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ECONOMIC CONTRIBUTION OF THE FORESTRY MANUFACTURING INDUSTRY TO MEXICO'S GROSS DOMESTIC PRODUCT IN 32 YEARS (1993-2024).

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Abstract: This article deals with the evolution and modification of land use change in one of the most important watersheds of the country, which in addition to generating electricity by means of a hydraulic infrastructure work for a territorial surface of central Mexico and how anthropogenic activities modify land use change within the watershed by means of agriculture and livestock. The methodology used was worked in two phases: the first one on land use change using series III to VII provided by INEGI in a time span from 2002 to 2022 and with data processing using ArcMap 10.8.1 within the Laxaxalpan river basin and in particular in three municipalities of the state of Puebla: Ciconcuatla, Chignahuapan and Zacatlán and with the evolution in planted surfaces of four fruit trees: avocado, blueberry, cherry coffee and apple, the first two of recent introduction and the others that are of traditional type in diverse areas of the mentioned municipalities. The second phase was documentary with information from SIAP for planted areas and production value and from CONAPO for population growth in the study sites. The sum of the four fruit trees in the planted area had a small growth of 0.9 %, but in the value of production at market prices its growth rate was 7.71 % and in both cases the blueberry was the one that had the best indicators with 6.12 % and 9.66 % respectively and for the last year of the data, the contribution of the fruit trees to the economy of the region was 136.7 million Mexican pesos.

Keywords: planted area, average annual growth rate, land use, production value.

INTRODUCTION

As a historical background (Aguirre, 1991) mentions that during the Reform period, particularly in 1857, when the laws that modified land tenure and access to natural resources were issued, the indigenous populations were the most important in the region, In order to encourage investment in the primary sector, the Federal Government privatized lands in the hands of the church and some communal lands, which were largely located in areas of temperate and cold forests and jungles in the humid and dry tropics, in order to encourage investment in the primary sector.

In the mid-19th century, (Gonzáles, 1992), points out that large areas of forest lands were granted in concession for cutting trees that were used for railroad sleepers, highways and in the mining and construction industries. These actions were carried out under the focus of the country's modernization and the public policy of free access had a very strong ecological impact on natural resources, a situation that occurred with greater emphasis in the north and center of the country.

As a result of the previous policy to promote the country's growth (Klooster, 1996 and 1997), he comments that the result was a great dispossession of indigenous and peasant properties and a high concentration of landowners' property and in the 1910 - 1917 period of the Mexican Revolution, the emergence of the Mexican Revolution was based on the demands for control of land and natural resources by rural populations. After two decades of the armed movement, the demands were not echoed by the governments after the revolution and public policy was oriented towards conservationism to try to stop deforestation and Miguel Ángel de Quevedo assumed leadership in the sense that the control of forests should be exercised by the government and also in this period the first forestry law was established in which the extraction of wood from forests and jungles was regulated, as well as promoting the non-use of the forest for agricultural and livestock activities.

During the Cardenist period (Bray and Merino-Pérez, 2002 and Merino-Pérez 2002), they mention that its agricultural policy was focused on attending the peasants' requests

for land and put emphasis on agricultural development and neglected the forestry production and the interest was centered on primary industrialization such as the extraction of resins from cold and temperate forests and the production of gum in the tropical forests of southeastern Mexico.

With information from (Inegi, 2017), the territorial extension of the country is 1'964,375 km2, of which forests and jungles cover an area of 55.3 million ha, of which, 80% are ejido and communal property, 15% is private property and the rest, 5% is property of the nation. Semarnat (Semarnat 1999) estimates that Mexico's forest areas are inhabited by 12 million people, most of whom are classified as extremely poor and one of the options available to them is migration. There is little encouragement for structured training to form efficient foresters, who have better management skills and have a better quality of life and well-being. The lack of human involvement and commitment to forest resources is at the root of the forestry problem; As long as people continue to believe that forest resources are a nuisance and will never be exhausted, and that they see them as a source of decent employment, income, rootedness to their land with personal and social benefit, it will be difficult to achieve sustainable forest development and also the organization of foresters, under criteria of productive, profitable, efficient and effective use, is another of the national priorities that require attention from the three levels of government: municipal, state and federal: municipal, state and federal.

The main timber species existing in Mexico, seen by the surface area they cover, as well as their economic importance, are those corresponding to the Pinus and Quercus genera, from which, in terms of volume, approximately 80% and 5% of the national timber production are obtained approximately Conafor (2015).

