A Mesquite Pod Industry in Central Mexico: An Economic Development Alternative

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Abstract

In central Mexico's semiarid highlands, mesquite pods are utilized for food and livestock feed. In 1975, a union of 53 rural communities opened a storage and processing facility for mesquite pods. This paper presents information from a 1986 study of the cooperative, including interviews with subsistence farmers, feed dealers and large-scale ranchers in 26 communities, data collection from the cooperative and supporting institutions, and an economic analysis of current operations and potential improvements. The study concludes that the mesquite cooperative has increased the cash incomes of rural farmers and provided a local source of nutritious livestock feed. The net returns of the enterprise could be increased through pest control in mesquite storage areas, production of mixed feeds, and better marketing of mesquite pod products. Similar operations could succeed in areas with dense mesquite woodlands, a history of pod collection and use, and a need for supplemental income sources.

Introduction

In the semiarid portion of San Luis Potosí, Mexico (S.L.P.), 97% of the land is unfit for agriculture (INEGI 1986a). In an effort to improve the livelihood of the rural populace, 53 communities organized an economic development cooperative in 1975. Their first effort was the establishment of a storage and processing facility to produce livestock feed from the pods of native mesquite trees (*Prosopis* **spp.) called the** *Unión de Ejidos Productores de la Vaina del Mezquite 'Emiliano Zapata' (Unión)***. A study of the** *Unión* **in 1986, presented in this paper, has attempted to:**

- **Identify the social, economic, and environmental factors affecting the harvest of mesquite pods in the** *altiplano* **(central Mexican highlands)**
- **Evaluate the systems used by mesquite dealers to transport, store, and mill the pods**
- **Analyze the market for mesquite as a livestock feed**
- **Estimate the costs and benefits of making structural and technical improvements to the cooperative mesquite operation.**

Methods

The first phase of the field research consisted of interviews with 35 mesquite harvesters in 26 *ejidos***, 8 large-scale private ranchers, and 12 private mesquite-pod dealers. Interviews were conducted in Spanish in the informant's home, ranch, or store following one of three questionnaire formats. The second phase of research involved data collection from the** *Unión***, the** *Secretaría de Reforma Agraria* **and** *Bancorural* **in Matehuala. Phase three focused on mesquite research in Mexico, including meetings with researchers from universities and institutions in three states and an extensive literature review. The last phase of the field work involved collection of climatological data from mesquite-producing areas of San Luis Potosí and southern Nuevo Leon.**

The Study Area

The cooperative's storage and milling facilities are located in Matehuala, San Luis Potosí, in east central Mexico at an altitude of 1570 meters, and a few kilometers north of the Tropic of Cancer. The surrounding *altiplano* encompasses 21,510 km^2 and varies from 1500 m to 2000 m in altitude. The region's erratic and poorly distributed rainfall is concentrated in the summer months, and mean annual precipitation averages 200S500 mm (Gomez 1985). Matehuala's mean annual temperature is 19ºC, with maximum temperatures reaching 38ºC in August and minimum temperatures as low as S3.5ºC in January. Freezes occur 15 to 20 days per year, from November through March (Dir. de Fomento Económico e Industrial 1986).

Mesquite trees in the *altiplano* can be found on 3,349,442 hectares (Villanueva n.d.), with densities ranging from 10 to 250 trees/ha. Overall, mesquite density averages about 100 trees/ha. The region's most common mesquite species is *P. laevigata*, a species found also in other areas of Mexico and in Peru (Galindo 1983, Ffolliott and Thames 1983). A second important species is *P. glandulosa* var. *torreyana*. Hybrids of these species have been noted locally (Galindo 1983).

The vast majority of rural communities in the *altiplano* were established through federal agrarian reform laws on government-owned land. All range and forest land in these communities, or *ejidos*, is shared communally; hence, mesquite found on communal land can be harvested by any *ejido* member. In 1986, 54% of the *ejidos* had no electricity, 42% lacked potable water, and 98% had no sewage systems (INEGI 1986a). Illiteracy rates were about 16%. Only 1% of the *ejido* fields were irrigated (SARH 1987).

Uses of Mesquite

In many areas of semiarid Mexico and the southwestern United States, mesquite pods constituted a major portion of the diet of indigenous peoples. The Chichimecas, a hunter-gatherer group that inhabited the highlands of San Luis Potosí, counted mesquite pods and mesquite honey as two of their principal diet components (Galindo 1983). Today, the mesquite pod is consumed fresh, boiled in its own syrup, or prepared as a sweet flour (*pinole*), a dried candy (*queso* or *piloncillo*), a beverage boiled in water or milk with corn meal (*atole*), and occasionally as an alcoholic drink (Galindo 1983). In Matehuala, an estimated 21,000 *piloncillos* of molded mesquite flour are sold in August-October. In 1988, each sold for 250 pesos or about 16 U.S. cents.

