

# **Overview of Past, Current and Potential Uses of Mesquite in Mexico**

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## **INTRODUCTION**

In developing countries, forestry activities have not generated sufficient income to become an important influence in the development and welfare of the population. This is primarily due to the situation in these countries where forestry activities are usually focused on competing food production needs where agriculture and animal husbandry are the principal players. Developing countries are generally characterized by having a large variety of renewable natural resources which are little known and underutilized and a small number of well-known resources which are over exploited.

Regarding forest resources, most developing countries have historically been guilty of a lack of management planning, which is a consequence of a lack of technical knowledge as well as the intense pressures placed on forests such as the creation of new human settlements; growth of agricultural and ranching lands; development of an infrastructure, such as roads, water projects, electric lines, and railroads; and the use of products including firewood, medicinal plants, and food sources. Mesquite is a case in point.

## **1. MEXICAN FOREST RESOURCES**

Mexico is located between longitude 87° W and 117° W and latitude 14° N and 32° N and has 200 million hectares of surface area. Of this area, 60% is mountainous and 40% ranges from hilly to flat. The Mexican climate is also varied with 60% of the country being arid or semiarid and 40% being divided between temperate and tropical climates. The mean annual precipitation varies from 0 to 500 mm in the most arid regions, 500 to 1500 mm in temperate regions, and from 1600 to more than 3000 mm in tropical zones.

These characteristics, together with the geology and soil of the country, have created a great diversity of vegetation. According to the Sub Secretaria Forestal y de Fauna Silvestre (1994), there are 138.65 million hectares suitable for silviculture, of which 56.87 million hectares are forested and 58.44 million are covered with shrubs and nonwoody vegetation, mostly from the Cactaceae family. There are also 22.23 million hectares of disturbed areas and 1.11 million hectares of aquatic vegetation (Table 1).

Mexican forest resources can be divided into three groups according to climate: temperate forests, tropical forests, and desertic vegetation.

**Table 1. Areas Covered by Forest Ecosystems in Mexico**

Ecosystem Type	Area	
	Millions of ha	Percentage
Temperate Forest	30.43	21.94
Tropical Forest	26.44	19.06
Shrub Lands	6.94	5.00
Drylands Vegetation	51.50	37.14
Disturbed Areas	22.23	16.03
Aquatic Vegetation	1.11	0.83
<b>Total</b>	<b>138.65</b>	<b>100.00</b>

### **1.1 Temperate Forests**

Temperate forests consist of pure conifer stands, mixed conifer and hardwood stands, and pure hardwood stands. These forests are found in the mountainous regions of the country, in altitudinal bands ranging from 800 to 3,300 meters above sea level. Mexico has a wide variety of coniferous genetic material, principally in the genus *Pinus*. Martínez (1945) listed 39 species, 18 varieties, and 9 forms; these numbers have increased recently with new research (Eguiluz, 1978). The following genera (among others) are also found in these forests: *Abies*, *Cupressus*, *Taxodium*. The hardwoods are represented by the *Quercus*, *Arbutus*, and *Alnus* genera.

The regional distribution of temperate forests is very important in the Sierra Madre Oriental, Sierra de Chiapas, and the Baja California peninsula mountain systems. This forest class has a total surface area of 30.43 million ha. Chihuahua, Sonora, Durango, Sinaloa, Jalisco, Michoacán, Guerrero, Oaxaca, and Chiapas have the largest area of temperate forest.

### **1.2 Tropical Rainforests**

Tropical rainforests are characterized by the diversity of their ecosystems which can reach 60 tree species and more than 100 plant species per ha. The commercially most important timber genera are *Cedrela*, *Swietenia*, *Platymiscium*, *Buscida*, *Piscidia*, and *Calophyllum*. The natural distribution of the tropical rainforests is the coastal flatlands of the central and southern regions of the country below 800 meters above sea level. Jungles occupy 11.4 ha of the country, including the states of Campeche, Yucatán, Quintana Roo, Chiapas, Tabasco, Oaxaca, Veracruz, Puebla, San Luis Potosí, Hidalgo, Tamaulipas, Guerrero, Michoacán, Jalisco, Nayarit, Sinaloa, and Colima.