The indicator used in economics to measure the amount of goods and services produced in a country is the Gross Domestic Product (GDP), which is expressed in money (currency of the country or internationally, generally in US dollars) and is expressed in periods that are normally annual, although they are also expressed in semesters or quarters and even in shorter periods. The GDP indicator is the one most commonly used in macroeconomics, which, as part of economics, deals with those variables of a general nature that affect the country's economy and by means of the GDP it is possible to analyze the growth, stagnation or regression that occurs in that nation. According to Callen (2008), the expression used to calculate the indicator is:

GDP = Consumption + Investment + Expenditure + Exports - Imports.

Knowledge of GDP at the country level is fundamental and necessary because it informs us and sends us signals about the production of goods and services in a nation, during a specific period and is expressed by means of a monetary value (millions of dollars or local currency). It is convenient to remember that within what a country produces, regardless of whether it is its own or foreign capital, illicit activities are not counted and it is also convenient to clarify that the amount of the GDP does not imply the wealth or poverty of a country or the good or bad performance of the economy, since the GDP is a monetary result of the country, but it is not the framework in which the activities and their consequences take place, therefore, this indicator helps us to know the increase, decrease or stagnation that a country experiences in terms of production of goods and services of the country and the competitiveness of the companies that generate the economy.

The objective of this research was to quantify the growth (positive or negative) of the forestry sector from the perspective of secon-

dary activities (with industrialization or value added processes), in order to have a point of comparison with the growth of the Mexican economy and to determine the relative importance of forest resources in the country.

METHODOLOGY

The methodological process used was of the documentary type and was divided into five stages:

First stage: selection of the topic to be studied

The topic chosen for this research was the evolution of the forestry economy in terms of its growth, taking as a reference the indicator known as gross domestic product.

Second stage: collection of information from secondary documentary sources.

The main idea was to collect data in order to quantify, sort and classify them to determine the importance of the topic, as well as to build a content outline for the document. We resorted to the search and precise location of the documents kept in information centers, libraries, reference centers, databases, as well as articles and abstracts of proceedings of seminars and national and international congresses, among others. During this phase, an Excel database was designed and elaborated, which was fed with the information generated by the National Institute of Statistics, Geography and Informatics (INEGI) in its various documents published periodically, which served to organize the documentary sequence. The study period was delimited according to the national accounts published by the aforementioned source during the period 2003 - 2017, it should be clarified that at the time of data collection (June 2019), the data for 2018 were not yet published.

Third stage: development of the research plan

In order to order and exercise thinking and understanding, as well as to ensure that the concepts have a logical and systematic structure, as well as to define sub-themes to segregate and hierarchize between the transcendental and important, and the secondary or superfluous. The economic indicator selected for this analysis was the forestry gross domestic product with annual quantifications, which was divided into two sections: primary and secondary activity, in order to make comparisons between the two sectors.

Fourth stage: organization of the information collected.

This was done by indexing the content and secondary sources of information, for which the forestry sector was segmented into its primary activity and then into its transformation or industrial component, and finally showing the data at an aggregate level (primary + industrial) of the economic part of the forestry sector to allow a better understanding of the subject. The period taken into account for analysis purposes was from 2003 to 2017.

Fifth stage: statistical function

It was considered that the mathematical formula that best reflects the annual growth is the average annual growth rate because it is supposed to be the one that best reflects the growth of an activity in a medium and long term period, its mathematical expression is: $AAGR = ((Vf / Vi) \wedge (1 / n) - 1) * 100$. Where Vf means the final value of the period; Vi corresponds to the initial value of the period and n represents the number of years considered in the analysis. Likewise, the growth of a specific year was taken into account, which was compared with its immediate previous one, to facilitate and identify the sizes of positive and negative increases that result throughout the period (Addin Technology, 2018). Likewise, a

trend line was included to have a better understanding in the evolution of the indicators and finally a comparison of the Mexican GDP with that of some other countries is made, in addition to contrasting it with the national GDP and with that of the agricultural, hunting and fishing sector.

RESULTS AND DISCUSSION

The information was presented for a better understanding under the modality of secondary forest GDP in the following components: sawmilling and wood preservation, manufacture of laminates, manufacture of other wood products, manufacture of pulp, paper and cardboard, and manufacture of cardboard and paper products.