A 1965 survey of nine Mexican states recorded a collection of 43,000 tons of mesquite pods, with a total value of 14 million pesos or more than US$1,000,000 (Gomez et al., 1970). In San Luis Potosí, total commercial value of pods surpassed that of mesquite wood products by 70 times. Commercial pod values far exceeded wood values in every state except Sonora (Table 2). These figures indicate that pods were, and may still be, more important economically than wood in at least seven of the states (Table 1).

Aside from its uses for pods and wood, mesquite rates as a valuable honey plant (Martin 1985). Its gum is being investigated as a substitute for gum arabic (Anderson and Farquhar 1982, Espejel 1981) and several tons have been bought in the *altiplano* for research purposes (Yrizar 1987). Various parts of the tree have been used for medicinal purposes (Galindo 1983). Mesquite plays an important role in providing food and cover to a wide variety of birds, rodents, large mammals, and insects (Schuster 1969). In addition, it is used for landscaping, erosion control, and reforestation.

Commercialization of Mesquite Pods

The first known commercial effort to market mesquite as a feed in Matehuala began in the 1940s, with an average of 300 tons of pods sold per year. In the 1950s, a second mesquite dealer began purchasing an average of 500 tons annually, with as many as 900 tons in his best year. Both businesses sold pods whole, milled, or milled and mixed with other feeds. Other entrepreneurs bought pods in

the *ejidos* to sell to the feed stores, and ranchers also bought mesquite pods directly from *ejido* residents.

Formation of the *Unión*

Government-sponsored workshops on small business management and leadership training in the 1970s sparked the idea to establish a farmers' cooperative to buy, mill, and sell mesquite pods and to develop other rural industries based on indigenous natural resources. With government funding and organizing assistance, the cooperative initiated operations in July 1975 (Union de Ejidos 1986). A goal of the *Unión* has been to eliminate intermediaries in mesquite sales and to allow *ejido* farmers to gain control over prices.

The *Unión's* warehouses and mill are located a few miles northeast of Matehuala on Highway 57, the major highway between S.L.P. and the northern cities of Saltillo and Monterrey (Appendix A). The four 70 x 12 x 5 m warehouses are constructed of cement block with corrugated tin roofs. Together, they hold 2,800 tons of pods at capacity. The milling room stands behind the warehouses and contains two Wetmore hammer mills with 30-horsepower electric motors. As mesquite pods are milled, the fine flour is blown into two 15 x 12 x 5 m cement-block storerooms with sliding metal doors for easy access and loading. For weighing incoming and outgoing mesquite, the *Unión* has a truck scale adjacent to a 5 x 6 m office in front of the warehouse. They also have an auxiliary electric substation and transformer, but power is turned on only during the milling season. In 1987, the cooperative owned an 11.5-ton Dodge truck, 1976 model, for transporting mesquite from the *ejidos* to the warehouse. The *Unión* had no telephone and all files and records were kept either at the Bancorural or at homes of *Unión* officers. Total capital invested in the structures and equipment upon establishment was US$48,997 (Bancorural 1975).

Production and Sales of the *Unión*

The *Unión's* mesquite harvest seems to depend largely on fluctuating mesquite yields. The 1982 harvest of 2,843 tons shows the highest recorded level of production since formation of the cooperative. In 1990, the *Unión* produced 2,000 tons. In 1980 and 1981, the Unión showed no harvest (Figure 1), and data has not been accurately kept from 1988 to 1995, with the exception of 1990. The majority of the harvest came from the neighboring state of Nuevo Leon (53.6% of pods in the seven years where records on pod origin were kept), although all *ejidos* belonging to the *Unión* are in the state of S.L.P.

In its first few years, the *Unión* sold almost all mesquite as milled flour and individual ranchers made up the majority of *Unión* customers. However, by 1985, the *Unión* sold 83.5% of the mesquite as unprocessed, whole pods and one buyer bought 55.9% of the harvest. By 1987, he was purchasing 65.8% of the *Unión's* production, all as unmilled pods. Discussions with this buyer revealed that he mills the pods for resale, mixed with other livestock feeds, and ships most of it to large-scale ranchers in S.L.P. and other states. A second buyer bought more than 15% of the total in 1985 and 1987 (the only years with complete sales data). This buyer ships the mesquite to dairy farmers and some cattle ranchers in the neighboring states of Jalisco and Guanajuato, at least 400 km south of Matehuala. A third buyer from Matehuala purchased almost 10% of the production as whole pods, later selling it as a milled feed to local ranchers.

