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Article

Importancia económica del pino (*Pinus* spp.) como recurso natural en México

Economic importance of pine (*Pinus* spp.) as a natural resource in Mexico

Georgel Moctezuma López[1*] y Andrés Flores[1]

Resumen

La importancia del valor económico del género *Pinus* spp. como un recurso natural en México se basa en su presencia en 75 % de su superficie. El estudio que se documenta se orientó a cuantificar el valor monetario que aporta a la economía forestal; para ello se consideraron los datos estadísticos de la Secretaría del Medio Ambiente y Recursos Naturales (Semarnat), de los cuales se examinó un horizonte de 15 años (2002-2016), con la idea de conocer el comportamiento y evolución del valor de esta conífera; y en el que se segmentó el correspondiente al pino como madera en rollo y en escuadría. El proceso metodológico consistió en actualizar los valores corrientes por medio de la deflactación y mostrarlos a valores constantes, para lo cual se seleccionó como año base el 2013. De esa manera, los datos fueron comparables para conocer sus tendencias; también, se cuantificó su variación por medio de la función estadística tasa media de crecimiento anual. En términos reales, la importancia del valor del pino disminuye, sobre la cual tienen una fuerte influencia los precios de mercado que no crecen lo suficiente para detener la caída del valor de la producción; situación que se acentúa en el rubro de la madera en rollo, con respecto al de la escuadría.

Palabras clave: Bosques templados, escuadría, madera en rollo, precios, tasa media de crecimiento anual, valores deflactados.

Abstract

The economic value importance of pine (*Pinus* spp.) as a natural resource in Mexico is that it is present in 75 % of its surface. This study aims at quantifying the monetary value that pine contributes to the forest economy, based on the statistical data provided by the Ministry of Natural Resources and the Environment; a horizon of 15 years 2002-2016 was selected with the idea of learning about the behavior and evolution of the value of this conifer, as roundwood and as square timber. The methodological process was to update the current values through deflation and display them at constant values, for which 2013 was selected as the base year. The data were thus made comparable in order to identify their trends, as well as to quantify their variation through the statistical function annual average growth rate. In real terms, there is a reduction of the importance of the value of pine, which has a strong influence on market prices. These fail to grow enough to stop the fall in the value of production, a situation that is more prevalent in roundwood than in square timber.

Key words: Forests, square timber, roundwood, prices, average annual growth rate, deflated values.

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[1]Centro Nacional de Investigación Disciplinaria en Conservación y Mejoramiento de Ecosistemas Forestales, INIFAP. México.
*Autor por correspondencia; correo-e: moctezuma.georgel@inifap.gob.mx.

Introduction

Pine species are native to the Northern hemisphere, and in the American continent they are found from 66°00'00"N, in northern Canada, to 12°00'00"N in southern *Nicaragua* (Torres, 2015). The mountains of both the Eastern and the Western *Sierra Madre* of Mexico are home to the greatest diversity of the *Pinus* genus (Pinacacea) in the world, with 400 taxa (Gernandt and Pérez-de la Rosa, 2014).

Pines belong to the group of conifers, which represent about 60 % of the 900 species of gymnosperms (Sánchez, 2008); in absolute numbers, this percentage is equivalent to 540 species. 111 pine species are estimated to exist worldwide (Farjon, 2003; Earle, 2007).

Pine is the main conifer of temperate and cold climate in Mexico, is distributed in 24 states of the country, of which two stand out in the North Central region, one in the west, one more in the south, and two in the central Gulf (Semarnat, 2016).

The economic importance of pine forests in Mexico is accounted for by their contribution to the country and their contribution to the forest Gross Domestic Product (GDP). In the social context, their relevance is given by the population that lives in the forest areas, on the goods and services provided to them. It should be noted that 23 % of the country's inhabitants (113.5 million) live in the rural sector (Inegi, 2016) and it is estimated that 5.3 million people live and depend on forests (Conapo, 2015).

Forest ecosystems are a fundamental component of the planet's biogeochemical systems; they play an essential role in the water cycle, and as nitrogen fixers and natural refuges for flora and fauna; also, they are listed as one of the solutions to climate change because of their contribution to the mitigation of its harmful effects (Cemda, 2018).

Researchers at the World Bank (Pagiola and Platais, 2002) point out that natural ecosystems provide a wide variety of environmental services and cite as examples the various types of forests, which provide hydrological services such as water filtration and regulation of water flows, and these services are rarely valued until the effects of deforestation are felt in the form of floods, or through loss of water or of its quality.