GROSS FORESTRY DOMESTIC PRODUCT OF THE SECONDARY SECTOR

In the case of the secondary forestry sector, which values the industrial or transformation part, its economic quantification was carried out with data from (INEGI, National Accounts System) which considers two branches: 321, which refers to the Wood Industry, comprising three sub-branches; 3211 Sawing and preservation of wood, 3212 Manufacture of laminates and 3219 Manufacture of other wood products, and 322, related to the Paper Industry, with two sub-branches; 3221 Manufacture of pulp, paper and cardboard and 3222 Manufacture of cardboard and paper products, from which the data shown in Table 1 is derived.

During the 32-year period of analysis, the component that contributed the most to the GDP of the secondary or transformation sector was the paper industry and in particular that which refers to the manufacture of paper and cardboard products in their final phase, which generate the most added value,

and what contributed the least were the activities of manufacturing wood laminates and agglutinates that correspond to the timber industry. It should be noted that any of the two branches of the forestry industry individually contribute more to GDP than the total of primary activities. The behavior of the industrial or transformation part of the forestry GDP is shown in Figure 1.
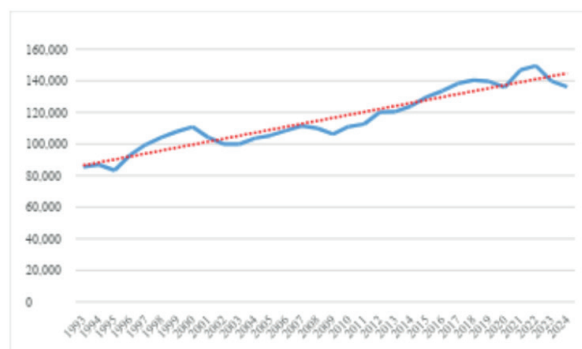

Figure 1. Secondary Forestry Gross Domestic Product and Trend Line.

Own elaboration with data from INEGI.

The previous graph shows that the slope during the whole period is positive and the equation that came closest to the trend line is a polynomial equation ($y = 16.179x^2 + 1348.5x + 87561$) with an $R^2 = 0.9051$, which is considered to be highly correlated. The years with the highest growth compared to the previous year were 1996, 2021 and 1997, respectively, and in absolute terms, the year 2022 reached the figure of 149,501 million pesos, of which 49.2% was contributed by the manufacture of final paper and cardboard products, and when adding the manufacture of pulp, paper and cardboard, the percentage composition for this year shows that between its two components it contributed 73.3% and the remaining 26.7% was contributed by the wood industry. The smallest share came from the manufacture of wood laminates and binders, with only

Year	Millions of pesos	Variation % previous year
1993	85,459	0
1994	86,821	1.593
1995	83,312	-4.041
1996	93,064	11.706
1997	99,642	7.068
1998	104,146	4.520
1999	107,860	3.567
2000	110,809	2.733
2001	104,231	-5.936
2002	99,941	-4.116
2003	99,963	0.022
2004	103,670	3.708
2005	105,403	1.672
2006	108,559	2.995
2007	111,443	2.656
2008	109,923	-1.366
2009	106,266	-3.327
2010	111,071	4.522
2011	112,627	1.400
2012	120,258	6.775
2013	120,541	0.236
2014	124,052	2.912
2015	129,825	4.654
2016	133,552	2.871
2017	138,355	3.596
2018	140,450	1.514
2019	139,569	-0.627
2020	136,003	-2.551
2021	146,777	7.921
2022	149,501	1.856
2023	139,736	-6.532
2024	135,227	-3.226

Table No. 1. Gross Domestic Product of the Secondary Activities of the Forestry Sector during the period 19933 - 2017 at constant values of 2018 and its percentage variation.

Source: INEGI. System of National Accounts of Mexico. Goods and Services Accounts. 2018 constant prices.

1.4 %. Sawmilling, which is the immediate industry to the primary activity, has a relative importance, since it occupied the third place as a contributor to the GDP with 11.87 %.

The behavior of the 32 years of analysis of the secondary activities of the forestry sector is shown in Figure 2.
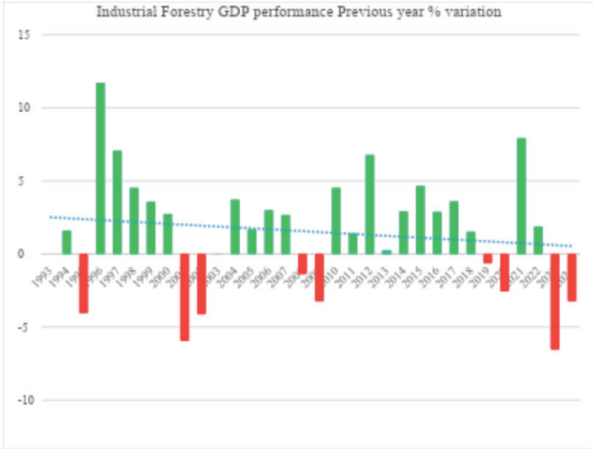

Figure 2. Behavior of the Secondary Activities of the Forestry Gross Domestic Product during the period 1993 - 2024.

