PRODUCTION AND COMMERCIALIZATION OF BACANORA: AN ECONOMIC OPPORTUNITY FOR SONORA, MEXICO?

by

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ABSTRACT

This dissertation examines the opportunities and constraints surrounding the production and commercialization of bacanora, which is analyzed as an economic alternative for Sonora, in the context of a new legal and economic environment that forces farmers to become competitive and efficient. It integrates many topics related to the knowledge of *Agave angustifolia* and other Agavaceae and the study of several distillates from agaves, contributing to the emergence and development of the bacanora industry in Sonora, Mexico.

The economy of small-scale bacanora producers in the sierras is analyzed. Cost and return estimates for the activity show the relative profitability of bacanora making. Subsequent analyses of marketing strategies indicate that serrana producers have potential in bacanora production by adopting or adapting different technologies and marketing schemes. The new institutional frame will increase competition among producers, which in turn will put greater pressures on agave populations. Therefore, more research on domestication of agave is required to find sustainable solutions to avoid overexploitation of the resource.

The major outlet for increased bacanora production is the international market, especially the United States. However, regional and national markets might provide an important group of consumers, as derived from the study of the tequila and mescal industries.

CHAPTER I. INTRODUCTION

"Para todo mal mezcal, para todo bien también"

(Popular Mexican saying)

1. Introduction

Bacanora is a liquor produced in the mountainous region of Sonora, Mexico, from the distillation of an agave or maguey species, identified as *Agave angustifolia* Haw., previously known as *Agave pacifica* Trel. (Gentry, 1982). The species grows wild in most of the Sonoran Sierra Madre, a large geographic highland located in the Eastern part of the state. Production and consumption of bacanora --frequently called mescal-- has been part of the culture of the *serrana* people since the introduction of distillation practices and technology by Spanish conquerors. The use of bacanora was associated with various rituals and ceremonies held by Sonoran Indian tribes (Castetter et al., 1938). At the end of the 19th Century a boom in the Sonoran mining industry resulted in a short-lived increase in the demand for bacanora. In 1915 General Plutarco Elías Calles, then Governor of Sonora during a time of social unrest, banned the production and commercialization of bacanora (Gobierno del Estado de Sonora, 1985). As a result, rural police targeted bacanora producers, destroying their *vinatas* and incarcerating them. In Sonora, that was the law of the land for most of the 20th Century. Consequently, the bacanora industry remained stagnant, distillation technology developed poorly, and the plant was never domesticated.

More recently, the *Ley de alcoholes* in Sonora has been overhauled and bacanora

can be produced and commercialized with fewer restrictions. However, the convergence of a liberalized law and a general economic crisis has contributed to an overcollection of wild agave. As a result, an agave scarcity has ensued (Moreno-Salazar and Martínez-Heredia, 1996; Valenzuela and Cervantes, 2000), creating uncertainty in the supply of bacanora and price fluctuations.

1.1. General purpose

The purpose of this research is to analyze the opportunities and constraints surrounding the production and commercialization of bacanora. This research considers the bacanora industry as an economic opportunity for the state of Sonora, and is presented in the framework of a new legal and economic system. This thesis constitutes a first attempt to integrate several issues related to bacanora production and commercialization from historical, economical, anthropological, and botanical/agricultural perspectives. Finally, the potential for expanding the bacanora industry in Sonora is examined.

1.2. Summary of the current problem

Since the end of bacanora prohibition in 1992, harvest and use of agave for bacanora production have increased substantially. The short period of legalization has encouraged an over-harvest of wild agave, creating ecological concern and problems in soil conservation (Reyes-Sánchez, 1997). The challenges faced by bacanora producers are summarized as follows: 1) unregulated harvest of wild *A. angustifolia*; 2) absence of commercial plantations to meet current demand; 3) insufficient experience in cultivation

and management; 4) lack of technological knowledge for efficient bacanora processing; and 5) ignorance of marketing elements to better position bacanora in the market.

1.3. Scope of the study

A multidisciplinary approach is imperative for the successful production of bacanora. Three critical elements will be addressed in this thesis.

- Agriculture

The establishment of commercial plantations is imperative to increase the availability of agaves. However, the domestication of agave is a prerequisite to the development of these plantations. Knowledge of the physiology of agave is important if vigorous plants are to be cultivated (Ravetta and McLaughlin, 1993; Reyes-Sánchez, 1997).

- Technology

Parallels between tequila, mescal, and bacanora will be established by examining processing techniques used by tequila and mescal industries. This may assist in the development of an efficient technology for the bacanora industry. Traditional elements that distinguish bacanora from other mescals, such as flavor and scent, must be protected regardless of the technology developed or adapted for its industrialization.

- Marketing

A marketing strategy based on traditions and beliefs rooted in the culture of the *serrana* people of Sonora will be proposed.

1.4. General objectives

The objectives of this dissertation are:

1) To examine the potential problems for the bacanora industry based on the experience of the tequila and mescal industries.
2) To provide a general history of bacanora and its associated culture.
3) To discuss the current methods used in the bacanora production.
4) To discuss elements needed for a successful bacanora marketing strategy.
5) To review botanical and agronomic information relevant to the establishment of commercial plantations of *A. angustifolia* in Sonora.
6) To discuss current issues related to the bacanora project in Sonora based on the author's involvement in the project.

1.5. Methodologies

The Mexican strategy for economic growth is based partially on the opening of the economy to international investment. This strategy forces a redefinition of the role of the state. In the paradigm of the new economic environment, foreign investors would find attractive opportunities in Mexico and domestic producers would pursue quality and lower costs. The strategy for economic growth represents a tremendous change for agriculture. For several decades the government had supported farmers, producing a climate of relative stability. Large subsidies (*i.e.*, price supports, input and factor subsidies) were transferred to farmers, creating incentives to grow non-competitive crops and to acquire technology that was costly or not adaptable to local conditions.

According to the neoclassical theory (Dornbush, Leslie, and Helmers, 1988), domestic and international prices should be equal in an open economy. An open economy creates changes in the profitability of agriculture. Farmers must restructure production and adopt technologies that reduce costs, increase efficiency, improve marketing, in short, take advantage of their competitive advantage in domestic and international markets.

To identify the profitability of bacanora production, I conducted a cost-benefit analysis. A simple identity used in economics, revenues minus costs equals profits, is calculated at market prices. Profits depend on prices of inputs and factors of production. Additionally, a capital recovery analysis is developed to estimate the return to bacanora producers considering a five-year equipment depreciation period.