Mexico has 138 million hectares with forest vegetation, which is equivalent to 70 % of the country's surface area; part of that area —64.9 million hectares— is covered by forests and tropical forests, of which 15 million ha are estimated to have productive potential for commercial use and are located mainly in the mountainous massifs of the east and west of the country. However, timber extraction is carried out only in 5.9 million ha (Torres, 2015).

In terms of the primary forest GDP, the activity that most contributes to the economic value is the cutting (logging) of trees, and among the secondary activities (transformation), the production of square timber; under this scheme, research was conducted to determine which is the economic spill of the *Pinus* genus as logs (roundwood) and as square timber (Inegi, 2016a).

The aim of the research was to quantify the value of pine production at constant prices over a period of 15 years as well as its trend; to compare these with those of Sacred fir and other (tropical) species, both as roundwood (logs) and squared timber, and to calculate their average growth rates over the assessment period.

The hypothesis of the study is based on the fact that the increases in the market prices of both the logs and the square timber are not high enough to encourage production, so that every year pine provides a greater economic contribution within the forest sector.

Materials and Methods

A five-stage documentary research process was used:

First stage: selection of the topic to be studied; the one dealing with the evolution of the value of the production of pine roundwood (logs) and square timber was chosen.

Second stage: collection of data from secondary sources; the primary ones were the statistical yearbooks available from the *Secretaría de Medio Ambiente y Recursos Naturales* (Semarnat, 2002-2016). With this series, the documentary sequence (15 years) of the value of pine production in the two items mentioned above was organized. The year selected as a baseline for deflating the prices was 2013 —the same year used by the *Secretaría de Hacienda y Crédito Público* and by the *Banco*

de México— thus estimating the series at constant prices, so that the figures were comparable (Inegi, 2016b). The information was recorded in a database designed in Excel. In addition, articles from forestry journals, reports of national and international congresses, and several scientific publications were reviewed (Semarnat, 2002-2016; Moctezuma and Galicia, 2018).

Third stage: elaboration of the research plan. Subtopics were defined to prioritize between the transcendental and important, the secondary or superfluous. These were: value of the pine, sacred fir production and of other (tropical) species; which in turn, were subdivided into value of the production as roundwood (logs) and as square timber. The selected indicator was the average annual growth rate. In addition, five entities of Mexico were chosen, based on their greater contribution to the value of production of pine in roundwood and in square timber.

Fourth stage: organization of the information. This was done by indexing the values recorded in the secondary source (statistical yearbooks). For this purpose, first the values were placed at the current prices; then, the deflation factor was included, and, finally, the data series at constant values with which comparisons were made and trends were calculated for the *Pinus* genus.

Fifth stage: statistical function. The average annual growth rate was chosen as indicator, which works for the medium and long terms. Its mathematical expression is:

$$AAGR = ((Fv / Iv) \wedge (1 / n) - 1) * 100$$

Where:

Fv = Final value to period

Iv = Initial value of the period

n = Number of years considered

In addition, the corresponding graphs were elaborated, in which a trend line was included in order to facilitate a better understanding of the evolution in the monetary values at constant prices, and to visualize the slopes for the two products analyzed: roundwood and square timber.

The information was presented for the following modalities: value of the production of roundwood and square timber of the *Pinus* genus and its comparison with that of Sacred fir and other species, as well as between the main producer states of the countries, and the evolution of the prices of roundwood *vs* square timber and the average annual growth rates of both products.

Results and Discussion

Value of timber production in pine, Sacred fir and other species

For purposes of economic quantification of pine, Sacred fir, and other timber species, Table 1 shows the value of their timber production as roundwood.

Table 1. Production value pine, sacred fir, and other species as roundwood at constant 2013 prices.

Year	Production value of pine	Production value of Sacred fir	Production value of other species	Total
2002	7 777.24	263.58	1 126.41	9 167.22
2003	9 536.02	244.60	1 319.11	11 099.29
2004	8 233.67	236.29	1 367.00	9 836.96
2005	8 198.39	167.60	1 421.33	9 787.32
2006	8 065.17	114.55	1 134.96	9 314.67
2007	8 850 99	119.34	1 098.63	10 068.97
2008	7 879.82	129.74	1 145.37	9 154.93
2009	6 254.78	191.20	1.074.66	7 520.64
2010	7 098.66	303.79	1 008.58	8 411.03
2011	5 701.64	154.01	873.54	6 729.19
2012	6 258.27	139.30	825.01	7 222.58
2013	6 219.20	150.78	760.21	7 130.19
2014	5 784.08	143.55	807.98	6 735.62
2015	6 272.90	174.54	1 076.65	7 524.08
2016	6 425.06	157.40	1 241.22	7 823.68

Source: Semarnat, Statistical yearbooks from 2002 to 2016. Figures in millions of Mexican pesos (MXN).

