies of applied instruments. S = Sawmill; TC = Timber company; EC = End consumer.

Discussion

According to Manfre and Rubin (2013), Barrera *et al.* (2021) and Conafor (2021), women have few opportunities for social and economic development in the forest sector, as their legal and social status is not recognized, which negatively impacts the potential for fair and inclusive growth. Notably, it is important to strengthen and make women's work more visible, to open to employing them and integrating them into support programs that promote conservation, production, sanitation, and

protection activities, thereby increasing the benefits of their participation in the value chain.

Despite the fact that respondents expressed acceptance of gender equality, this is not reflected in the practice, since only 7 % of sawmill staff and end consumers are women.

However, Agarwal (2009) and Setyowati (2012) cite that women contribute significantly to forest management through the performance of agroforestry activities, the collection of firewood and the manufacture of non-timber forest products. In addition, they note that in some countries such as Indonesia and Vietnam, women work in nurseries and are in charge of forest monitoring. In India and Nepal, on the other hand, increased participation of women in community forest management committees has been shown to benefit forest regeneration and forest governance.

In Mexico, a clear example of women's empowerment in the sawmill industry is the *El Progreso* sawmill in *San Pedro el Alto*, *Pochutla*, *Oaxaca*, which is managed by women and has forest certification. Another case is that of Alma Lili Mena García, the only woman in Mexico who is the director of a business association that exports timber products, and the first woman to be president of the *La Ciudad de Pueblo Nuevo ejido*, state of *Durango* (Conafor, 2017; Focir, 2019).

From the nature of their activities, a mechanistic structure (strict hierarchy, rules, authority, and centralized control) prevails in most of the companies surveyed. However, they agree with sustainable economic growth, which demonstrates a bond between the physical and the social, linked by culture and technology that involves communication and performance to achieve growth in line with the changes in the world (Daft, 2011; Hatch and Cunliffe, 2013).

With respect to fiscal, legal, and certification issues, Semarnat (2018) and CCMSS (2020) record that in the state of *Puebla* (2020) there are 11 *ejido* properties with Sustainable Forest Management (NMX) certification, and 13 properties have Forest Stewardship Council (FSC) certification, of which 12 are *ejidos* and one communal property; the *Sierra Norte* has the highest number of certifications in *Puebla*. Although most of the companies (timber and sawmills) in Region VII are legally established as natural persons, and lack FSC, Program for the Endorsement of Forest Certification (PEFC), and NMX forest certification, which is a way of accrediting good forest management.

There is a greater commitment to nature on the part of sawmills and timber companies than on the part of the end consumer. However, in the sawmills, owners report problems such as a lack of government support for land regularization and program follow-up, delays in the execution of forestry procedures, illegal logging, unfair trade, and insecurity in the area. In addition, Barrera *et al*. (2021) and Conafor (2021) point out the lack of budget, staff and equipment in the institutions responsible for forest management, inefficient procedures for obtaining forest permits, complicated regulations for stakeholders, and inadequate response times.

Regarding financial and commercial strategies, the main interest of sawmills and timber companies is to continue investing in the sale of squared timber. The first group (sawmills) does not handle non-timber forest products, the woodworking industry does not include these products, but does include plywood and other agglomerates, while the final consumer (builder and carpentry) is the one that adapts more easily to products other than timber.

There is little diversification of sawmills, since non-forest products are not integrated. This is associated to the sawmill industry in northern Mexico. According to Luján *et al.* (2016), globalization has had unfavorable impacts on profitability, competitiveness, administrative, and organizational culture, as well as on forest certification. However, Castro *et al.* (2013) indicate that the indigenous community of *Nuevo San Juan Parangaricutiro*, *Michoacán*, is an example of the evolution to achieve a forest cluster, since after the eruption of the *Paricutín* volcano, the community members changed their activities to obtain income, but realized that they did not have the expected benefits and that the natural resource was being irrationally exploited. As a result, innovative actions were implemented that integrated a balance between inhabitants, environment, and industry.

Outstanding features are the social-environmental bond based on the dynamics of its governance, the demand for forest products, and the situations for the availability of supply sources, as well as the vertical-horizontal industrial integration of the production system.