### **1.3 Desertic Vegetation**

Desertic vegetation consists of scrub land, desert brushwood, chaparral, and members of the Cactacea family. This type of vegetation is found throughout coastal Mexico, in the northern desertic regions, and in other regions in central and southern Mexico with similar arid characteristics. This ecosystem occupies 58.44 million ha, of which 51.50 million ha are legally required to be forest lands due to the topography which has more than 15% slope. This type of vegetation is utilized as an energy source in the form of firewood and charcoal, and several genera, such as *Euphorbia*, *Parthenium*, *Opuntia*, and *Agave*, are used in domestic industries and food production.

In conclusion, it can be stated that the largest vegetation area is 58.44 million ha (42.14%), which is made up of shrubs and scrub vegetation. Shrubs occupy 6.94 million ha (5.00%) and scrub occupies 51.50 million ha (37.14%).

The second largest vegetation area is forest land which consists of 56.87 million ha (41.01%) of which 30.43 million ha have temperate forests (21.94%) and 11.4 million ha are tropical rainforests (8.22%). The remaining 15.04 million hectares correspond to tropical dry forest (10.84%).

## 2. THE HISTORY OF MESQUITE IN MEXICO

The uses of mesquite in Mexico have changed over time due to cultural and technological advances. However, some of the most important uses have remained constant even to the present time.

The common name, mesquite, is actually derived from the Aztec language "Nahuatl", in which the plant was called *mizquiltl*, or "bark used for tanning." The genus name, *Prosopis*, comes from ancient Greek which means bark used for tanning sheep skins.

In Mexico's history, it is possible to separate and observe several eras associated with mesquite use as summarized in Table 2.

Table 2. Forested Areas at Different Times During Mexico's History\*

Era	Year	Temperate Forest (millions of ha)	Decreasing Rate (%)	Tropical Forest (millions of ha)	Decreasing Rate (%)
Prehispanic	1500	126.6		28.9	
Spanish Conquest	1800	120.6		18.4	
Independence	1825	123.1		20.8	
Revolution	1900	48.8		20.7	
Postrevolution	1940	40.8	0	20.4	1.4
Current	1950	39.5	3.18	19.8	2.9
	1960	33.3	15.6	17.7	10.6
	1975	29.5	11.4	15.2	14.1
	1976	28.7	2.7	15.0	1.3
	1986	27.5	4.1	11.4	24.0
	1996**	30.4		26.4	

\* Data were derived from a map integrated by Moncayo (1981) under the title "General distribution of vegetation in prehispanic Mexico acerca 1521", and a table showing forested areas until 1976 (Moncayo, 1981). Finally, it was updated by the authors.

\*\* Forested area increased because of a very detailed forest inventory (completed in 1994) that includes forest plantations for temperate forest areas, and mangrove areas, savannas, and riparian areas with tree cover in tropical forest areas.

### 2.1. Prehispanic Era

Before the Spanish conquerors arrived, ancient cultures in Mexico tried to keep a balance between extraction and production of forest resources, due to the religious base of these cultures.

Historical records of ancient cultures in Mexico show that they used forest resources for building homes, firewood, making weapons, for medicinal purposes, fruit harvesting, and religious uses. The ancient cultures involved with mesquite in Mexico are discussed below.

### **2.1.1 Seri and Yaqui Cultures**

These cultures were located in the Mexican northwest in the states of Baja California and Sonora. They used mesquite for food, firewood, housing, weapons, tools, fibers, and medicine. They used every part of the plant.

The Seri culture used heat to kill a beetle from the bruquidae family in mesquite pods and to facilitate grinding the fruit. The powder obtained from pods was mixed with water to produce a kind of bread or a beverage called atole (Felger *et. al.*, 1979).

### **2.1.2 Purepecha Culture**

This indigenous group settled at the edges of Pazcuaro Lake, and spread over the current states of Michoacan, Guanajuato, Queretaro, Guerrero, Colima, Jalisco, and Nayarit. This culture used firewood for religious ceremonies and wood for carving religious figures (Moncayo, 1981).