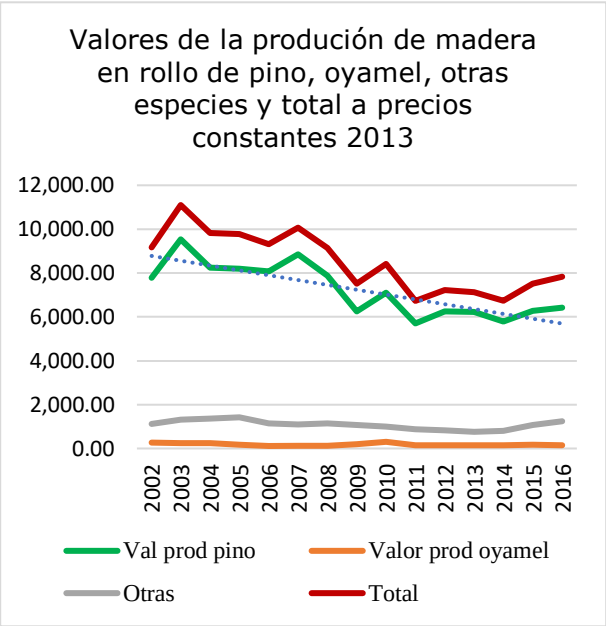
The average value of pine production in the analysis period represented 85.1 % of the total of all forest species under exploitation, with a minimum participation of 82.1 % in 2016, and a maximum of 87.9 % in 2007. These figures confirm the great relevance that pine has in the country. The values found show the high potential of forests in the territory, since they increase the profitability of the areas where they are distributed and provide a wide range of ecosystem services to communities (Chavarría, 2011).

On the other hand, although difference in values (maximum and minimum) were detected during the analysis, a considerable percentage decrease (5.8 points) in the importance of their value was observed.

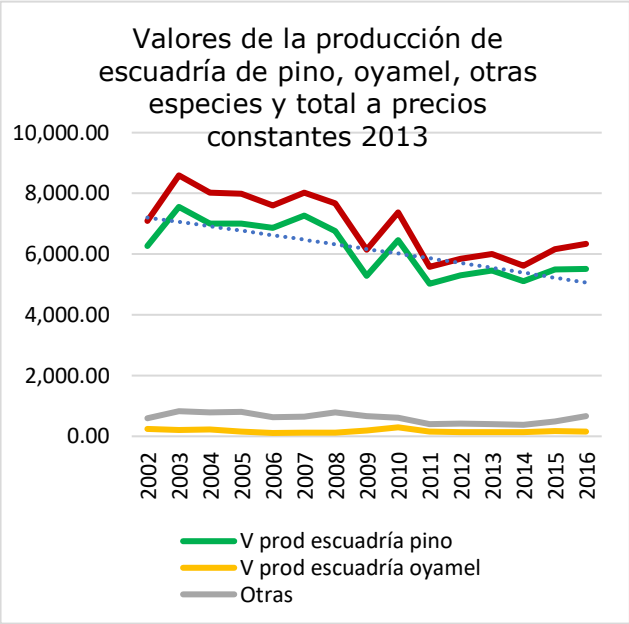
In general, Mexican pines, along with other conifers are the main support for the forest industry because they produce sawn wood, resin, chips, posts, needles, cones, seeds (Semarnat, 2016; Flores *et al.*, 2019); products used to manufacture cellulose, paper and derivatives, furniture, house building, sleepers, packing boxes, frames, moldings, plywood, musical instruments, crafts, and fuel (Semarnat, 2016).

Figure 1A shows the evolution and trend of the production value of forest species as roundwood in millions of constant Mexican pesos (2013). For pine species, the value of timber production showed increases and decreases, almost annually; the maximum value was registered in 2003, without reaching that level again, even its trend was clearly negative.

A.



B.



Valores de producción de madera en rollo de pino, oyamel, otras especies y total a precios constantes 2013 = Production values of roundwood timber from pine, Sacred fir, other species and constant Mexican pesos (MXN) from 2013; *Otras* = Others; *Val prod pino* = Value production of pine; *Valor prod oyamel* = Value production of Sacred fir; *Valores de producción de escuadrería de pino, oyamel, otras especies y total a precios constantes 2013* = Production values of squared timber from pine, Sacred fir, other species and constant Mexican pesos (MXN) from 2013; *Val prod escuadrería pino* = Production values of squared timber from pine; *Val prod escuadrería oyamel* = Production values of squared timber from Sacred fir.

