

A Review of the Social and Economic Opportunities for *Prosopis* (Algarrobo) in Argentina

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INTRODUCTION

It is a great pleasure to share my experiences with one of Argentina's great trees with you. Today in Argentina, *Prosopis* is known as algarrobo, but, in quechua, the language of the indigenous people, its name was "taco", which means "el arbol" or "the tree" (Bravo, 1977). My work in Argentina has been primarily with cactus (*Opuntia*) for fruit production. We have made excellent progress with cactus fruit production with more than 500 ha planted in the last two years. Growing up and working in Argentina, I always had *Prosopis* around me. My interest in algarrobo is from its potential for integrated, sustainable economic development, rather than any particular scientific discipline. I was fortunate enough to have been involved in a major *Prosopis* workshop in Argentina in July 1995 that brought scientists, development people, and algarrobo furniture builders together. Information resulting from this workshop will be used to provide an overview of the social and economic status of algarrobo in Argentina. My colleague, Mariano Cony, a geneticist, will illustrate the genetic diversity of *Prosopis* in Argentina. Because of the vast arid and semiarid land with great ecologic and geographic diversity, there is great genetic variability in this *Prosopis* genus.

Prosopis has a rich history of uses in Argentina. The ancient inhabitants had a special appreciation for *Prosopis* as evidenced by the use of a simple word that was reserved only for the algarrobo tree. When the Spaniards arrived in America, there were extensive algarrobo forests. Historians have noted that the fruits, picked up and stored together with maize, became the daily food that was kept in storage for use during the rest of the year. In their long travels, the men would restore their energy in the Indian villages that they found on their way. As Diego de Rojas (1453-1546) said:

"en el camino no habia agua, porque era tierra seca de ella, sin haber otros arboles que algarrobos. Caminaron con toda la prisa que permitia el bosque de algarrobos que entorpecia el paso de cabalgaduras y cargueros, y desafiando la creciente falta de luz(In the road there was no water as this was an arid land with no trees other than algarrobos. They hurried as fast as the algarrobo forest allowed, which was a hindrance to the horses feet and the oxcarts in the dim light of the forests" (Prebisch, 1986)

The evolution of the utilization of algarrobo occurred in about six stages:

- In the first and longest stage, the algarrobo was mainly used as food for indigenous people. The impact of this utilization on the ecosystem was very low.
- The second stage occurred with the introduction of European cattle in the later 16th century. The pods of the algarrobo were a very important source of forage and the pods are still an important source of forage today. The introduction of cattle lead to the general degradation of the algarrobo due to fires in the ecosystem that were created by the cattlemen to improve the grass production and quality of the land.
- In the railroad construction stage, that lasted until the First World War, the trees were used for railway ties and for fuel for the locomotives, thus increasing the demand for *Prosopis*.

The main railroad centers were built in Monte Coman in Mendoza, Patquia in Llanos de la Rioja, Chumbicha in Catamarca in the Zone del Rio Dulce of Santiago del Estero, etc. These sites were abandoned when the forests were depleted. An example of the type of devastation that occurred from overharvest of algarrobos is shown in Figure 1. Fortunately, as can also be seen in Figure 1, young algarrobos are beginning to occupy the drainage channels, which should begin to slow the erosion.

- With the continuing increase of population came an increase in the use of algarrobo for firewood and charcoal (Roig, 1992). This demand led to an irrational use of the forest. About 1940, with the increased use of hydrocarbons for fuel (first kerosene then natural gas), the use of algarrobo for fuelwood declined.
- While crude furniture for the ranch has been made from algarrobo for centuries, there has been a recent interest in fine furniture fabrication from algarrobo as described in more detail below. With regard to harvest of *Prosopis alba*, Burkart (1976) remarked "Trees with straight trunks 8 to 10 m tall occur, but these are becoming extremely rare, from being cut in preference to shorter ones. Thus, a negative artificial selection is taking place that should be counteracted by genetic improvement of the best lines in experimental plots".
- And last, a broad-based reawakening of interest in algarrobo has occurred in Argentina. This revived interest in the sustainable use of algarrobo has given rise to new taxonomic, biological, ecological studies as well as development of seed banks, forestry trials, genetic improvement programs and utilization projects.