### **2.1.3 Chichimeca Culture**

The Chichimeca lived in central Mexico in temperate forest areas. Due to their hunter-based culture, they developed a deep respect for nature. They used mesquite for weapons, mainly because of its durability and strength.

## **2.2. Spanish Conquest**

After the Spanish conquerors arrived in New Spain, and following bloody battles, the indigenous cultures were conquered, and a new era for Mexico was born. At the same time as Spanish settlement advanced, gold and silver explorations were carried out as a result the discovery of huge ore deposits in Taxco, Zumpango del Río, Zacualpan, Sultepec, Temascaltepec, Espiritu Santo, Tlalpujahuá and Zacatecas (Moncayo, 1981). Mining operations required different wood products throughout the mining process. Those wood products were poles, firewood, and charcoal. These mining activities were responsible for forest destruction, the change of forest lands to agriculture and animal husbandry activities, and establishment of new settlements (Moncayo, 1981; Sanchez *et. al.*, 1990).

It was during this period that the genus *Prosopis* was reported for the first time in 1651 by Hernández. Later, in 1767, Solís, a catholic friar, who was visiting the missions located in the northern part of New Spain, described the presence of the genus *Prosopis* (González, 1979). Finally, Clavijero, in his study of California's flora, mentioned the genus *Prosopis*.

## **2.3. Independence**

After Mexico won independence from Spain, anarchy reigned in Mexico, causing a great decline in economic and productive activities. All agricultural activities were reduced to simple self-sufficiency levels.

It was during this time that private ownership started to be recognized, and forests were cut down in Mexico's tropical regions, mostly for wood exportation to Europe. The use of forest resources at this time was without any technical criteria, and with very severe overuse.

## **2.4. Revolution**

With the stabilization of the economic, social, and political conditions after Mexico's civil war, the use of forest resources was based on the idea that they were infinite, and foreign investment was promoted for building railroads and to facilitate the transportation of minerals and raw lumber.

In conclusion, the decreasing rate of Mexican forest resources in an area can be observed for the different eras of Mexico's history.

### 3. MESQUITE IN MEXICO

Although it has been subjected to irrational human action since the Spanish conquest, which has caused a striking deterioration in natural population, mesquite remains a biological resource with a wide distribution in arid and semiarid zones in Mexico. Ecologically, *Prosopis* species and varieties play a very important role in the food chains of the ecosystems where they are found. Mesquite serves as a food source and refuge for wildlife, stabilizes the soil and prevents erosion, and protects watersheds. In short, it is a prime candidate for integrated management. However, as with the rest of the flora of arid regions, mesquite has not been given the economic importance that it deserves.

In most arid regions, mesquite is found as a shrub, only in ecosystems with an abundance of water does it grow into trees. It grows better near deep river pools, in valleys with deep soil, and places where the water table is high. Mexico has a wide variety of native mesquite species (Tables 3 and 4). In many arid regions in Mexico, mesquite is the most common vegetation for many kilometers forming forests called "mezquites."

Table 3. Native Mexican Species of the Genus *Prosopis*

SPECIES
1. <i>Prosopis laevigata</i> var. <i>laevigata</i>
2. <i>P. glandulosa</i> var. <i>glandulosa</i>
<i>P. glandulosa</i> var. <i>torreyana</i>
<i>P. glandulosa</i> var. <i>prostrata</i>
3. <i>P. juliflora</i> var. <i>juliflora</i>
4. <i>P. velutina</i>
5. <i>P. reptans</i> var. <i>clonerascens</i>
6. <i>P. pubescens</i>
7. <i>P. articulata</i>
8. <i>P. tamaulipana</i>
9. <i>P. palmeri</i>
10. <i>P. pazensis</i>
11. <i>P. bcharis</i>

Adapted from Maldonado-Aguirre (1991).