Figure 1. Evolution of production value in millions of constant Mexican pesos (MXN) from 2013 for pine, Sacred fir, and other roundwood and squared timber from 2002-2016.

As for Sacred fir, the value of timber production exhibited greater losses; it decreased during the first five years, and it reached its highest value in 2010, though this was not repeated; its slope was also negative, and higher than that of pine. In the case of the other species, in the first four years, the value of production showed an increase with its highest value in 2005, and in the last three years of the period showed a rebound, but without reaching the value of the first years.

The trend of the line of total forest production value exhibited a parallelism with the trend of pine, which had a direct and determining influence because it contributed a high percentage (> 80 %). In general, the above information supports the results obtained by Fuentes *et al.* (2006) and Torres-Rojo *et al.* (2016) in relation to the fact that Mexico has a variant national forest production and that it does not manage to satisfy its annual demand of products (for example, of sawn wood), because it is based on the transformation of roundwood.

In Mexico's forests, the volume of roundwood harvested has a direct economic relationship with the timber products produced in the industrial sector; these resources are also providers of ecosystem services. In this regard, the shares of each gender differ significantly; thus in 2016, *Pinus* contributed 75.1 % of the annual timber forest production; while *Abies* contributed 2.8 %, which generated an income of $7 266 111 524.00 and $177 951 183.00, respectively (Semarnat, 2016).

The economic value of forests is of utmost importance. Within this context, the temperate forest is estimated to contain 613 of usable plants capable of generating 1.17 million tons of biomass with a market value of 528 million of dollars (de Alba and Reyes, 1998).

Mexico's temperate and cold climate forests, dominated by *Pinus* species, represent a potential for the development of programs for the payment of environmental services (PES), which today is of singular importance due to its contribution to the mitigation of climate change; soil retention to avoid erosion, and water and carbon capture, as a refuge for flora and fauna, as well as to its contribution to the scenic landscape.

In this regard, the INECC (2015) has estimated the economic value of Mexico's forest by type of environmental service; so that, for temperate ecosystems a cost of $1 224.92 for regulation and maintenance services and $144.59 per ton of CO_2 (greenhouse gas capture) is calculated. In particular, for coniferous forests, the sum of $1 897.95 per visit has been determined for the enjoyment of scenic landscapes (cultural services).

Cordero (2008) documents the payment to foresters for the conservation of 390 ha of forest by water users located in the lower *Pimampiro* watershed, in Ecuador, at a monthly rate ranging between $0.34 and $2.88 (USD). These figures give an idea of the magnitude that the pine forest massifs and mixed pine forests could bring to the forestry sector.

Production value of square timber of pine, sacred fir, and other species

Among the wood products with an industrialization process, the pine squadron is the most representative and the one that contributes most to the production value, with an average of 88.8 % for the 15 years evaluated; the highest value, of 90.9 %, was registered in 2013, and the minimum, of 86.1 %, in 2009 (Table 2).

Table 2. Production value of square timber of pine, sacred fir, and other species squares, in millions of Mexican pesos at constant 2013 prices (2002-2013).

Year	Production value of square timber of pine	Production value of square timber of sacred fir	Production value of square timber of other species	Total
2002	6 263.87	236.89	593.04	7 093.80
2003	7 554.60	210.85	826.99	8 592.43
2004	7 004.44	222.40	793.23	8 020.08
2005	7 010.41	157.62	811.79	7 979.83
2006	6 859.27	109.57	630.54	7 599.37
2007	7 262.44	112.50	644.34	8 019.28
2008	6 755.97	124.73	794.18	7 674.88
2009	5 289.50	183.13	668.06	6 140.69
2010	6 456.82	296.50	614.66	7 367.98
2011	5 024.23	150.25	406.05	5 580.53
2012	5 294.00	135.48	417.28	5 846.76
2013	5 462.92	146.33	399.08	6 008.33
2014	5 103.12	139.42	378.90	5 621.44
2015	5 498.57	168.72	495.78	6 163.08
2016	5 509.03	152.53	672.00	6 333.56

Source: Semarnat (2002-2016).

Sacred fir and other species recorded a marginal participation in the value of square timber production with an added value of 9.1 % and 3.9 %, respectively. Figure 1B shows the behavior of the square timber in the value of sawn timber production.