GEOGRAPHIC SITUATION

The genus *Prosopis* in Argentina is widely distributed. Roig (1993) has classified the *Prosopis* distribution into the following six major climatic regions of the country (Table 1):

- Chaqueño-Mesopotámico, with subtropical trees and without a dry season
- Chaqueño-xerico with dominant trees, and few shrubs, subtropical climate but with dry season
- Pampeano with mild climate and least discernible seasons, with rainfalls around 600 mm
- Preandino in hills and valleys, xeric with a wide variation of temperatures
- Monte, predominantly shrubs in semiarid to arid climate and continental climate
- Patagónico with only shrubs, cold climate and frequent freezing of the soil.

In some very arid (<350 mm/yr) regions of northwestern Argentina, *Prosopis* occurs in areas that receive runoff between mountain chains. One such example is the Salar de Pipianco, located west of the city of Catamarca (Figure 2). Near the center of this salar, where the water table is close to the surface, large algarrobos, principally *P. chilensis* and *P. flexuosa* can be found (Figure 3).

SOCIAL ASPECTS

The gathering of fruits in the fields, was and still is, one of the most important activities in the life of the Indians in some regions of Argentina (Rusconi, 1961). Even today, algarrobos are left in cultivated fields as illustrated by this *Prosopis alba* being grown in a tobacco field in Salta (Figure 4). Where there were fields of algarrobos near Indian settlements, each village was the owner of one of the algarrobo groves. Occasionally, there were arguments between the owners about the use of the trees. The

disputes between owners of algarrobo groves were resolved with government rules in the Tucuman region as early as 1576 (Rusconi, 1961).

Today, many of the people and Indian cultures in the north of Argentina [los Pilagas, Wichis (matacos)] (Alvarsson, 1988) use the pods. They eat them fresh and store them in a granary for use later in the dry season. The indigenous people also use the wood for carving, toolmaking, and as fuelwood.

ALGARROBA FLOUR

The main use for the fruits of algarrobo has been for flour production to make loaves of algarrobo (patay) (Figure 5) in order to store the value of the pods for a long time. This is necessary because, normally, the pods ripen and fall quickly; the time for use is very short (a month). (Burkart, 1952). Patay is not cooked, but is only a coarsely ground flour from the entire pod. Due to the very high sugar content of the pods (30S40%), this flour is also very high in sugar and thus hardens after the moistened flour is pressed into cakes. The most commonly used species to make patay are *P. alba*, *P. nigra* and *P. flexuosa*, and in less quantity *P. elata*, *P. ruscifolia*, *P. vinalillo* (Arenas, 1981). Burkart (1952) explains the process to make patay and gives details of its food value. Patay prepared in the traditional manner is very coarsely ground and not very attractive to contemporary buyers. However, this author finds the flavor very pleasing and thinks that algarrobo pods could be developed into highly marketable products by contemporary chefs and culinary professionals. Currently, the Mendoza government has approved a research project to supply public hospitals and school dining rooms with a food made out of concentrated grape juice and algarrobo flour. This program would produce one million portions per semester with a cost reduction of 50% compared to the normal supply made from corn or wheat flour, eggs, and cane sugar. The algarrobo product would have the additional advantage of using local byproducts from the wine industry, which is the most important industry in Mendoza Province (Mariano Cony, 1996 pers. comm.).

ALGARROBO PODS IN BEVERAGE PRODUCTION

Another important use of algarrobo pods is beverage production. Chicha or aloja is a drink made from the fermentation of the pods in water. It is flavorful and has a high alcohol content. A great variety of species are used to make the drink. Favorites are *Prosopis alba* and *P. chilensis* (Burkart, 1952), *P. ruscifolia* (Martinez Crovetto, 1964), *P. hassleri* and *P. torquata* (Ragonese y Martinez Crovetto, 1947), *P. elata*, and *P. vinalillo* (Arenas,1981). Añapa is another drink made of ground pods of algarroba in cold water. It is a fresh sweet beverage. The same species used to make Anapa is used to make Chicha.