Interview Data

Of the 35 respondents interviewed in the *ejidos*, 82% earned a living through a combination of agriculture, indigenous plant collection, and livestock and 13% through wage-earning jobs. In the last 10 years, 59% had immediate family members who had migrated to the United States for work and 31% had family members who had worked in other parts of Mexico. Only 10% of the families had never worked outside the region. Ninety-four percent harvested mesquite pods for sale, livestock feed, or family food. Almost half had collected mesquite throughout their entire lives. Another 36% began

harvesting after they heard about the formation of the *Unión*. The vast majority (93%) of all respondents said their parents or grandparents used mesquite, but only 38% of them had sold the pods.

According to respondents, it takes an average of 27 minutes for an individual to harvest 10 kg of mesquite. If one selects only high quality, sweet pods, it could take as long as three hours for the same amount. The whole family participates in the harvest: men often gather pods as they walk to the fields and children collect pods after school, sometimes to earn spending money from ranchers on private land.

Harvesters stated that mesquite and *tuna*, the fruit of the prickly pear cactus, bring in the first bit of cash income before crops ripen. They praised mesquite as a type of insurance crop, repeating as if a chant, *"Cuando no hay maiz, hay mezquite Y cuando no hay mezquite, hay maiz."* ("When there's no corn, we have mesquite. And when there's no mesquite, we have corn.") They believed that good mesquite harvests alternate with good corn harvests. However, all agreed that 1986 and 1987 had been poor years for both crops.

In the two years before the study, pod harvests had been exceedingly low, with 75% to 85% of the respondents stating they sold no mesquite. The largest harvest of any family in either of those years was 3 metric tons. The largest harvest in any year recalled by a single family was 14 tons. Every person stated that fluctuations in pod yields were extreme. Respondents frequently blamed poor production on freezes or cold weather during flowering (46% of all causes mentioned). Other causes given included (in order of most frequent mention): eclipses, insects, hail, ballmoss, rain at harvest time, dry years, and wind.

While the majority did not tend mesquite trees, 20% said they pruned lower branches and weeded underneath the trees to facilitate the harvest or to strengthen the tree and increase growth and pod production. One man also removed ballmoss from the branches of high-yielding trees. A woman mentioned that she had worked with an small *ejido* nursery that had attempted to grow mesquite from other regions that might prove resistant to ballmoss. The nursery abandoned the project when all seedlings died, apparently from damp-off. Another respondent frequently removed mesquite seed or seedlings from stock manure to plant around her yard and field.

Fifty-two percent of the respondents harvested from specific trees known to be especially productive or to yield sweet pods. Many identified the qualities of specific trees, such as color, texture, size, and flavor of pods. All believed pod quality and production differed greatly between individual trees

All respondents who owned livestock used mesquite pods for feed, and 38% bought additional pods for this purpose. Twenty-one percent had fed mesquite as flour, and another 38% would prefer using flour to pods if it were affordable and readily obtained.

Of the *ejido* members interviewed, all used fuelwood for cooking, although 65% also had gas stoves. Mesquite was the most common, and often the only, wood used. All informants claimed not to fell trees for fuelwood, but instead lopped off branches of live trees or gathered deadwood from areas cleared for agriculture. Mesquite, some noted, was too valuable for its pods to be cut for fuel. When asked if there were more mesquite trees now or 15 years ago, 44% said there were less now because of the felling of trees for charcoal industries and mines and the clearing of land for agriculture. Two informants in Nuevo Leon mentioned that government agricultural development projects had cleared mesquite stands to plant prickly pear or peaches. Another 37% felt mesquite was more prevalent now than 15 years ago because charcoal and fuelwood use had declined. Some also noted that mesquite had proliferated in agricultural fields abandoned due to urban migration. "Mesquite is very prolific,"

one woman explained. "Wherever a seed falls, a tree is born. In the old fields, they come up faster because the soil is fertile and soft."

Factors Affecting Pod Harvest

Comparisons of harvests of mesquite beans with those of corn and field beans indicate an inverse relationship for the years for which data is available (1981S1985). Nonirrigated crops generally yield more with higher precipitation; however, heavy rains could decrease mesquite pod yields, especially if they occur while trees are in flower. Social and economic factors affecting the harvest must also be considered. Farm families expecting high corn and bean yields might feel less of a need to harvest mesquite beans, although the mesquite harvest occurs primarily in July and August, while corn harvests do not occur until October and November. During a dry year, range forage and cultivated feeds are in short supply, so a farmer might feed mesquite to his/her livestock instead of selling pods. Migration may also increase in dry years, playing a role in total harvest.