The results for Sacred fir prove that it is the second most economically important pine tree in the country, as stated by Flores (2019), because it provides valuable dividends to the industrial sector. In the case of other species, the different types of wood play an important role in the market, as they open up the possibility of a diversified market. In this regard, Núñez and Raffaele (2014) record that timber production based on the management of interspecies variation has increased the diversification of the production, the added value, and the development of local economies; for example, 87 % of plantations in Andean *Patagonia* correspond to *Ponderosa* pine (*Pinus ponderosa* P. Lawson & C. Lawson); 7.5 %, to *Murrayana* pine (*Pinus contorta* Douglas ex Ludon); 4.0 %, to *Oregón* pine (*Pseudotsuga menziessi* (Mirb.) Franco), and 1.0 %, to *Radiata* pine (*Pinus radiata* D. Don).

Figure 1B highlights the parallelism between the values of the production of square timber of pine and the total production, since the vast majority of the volumes come from the former. In pine, the highest value was obtained in 2003, and there were six decreases (in 2004, 2005, 2006, 2008, 2009, and 2014). In the last two years, there was an increase, but the value was lower than that attained in 2003. For Sacred fir, the maximum value was reached in 2010; however, it was not representative within the total, and its reductions (2003, 2005, 2006, 2011, 2012, 2014, 2016) were greater than those exhibited by pine.

Like pine, the other forest species reached their maximum in 2003; however, they did not recover this level throughout the rest of the period considered, and, like sacred fir, they had a marginal participation. The results show that square (sawn) timber continues to be the main product (Semarnat, 2016), and that reductions in timber production have a negative impact on the sector, since they do not meet the consumption demand and consequently, there is a greater deficit in the timber supply. FAO-Conafor (2012a) determined a deficit of 12 % in the production supply because the production of wood decreased by 1.95 million cubic meters during the

2001-2006 period. On the other hand, the decrease in national square timber production is related to wood imports from the international market; thus in 2003, the domestic production was affected by the supply from Chile (Flores *et al.*, 2007).

Timber production value for pine, sacred fir, and other species in five states

The states selected from their economic importance were: *Chihuahua, Durango, Michoacán, Oaxaca* and *Veracruz*, and the rest were grouped under the heading of "other states"; the data are presented in Table 3.

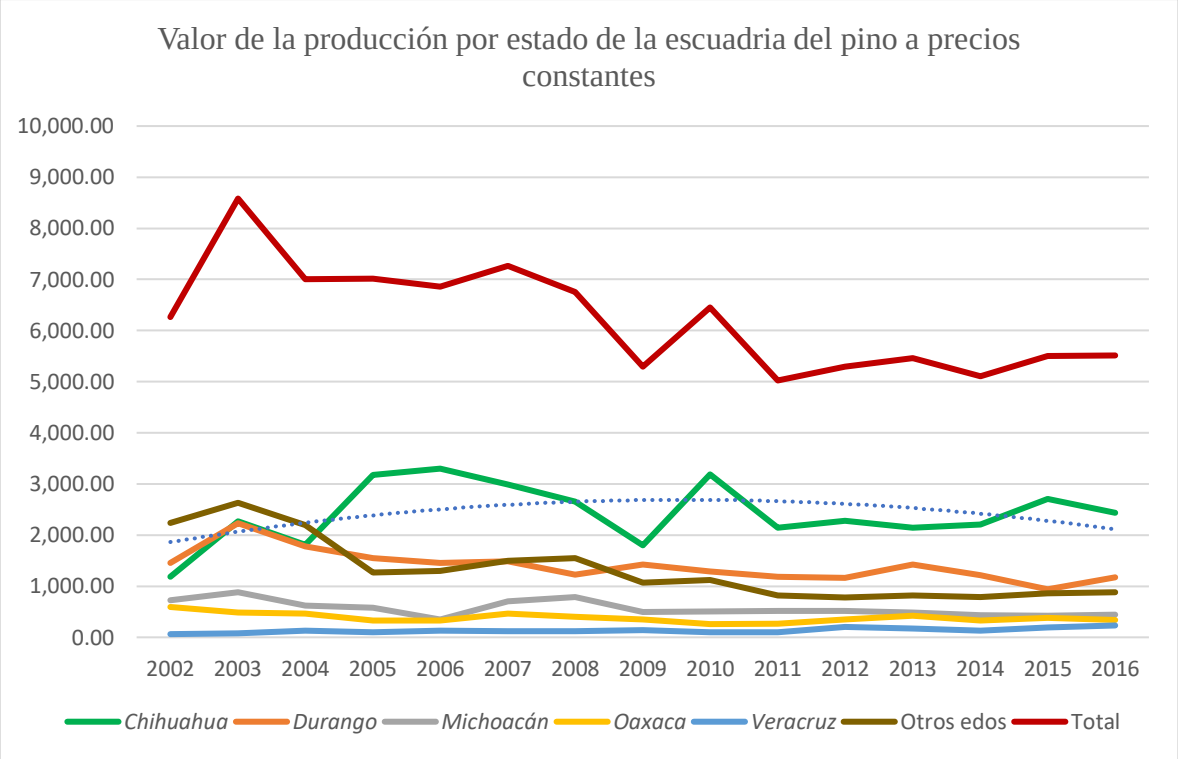
Table 3. Production value of square timber of pine in five selected states, at constant 2013 prices.