ALGARROBO COFFEE

Café de algarrobo is produced from toasted and ground pods. Local people believe it to have medicinal value (Ochoa unpub. obs.), and it is free of caffeine. Different species of *Prosopis* are used to make café de algarrobo.

FORAGE

The semiarid Chaco region of Argentina, Bolivia, and Paraguay has more than 2,000,000 head of cattle, a similar amount of sheep and goats, and around 300,000 horses (Saravia Toledo, 1990). Algarrobo is a very important forage supply for these livestock. An example of goats being hand fed *Prosopis alba* pods is shown in Figure 6.

The shift in the use of algarrobo from human food to forage has resulted in the unsustainable use of pastures. The importance of algarrobo as forage lies in its quality, it is high in protein (15-25%) and energy (in pods) (Karlin, 1983). The fruit is very well appreciated, but the leaves, at least of black algarrobo (*P. flexuosa* and *P. nigra*), are not palatable to livestock. In our country there is only general knowledge about individual tree pod production. Karlin and Diaz (1984) estimated pod yield per adult tree to be 5 to 100 kg or 50 to 10,000 kg of pods per hectare. These yields vary depending to the region, species, year, and plant density (Karlin and Diaz, 1984).

Forage yield normally occurs in summer, i.e., from the end of December to February. At this time, the fruits ripen, fall, and are eaten by wild and domestic animals. To improve the use of the pods, it is necessary to harvest and store them so they will be available in the season of shortage of forage supplies. Today, this is done in northwestern Argentina (Karlin, 1979), where the fruit is manually gathered and stored on elevated platforms. These procedures are possible only in low-rainfall areas. In the province of Salta, 30% of the diet of goats is ground pods (Carlos Lewis pers.com.1995). Ground pods are rich in protein and carbohydrates and have been reported to have equivalent digestibility to alfalfa (Felker, 1979). A major drawback to the use of algarrobo pods for forage is the wide variability of fruit production from year to year due to factors such as rainfall, wind, and late frost.

MEDICINAL USE

Many documents state the medical uses of *Prosopis* (Arenas, 1981; Munoz et al., 1981; Pena, 1901). For example, the resin (gum exudate from the bark) of *P. chilensis* in small quantities is used to rinse the mouth and fix the teeth (Munoz et al., 1981). *P. strombulifera* pods are chewed to calm toothache and swollen gums. *P. kuntzei* pods have been used to alleviate pain from toothaches (Arenas, 1981). The leaves of *P. ruscifolia* have been used as popular medicine to heal sight problems, and is still used by the inhabitants of those regions for this purpose. According to Parodi (1981), a noncrystallized, nitrogen alkaloid with a sour, astringent taste is a popular medicine for the eyes (Hieronymus, 1882; Ragonese and Martinez-Crovetto, 1947). The leaves of *P. strombulifera* have been used as a diuretic (Munoz, et al., 1981). Remarkable diuretic effects have also been reported from a fermented infusion of the seeds of *P. chilensis* (Munoz, et al., 1981). The unripe fruits of *P. sp.* (sub *P. dulcis*) are astringent and have been used to treat dysentery (Pena, 1901).

FUEL

Firewood and charcoal have been considered by the government and R&D advisors as renewable resources. Nevertheless, the high rate of extraction has exceeded the regeneration rate, leading to substantial deforestation. Therefore, the designation "renewable" for firewood and charcoal is dubious. In northwestern Argentina, algarrobo is a major source of fuel for marginal poor people who constitute 15% of Argentina's population (Velez, 1992). Here we must add that the energy conversion efficiency from fuelwood to charcoal is very low due to the crude rural techniques that require 5 kg of wood per kg of charcoal produced.

BUILDING

Prosopis has been an important source of building materials, such as beams, frames, pillars, doors, and windows for rural houses and sheds. Keels of ships used in our Parana and Paraguay rivers were also made out of algarrobo wood (Dobrishoffer, 1783). In addition, artisanal looms made of *Prosopis* wood are still used. (Michieli,1984).

In the arid regions of South America, *Prosopis* wood has had multiple uses. For example, *P. alba* and *P. kuntzei* have been used for tobacco pipes and the thorns of *P. ruscifolia* for tattooing (Martinez-Crovetto, 1964). *P. caldenia* was used as pavement in Buenos Aires streets.