Mesquite Pod Processing

Techniques for milling mesquite range from the crude mortar and pestle carved from mesquite wood that is used in the *ejidos* to an advanced process that separates the pod into cotyledon, seedcoat, endocarp hull, and exo-mesocarp flour for use in the food industry (Saunders et al. 1986). The *Unión's* milling process consists of air drying and grinding the entire pod, including the seed, in a hammer mill. Six workers are needed, and in years of large harvests, two work shifts have been used. Although the mills have a theoretical capacity of 2 tons/hour each, the total output reaches only about 12 tons/day because of the time-consuming task of cleaning stones from the mesquite batches. Clogging of the mills is also a problem. Other mesquite buyers in the *altiplano* mill mesquite with dried corn cobs, alfalfa, or sorghum to reduce clogging. This mixture allows a throughput of 800S900 kg/hour while mesquite alone allows only 500S600 kg/hour.

Markets for Mesquite Pods

Mesquite use as a livestock feed has been reported throughout the world (D'Antoni and Solbrig 1977, Habit 1981, National Academy of Sciences 1979, Douglas 1973, Mahadevan 1954, Abdelgabbar 1981, Kargaard and Van der Merwe 1976, Smith 1950, Gomez et al. 1970), making the livestock industry an obvious market for mesquite pods. The market for mesquite in processed human food products is largely unexplored. In Chihuahua, Mexico, a manufacturing plant has successfully marketed a candy of 10% mesquite flour with peanuts, sugar, and salt and has distributed mesquite flour to natural food stores in Chihuahua with positive responses (Saunders and Becker 1987). Recipes using mesquite have been developed (Niethammer 1987), and several nonprofit institutions in Arizona have sold flour for food products. Studies on the health benefits of mesquite and other desert products have been conducted (Snow et al. 1987). These factors point to a potential market for human consumption of mesquite flour, both in the U.S. and in Mexico.

Nutritional Value of Mesquite Pods

Proximate analyses (Table 1) show mesquite pods to be high in fiber (17.0% to 30.8%) and low in fat (1% to 4%), with the seed similar in protein to soybeans and the outer pod similar to rice or barley. Sugar content varies from 13% to 41% (Zolfaghari and Harden 1982, Del Valle et al. 1983, Becker 1982). Total digestible nutrients (TDN), a measure of gross energy of a food minus the energy lost in the feces, is a good general indicator of feed value. In mesquite pods, TDN is high, ranging from 70.5% to 84.1% in whole pods (Mahadevan 1954, Castano 1966, Barbosa and Campos 1981, Morrison 1965, Talpada et al. 1979), falling between values reported for oats and corn, but slightly higher than barley (Lane 1988). Crude protein levels are adequate for maintenance and milk production. Studies on mesquite consumption by cattle, sheep, goats, pigs, and rabbits have shown it to be an economical feed, with varied production results, depending on the rations (Del Valle and Marco 1985, Castano 1966, Garza and Narvaez 1963, Talpada et al. 1982, Buzo et al. 1972, Kargaard

and Van der Merwe 1976, Debler 1974, Portilla 1967, Rojas 1963, Castillo 1979, Awad-alkreem and El Sammani 1985, Zelada 1986). Problems related to mesquite consumption seem to be due to diets based solely on mesquite, especially whole pods. (Alder 1949, Dollahite and Anthony 1957, Garcia 1976).

Livestock Feeding in the *Altiplano*

In S.L.P., mesquite is used to feed beef and dairy cattle, sheep, goats, horses, burros, mules, and pigs. Ranchers feed goats whole pods, but most prefer mesquite flour for other livestock. Those interviewed stated that they use mesquite because, in order of frequency of mention, it leads to good weight gains, gives good overall results, is palatable, can be fed on the day of the sale to make cattle look fat and healthy, has a high protein percentage, is recommended by the veterinarian, and is better than any other feed. Seventy percent of livestock owners using mesquite had never had problems with it, but some mentioned its laxative effect and the hazards of intestinal obstruction from feeding too much whole mesquite. Deaths of five horses and one cow were reported by two informants.

Informants provided a number of mesquite feeding rations. The largest rancher in the *altiplano* uses the following milled ration for finishing beef cattle in a feed lot: 20% mesquite flour (can substitute molasses), 40% sorghum, 20% sun-cured corn stalks, and 20% poultry manure, combined with 10 kg of salt per ton. Alfalfa is substituted for chicken manure for sheep. Other milled rations for sheep and cattle combine 10% mesquite with 30% corn stalks, 25% corn kernels, 25% alfalfa, and 10% chicken manure, or 15% mesquite flour, 60% chicken manure, and 25% bran. According to one dairy farmer and to feed dealers, mesquite is particularly beneficial for increasing milk yields. Dairy cows have been successfully fed 75% mesquite flour with 15% bran and 10% corn. For good growth and production in high yielding dairy cows, such as Holsteins, mesquite's crude fiber must be balanced with a feed high in crude protein such as cottonseed meal or soy paste.

Price Comparisons

Mesquite, which is highly palatable, is often used as a substitute for molasses or sorghum to increase consumption. Interviews show the great desire for mesquite among livestock owners in central Mexico, particularly dairy farmers. Cost and availability, however, form the major barriers to increasing mesquite's share of the livestock feed market.