Year	*Chihuahua*	*Durango*	*Michoacán*	*Oaxaca*	*Veracruz*	Others	Total
2002	1 185.32	1 458.67	727.89	593.64	62.57	2 235.77	6 263.87
2003	2 272.24	2 232.12	882.37	481.82	82.47	2 631.44	8 582.47
2004	1 815.04	1 778.95	617.65	467.82	132.12	2 192.87	7 004.44
2005	3 173.06	1 545.82	582.72	332.69	104.23	1 271.90	7 010.41
2006	3 299.82	1 452.03	348.54	330.19	128.11	1 300.57	6 859.27
2007	2 987.54	1 490.81	705.50	459.97	121.81	1 496.81	7 262.44
2008	2 659.95	1 225.77	789.58	405.40	121.68	1 553.59	6 755.97
2009	1 804.36	1 421.86	499.99	349.87	143.98	1 069.44	5 289.50
2010	3 186.18	1 288.76	504.69	259.01	101.49	1.116.70	6 456.82
2011	2 145.59	1 179.54	515.49	264.84	99.55	819.23	5 024.23
2012	2 274.65	1 166.34	517.90	354.52	201.31	779.28	5 294.00
2013	2 143.70	1 421.82	485.30	420.56	168.56	822.98	5 462.92
2014	2 205.65	1 217.76	434.89	331.11	127.13	786.58	5 103.12
2015	2 707.07	939.39	425.91	379.16	188.43	858.61	5 498.57
2016	2 437.17	1 176.65	438.53	340.95	232.11	883.63	5.509.03

Source: Semarnat (2002-2016). Figures in millions of Mexican pesos (MXN).

Chihuahua has the highest value for the production of pine square timber, and its average participation was 39.4 %; however, in the first year of the analysis, *Durango* stood out with 22.5 %, and in the third place was for *Michoacán*, with 9.1 %; these two states together contributed the majority of the value of production (71 %).

In order to illustrate the above, Figure 2 shows the behavior of the production value of the square timber of pine in the five selected states, as well as the trend in the main state.



Valor de la producción por estado de la escuadria del pino a precios constantes = Production value of constant prices by state of the pine square timber; *Otros estados* = Other states.

Figure 2. Value in millions of constant Mexican pesos (MXN) (baseline year: 2013) of the pine square timber production nationwide and by states (2002-2016).

Throughout the period of analysis, the state of *Chihuahua* first occupied the second place, and since 2003 it remained the leader, with a marked separation from *Durango* (second place); its maximum value, of 3 299.8 million Mexican pesos, was recorded in 2016; the maximum value for *Durango*, of 1 457.8 million MXN, was obtained in 2003, after which its production decreased. This is in line with Flores *et al.* (2007) for both states, in the sense that they are the ones with the highest

forest production because they have vast areas of cold temperate climate covered with tree species (Conafor, 2017).

The only states whose production grew during 2002-2016 were *Chihuahua* and *Veracruz* —the latter with a significant increase—; the other three states analyzed showed decreases in the value of the production of pine square timber. In this regard, it is likely that the productivity of the forest industry in these states has increased through the implementation of efficient processing systems, such as proper process management and efficient processing of roundwood (Flores *et al.*, 2019).

However, the increase in forest production is not reflected in the national GDP, because there are other sectors of the economy with larger increases (Álvarez-López *et al.*, 2015).

Average annual growth rates of the value of roundwood and square timber production for pine, sacred fir, and other species (2002-2016)

Table 4 summarizes the average annual growth rates of the value of roundwood and square timber production of pine, sacred fir, and other species over 15 years (2002-2016).

Table 4. Average annual growth rates of the value of wood production of pine, Sacred fir, and other species from 2002 to 2016.

Production value	*AAGR* % for Roundwood	*AAGR* % for Square timber
Pine	-1.27	-0.85
Sacred fir	-3.38	-2.89
Other forest species	+0.65	+0.84
Total forest species	-1.05	-0.75

Source: Prepared by the authors; *AAGR* = Average annual growth rate.