The members of the forest value chain face economic, environmental and social challenges. Forest degradation has been reduced, but not eradicated, by generating one conservation program after another; therefore, this issue calls for an initiative adapted to Latin American countries whose application will allow sustainable development. Such an initiative must be based on forest governance, in which the government and society work together to achieve sustainable development. An example of this is Mexico's participation in the UN's 2030 Agenda for Sustainable Development, in which the country has committed to promote sustainable development by conserving and recovering the ecological balance.

Based on the FAO's paper "Assessing forestry projects impacts: issues and strategies", written by Gregersen *et al.* (1995), and the Program for Sustainable, Inclusive and Competitive Forestry Development in the Peruvian Amazon of the National Forestry and Wildlife Service (2019), the following solutions are proposed for some of the issues in Region VII of the state of *Puebla* (Table 7).

Table 7. Public policy proposal.

Issue	Solutions
a. Inadequate institutional and legal framework, and lack of administrative and policy continuity.	A1. To give continuity to policies regardless of the political ideology of the government in office, adapting to the new standards required by international environmental agreements. Consider strict and clear rules and regulations to define the necessary tasks and achieve results, providing financial subsidies to incentivize community participation (Luján *et al*., 2016; CONAFOR, 2021).
b. Environmental degradation -fires, pests, illegal logging-.	A2. Environmental education is a fundamental pillar to generate changes in attitude and aptitude and to achieve balance between humans and their environment (Severiche-Sierra *et al.*, 2016). Therefore, it is proposed to encourage environmental education in relation to the 17 SDGs of the 2030 Agenda from preschool and basic education, in order to instill the new model of sustainable development in the new generations.
c. Change of land use to agricultural and livestock activities.	A3. Encourage secondary forest management programs -human intervention- and agroforestry systems -planting of crops and forest trees-, necessary to extend the volume of those timber or other non-timber products that confer greater value to the forest (CONAFOR, 2021).

Source: Prepared by the authors.

The care, sustainable, and inclusive use of the forest sector is strategic and should involve foresters, producers, society, academia, and government (Forestry Research Centers).

Conclusions

Despite explicitly ignoring the UN SDGs, there is a willingness in sawmills and timber companies to promote sustained economic growth, which is in line with SDGs 8 and 12 (Decent work and economic growth, and Responsible production and consumption, respectively), this is not expressed by the final consumer. Timber companies and sawmills are committed to and support activities in favor of the environment, with an impact on SDG 15 (Life of terrestrial ecosystems). The studied companies do not comply with gender equity participation (SDG 5).

In terms of organizational structure, both timber companies and sawmills have an idea of their organizational structure and use strategies to guarantee the supply of their material, and apply incentives for their personnel.

Both sawmills and timber companies lack certifications and are not in the process of obtaining them; their raw material comes from non-certified sources. In addition, the end consumer is unaware of and confused between certifications and being registered with the tax authorities. There are problems in adapting to new

technologies due to the high cost of machinery. Companies are trying to protect and maintain forested areas, but lack technology and information.

All three groups surveyed had the capacity to respond to the economic challenges arising from the pandemic. The construction sector is economically strong and knows its profitability and productivity. However, a percentage of carpentry shops do not know their profit margin and are not up to date, so they choose low prices regardless of the legal origin of the timber. Sawmills benefited the most during the pandemic through the raise in prices, as they considered that their material was undervalued.

Some good policies and supports have reached the primary sector, but the lack of follow-up has caused discomfort, stirring up controversies that are reflected in the industrial sector, like those derived from the shortage of raw materials, along with a lack of interest by the end consumer in the environment and the origin of the items purchased.

Because the present study is exploratory in scope, the study subjects were not randomly selected, and the fact that it was conducted only in Region VII of the state of *Puebla* limits the generalizability of the results. Future research may expand the sample size, use proportional random sampling to ensure that each actor in this forest chain is representative, and include other states in the country.

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Conflict of interest

The authors declare that they have no conflict of interest.

Contribution by author

Raquel Hernández Hernández: idea, design, data collection, analysis and interpretation of results, and drafting the manuscript; Yesica Mayett Moreno: design, validation of results, and revision of the manuscript; Sandra Rodríguez Piñeros: editing and revision of the manuscript; Gregorio Fernández Lambert: editing and revision of the manuscript.

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