A review of the history of mescal from the state of Oaxaca and the Altiplano Potosino, a highland region within the state of San Luis Potosi, and the history of tequila from the state of Jalisco, provided insights and lessons that the emergent bacanora industry must carefully review and analyze. Their experience provides case studies that could be helpful in avoiding difficulties.

Another methodology used to analyze bacanora is ethnographic fieldwork. This was useful for the determination of the practices and household involvement in bacanora-making and consuming. It helped me understand the intricate web of social relations and economic ties generated by such activities.

Similarly, I approached the study of bacanora from both the production and consumption perspectives. I designed two questionnaires, one targeting bacanora makers and the other targeting bacanora consumers to learn about perceptions associated with the

production and consumption of bacanora.

I carried out a demand analysis to understand consumers' preferences and tastes. This methodology was applied among selected consumers in Hermosillo, Sonora, and provided insights about consumers' reactions to changes in the price of bacanora, changes in income, and changes in prices for alcoholic beverages.

Finally, through a literature review I analyzed some agronomical practices with the objective of evaluating the cultivation techniques and problems based on characteristics and adaptations of *Agave angustifolia*, and on experience derived from cultivation of other Agavaceae with similar physiological and growth patterns.

1.6. Dissertation outline

The lack of integrated information on bacanora created the need to support this research with information provided from literature dealing with similar industries, such as tequila and mescal in south-central Mexico. In the same way, the lack of information regarding cultivated agave in Sonora created the need to review the experience provided by literature dealing with Agavaceae with similar biology, environmental requirements, and reproduction pathways.

Considering the above, Chapter II discusses the history of tequila and mescal in Jalisco, Oaxaca, and the Altiplano Potosino, focusing on the emergence and development of these industries, the many problems encountered and the many benefits that the industries created for the regional economies. The experiences from tequila and mescal industries teach valuable lessons to the emergent bacanora industry and the Sonoran

institutions and agents of production involved.

Why and when the town was named Bacanora and when the liquor changed its name from mescal or *aguardiente de mezcal* to bacanora, creating a beverage with an identity, is not known. Chapter III is a first attempt to integrate the history of the liquor, discussing the relevance of historical facts to the current state of the industry. This chapter explains how the small-scale bacanora industry developed, creating unique rituals, customs, meanings, and social relations within communities.

The fact that the production and commercialization of bacanora was long prohibited created disincentives to improve the production technology. Therefore, the current methods of bacanora production are traditional and inefficient compared to other mescal industries. Chapter IV describes the current methods for the production of bacanora and analyzes the potentials and incentives for scaling-up the technology as derived from the experience of three businesses in Sonora. A cost and benefit analysis of bacanora production shows the profitability of the system. Finally, a section studying the uses and by-products of the species used for the production of bacanora is included. The objective is to present alternative businesses for agave producers based in fiber production and anti-tumor compounds found in the species that might add value to the crop.

Once the process for the traditional production of bacanora is known, the commercialization practices and market potentials are examined. Chapter V discusses the elements rooted in the culture of *serrana* people that can be used in a bacanora marketing strategy. The chapter includes an analysis of current formal and informal domestic markets as well as the potential domestic market based in a survey focusing consumer

preferences and tastes. A final section analyses the potential international markets derived from the information provided from current tequila exports.

Perhaps the most important problem faced by the emergent bacanora industry is the lack of agaves. The excessive harvesting of wild agaves is limiting the possibilities of a programmed expansion of the industry. Chapter VI analyzes the potential for the cultivation of *A. angustifolia* in Sonora.

Chapter VII discusses the current issues and conflicts related to bacanora in Sonora. It describes the conflicts associated with allocation of resources from groups of ranchers and farmers, as well as the intrasectoral conflicts within the ranching sector. This chapter also discusses the *denominación de orígen* and the *norma oficial* for bacanora, concepts and regulations that have profound implications for the future development of the industry.

Chapter VIII addresses several political issues related to bacanora, such as the conflicts and competition over the resources between the coastal and the *serrana* areas of Sonora and their impact on the bacanora industry. Equity issues regarding the beneficiaries of the bacanora development project are also addressed. This chapter analyzes the constraints to increased bacanora production. Finally, the advantages and disadvantages of using genetically uniform planting materials, the associated short and long-term risks, and the political factors that entered the choice of strategies for developing planting materials are included in this chapter.

CHAPTER II. THE HISTORY OF MESCALS AND LESSONS FOR THE BACANORA INDUSTRY

"El agua es para los bueyes y el mezcal para los reyes"
(Popular Mexican saying)

2. Introduction

Understanding the history of mescal will help us to interpret an important part of Mexican culture, traditions, beliefs, their way of thinking, and acting. Furthermore, many beliefs, customs, and traditions related to bacanora are rooted in the culture of south-central Mexico. Even the distillation technology was first adopted in south-central Mexico before it was introduced and spread in Sonora.

As mentioned below, the emergent bacanora industry has to learn from the experience of the tequila industry so bacanora makers can obtain a fair *denominación de orígen* or a certificate of regional authenticity issued to protect them if they produce the liquor in its traditional area. This will help to protect bacanora makers from producers from other Mexican states or countries. Additionally, the tequila and mescal experiences will be useful to negotiate and obtain a *norma oficial* or an official standard for bacanora, which will define what is considered bacanora and what is not. Such a *norma oficial* would have to be enforced and respected by producers of bacanora within the limits of the *denominación de orígen.*

2.1. The Mescals

The word "mezcal" comes from the nahuatl *metl* = agave, *calli* = *cocido* or cooked

(Luna-Zamora, 1991). After the Spaniards arrived in Mexico the broad diversity of uses of agave decreased drastically, the production of alcoholic beverages becoming its primary use. The pre-Hispanic fermented beverages were distilled to obtain what were called *aguardientes, vinos de mezcla* (mixed wines), or *mezcales* (Muria, 1990).

Mescal is produced in almost every place in Mexico where agaves grow. Famous are the mescals from Oaxaca, Guerrero, and Central and Northern Mexico. Even when pulque preceded mescal, there was already a legend around it saying that the first *tatema* (roasting) was made when lightning hit an agave (Valenzuela-Zapata, personal communication). For the post-conquest Mexican culture and beliefs, such folklore was strong enough to consider mescal as "a liquor coming from heaven."

The type of mescal produced varies with the species of agave, the climate, the distillation technique, and the container in which it is *reposado* (aged). Some of the best-known variants of mescal in Mexico are the *comiteco* from Chiapas, the *tuxca* from Colima, the *barranca* from Nayarit, the *raicilla* from Jalisco, and the *lechuguilla* and *bacanora* from Sonora. Mescal can be sub-classified into: *mezcal de gusano,* bottled with a maguey worm inside, and drunk accompanied with *sal de gusano* (a worm mixed with salt); *mezcal corriente* or *chaparro*, fermented in leather sacks with *pulque* and *timbre* (a tree that grows in Southern Mexico) bark and wood; *mezcal minero*, a variety that was given to mine workers as partial payment to make them work harder; and *mezcal de puntas*, a variety mixed with distillation from the first run and drunk mixed with honey.