A parallelism was evidenced between the AAGRs for roundwood (logs) and those for square timber of pine, sacred fir, and total. The growths were negative —to a greater extent for roundwood—, and they are slighter in the squared timber, since there is a primary value-added process in the latter. The exception corresponded to the other forest species, where they were positive for both types and higher for the square timber due to the effect of industrialization; however, their value is marginal and insufficient to stop the negative trend of the total value of timber production of all species (Table 4).

Table 5 shows the high growth of the AAGR corresponding to the state of *Veracruz*, with +9.13; *Chihuahua* occupied the second place, with +4.82; however, these two positive growths were not enough to revert the fall of the national growth, since the other states considered exhibited negative figures ranging between -1.42 and -6.0. In this regard, it can be seen that the growth in the state of *Veracruz* has grown higher than the national AAGR (6.60) estimated by Moctezuma and Flores (2018); while in *Chihuahua* it has become lower. Likewise, when compared to the national AEMR for the agriculture and livestock sectors [6.40 and 6.55, respectively] estimated by Moctezuma and Galicia (2018), *Veracruz* again has a higher value, which highlights the importance of the sector.

Table 5. Average Annual Growth Rates of the value of pine square timber production in the analyzed states (2002-2016).

States	*AAGR* %
Chihuahua	+4.82
Durango	-1.42
Michoacán	-3.32
Oaxaca	-3.63
Veracruz	+9.13
Other states	-6.00
National total	-0.85

Source: Prepared by the authors. AAGR = Average annual growth rate.

The negative values show that the states reduced their forest production in the analyzed period, which led to decreases in the AAGR. A comparison of the national rate (-0.85) with that estimated (-4.5) by FAO-Conafor (2012b) for 2001-2006 exhibits a reduction, due to the increase in the production.

Roundwood *vs* square timber prices

Market prices, in general terms, are the most important variable for both demand (what consumers are willing to pay for a product) and supply (what foresters are willing to put on the market).

Prices for pine square timber were higher than those for pine roundwood, with a range of variation from 6.03 % (2004) to 23.12 % (2013) (Table 6); this situation was mainly due to the added value of the former. However, these figures did not represent a sufficient incentive to boost the forestry economic activity and stop the drop in the contribution of pine products to the monetary value of the sector.

Table 6. Comparative prices at constant 2013 values for pine roundwood and pine squared timber.

Year	Price of the pine species as roundwood	Price of the pine species as square timber
2002	n / d *	1 639.41
2003	1 738.63	1 896.61
2004	1 611.13	1 708.27
2005	1 683.40	1 800.93
2006	1 635.63	1 797.04
2007	1 564.90	1 835.07
2008	1 603.65	1 793.19
2009	1 419.41	1 583.13
2010	1 673.83	1 842.10
2011	1 358.99	1 505.19
2012	1 325.07	1 474.00
2013	1 337.85	1 647.21
2014	1 343.93	1 437.89
2015	1 370.32	1 528.76
2016	1 274.80	1 426.73

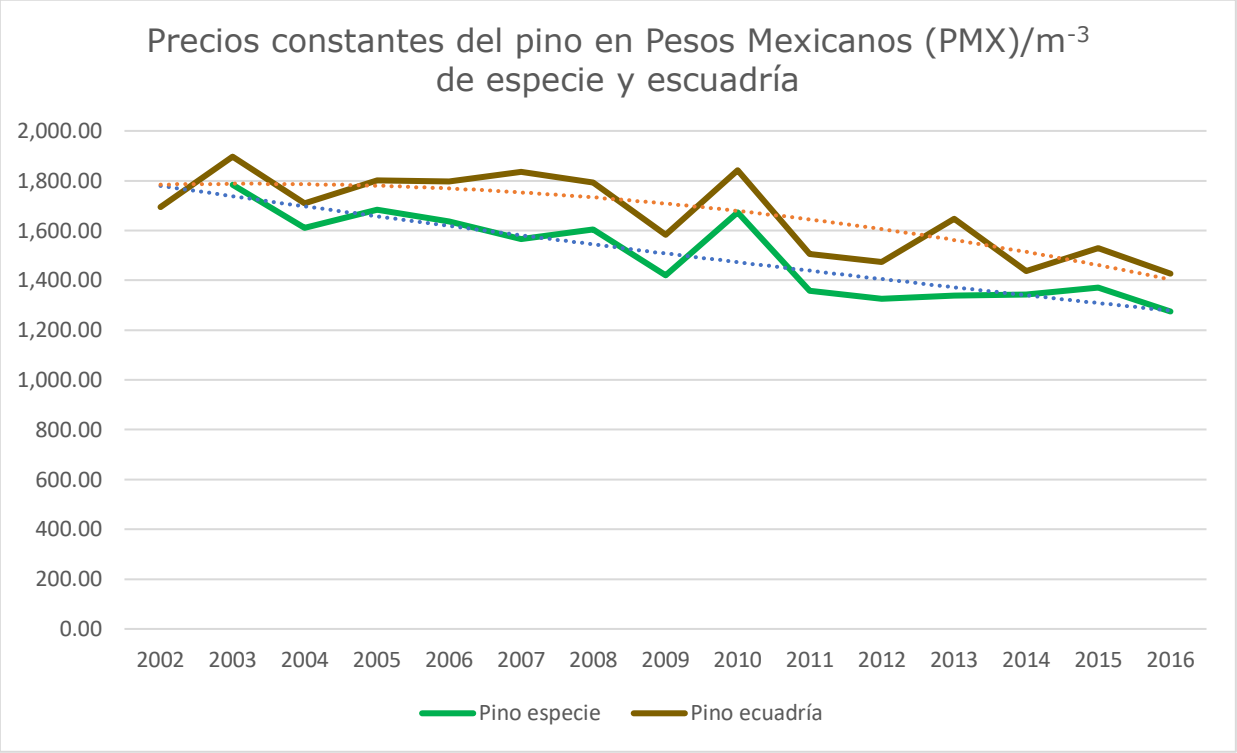
Source: Semarnat (2002-2016); * Data not available. Values in Mexican pesos (MXN) m^{-3}.