One of the problems in marketing *Prosopis* wood is the lack of standardization of its qualities. Today, it is sold by weight; the price depends on the condition of the logs. The price range is US\$70-90 per ton, and is used mainly for furniture. Only the best stems are harvested. The lesser quality stems and large branches are left in the fields as waste.

Inexpensive, simply constructed algarrobo furniture has been widely used for durable, utilitarian purposes, such as high-use restaurant settings (Ochoa, unpub. obs.). Algarrobo has also been widely used for parquet floors throughout Argentina. However, it has been only recently that fine algarrobo furniture suitable for use in corporate offices and elegant homes has been made. Figure 7 illustrates the excellent quality furniture made by the Fioramonte furniture company in Santiago del Estero. Another company that produces excellent furniture is Tulio Riva in the cities of Cordoba and Carlos Paz.

The low radial (2.1%) and tangential (2.8%) shrinkages of *Prosopis alba* (Tortorelli, 1956) are lower than the rosewoods, teak, mahogany, walnut, and oak (Chudnoff, 1984) and indicate greater dimensional stability than these other woods. When priced competitively with these other luxury woods at US\$450/cubic meter, clearly, *Prosopis* lumber is one of the most valuable products from arid lands. The best return is for the fine wood used in furniture (Felker, 1991). The extraordinary value of the algarrobo lumber is not yet widely known in the furniture industry, a circumstance that must be changed.

Research on parquet flooring from *Prosopis* (Figure 8) found that it can be produced economically from small, short logs using special equipment (Martinez, 1991). This process is also suitable for use in salvaging the wood of *Prosopis nigra* that is devastated by large wood-boring insects (*Criodion augustatum*) (Fiorentino and de Medina, 1987; Fiorentino and Bellomo, 1995).

ROADSIDE FORESTATION

Roadside planting is another possibility for *Prosopis* because this tree requires little care, both in initial establishment and maintenance of established trees. As *Prosopis* naturally grows on the roadsides in the arid Chaco regions, one could think of imitating nature, to establish roadside wood and fruit production entities. Other crops such as alfalfa are already produced in Santiago del Estero in this manner (Ochoa, L.H., 1995 pers. comm.).

DUNE STABILIZATION

There are major shifting dune areas that are approaching villages and economic units that must be stabilized and stopped. Examples include the arid lands such as Fiambala and Salar de Pipanaco in the Province of Catamarca and Cafayate in the Province of Salta. Figure 9 shows an example of *Prosopis* halting sand dune movement toward the vineyards in Cafayate, which are a major economic unit in this region. Many of these dune areas were former algarrobo forests that had been harvested. An important role for the *Prosopis* and *Opuntia* Associations could be to establish plantations as a fence to arrest the progress of the dunes. *Opuntias* provide excellent architectural characteristics and

have a high percentage of rooting (Ochoa, 1992), and *Prosopis*, according Hueck (1950), is the best species for the same purpose.

APICULTURE

Algarrobo is very important in beekeeping because it is widely distributed and flowers when there are almost no other flowers in the fields. Thus, bees can start their work earlier, significantly increasing honey production. An additional advantage is insect pollination, which enhances production of many fruit trees. Records in India state that an adult algarrobo tree can produce 1 kilo of honey (Burkart 1952).

CONCLUSIONS

The natural *Prosopis* forests in our country were exploited, without exception, since the beginning of the century. Exotic forests were studied more intensely, probably due to the economic possibility of an early return on the investment. Besides, it is often the case that people do not take special care of those resources that are naturally given, among which, *Prosopis* is a good example.

On the other hand, the lack of consistent, well-defined national policy and legislation for this genus has had the following consequences: lack of clarity in the objectives, poor coordination in research, and limited exchange of experiences. During the *Prosopis* workshop held last year in Santiago del Estero, the following proposals were suggested: creation of data banks using the Internet; establishment of genetic improvement of the genus *Prosopis* with enough flexibility to adequately address the diverse objectives for its improvement. Facing the insufficient trials in the management of native forests, it is suggested as necessary to concentrate on applied research in plantation forestry and the wood industry. A summary of the major research areas of emphasis in Argentina is provided in Table 2.