In all but one of the interviews, livestock owners stated that mesquite prices have steadily increased in relation to other feeds. The federal government sets minimum and maximum prices for most agricultural products, but no price limits have been established for mesquite. Several ranchers stated they buy whole mesquite if its price is less than that of whole sorghum, but are willing to pay the same price for mesquite flour as for milled sorghum due to the high milling costs of mesquite.

In the fall of 1987, the price of whole mesquite at the *Unión*, reached 200 pesos/kg or 12.7 cents US/kg, surpassing that of sorghum at 175 pesos/kg or 11.1 cents US/kg (Table 9). Mesquite can often be purchased for lower prices from other sources, such as feed dealers and *ejidos*. In 1987, ranchers bought mesquite from non-*Unión* sources for 30S150 pesos/kg (1.8 to 9.5 cents US/kg).

Potential of the Mesquite Pod Industry

The extreme variability of pod yields is probably the greatest barrier to the success of a mesquite industry, particularly when harvesting from natural mesquite. Great fluctuations in the *Unión*'s harvest from 1977S1987 (Figure 1) suggest that there may be an alternate bearing cycle in mesquite. From 1987 to the present, records were kept only in 1990, when the Unión purchased 2,000 tons.

Mesquite pod production has been measured at 33S20,000 kg/ha (Glendening and Paulsen 1955, Felker and Bandurski 1979, Smith 1950, Douglas 1973). Annual pod production in the *altiplano* has

been shown to vary from 4S50 kg/tree and from 200S2,200 kg/ha, with stand densities of 25S445 trees/ha (Villanueva n.d., Morales 1967, Galindo 1983, Bancorural 1975).

In an effort to explore variations in annual yield, separate regressions were run comparing annual precipitation, date of last spring freeze and number of spring freezes to the *Unión*'s total harvest. No significant correlations ($p \leq 0.05$) were found. Next, pod harvests in years with late freezes were compared to harvests in years without late freezes. In four of five *municipios* or townships, harvests were greater in years in which there was no freeze after March 14 (Table 3), but one *municipio* showed average harvest to be 55% higher in years with late freezes.

Insect damage is a second barrier to the mesquite industry. Under natural conditions, seed beetles (Bruchidae) can destroy from 8% to 75% of the seed crop in a given year (Johnson 1983). In Chile, insects have been noted to reduce seed crops up to 90% in a given year (Habit 1981). The *Unión* estimates losses due to insects at 10% to 25% of the harvest during storage.

The bromeliad called ballmoss, or *Tillandsia recurvata*, has also been considered a threat to pod production in the *altiplano*. Dense colonies of the epiphyte may inhibit photosynthesis through shading effects when growing on mesquite trees.

A fourth and quite serious threat to the industry stems from the widespread destruction of natural mesquite woodlands. This may be due to cutting for fuelwood or charcoal, or to clearing areas for agriculture. Without irrigation or water harvesting, however, cleared fields are often abandoned in two to three years (Medellin and Gomez 1979). Mesquite woodlands in southern Nuevo Leon have been cleared to plant range grasses, primarily *Pennisetum ciliare*, but these plantings have often failed due to freezes, poor drainage, or inadequate moisture. Thirteen thousand hectares of prickly pear were planted in the same area, after clearing mesquite trees, but did not withstand the area's cool temperatures. On another site, a joint Canadian/Mexican project cleared mesquite in 1986 to "reforest" an area with cypress (*Cupressus* spp.), carob (*Ceratonia siliqua*) and casuarina (*Casuarina equisetifolia*). Of the species chosen, none offered the fuelwood quality of mesquite, and only one (carob) had good forage value (de la Cruz 1987). The species were poorly adapted to the site, and only a few saplings remained 18 months after planting.

Because mesquite woodlands are often viewed as favorable sites for agriculture, the value of protecting a mesquite grove was compared to the clearing of the area to create croplands. Costs and returns per hectare of corn and bean production (SARH 1987) were compared to those of mesquite production in Table 2. Harvest was the only cost incurred for mesquite production, and cost was based on a conservative average of 1,400 kg/ha pod production and an estimated rate of harvest of 20 kg/pods/hour harvest cost. The harvest of mesquite, which requires gathering, but no cutting or picking, requires less effort per hectare than the harvest of corn or beans. This conservative estimate shows mesquite production to generate over twice as much return to farmers per hectare as nonirrigated beans and much more than nonirrigated corn, which had a negative value for the five-year average. Mesquite produced only 32% as much in earnings as irrigated corn and 15% as much as irrigated beans. Mesquite also provides benefits not counted in this comparison, such as fuelwood, forage, honey, shade, and windbreaks.