Square timber (together with railroad ties) contributes 74.6 % of the marketed forest producers (secondary activity); while, logging (primary activity) is not included within the forest products category (Semarnat, 2016).

With respect to the national GDP, the sawmill industry has a 19 % share, with respect to the total of the products of the secondary activity; and the logging industry has a 53 % share of the primary activity (Moctezuma and Galicia, 2018). In a global context, the above values show that Mexico does not stand out among the main timber producing countries due to the small size of its forest area under exploitation and to its low productivity: it contributes only 0.7 % of the world total timber production (Chapela, 2012).

On the other hand, sawn timber consumption in the country is low compared to countries such as Canada, Austria, the United States of America (USA) and Chile (Chapela, 2012); therefore, timber is imported from the USA, Canada, Chile, the European Union, and China (Conafor, 2005). Mexico's main competitors, Chile and the United States, surpass it in terms of the existence of direct and indirect subsidies, higher productivity, more modern technology and transport, as well as the presence of economies of scale (Chapela, 2012).

Figure 3 shows the behavior of the prices for pine roundwood and pine square timber during the analysis period (2002-2016) and with 2013 as the baseline year.



Precios constantes del pino en pesos mexicanos (PM/m^{-3} de especie y escuadrería = Constant prices for roundwood and pine squares in Mexican Pesos (MXN) m^{-3}; *Pino especie* = Pine species; *Pino escuadrería* = Pine square.

Figure 3. Constant prices for roundwood and pine squares in Mexican Pesos (MXN) m^{-3}.

During the whole analysis period, the prices of the pine square timber were higher than the price paid for pine as a raw material; both prices exhibited a negative slope trend, with average annual growth rates of -2.19 % for the roundwood, and -09.2 % for the square timber.

Negative average growth rates lead to an increase in the trade balance deficit —a situation that favors the importation of sawn timber in order to supply the domestic market (Chapela, 2012).

Conclusions

The activities that contribute the most to the forest GDP in Mexico are the cutting of trees to obtain roundwood (primary activity) and its transformation into square timber (secondary activity). Estimates for the 2002–2016 period prove that pine is the most relevant species in terms of roundwood production, followed by Sacred fir and other species; however, it exhibits a considerable percentage of decrease in the importance of its value.

As for valuation based on the added value, the negative trend is decreasing, though not enough to reverse it, and it continues to drop. This is highly influenced by market prices, both of raw materials (roundwood) and of the product with a primary industrialization process, (square timber).

Pine contributes the largest percentage to the square timber production, followed by Sacred fir and the other species; the same behavior is observed in the five forest states analyzed: *Chihuahua, Durango*, *Michoacán, Oaxaca* and *Veracruz*. In this regard, *Veracruz* and *Chihuahua* stand out in their contribution to the forest economy, with positive average annual growth rates.

A strategy to increase national production must be based on increasing the production of sawn timber, which requires the training of workforce and the modernization of the industry.

Conflict of interests

The authors declare no conflict of interests.

Contribution by author

Georgel Moctezuma López: drafting of the manuscript, analysis and elaboration of the graphics, and data capture; Andrés Flores: statistical and analytical support, review and editing of the manuscript.

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