**Table 4. Distribution of Mesquite Species in Mexico**

<b>Species</b>	<b>Distribution in Mexico</b>
1. <i>Prosopis laevigata</i> var. <i>laevigata</i>	San Luis Potosi, Central and Southern Tamaulipas
2. <i>P. glandulosa</i> var. <i>glandulosa</i>	Northeast
<i>P. glandulosa</i> var. <i>torreyana</i>	Pacific Northwest
3. <i>P. juliflora</i> var. <i>juliflora</i>	Baja California
4. <i>P. velutina</i>	Northeast
5. <i>P. reptans</i> var. <i>clonerascens</i>	Northeast
6. <i>P. pubescens</i>	Baja California
7. <i>P. articulata</i>	Guaymas, Sonora Tamaulipas; Veracruz; Baja California
8. <i>P. tamaulipana</i>	Tamaulipas; Veracruz
9. <i>P. palmeri</i>	Baja California
10. <i>P. pazensis</i>	Baja California
11. <i>P. bacheris</i>	Altar Desert, Sonora

Adapted from Maldonado-Aguirre (1991), Piña-Puente (1981), and Ezcurra, et al. (1981).

*Prosopis articulata*, *P. tamaulipana*, and *P. palmeri* are considered endemic to Mexico. Based on the absence of reproductive barriers and on numerical taxonomy, it can be concluded that there is natural hybridization between the populations of *P. laevigata* and *P. glandulosa* var. *glandulosa*.

*Prosopis laevigata* var. *laevigata* is typical of central Mexico. It can be found in the precipitation range from 300 mm to 900 mm and at altitudes up to 2300 meters above sea level. Industrial uses have not been developed for *P. laevigata* wood, but it is commonly used as domestic firewood. The fruit is used intensively as livestock forage as well as for human consumption.

*Prosopis glandulosa* is one of the most common mesquite species in Mexico. It is further taxonomically divided into two varieties: *glandulosa*, which is found in Texas and northeastern Mexico, and *torreyana*, which grows near the Pacific northwest coast. The latter is the most aggressive mesquite variety and is known as a pest on livestock ranges.

*Prosopis juliflora* var. *juliflora* is found in clearings, on slopes, and along stream beds. The species name comes from "Julus" which means inflorescence in the shape of a whip.

*Prosopis velutina* is a species which presents a short pubescence in the foliage and stems. It has a distribution in northeastern Mexico and grows in alluvial soils, low beaches, and in riparian zones.

*Prosopis pubescens* is found in northern Mexico in the states of Baja California, Chihuahua, and Sonora. It grows in deep alluvial soils. The species name refers to the fruit which is covered in fuzz.

*Prosopis reptans* var. *clonerascens* is a short species that is primarily distributed in northeastern Mexico in alluvial soils with a layer of calcium carbonate. The species name *reptans* means to crawl, a characteristic which can be observed in the growing plant.

*Prosopis articulata* is found only in a small area near Guaymas, Sonora, and in the states of Tamaulipas and Veracruz. It also grows in rocky mesas and clearings throughout Baja California.

*Prosopis tamaulipana*, an endemic Mexican species, is distributed along the eastern slope of the Sierra Madre Oriental mountains in the states of Tamaulipas and Veracruz. It grows in clay soils at low altitudes.

*Prosopis palmeri* is also an endemic species. Its distribution is limited to the Baja California peninsula and grows near dry creek beds and desert beaches.

Mesquite species can be found throughout Mexico, concentrated as shown in Table 5.

Table 5. Mexican States With Mesquite Species

State	Mesquite Area (hectares)
Aguascalientes	279
Baja California	219
Baja California Sur	75,387
Coahuila	178,731
Chihuahua	126,787
Durango	559,878
Guanajuato	62,294
Hidalgo	962
Jalisco	2,575
Michoacan	427
Nuevo Leon	587,849
Puebla	4,547
San Luis Potosi	116,257
Sinaloa	5,862
Sonora	1,888,044
Tamaulipas	457,568
Zacatecas	14,512
Total	4,092,178

#### 4. VALUE AND USES OF MESQUITE

Mesquite, due to its many different properties, has been used in different forms in many regions of Mexico. It can either be used directly or transformed. It is a magnificent soil builder, mesquite leaves deposit an important layer of organic material, it fixes atmospheric nitrogen, its roots control the movement of dunes, it is used for forage for domestic animals, it serves as habitat for wildlife, it produces nectar which is then converted into bee's honey, mesquite fruit serves as a human food source, mesquite wood is used for rustic construction projects, railroad ties and posts, and, of course, for domestic firewood. In some areas of Mexico, such as the northwest state of Sonora, mesquite is viewed as a plague, due to the intensive use of the range for livestock.