Mescal was not only used for ceremonies and fiestas, but also as a remedy for many diseases. In traditional medicine the mescal was used to clean, to sterilize, and to

heal the skin. It is still used to bless *milpas* (fields), new constructions, and crucifixes. In Oaxaca and Veracruz natives celebrate the traditional *Día de los Muertos* (Day of the Dead) on November 2nd by drinking mescal around the graves of their family members, spilling the last shot on the grave to give their relatives a better farewell.

In rural Mexico mescal is widely considered an appropriate gift for the ceremony when a groom asks for the hand of the bride, as well as for baptisms and funerals, and on *Fiestas del Santo Patrón* (Patron Saint Fiestas). Mescal is also shared and interchanged during volunteer communal work and night vigils. As such, mescal is considered an adult ceremonial beverage, consumed more often among large groups of people.

For some people mescal is considered an *ofrenda* (offering). In fiestas mescal is always offered in hierarchic order and cannot be rejected because it is considered offensive, although it can be saved in the bottles brought for that occasion. It has to be drunk only in the quantity and pace it is offered (Sánchez-López, personal communication).

2.2. History of mescals in Mexico

The uses of agaves or maguey are found in written reports made by the Spanish conquerors and their writers (Sahagún, 1956; Pfefferkorn, 1989; Benavente, 1963). The maguey played an important social role, and was associated with the goddess *Mayahuel* (Muria, 1990). According to *nahuatl* culture, the maguey is a divine creation with divine powers (López -Gimenez, 1988). The maguey's status of goddess was not just due to its yielding an intoxicating beverage (not distilled mescal in this case, but *pulque* instead, a

beverage with low alcohol content made by the fermentation of *aguamiel* which is a liquid extracted from the heart of the maguey (*Agave salmiana*) (López-Gimenez, 1988)), but also because it provided a food of highly nutritious value (George C. Vaillant as cited in Muria, 1990). That the maguey plant had so many uses and was incorporated into so many activities and rituals among a *Macehuales* (a group of free pre-Columbian indigenous people), as well as many other Mexican indigenous communities helps to explain why the plant earned the status of goddess, *Mayahuel*.

The maguey was also used as a stimulant, to heal stab wounds in warfare and to treat snakebites, to make cordage, ropes, shoes, quilts, and fabrics used by *Macehuales* to dress themselves (Benavente, 1963). The spines were used as nails and needles. The leaves were dried and used for firewood and to construct roofs for their huts. A kind of paper was also obtained from maguey. Muria (1990) reports that such paper was used in some famous documents, named *codices*, such as the *Zolin*, the *Coatepetl*, the *Descendencia Pitzahua*, and the fragment known as *Caltepaneca*, written by the Indians.

Both mescal and tequila share similar roots since Hispanic times. However, the mescal industry from the Altiplano Potosino is not well organized, remaining as a small-scale operation spread all along the north-central regions of the country. Meanwhile, the growth of the tequila industry was more consistent and, as mentioned below, its development was subject to ups and downs depending on the political relations and lobbying activities from the ever more organized *industria tequilera*. Large-scale businesses and even some transnational corporations such as Seagram currently own and operate a share of the tequila industry.

2.3. The mescal industry in Oaxaca and the Altiplano Potosino

In this section, current production of mescal in Oaxaca and the Altiplano Potosino in north-central Mexico is described. In these regions, the species used for production of mescal are *Agave angustifolia* in Oaxaca (Sánchez-López, 1989) and *A. salmiana* Otto ex Salm spp. *crassispina* (Trel.) Gentry (Gentry, 1982), commonly named *maguey verde*, in the Altiplano Potosino.

There is no evidence that the indigenous communities knew the process of distillation in pre-Hispanic times, but the process of fermentation was very well known. Segura (1901), wrote that even when the mescal manufacturing techniques brought to Mexico by the Spaniards were different from those used at the end of the 19th Century, the principles remained the same in processes such as cooking, milling, fermentation, and distillation.

In Oaxaca and in the Altiplano Potosino, agaves are cultivated in plantations because wild agave populations are overexploited (Sánchez-López, 1989; Martínez-Morales and Meyer, 1985). Agaves are *capados* (the inflorescence is cut off) to become ready for harvesting. The *capado* halts the flowering process while still encouraging the transport and storage of carbohydrates in the heart of agave. Tello-Balderas and García-Moya (1985) recommend that the period during which the plants remain *capada* prior to their harvest be 18 months minimum, but the common practice is a period of six to twelve months.

In the Altiplano Potosino the ovens to cook the heads of the agaves are made of

brick, stone, and concrete. The cooking time ranges from three to five days. The process to mill the heads of the agaves makes use of a circular stone rotating over a circular base made of concrete. The stone is attached to a horse by a long pole.

In Oaxaca and the Altiplano Potosino the product is fermented naturally in a period that takes from three to seven days. Once fermented, the agaves and the syrup are placed in a copper still, which is a boiler that collects the vapors and conducts them to the water-submerged coil in which they cool and condense. Pressurized kerosene and liquid gas are the most common fuels used in these regions to heat the still.

As with bacanora, the distillation process yields at the beginning a liquor called *cabezas*, with high methanol, a higly toxic component, and *colas*, which is low proof. A portion of both, *cabezas* and *colas*, is reincorporated in the second distillation--called *rectificación* (rectification). Once completed this process the product obtained is called mescal and can be bottled.

There are several differences between mescal production in Oaxaca and the Altiplano Potosino *versus* bacanora production in Sonora. The scale of the bacanora operation is smaller, and bacanora is still made from wild agaves. The relatively larger operations in the commercial mescal industry require larger facilities and more efficient methods for milling, fermenting, and distilling.

The roasting process involves another important difference: the roasting pit in Oaxaca is an open bowl-shaped hole in the ground, while in Sonora the pit is like a *jarro*, a hole with a narrow mouth, but wider in the bottom. In Sonora the heads are roasted in a pit that is sealed with metal sheets, and *lodo* (mud). In Oaxaca the pit is not sealed, and

the heads of agave are covered with bagasse and a few sacks of *ixtle* (burlap-like fiber spun from agave leaf fiber).