The previous figure shows the cyclicality of the secondary activities of the forestry sector, where the highest percentage growths of the forestry industrial branches, reached the highest percentage growth in 1996, with the historical record of the 32 years, when it reached more than two digits (11.7 %) of increase and in second place, in 2011, the variation of growth reached the figure of a little less than eight percentage points. On the negative growth side, in the recent past, in the year 2023, the percentage of this type was 6 ½ tenths, a situation similar to that of 2001, with a decrease of just under six tenths. It is also noteworthy that in a period of nine years (2010 / 2018), there was a continuous positive growth, while the negative ones, were distributed throughout the period, with a greater presence in the period of 2019 - 2024.

GROWTH RATES OF FORESTRY ECONOMIC ACTIVITY.

For the calculation of this indicator on the evolution of forestry activity, the formula was used:

AAGR = ((Vf / Vi) ^ (1 / n) - 1) * 100, where

AAGR = Average annual growth rate

Vf = Final value

Vi = Initial value

N = Number of years of the period

As a result of the application of the formula, the result of the economic growth of the secondary forestry sector in the period 2003 - 2017, of the secondary activities of the industrial forestry sector in the period is shown in Table 2.

Secondary activities	Average annual growth rates
Timber industry	-0.57
Sub-branch 3211. Sawmilling and wood preserving	-0.06
Subheading 3212. Manufacture of wood laminates and agglutinates	0.20
Manufacture of other wood products	-1.08
Branch 322. Manufacture of paper	2.58
Subbranch 3221. Manufacture of pulp, paper and paperboard	1.95
Subclass 3222. Manufacture of paper and paperboard products	2.99
Total secondary industrial forestry activities	1.44

Table 2. Average annual growth rates of the components of the forest industrial secondary activities.

The above indicates that secondary forestry economic activities had an average growth of the 32 years of the project's horizon, of a positive type with a little less than 1 ½ percentage points. The most dynamic branch was the paper industry with slightly more than 2 ½ points, and of these, the most dynamic was the activity that generated the greatest aggregate, which was finished paper and cardboard

products, with one hundredth less than three percentage points. The opposite case occurred in the primary wood industry, which as a whole decreased in the period under analysis by a little more than ½ point, and the only activity in this branch that managed to maintain growth, but of a marginal type, was that of laminated and bonded wood, with barely two tenths of a percentage point.

With regard to the average annual growth rates in each of the presidential periods (6 years), Table 3 shows the results of the indicator in each of them, as well as in the total period (32 years),

Period	Average annual growth rate (aagrcgt) % 1995 - 2000 Ernesto Zedillo
1995 - 2000 Ernesto Zedillo Ponce de León	4.87
2001 - 2006 Vicente Fox Quezada	0.68
2007 - 2012 Felipe de Jesús Calderón Hinojosa	1.28
2013 - 2018 Enrique Peña Nieto	2.58
2019 - 2024 Andrés Manuel López Obrador	-0.53
1993 - 2024 Total	1.44

Table 3. Average annual growth rates by six--year period and total.

Except for the period 2019 / 2024, all the others had positive growth, the most significant was that of 1995 /2000 and followed in importance of growth, the one related to the years 2013 / 2018.

PERCENTAGE SHARE OF GDP OF SECONDARY FORESTRY ACTIVITIES IN THE NATIONAL GDP

The secondary forestry activities throughout the 32 years of the research project horizon, had a very low participation in the country's economy, since, on **average** for the period, their contribution is only **0.582%**, with a minimum of 0.536% in the year 2024 and a maximum in 1996 of 0.642%.

EVOLUTION OF THE PERCENTAGE COMPOSITION (%) OF FOREST INDUSTRIAL SECONDARY ACTIVITIES (1993 - 2024).