##### 4.1. Human Consumption

Mesquite seed pods are eaten as fresh fruit or they are dried and pulverized. Candy, cookies, and bread are made from the seed pods and sold locally. Mesquite seed-pod powder is used as a coffee substitute and an alcoholic beverage is distilled from the sugars. Mesquite's abundant nectar is used in raising bees.

The protein content of mesquite seed pods is similar to soy beans and higher than many other legumes. Mesquite also has high sugar, alcohol, fiber, calcium, magnesium, potassium, iron, and zinc content (Table 6 and Table 7).

**Table 6. Chemical Composition of *Prosopis***

<b>Component</b>	<b>Percent of Total</b>
Crude protein	12.12
Ether	2.73
Crude fiber	21.80
Ash	4.00
Calcium	2.20
Phosphate	0.30

Source: Franco de la Cruz (1980)

**Table 7. Fractions of *Prosopis* Seed Pod**

<b>Fraction A</b>	<b>Fraction B</b>	<b>Fraction C</b>	<b>Fraction D</b>
Exocarp 55%	Endocarp 25%	Endosperm 10%	Cotyledon 10%
Sugars 30-40% Fiber 10-20%	Fiber 35-40% Protein 8-12%	Sugars 50-70%	Protein 60% Fat 8-12%
Production of ethanol	Food production	Gum	Concentrated protein
Sugar extraction Food production			

Source: Maldonado-Aguirre (1991).

#### **4. 2. Traditional Medicine**

Mesquite plants offer a cornucopia of medicines. An extract of the seed pods as well as the fermented leaves of the mesquite plant have antibacterial effects against both *Staphylococcus aureus* and *Escherichia coli*. An infusion made from the bark is used to cause vomiting. Resin from the trunk helps a sore throat, aids in the treatment of dysentery, strengthens the teeth, and helps with stomach problems. The leaves are also used as eye compresses to combat infections.

#### **4. 3. Forage**

The flowers and pods are eaten by domestic animals. The flowers are only available for a short time, but the fruit has a longer viability; rural people collect the seed pods, then dry and crush them to store during dry periods. This powder is fed to livestock. Castro-Gil (1980) reports harvests of up to 25 metric tons/ha of mesquite fruit. Although domestic stock is not enamored of mesquite leaves, they are rich in nitrogen and other nutrients.



#### 4. 4. Forestry Uses

Mesquite wood has a variety of uses ranging from its use as fence posts, furniture, firewood, parquet floors, handicrafts, cart wheels, and for rustic buildings. The native Seri people use the fibrous root (soaked in water) to make rope. Two different types of resin are extracted from mesquite: an amber one from the bark that is similar to arabic resin, and a black one used as a dye. However, the main use of mesquite in Mexico traditionally has been as firewood (Table 8).

Table 8. Firewood Characteristics

Region	Cooking Style		Most Frequently Used Species	Distance Traveled to Collect Wood		Rural Firewood Consumption (kg/month/person)
	Fire	Stove		Max.	Min.	
	(%)	(%)		(km)	(km)	
Baja California	84.54	15.46	Mesquite, Ironwood	34.17	1.73	64.819
North Pacific	83.41	16.59	Mesquite, Oak	18.62	1.50	29.635
North	17.70	82.30	Mesquite, Oak	32.00	0.92	70.906
Northern Gulf	93.31	6.69	Mesquite, Oak, Huizache	5.41	0.30	58.481
North Central	36.81	63.19	Mesquite, Huizache	12.75	1.00	38.125
Pacific Central	53.85	46.15	Huizache, Mesquite, Oak	5.95	0.33	42.438
Central	99.84	0.16	Oak, Mesquite, Pine	4.00	0.41	42.058
Central Gulf	99.22	0.78	Guisimo	3.41	0.83	90.987
South Pacific	100.0	0.00	Cualote, Oak	6.87	0.72	69.106
Yucatan Peninsula	96.45	3.55	Habin, Tzalam, Catzin	5.49	1.04	54.026

Adapted from: Secretaria de Energia, Minas e Industria Paraestatal (Nacional) (1988).