The milling of cooked agaves in Oaxaca is done with an animal-powered circular stone, while in Sonora agaves are *machucados* (shredded) by using a *jaibica* (an ax as described below). In Oaxaca the process of fermentation is accelerated by adding hot water to the shredded-roasted agave, a practice unusual in Sonora with bacanora.

Distillation practices in Oaxaca include the use of a coil immersed in water. However, these practices are not very efficient because as the vapor condenses, the water-cooling coil gets hotter, affecting both the flavor and alcohol content. In Sonora, the water that cools the coil is changed frequently or is constantly flowing, thus maintaining the coil at a cooler and more uniform temperature, yielding a homogeneous beverage and a more controlled alcohol content for the liquor.

2.4. The tequila industry in Jalisco

Tequila is made from *Agave tequilana* Weber in Jalisco and neighboring states in Mexico. It is still a matter of discussion what the word "tequila" means. Some say that tequila derives from *tetl* = *cerro* (hill) and *quila* = *lava* (melting rock) (Valenzuela-Zapata, personal communication). Others attribute the name to a breast-shaped hill near the place where agave plants were known to grow wild. Accordingly, the name *tetilla* (breast) transformed in the following years to tequila (Tequila "Cascahuín", promotional brochure). Luna-Zamora (1991) attributes the name to the Tiquila tribe living in the area of Amatitlán. He says that the Tiquila tribe was the first to learn from the Spaniards the

essential processing techniques to produce mescal.

Looking for the roots and the origin of the word and utilization of "tequila" as generic to *vino mezcal* produced in the area of Tequila, Ernest Vigneaux, a war prisoner of Mexico during the French invasion, wrote in 1854 that Tequila bestowed its name to the *aguardiente* of mezcal, the same way that cognac gives its name to *aguardientes* in France (Vigneaux, 1863). This suggests that the word tequila denoted the *vino mezcal* at that time. However, it was in 1910 during an exposition in San Antonio, Texas, when the liquor was called *vino de Tequila*, and from that time the mescal was identified as tequila. Some historians argue that the term tequila, as generic to the liquor, was coined and generalized in the years when Texas, California, New Mexico, and Arizona were taken from Mexico. Such action created a spirit of nationalism among those who remained in the Mexican territory accentuating pride in everything from Mexico (Muria, 1990).

Currently there are 16,000 hectares planted in Jalisco with *maguey azul*, which is a cultivated variant of *A. tequilana*. However, there are more than 50,000 hectares cultivated in all Mexico. In 1989 there were 30 distillery plants operating in Jalisco (Muria, 1990) and 50 operating in the country (Valenzuela-Zapata, 1985).

2.4.1. History of tequila

The production of tequila has a long history. Some authors argue that agave was cultivated long before the arrival of the Spanish conquerors (Ramírez-López and Sánchez-López, 1985). They say that agaves were first cultivated around the year 1224 for *aguamiel* production and later fermented for *pulque* production around the year 1239,

although, they do not provide supporting evidence. However, the domestication of agave contributed to improvement of the plants for their different uses (*e.g.*, *aguamiel*, *pulque*, fibers, and cooked mescal).

In his *Descripción de la Nueva Galicia*, Lázaro de Arregui (1946) contends that the first tequila factory was established in Mexico in 1621, as a result of the first Spanish settlements in mining centers. These crowded areas were a necessary condition to initiate the establishment of the tequila industry.

It was Dr. Juan Canseco y Quiñones, president of the *Audiencia de Guadalajara*, and governor of the *Nuevo Reino de Galicia* from 1636 to 1640, who first regulated the manufacture and commercialization of *vino mezcal* (later known as tequila). His idea was to establish minimum standards for quality control and to obtain revenue from the taxes imposed on the incipient industry to pay for the public services required by the increasing population of Guadalajara. One example of this was water scarcity problems faced by the city, when Francisco Calderón Romero was president of the Audiencia and governor of *Nueva Galicia* in 1672. At that time revenues obtained from *vino mezcal* were used to bring water to Guadalajara (Muria, 1990).

More important hydrologic projects and governmental buildings were built in *Nueva Galicia* during the 18th Century thanks to revenues provided by the *vino mezcal* industry (Muria, 1990). In 1785 Carlos III, lobbied by the Viceroy Matías de Gálvez, issued a *Cédula* (royal order) to prohibit the manufacture and sale of intoxicating beverages in Mexico, favoring the sale of Spanish *aguardiente* (rum) produced mainly in the Canary Islands. As a result, the government of *Nueva Galicia* lost the income from

vino mezcal, stopping the construction of the Municipal Palace among other important public projects (Muria, 1990). The royal permit was annulled in 1795, when José María Guadalupe José Cuervo obtained, directly from the King of Spain, the first concession to manufacture *vino mezcal*. However, Sr. Pedro Sánchez de Tagle is considered *el padre del tequila* (the father of tequila) because he was the first to cultivate agave in the Tequila valley in his *Hacienda Cuisillos* in 1695. The Cuervo Montaño family was second in their *Hacienda de Arriba* (Valenzuela-Zapata, no date).

An important event that led to the export of *vino mezcal* to other countries was the construction of the San Blas harbor in Nayarit in 1768, the first harbor on the Pacific coast of Mexico (Muria, 1990). The main product, practically the only product exported by the San Blas harbor was precisely *vino mezcal*, as the naturalist and expeditionary José Martínez Longinos wrote in his *Diario de la Ciudad de México a San Blas* in 1792. He wrote that between Amatitán and Tequila there were only mescal plantations, from which tequila in the quantity of several thousand barrels was manufactured and shipped every year (Martínez-Longinos, 1961).

There is evidence that the tequila industry was growing during the 18th Century as narrated by Matías Angel de la Mota-Padilla, a lawyer in the *Audiencia de Guadalajara*. In his book *Historia del Reino de la Nueva Galicia en la América Septentrional* written in 1742, he made allusion to the prohibition and penalties prevailing for those who manufactured, commercialized, and consumed *vino mezcal* in excess. He noted that even with such regulations and laws the *vino mezcal* was manufactured on a larger scale (Mota-Padilla, 1973). Additionally, Muria (1990) makes reference to a *Memoir* published in 1846

saying that since 1786 the *Departamento de Tequila* had been supplying *vino mezcal* to Sinaloa, Sonora, and the Californias.

There is not much information about production of *vino mezcal* for the first part of the 19th Century. Alexander Von Humboldt observed that in 1803 its manufacture was prohibited. Humboldt mentions that "the *aguardiente* named mezcal, or *aguardiente de maguey* which is very intoxicating, is produced from the distillation of pulque [sic]" (Humboldt, 1972), thus confusing tequila and *aguamiel*.