Operating Expenses of the *Unión*

The *Unión* has paid off an initial loan of $877,500 pesos made in 1976 at an interest rate of 13%, and has obtained and paid several other loans. Detailed financial information was difficult to obtain. Annual expenses from the available years, 1978-1983, are shown in Table 3. During these years, with the exception of 1981, in which the Union closed for lack of harvest for two consecutive seasons, the average percentage spent in the various categories was: 49.8% for raw material (mesquite pods), 16.5% for personnel, 21.7% for interest payments, 4.8% for electricity, 1.7% for gas, service, and

repairs on the truck, 1.5% for maintenance of mills, building, and other equipment, and 4.1% for miscellaneous expenses.

A baseline estimate of annual expenses for a mesquite storage and milling facility has been prepared (Table 4) for pod harvest levels of 1,000 and 2,000 tons. Estimated expenses are shown for 5%, 10%, and 15% interest rates. The estimated total annual expenses are US$152,995 to US$165,655 for a 2,000-ton harvest and US$79,766 to US$86,096 for a 1,000-ton harvest. Annual net return for a 2,000 ton harvest, based on this estimate, equals US$46,372 at 5% interest, US$40,042 at 10% and US$33,712 at 15%. For a 1,000 ton harvest, the return is US$19,968 at 5%, US$16,803 at 10%, and US$13,638 at 15%.

Improvements Needed at the *Unión*

Fumigation or drying of pods before storage could reduce the current 10% to 25% loss of the harvest due to insects. If insect losses could be reduced from 25% to 2%, benefits to the industry would be in the order of US$65,506/year for a 2,000-ton harvest, or US$32,703 for 1,000 tons (Silbert 1988). In order to fumigate, structural changes may need to be made to the warehouses to close off broken windows and openings in the roof. Pesticides could be used, but possibilities also exist for use of carbon dioxide or other materials in an airtight environment.

The major problem in mesquite drying, as in other legumes, is the high resistance of seeds to air-flow. A simple method, similar to coffee and cocoa drying systems throughout the world, could be to spread pods on corrugated tin painted black, raking each day to allow for air circulation. A second method would be to install clear corrugated fiberglass roofing and a black attic floor in one warehouse, pulling hot air though the pods through use of a fan and an attic duct. An electrically powered heat pump could be installed to provide constant drying at night and during low insolation periods. The most costly option would be to use a drying oven, such as that described by Meyer (1984) for mesquite pods. Cost of this system is estimated at US$61,000 plus operation and capacity would be 2.7 tons. The oven would require electrical heating coils and exhaust fans, and pods would move through on a conveyor belt.

Drying would not only aid in pest control, but it would also allow the Union to more quickly mill pods into flour. This would enable earlier sales and a faster turn-around time on loans, ultimately saving interest charges. Methods would have to be tested on a small scale to determine if temperatures could be raised high enough to kill bruchid beetles and dry the pod to moisture levels low enough for milling (8% to 13%).

Through improved marketing, a mesquite pod operation such as the *Unión* could develop promotional pamphlets explaining the qualities and uses of mesquite as a livestock feed, place advertisements in livestock journals and with livestock associations, survey ranchers to determine needs for related feed products, and look at other methods for boosting sales. Sales of milled mesquite would also need to be increased to recover the highest value of the product.

Improved marketing would require a production and marketing manager to analyze sales potential, product development, and promotion, a business office with a phone, an efficient and dependable vehicle, and improved organization of the operation. Estimated additional costs of this option are US$10,147 per year. Additional net returns would be US$12,004 to US$34,157 for a 2000-ton harvest and US$929 to US$12,004 for a 1000-ton harvest (Silbert 1988).

Production of balanced livestock feeds would increase sales and could be especially important in years of poor mesquite harvests, when mixtures with little or no mesquite could be prepared. A location, such as that of the *Unión* facility on a major Mexican highway, is visible, accessible, and convenient for ranchers traveling through on their way to livestock markets. A well-organized, reliable feed outlet

would mesh well with the marketing option because the manager could also make decisions on feed rations and direction of sales efforts. The additional annual cost of preparing 3,500 tons of a cattle ration is estimated at US$147,472, utilizing half the supply of mesquite in a 2,000-ton harvest or all of the mesquite in a 1,000-ton harvest. Assuming all is sold, additional net return would equal US$162,655 to US$664,557 (Silbert 1988).

A clear strategy for establishing buying and selling prices for mesquite is needed. At the *Unión*, **there has been no correlation between the current year's buying or selling price and the quantity harvested. To increase mesquite sales, prices should be based on prices of competitive feeds (especially sorghum), availability of mesquite, and demand for mesquite. Whole mesquite pods should be kept below the price of whole sorghum in abundant harvest years and milled mesquite at or below the cost of milled sorghum in poor harvest years.**

The problem of inconsistent availability of mesquite pods remains a major stumbling block to the mesquite-pod industry. Expansion of harvest areas could reduce impacts of localized weather patterns on production. Storing pods in high harvest years and producing mixed feeds would allow for greater industry control. Finally, as more is learned about factors affecting mesquite pod production, options may be developed to improve mesquite woodland management or establish mesquite plantations.