An elevated awareness must be spread in the society about the intrinsic value of *Prosopis* in all aspects: economic, social, and ecological. A strong recommendation to the government was the urgency of promoting and obtaining financial support for forest management and reforestation of this species.

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Table 1. Phytogeographic Distribution of *Prosopis* in Argentina

Group I Chaqueño-mesopotamico

Trees: *Prosopis hassleri*, *P. hassleri* var. *nigroides*, *P. fiebrigii*, *P. alba*, *P. affinis*, *P. kuntzei*, *P. nigra* var. *longispina*, *P. alba* var. *panta*

Group II Chaqueño-Xerico

Small trees: *P. nigra*, *P. ruscifolia*, *P. chilensis*
Trees: *P. pugionata*, *P. vinalillo*, *P. torquata*, *P. abbreviata*
Shrubs: *P. elata*, *P. sericantha*, *P. reptans*, *P. campestris*

Group III Pampeano

Trees: *P. caldenia*, *P. flexuosa*
Shrubs: *P. humilis*

Group IV Preandino

Trees: *P. laevigata* var. *andicola*, *P. ferox*
Shrubs: *P. humilis*

Group V Monte

Trees: *P. flexuosa*, *P. chilensis*, *P. chilensis* var. *catamarcana*, *P. chilensis* var. *riojana*
Small Trees: *P. alpataco* var. *lamaro*
Shrubs: *P. flexuosa* var. *depressa*, *P. strombulifera*, *P. strombulifera*, *P. ruiziana*, *P. alpataco*, *P. argentina*

Group VI Patagonico

Shrubs: *P. denudans*, *P. denudans* var. *patagonica*, *P. denudans* var. *P. stenocarpa*, *P. ruiz lealii*, *P. catellanosii*

**Table 2. *Prosopis* Research and Development Projects
Grouped According to Research Area, Province, and Species**

SUBJECT	PROVINCES	SPECIES
Agrosilvopastoral Systems	E.Rios, Cordoba, Sgo del Estero, Salta	
Geneology	Cordoba, Tucuman, Mendoza, Jujuy	<i>chilensis, alba, flexuosa</i>
Ecophysiology	Mendoza, Cordoba, Sgo.del Estero, Jujuy	<i>alpataco, flexuosa, chilensis, strombulifera</i>
Wood Technology	Santiago del Estero	all
Wood and Seed Diseases	Sgo. del Estero, Cordoba, Jujuy	all
Wood Anatomy	Sgo. del Estero, Buenos Aires	all
Bioecology	Cordoba, Mendoza, Buenos Aires	<i>alba var. panta, nigra, chilensis, torcuata, elata, flexuosa</i>
Isoenzyme Studies	Cordoba, Buenos Aires, Jujuy	all
Taxonomy	Buenos Aires, Sgo. del Estero, Mendoza	all
Forestry	Jujuy, Cordoba, Mendoza, Chaco, Sgo. del Estero, Tucuman, Salta, La Rioja	<i>alba var. panta, chilensis, nigra, flexuosa</i>
Stand management	Santiago del Estero, Salta, Cordoba	
Germplasm banks	Sgo. del Estero, Cordoba, Mendoza	
Forage Quality	Cordoba, Tucuman, Salta, Jujuy	<i>alba var. panta, chilensis, nigra, alba</i>



Figure 1. An Algarrobo Forest That Was Overexploited for Railroad Ties and Charcoal



Figure 2. View Toward the Center of the Salar de Pipanico



Figure 3. Large *Prosopis flexuosa* Near the Center of Salar de Pipanaco



Figure 4. *Prosopis alba* Intercropped With Tobacco Near Salta



Figure 5. Patay, the Flour of *Prosopis* Pods Sold for Human Food



**Figure 6. Goats Being Hand Fed *Prosopis alba* Pods,
as is Common in Northwestern Argentina**



Figure 7. Tables and Chairs Manufactured of Prosopis by Fioramonte of Santiago del Estero



Figure 8. Prosopis Parquet Flooring in Cordoba, Argentina



Figure 9. Natural *Prosopis* Forest That Has Halted the Sand Dunes From Advancing on Prime Vinyards Near Cafayate