The proclamation of Jalisco as a state in the new independent Mexico was made in June 1823. It was not coincidental that the first elected governor, Prisciliano Sánchez, was a merchant from Ahuacatlán, a place known for its large production of mescal. As expected, he knew exactly the needs of the mescal industrialists, and supported them decisively (Muria, 1990). At that time and with the new incentives provided by Sánchez, the development of the industries and brands began.

The town of Tequila grew rapidly and became internationally famous for its *vino mescal* by the first quarter of the 19th Century. The specialization and the importance of mescal for this area are evident in the eyes of a European tourist of the time, Beltrami, (1830) who wrote that the maguey and other indigenous plants gave to the town of Tequila the prosperity not obtained from cereals. Beltrami also mentioned that the maguey from Tequila yields a magnificent quality of liquor, the *aguardiente* named *vino-mezcal* (Beltrami, 1830). Victoriano Roa, who gathered data in Jalisco in 1825, concluded that the inhabitants from Tequila were in general dedicated to the cultivation of mescal and manufacture of wines (Roa, 1981).

During the 19th Century different varieties of agaves were used for the production of tequila. Agaves received regional names such as *mezcla chino, azul, bermejo, siguin, moraleño, chato, mano larga, zopilote, pie de mula* which were among the most common (Pérez, 1987).

José Pérez Moreno, in his *Biografía de Ramón Corona*, cites an example of the important power of the tequila industrialists in domestic politics. By the mid 1860's Antonio Gómez Cuervo, a prominent tequilero, was elected governor of Jalisco. He supported the interests of the tequila industry by decreeing a significant tax reduction on tequila and heavily taxed the textile industry and other branches of commerce in the state to maintain a budgetary balance. While governor, he established an official prize of $500 pesos to the individual who discovered the way to eliminate a disease affecting agaves in Jalisco during his mandate (Pérez -Moreno, as cited in Muria, 1990).

During the term of the Mexican President Porfirio Díaz (from 1870's to 1910), the tequila industry grew steadily, as derived from data about population growth in tequila producing areas (Muria, 1990). The domestic population was increasing steadily in Jalisco as well as in Mexico City, thus increasing the demand for tequila.

Unfortunately, as a result of the Mexican revolution and some political maneuvers, the transfer of the seat of the Municipality from Tequila to Ahualulco at the end of the 19th Century (Muria, 1990) contributed to a massive migration of people outside the Municipality of Tequila to larger cities. This caused a significant reduction of Tequila's population from 32,000 inhabitants to just 1,000 in a five-year period (Muria, 1990). Labor became a critical issue for the tequila industry for several years.

During the Mexican revolution and during the *Cristiadas* (from 1910 until mid 1930's) the tequileros suffered many losses as a result of the prevailing anarchy. The constant uprisings became fertile soil for the emergence of many bandit groups. Assaults on the *haciendas tequileras*, destruction, and the theft of tequila became common. During this convulsive time the tequila industry suffered enormous losses. However, the increasing demand brought by the World War II saved the industry. Therefore, the industry reemerged from 1940 to 1970 thanks to the war, the construction of a paved road linking Tequila and Guadalajara, and the construction of a railroad connecting Mexico City with Arizona via Guadalajara, Jalisco.

One single event revolutionized the commerce of tequila --the introduction of glass bottles. Brought initially from Germany at the end of the 19th Century, glass bottles changed the pattern of tequila consumption. Tequila sold in glass bottles gave the consumer the sense of a hygienic product, and the consumption of tequila became a more intimate act.

An additional fact that contributed to increasing demand for tequila was doctors pronouncing tequila effective for alleviating the *influenza española*, an illness affecting many people in Zacatecas and San Luis Potosi (Muria, 1990).

During World War II tequila was exported to the U.S. in large quantities. The adulteration of the liquor by adding water and other chemicals was common, creating worldwide credibility problems for tequila producers. Additionally, the emergence of tequila producers in other countries, such as Spain and Japan, and non-tequila regions of Mexico, resulted in the reduction of revenues for *tequileros* from Jalisco. These events

created the need for organizing the tequila industry to protect it from unfair practices.

In 1958 the tequileros organized the "*Productores de Tequila de Jalisco S.A. de C.V.*" in order to register their brands and distinguish tequila from other liquors. In 1964 a quality standard of production was issued by the government and its adoption became mandatory for beverages labeled tequila beginning in 1968 (Diario Oficial, 1968). In 1973 the *denominación de orígen* (certificate of regional authenticity) was issued for tequila (Diario Oficial, 1973) under the mandate of the Mexican President Luis Echeverría Alvarez, who was born in Jalisco. Nineteen months later the *denominación de territorio* or the territory where tequila must be produced, was officially issued for the manufacture of tequila (Diario Oficial, 1974), and included all places where tequila could be manufactured in order to be recognized and protected. Henceforth, any product labeled tequila had to originate within the boundaries established by the *denominación de territorio.*

2.4.2. The size of the tequila industry

Tequila production has been increasing steadily since the mid 20th Century. Muria (1990) estimates that domestic demand has been stable even considering the increasing importation of liquors from other countries. Tequila production was 62 million liters in 1991, of which 65 % was exported, becoming an important source of foreign currency. It is estimated that of all exported tequila, 88 % is sold in the U.S., and 9 % in Europe (Valenzuela-Zapata, 1994). From 30.7 million liters exported to the U.S. in 1988, only 0.4 million liters were exported in bottles, the rest was exported in drums or truck containers and bottled in the U.S. by American companies. California is the largest importer in the

U.S. Data from 1973-1974 indicate that California imported 4 million liters, New York 616,365 liters, Texas 528,012 liters, Colorado 437,724 liters, Illinois 417,465 liters, Michigan 376,083 liters, Arizona 254,934 liters, and Wisconsin 206,055 liters (Muria, 1990).

Quality control is maintained under strict standards. The Mexican regulatory agency NORMA created and enforced the guiding rules granting a permit to those distilleries that meet the standards. By law, to be called "tequila" the product has to come from designated areas and a government inspector checks quality *in situ*. The product must contain a minimum 51 % blue agave. Some manufacturers claim that they distill the liquor three times to obtain the highest quality by removing all impurities, thus exceeding the standards (Tequila "La Bodega", Promotional brochure).

Muria (1990) also points out the importance of the tequila industry as a generator of employment. From an estimated cultivated area of 85,000 hectares there are 2,890 workers dedicated to the manufacture of tequila. This area produces an estimated average of 59 million plants of agave.

As in past times, the Mexican government welcomes the revenues provided by the tequila industry. In difficult times such as the recent economic crises, foreign currency becomes fundamental to finance imports. The tequila industry has been producing revenues from exports in the order of $18.3 million pesos in 1968, increasing to $63.6 million pesos in 1987.