Mesquite wood, with a specific weight of 0.88 gr/cm<sup>3</sup> makes an excellent charcoal with a specific weight of 0.41 gr/cm<sup>3</sup> and a caloric value of 29.7 kj/g (Maldonado-Aguirre 1991; Wolf 1986). Annual charcoal production in Mexico is approximately 80,000 metric tons. Mesquite charcoal is highly prized for the flavor it gives the roasted food.

Studies conducted on the sapwood, heartwood, and internal and external bark of *Prosopis laevigata* have shown that the wood is hard and durable and has many physical qualities that make it apt for furniture. This same hardness, however, makes it extremely difficult to work. The wood fibers are libriform, are moderately short, have a small diameter, and a thick wall. These fibers are suitable for high grade, medium quality paper (Table 9).

Table 9. Microscopic Characteristics of *Prosopis laevigata* Wood

Fiber Length ( $\mu$ ) Diameter ( $\mu$ ) Thickness ( $\mu$ )	Libriform	Moderate cut x = 887 Min. 114 Max. 1523 D = 239	Thin cut x = 11 Min. 7 Max. 21 D = 2.9	Very thick cut x = 4 Min. 2 Max. 9 D = 1.4
Cell content	Gum vessels	Axial and radial parenchyma rhomboid crystals		Fibers absent

Source: Maldonado-Aguirre (1991).

The main source of extracts in *Prosopis laevigata* is the inner bark (Table 10).

**Table 10. Analysis of Extracts from Phloem, Sapwood, and Heartwood from *Prosopis laevigata***

Solvents	Floem	Sapwood	Heartwood
Benzene	1.623	2.684	3.109
Chloroform	0.507	1.000	0.836
Ether	0.779	0.313	0.934
Acetone	12.856	0.878	8.573
Ethanol	10.779	4.660	5.501
Water-ethanol	16.413	2.300	3.700
Water	3.000	0.500	2.050
Sum	45.955	11.837	24.704
Sum (4+5+6)	40.042	7.387	17.774

Source: Maldonado-Aguirre (1991).

The tannin content in the wood and inner bark is presented in Table 11.

**Table 11. Tannin Content in Laboratory Extracts of *Prosopis laevigata***

Component	Total Extract (%)	Strasny Number (%)	Tannins (%)	Total Extract Tannins
Inner bark	9.75	62.22	6.07	0.62
Wood	8.00	37.17	3.10	0.37

Percent based on stove-dried sample.

Source: Maldonado-Aguirre (1991).

#### 4. 5. Environmental Improvement

Mesquite trees provide shade for livestock, shelter for wildlife, and nesting sites for birds. The plants improve the soil by adding organic matter in the form of leaves, by fixing nitrogen, and by adding sulfur and soluble salts. A mesquite tree can fix up to 11.2 g/m<sup>2</sup> of nitrogen (Maldonado-Aguirre (1991)).

#### 4. 6. Reforestation

Mesquite trees have been used for firewood in reforestation projects in different regions throughout Mexico. Due to the species' ability to adapt to different conditions, they have been used in urban forestry projects in different cities in northern Mexico. The genus has also been used as wind breaks, and is a candidate for controlling dune movement.

### 5. MESQUITE'S POTENTIAL IN MEXICO

It is evident that the growing demand for mesquite wood, as well as the growing population, overgrazing, insect infestation, disease, and fire all contribute to the deterioration of this important resource. Therefore, it is necessary to develop restoration, conservation, and sustainable-use technologies in order to provide for these growing demands into the future.

Priority should be placed in the following areas: taxonomy, determination of the limits of the ecosystems where mesquite species are found, development of plans for the conservation of the biodiversity of the genus *Prosopis* for current and future use, as well as genetic improvement programs. Aspects of domestication and planting should be considered for each region. Efficient methods of inventory need to be developed for mesquite. It is also important to define the different production systems that mesquite can take part in, such as windbreaks, soil improvement, forage, firewood, and as a drought-resistant plant.

All of this should be undertaken keeping in mind the need for diversity of employment and income in rural areas as well as the need for technology development and integrated management that includes wildlife.

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