Conclusion

The *Unión*'**s mesquite facility in Matehuala has proven to be beneficial in providing an income option in rural** *ejido* **communities and in providing a source of locally-produced feed to livestock owners. Several improvements, which must necessarily be coupled with better management and a more stable pod supply, would increase the profitability of the mesquite cooperative, thereby increasing the return to rural residents.**

Mesquite shows great potential as a multiple-use resource in dryland areas, but further study is needed in the areas of pod production, nutritional qualities, management and values of native stands, plantation establishment, agroforestry and silvo-pastoral systems, and economic comparisons of mesquite with other dryland production options. In the area of pod production, the possible alternate bearing pattern in mesquite needs further investigation, including study of the impact of spring freezes and precipitation levels. Cultural methods for improving yields, especially low-capital, labor-intensive techniques should be considered for management of native stands. Pruning methods in particular may be viable since they can be combined with the harvest of fuelwood. The effect of the epiphyte ballmoss on pod yields should be studied.

The Mexican *altiplano* **is an ideal location for research and development of mesquite plantations because of the knowledge and interest in mesquite, the ecology and climate, the availability of land and labor, and the potential for mesquite to be further utilized in economic development efforts. Improved pod and/or wood yielding varieties suitable for this and other regions need to be identified, along with management techniques as mentioned above.**

Mesquite pods represent an important natural resource for poor, rural families in dryland Mexico, as well as a desirable livestock feed product for ranchers. The *Unión de Ejidos,* **although not without its flaws, can serve as a model for other community development projects in mesquite-producing regions. Such an innovative approach to produce income through natural resource utilization is worthy of attention from natural resource managers, government agencies, rural communities, and others involved in development work.**

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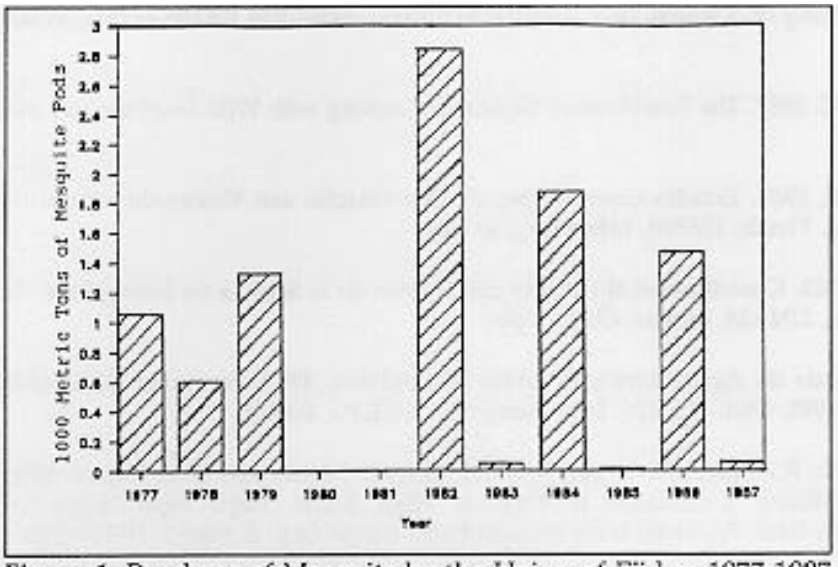

Figure 1. Purchase of Mesquite by the Union of Ejidos, 1977-1987

Table 1. Proximate Analyses of *Prosopis* Pods of Various Species

Species	Origin	Moisture (%)	C.P. (%)	Fat (%)	Ash (%)	Fiber (%)	Source
laevigata	S.L.P.	4.73	10.12	1.62	3.16	26.07	Villanueva n.d.
species	Mexico	15.09	20.30	1.68	5.24	26.18	Castano 1966
glandulosa	Texas	7.55	9.38	2.66	3.27	21.68	Becker & Grosjean 1980
glandulosa	Chihuahua	0.79	11.33	1.63	3.00	28.30	Del Valle et al. 1987
glandulosa	California	2.20	14.00	--	3.40	20.00	Becker 1982
velutina	Arizona	7.27	11.81	2.36	4.83	22.61	Becker & Grosjean 1980
velutina	California	2.83	13.00	--	4.03	25.00	Becker 1982
juliflora	Chihuahua	9.00	14.70	3.20	5.50	21.30	Del Valle et al. 1983