2.4.3. Technology used in the manufacture of tequila

There are a few traditional distilleries in Jalisco, which are very labor intensive. One example of a traditional distillation factory is nicely described in *El Agave Azul: de las mieles al tequila* (Pla and Tapia, 1990). A marketing specialist argues that the romanticism associated with traditionally manufactured techniques has a market value that increases the value of the product (Erik Shapiro, personal communication). Modern mills replace labor-consuming activities such as that of the *tahonero* who mills agaves with an animal assisting the stone mill. Large electric blenders now make the *batido*, a process of blending previously done manually in these factories. The copper still distillation heated by firewood is now replaced by large stainless steel distilleries heated by gas.

There is detailed knowledge about every activity involved in the production process from soil preparation, plant selection, cultivation, disease control and the manufacture of the final product (Granados-Sánchez, 1993). *A. tequilana* is propagated by vegetative means, using the offsets produced by the parent plant. These are planted in nursery beds where irrigation and fertilizing are carefully monitored. Once the plants are sufficiently vigorous, or have a fresh weight of 750 grams, they are transplanted to the commercial plantations (Valenzuela-Zapata, 1985). The planting is made during the rainy season to save the costs associated with artificial irrigation. There are many small farmers who intercrop agaves with beans, corn, and garbanzo to obtain some extra income from the land.

The young inflorescence is cut off to prevent flowering. This process, named *capado* or *desquiote* in Sonora, and *desquiste* in Jalisco is done to force the plant to store

its carbohydrates in the head instead of the stalk. Additionally, older leaves are also cut off every year in a process named *poda*, and a few months previous to the harvesting the tips of the leaves are completely removed. Bustamante (1983) claims that this process stimulates the concentration of sugars in the head of the plant.

An indication that an agave is ready for harvesting is when the leaf base starts to shrink and the inflorescence base has a dense rosette of leaves. The leaves are then cut off and the head is removed and transported to the processing plant to be cooked. The small-scale cooking operation uses a steam heater in a 48-hour process. However, large tequila plants use autoclaves, thus reducing the cooking time to only 12 hours. The heads are then milled, shredded and washed with pressurized hot water to help dissolve the sugars.

In large operations in Jalisco many tequileros add sugars from sugarcane or sorghum. By regulation, these may total no more than 49 % of total sugar. Adding sugar accelerates the fermentation process and increases the volume of *mosto* (fermented mix). In larger operations, yeast strains mainly of the genus *Saccharomyces* are added to the syrup with a mixture of nitrogen and phosphorus nutrient salts.

Two distillation processes are performed in the tequila production: first, the *breaking* that delivers the *tequila ordinario* or *vinaza*. The distillation of tequila *ordinario* is called *rectificación* and yields *tequila rectificado*, with higher alcohol content. *Cabezas* and *colas* are also obtained from the first distillation. *Cabezas* are used as solvents by the paint industry. The primary product of the second distillation is known as *tequila blanco*. This tequila is sold in domestic and international markets. The *tequila blanco* is sometimes placed in oak casks yielding golden tequila or *tequila reposado*. When the tequila blanco is

placed in oak casks for more than 90 days it is called *tequila añejo* or aged.

2.5. Lessons for the bacanora industry

Bacanora producers have several lessons to learn from the historic development of the tequila industry. Among the most important are the factors that contributed to a reemergence of the tequila industry in recent years. This is the case of the tequila 100 % agave, which is increasing its market share at the expense of the regular or blended (sugar incorporated) tequila (CRT, 1999), as is mentioned in this document. With such an exclusive market, high quality has to be maintained, as is also the case with cognac in France. The Sonoran government has been negotiating a *norma oficial* for bacanora with two proposals: a bacanora altered with 20 % of other sugars, and the 100 % agave. The second proposal appears to be receiving the greatest support. Obtaining the *denominación de origen* (granting Sonorans the right of exclusive production) before *A. angustifolia* becomes intensively cultivated in Sonora will protect Sonoran bacanora makers from potential competition from other states or countries.

The domestication of *A. angustifolia* is another matter learned from the tequila industry. However, care must be taken regarding the genetic variability of the plant to avoid problems recently found in *A. tequilana* plantations. This is the case of the *SIDA del maguey* or maguey AIDS, a disease that is affecting 10 to 15 % of all agave plantations in Jalisco. The uncurable disease is produced by a virus that kills the cells of the plant. Some researchers argue that such disease problems might have been avoided if a wider genetic variability were available. The problem is that the industry focused on the cultivation of

the highest yielding variety in an attempt to obtain the highest returns. This increased the problems due to the lack of wild stock carrying genetic materials more resistant to plagues and diseases.

The problems associated with the overexploitation of wild agave populations also contain important lessons that the bacanora industry can learn from the tequila and mescal industries. The Sonoran government as well as all institutions involved in this project must exercise a more strict control over wild agave populations to reduce the possibilities of extinction of some varieties of agave, and thus avoid an irreparable loss of germplasm. That seems to be the case of *Agave jaiboli* Gentry, a species native of the area north of San Bernardo and Alamos as documented by Gentry (1972). It is said that mestizos used to make an especially tasteful bacanora with it. The species is considered endemic, and a few plants have been found in the wild in recent years, but overharvesting apparently greatly reduced its members, which were not large to begin with (David Yetman, personal communication).

At the macroeconomic level, as happened with the tequila industry, bacanora can also become an important source of revenue for the government once the industry develops and becomes taxed. Such revenue might enable the development of civil projects such as the construction and maintenance of rural roads, schools, health centers, dams, and ditches.

For the tequila industry the increase in exports has been the basis for its reappearance in the last 5 years (CRT, 1999). Bacanora exports might also constitute a source of foreign currency that could be used to reduce poverty and increase rural income.

The tequila industry and the emergence of the mescal industry teach a lesson regarding the maintenance of traditional practices. There is a new segment of consumers that differentiates between similar products and makes choices based on the traditional and the natural production of the liquor. That is the case with consumers who prefer the more expensive 100 % agave. The tequila industry modernized by incorporating high-level processing technology, yet the mescal industry in Oaxaca followed a different path. Project coordinators promoted small-scale and traditional mescal operations throughout the state (Sánchez-López, 1989). Additionally, the steps used in tequila processing can also be used to produce a different bacanora. Bacanora could also be bottled with regional fruits, as is traditionally prepared in many Sonoran towns. Storing bacanora in oak barrels can produce *bacanora reposado,* with a different flavor.