In order to know the percentage change in the composition of the activities with added value through industrialization, the years of beginning (1993) and end (2024) were taken to observe the changes throughout the 32-year horizon of the research project, which is visualized in Figure 3 a and b.
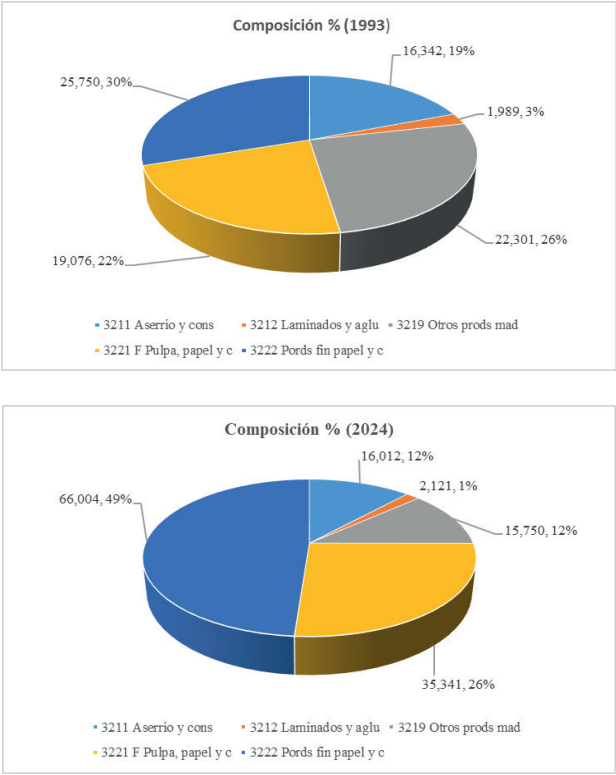

Figure 3 a and b. Evolution of the Percentage Composition of Forestry Industrial Activities from 1993 to 2024.

The above shows how branch 322 of the paper industry (in its two sub-branches: pulp, paper and cardboard manufacturing and the manufacturing of final paper and cardboard products), were the ones that gained participation in the GDP, since, in 1993 its participation was two tenths more than half of the forest industrial GDP and by the final year of

2024 its participation increased to two thirds of the forest industrial GDP and the opposite case occurred in the sub-branch 321 of the wood industry, At the beginning of the analysis period, it represented 48% of the industrial GDP and by the year 2024, its participation declined to only a quarter, which places it as the loser in the composition of the industrial forestry GDP.

In a retrospective and historical way and according to (González 1979), in the year 1917 the participation of the forestry GDP in the national GDP represented 1.45 % and in the report of the Bank of Mexico 1979, during the triennium 1965 - 1966 - 1967 the forestry GDP represented within the total the proportions of 1.70 % - 1.64 % - 1.57 % respectively, which indicated a setback in the forestry economy. The above data show that historically the forestry GDP, from 1917 to 2024, in general terms, this sector loses about one percentage point in its contribution to Mexico's economy.

INTANGIBLE VALUATION OF THE FORESTRY SECTOR

In the national accounts managed by the Ministry of Economy and Banco de México, S.A., the intangible values of the forestry sector are not quantified, The monetary values of various activities generated by forestry activities are not quantified, despite the fact that several studies have been carried out to quantify the monetary benefits that are not taken into account in the country's gross domestic product: rainwater capture and filtration, soil retention and enrichment, carbon sequestration, scenic landscape, outdoor recreation and sports activities, contribution to climate change mitigation, collection of by-products from forest areas, and refuge for flora and fauna among others (Torres and Guevara, 2002).

CONCLUSIONS

The importance of the industrial forestry sector seen from the point of view of the national accounts that serve to measure the country's Gross Domestic Product is scarce, since it only represented on average over 32 years of analysis about half a percentage point of this macroeconomic indicator. The forestry agro-industry segment showed a growth with a positive slope during the whole period and the best segment, in terms of contribution to the National GDP, was the processed paper and cardboard products, which are the most relevant due to their high generation of added value. The average growth rate of the forestry sector with transformation or added value reached a little less than one and a half percentage points during the period, which is considered acceptable but not enough to generate greater growth and better development for the inhabitants dedicated to forestry activities in their industrial phase, This situation leads us to infer that this sector should be reinforced through public policies and support to benefit low-income foresters in the secondary sector, especially those engaged in sawmilling, since it is estimated that the forest and jungle areas are home to just over a dozen million Mexicans, who live in conditions of poverty, but with a great wealth of natural resources. Finally, there are several primary activities generated by the forestry sector, which are not considered and quantified within the economic activities that are quantified in the country's Gross Domestic Product, because they are considered intangible, but their lack of monetary valuation is increasingly visible and they are highly beneficial for the welfare of the entire Mexican population.

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