Note: Figures from Becker (1982) are averaged for each species.
C.P. = Crude Protein

Table 2. Comparison of Costs and Returns/Hectare of Mesquite, Corn, and Beans (1986 pesos)

	COST OF PRODUCTION				
Type of expense	Mesquite, wild	Corn, dry.	Corn, irrig.	Beans, dry.	Beans, irrig.
Land preparation					
Plowing		7000	7000	7000	7000
Disking			7200		3600
Irrigation (gravity)			4550		4800
Seeding					
Seed		2850	3960	12950	11750
Fertilizer			11075		5270
Labor		5000	4200	4200	4200
Cultivation					
Fertilization			5400		
Weed control		4000	6400	3200	6400
Insect control		4900	5400		5075
Irrigation			27440		30630
Harvest	11725	1098	9150	4000	4950
Indirect costs					21777
Insurance		5055	13873	5055	
Interest		8642	38015		
Total pesos	11725	38545	143663	36405	105452
	PRODUCTION AND VALUE				
Tons produced/ha	1.4(a)	0.3(b)	2.5(b)	0.2(b)	1.5(c)
Gross return/ha (d)	61600	36000	300000	60000	440789
Net return/ha	49875	-2545	156337	23595	335337
Net return/ha(U.S.)	$74.92	($3.82)	$234.85	$35.44	$503.74

a. Average of three mesquite production estimates in the Altiplano: 2.2 ton/ha, 1.8 ton/ha, and .2 ton/ha.
b. Five year average.
c. 1986 figure available only. May reflect higher return than five year averages of other crops.
d. 1986 prices. Fall 1986 dollar = 665.69 pesos.

Source of production data: SARH (1987).

Table 3. Annual Expenses of the Union de Ejidos, 1978-1983 (US$)

Year	Mesquite harvest (tons)	Raw material	Personnel	Electr. energy	Transport	Maintenance	Misc.	Interest	Total	Adjusted for inflation
1978	602	37097	8332	1933	2478	710	60	--	50611	73843
(%)		73.3	16.5	3.8	4.9	1.4	0.1	--		
1979	1337	87927	9723	2018	856	81	1603	19866	122274	151494
(%)		71.9	8.0	1.7	0.7	0.1	1.5	16.2		
1980	0	0	8984	3232	276	1098	74	4134	17798	17798
(%)		--	50.5	18.2	1.6	6.2	0.4	23.2		
1982	2843	91345	4125	--	1055	--	1322	--	97847	199660
(%)		93.4	4.2	--	1.1	--	1.4	--		
1983	51	2835	920	14	--	--	4517	18402	26688	40266
(%)		10.6	3.4	0.1	--	--	16.9	69.0		
Avg.%		49.8	16.5	4.8	1.7	1.5	4.1	21.7		

Note: In 1981, there was no production or sale.
Source: Records of the Union de Ejidos Productores de la Vaina del Mesquite, Matehuala, S.L.P.

Table 4. Baseline Estimate of Annual Expenses of a Mesquite Storage and Milling Facility at Two Levels of Production and Three Interest Rates (US$)

HARVEST OF 2000 TONS OF MESQUITE

Category	At 5%	% of total	At 10%	% of total	At 15%	% of total
Raw material	126,600	83	126,600	79	126,600	76
Personnel	9,285	6	9,285	6	9,285	6
Energy	330	<1	330	<1	330	<1
Transport	5,250	3	5,250	3	5,250	3
Maintenance	3,200	2	3,200	2	3,200	2
Miscellaneous	2,000	1	2,000	1	2,000	1
Interest on loan	6,330	4	12,660	8	18,990	11
Total expenses	152,995		159,325		165,655	

HARVEST OF 1000 TONS OF MESQUITE

Category	At 5%	% of total	At 10%	% of total	At 15%	% of total
Raw material	63,300	79	63,300	76	63,300	74
Personnel	7,860	10	7,860	9	7,860	9
Energy	165	<1	165	<1	165	<1
Transport	2,625	3	2,625	3	2,525	3
Maintenance	1,626	2	1,626	2	1,626	2
Miscellaneous	1,025	1	1,025	1	1,025	1
Interest on loan	3,165	4	6,330	8	9,495	11
Total expenses	79,766		82,931		86,096	

Raw material = $63.30/ton x total tonnage of pods.
Personnel = 1 administrator @ $5/day, 1 truckdriver @ $4/day, warehouse workers @ $3.50/day, all 312 days/yr. For 2000 tons, 4 mill operators $3.50/day for 96 days. For 1000 tons, 2 mill operators.
Energy = 50% of harvest x 11 kwhr/ton x $.03/kwhr
Transport = 75% of harvest x 1 trip/10 tons x $35/trip.
Maintenance = 2% of avg. total expenses
Miscellaneous = office expenses, unexpected costs, etc.