The regulated mescal industry in Oaxaca is more than 12 years old. The market for traditional mescal without any standard is much older. Fortunately for the emergent bacanora industry, the new trends in consumption indicate that consumers are becoming better informed and educated, willing to pay a premium for traditional products. Thus the bacanora industry can grow following a dual path: both traditional and high tech production schemes.

One final lesson derived from the tequila industry is related to the long cycles of agave growing and the effects on the supply of agave plants. The supply of agave reduced significatively in the year 2000, thus affecting the industry. First, the processing industry had to pay very high prices to agave growers as demand for agave is constantly increasing due to the increase in the demand for tequila. Second, many agave growers attracted by

the high prices cultivated agaves the following year, which will be reflected in a possible excess supply of agave plants 8-10 years from today. These long-term cycles of prices and supply of agave plants may negatively affect a planned supply of tequila. Third, shortages of plants may result in poor quality tequila as a result of the fraudulent use of immature agaves and sugarcane in the production of tequila.

CHAPTER III. HISTORY AND CULTURE OF BACANORA

"Bonito Sonora donde el bacanora enciende pasión"
(Popular Mexican song)

3. Introduction

Bacanora (frequently called 'mescal') has been part of the culture of Sonoran Indian tribes since the introduction and adoption of distillation by the Spanish conquerors. Castetter et al. (1938) discussed some of the uses of bacanora associated with rituals and ceremonies among Sonoran Indian tribes.

Gentry (1982) characterized bacanora, which takes its name from the locality where it is produced, as one of the most famous mescals in Mexico. Sheridan (1988) gives a detailed description of the processing of lechuguilla (a liquor similar to bacanora), made from a different agave species, *A. palmeri* Engelm. Gentry (1982) and Bahre and Bradbury (1980) discuss the special properties of bacanora. Gentry (1982) mentions that the exceptional taste of bacanora might come from the particular variety of agave, from the minerals in the soil in which it grows, from the particular bacteria or fermentation, or from the type of firewood used for cooking.

Granados-Sánchez (1993) comments on some medicinal uses of bacanora as well as the manufacturing process, including the slashing of the *quiote* (the inflorescence), the yield obtained (40 liters of bacanora from the processing of 60 to 70 heads), and the traditional commercialization.

Several authors address the sustainability of the *A. angustifolia*. Bahre and Bradbury (1980) suggest that the production of bacanora in Sonora is sustainable because

the resource is not subject to overexploitation. Nabhan (1985) writes that some *vinateros* have to walk farther to obtain agaves, which is an indicator of some degree of overexploitation of the plant. Sheridan (1988) comments that agave plants are harder to find in areas surrounding the towns, although agaves have incredible reproduction powers. Nobel (1994) considers that because the state of Sonora is arid in general, harvesting wild agave might have severe ecological consequences, such as the loss of associated species, especially in the mountainous areas, where the plant is collected to make bacanora. Reyes-Sánchez (1997) discusses some issues surrounding the practices of cultivating *A. angustifolia* (called *A. pacifica* in the paper) in a controlled environment. The IMADES (Sonoran Environmental Institute) (1998) studied the reproduction of *A. angustifolia in vitro*.

3.1. A history of bacanora

Although there is no written history of bacanora, many misconceptions have arisen around it. I believe that the lack of a history of bacanora supports his thesis that Sonorans share a history of clandestine activity, a history that they take pride in, and bacanora is an important part of it. Before 1992 bacanora production was illegal, yet encouraged by most Sonorans. Although it was illegal, a bottle was a highly appreciated gift among high-level government officials, who never questioned the legality of the offering.

Keeping bacanora as a socially well-known and accepted Sonoran "secret" might be called a social complicity where every Sonoran became a holder of the secret under the tolerance of the state and federal authorities. Many people believe incorrectly that

bacanora has been produced since pre-Hispanic times, although evidence indicates that the Spaniards introduced the distillation technology.

3.2. When bacanora acquired its name

The name *bacanora* is historically connected to the town of Bacanora. Official documents say that Father Pedro Méndez founded Bacanora in 1627 (Gobierno del Estado de Sonora, 1985). However, there is evidence that the town of Bacanora was founded in 1628 and referred to as Bacanora in official documents in 1658, 30 years after its first church was erected. This might indicate that the Indian community living in the region referred to the indigenous community as Bacanora even before the arrival of the Jesuits, or that the Jesuits took an Opata name and attached it to the mission. Whatever happened first, as early as the middle of the 17th Century there was an Opata town officially recognized as Bacanora, Vacanora, Bacañora, or Bacanora Vistasuya (Ocaranza, 1939).

The above is not an indication that the *vino de mezcal* (name given to bacanora at that time) was produced in the region because the distillation practices and technology were not known until the following century. The date when *vino de mezcal* produced in the sierra of Sonora was first given the name *bacanora* is unknown. However, the *vino de mezcal* took its name from the *pueblo* of Bacanora. As explained below, bacanora did not get its name until some time in the 20th Century, because in 1915 it was still called *aguardiente de mezcal*.

3.3. Recent history of bacanora

No process or technology improvements for bacanora production are recorded throughout the 19th Century. However, at the beginning of the 20th Century there were many small bacanora operations disseminated all along the Sonoran sierra. The hypothesis of this author is that at the end of the 19th Century, during the Porfiriato in Mexico there was a generalized rural crisis, accentuated by land concentration, suffocating the income of rural communities in the Sonoran sierra. Then as now, many small farmers turned to other income generating activities in order to survive the economic crisis. The activities sought included the production of bacanora, a well-known, low-cost, and profitable activity.

It is possible that Ramón Corral, governor of Sonora at the time of President Porfirio Díaz (Gobierno del Estado de Sonora, 1985), knew about the manufacture of mescal but decided not to interfere with the activity to avoid conflicts. If the above is true, then Ramón Corral perhaps allowed bacanora makers to search for a living in a manner not possible under the Díaz regime.

Additionally, the emergence and development of important mining centers in Sonora, which was supported by the Porfiriato (*e.g.*, Cananea Consolidated Copper Company, Nacozari) and which employed thousands of workers, increased the demand for liquors which was largely satisfied by bacanora makers. At a request of the Federal Government, a census made in Sonora in 1899 indicated 68 producers of *aguardiente mezcal* spread all along the sierras (El Imparcial, 13 de Abril de 1999).

With the revolutionary turmoil at the beginning of the 20th Century, the economic

crisis was accentuated, thus enhancing conditions for the spread of the small bacanora industry in the state. Additionally, there were not enough alcohol-control agencies or agents to enforce any law.

In 1915 the *Tesorería General* of Sonora issued four permits to distill *aguardiente mezcal* to producers in Baviácora, Nuri, Arizpe, and Caborca (El Imparcial, 13 de Abril de 1999). However, in August 8, 1915, the governor of Sonora, General Plutarco Elías Calles, issued a decree prohibiting the manufacture and commercialization of alcoholic beverages in the state. Bacanora was used as an example, as shown by a famous photograph where Elías Calles himself is pouring several five-gallon *damajuanas* of bacanora onto the street. The decree was followed by ruthless and ferocious persecutions by the judicial police all over the state directed toward both bacanora makers and merchants. The so-called *Ley Seca* (dry law) applied to bacanora ruled in Sonora for almost all the 20th Century (Gobierno del Estado de Sonora, 1985).

It was not until 1992 when a Sonoran lawyer, Lic. Jesús Enríquez Burgos, a congressman and former Minister of Interior born in Nácori Chico, Sonora, led the movement to reform the Sonoran law that regulated the production and commercialization of bacanora. He introduced an initiative of reform to the Sonoran Constitution, which was approved without any discussion (Jesús Enríquez Burgos, personal communication).

Once legalized, many small ranchers decided to enter the activity and some bacanora producers decided to increase their operations. An immediate result was additional pressures on the agave resource. It seems to me that today more and more small

ranchers and unemployed *serrana* people are entering the activity as a way to diversify their stagnant traditional local economies or as a new way of making a living.

3.4. Uses of *penca* and *vino de mezcal*

According to Father José de Acosta (1954), maguey was a very important plant named *árbol de las maravillas* (tree of wonders) because it provided Indians with water, wine, oil, vinegar, honey, clothes, cordage, and needles. Another historian wrote in the third quarter of the 18th Century on maguey:

> "Beyond maize the most common plants cultivated by Mexicans were cotton, cocoa, *metl* or maguey, chia, and pepper, all of which were very beneficial to them. The maguey granted everything required for a better living for poor people. Not only was it excellent as a fence for the *sementeras* (livestock), but also the stalk and leaves were used for the roof for their huts. From the leaves they obtained paper, thread, needles, clothing, shoes, and ropes, and from the abundant juices they made wine, honey, sugar, and vinegar. By roasting the head and the base of the leaves in ground pits they obtained an exquisite candy." (Clavigero, 1944: 83; translated from Spanish by the author).

The Spaniards also quickly learned about the many properties of mescal plants. However, mescal's reputed medicinal properties were known long before the arrival of the Spanish conquerors. Many of the remedies associated with mescal were subsequently recorded in historical documents written by them.

3.4.1. *Penca* and *vino de mezcal* as medicine

Bacanora, *vino de mezcal*, *aguardiente de mezcal*, and roasted agave have a long tradition as medicine. After the Spaniards came to Mexico they discovered the curative

properties of agaves and their products. However, it was not until the distillation practices were introduced that the medicinal properties of the *vino de mezcal* were discovered, probably associated with the known medicinal properties of agave.

Jesuit missionary Father Antonio Sterkianowski described the travel of 50 Jesuit missionaries exiled in 1768. At the time of the Jesuit expulsion the ship left Guaymas, Sonora on its way to San Blas harbor in Nayarit. However, due to the inexperience of the captain they had to make a stop in Loreto in Baja California. At that time most of the Jesuits were sick with scurvy (*escorbuto*). Furthermore, the overcrowded ship was carrying spoiled drinking water and food, which gave them a stomach infection. Their miserable and unhealthy condition was worsened by dehydration as a result of the excessive heat.

In Loreto the Jesuits were confined to the ship for two weeks until the governor of California granted a permit to get off the ship where they received from Indians an extraordinary medicine. Father Sterkianowski described that experience:

> "Because God wanted to preserve them (the missionaries) for future work, He provided the sick men, right there in the desertical [sic] beach, with an unthinkable and unknown medicine very efficacious for their disease. God –said Father Ita- (...) put some Indians in our way to provide us every day with a portion of mescal (in *penca*) that grows abundantly in the area. In it (mescal) we found the remedy for our diseases. In the afternoon the mescal was roasted in hot ashes and the juices were extracted and rested in a container all night, and drunk in the morning before any food. Repeating this process for two or three mornings -depending on the advance of the scurvy- the disease ceased immediately. In some cases when the disease was stronger, still having their knees tired and some purple spots in their legs, they needed to take the medicine four or more times to feel better and get rid of the disease" (Pradeau, 1959: 90-91; translated from Spanish by the author).

The anti-scorbutic properties of the mescal plant are also described in Pfefferkorn's writings. However, Father Sterkianowski discovered such properties of agave from Baja California Indians. It is very clear that he did not know about it from Sonora.

Writing at the same time but from Sonora, Father Pfefferkorn described the same remedy Father Sterkianowski discovered in Baja California. The mescal-based remedy was made almost exactly the same way in Sonora, meaning that both Indians from Sonora and Baja California shared a common knowledge on the medicinal properties of the mescal plant at that time, properties undoubtedly learned by hundreds of years of experience. Father Pfefferkorn (1989: 60) wrote:

> "The leaves of the mescal are an infallible antiscorbutic. For this purpose they are slowly roasted in hot ashes, then heavily pressed so that they yield their juice. The juice is cooked, assiduously skimmed, and after it has cooled a small glassful is drank [sic] by the patient in the mornings on an empty stomach. The drink is uncommonly bitter and bad tasting, to be sure, but it completely cures the evil in a few days."

Pfefferkorn (1989: 60-61) also discussed some other antibiotic properties of mescal, as well as the beneficial properties for stomach related problems:

> "One can hardly find a more efficacious remedy for the healing of all fresh wounds (and not infrequently also old ones) than the juice of his [the agave] root when it is applied to the wound with a saturated cloth. Truly, the cure is somewhat painful, but it is accomplished quickly, as is proved by almost daily experience.
>
> "Pleasant spirits are also distilled from the root. These excel the best so-called Rossoli and, besides strengthening the stomach, stimulate the appetite and are very good for the digestion. Hence, in Sonora, where wine is hardly known and water is usually unhealthful, this drink can be considered a real healing remedy if it is used moderately and only according to the needs of health. Once, while in Sonora, I had these spirits to thank for the restoration of my health. I had so upset my stomach that during a period of six months I could retain no food and had been completely

> weakened by frequent and violent vomiting. An honest Spaniard advised me to take a small swallow of mescal spirits every day one hour before the noon and evening meals. I heeded him, and my health was completely restored in a short time."

Vino de mezcal has been associated with longevity for more than two centuries, as Nentvig (1980: 38) wrote in the third quarter of the 18th Century:

> "Some have attempted to give this liquor [a distillate from Sonoran agave] a bad reputation by saying it is injurious to the health of humans, but I as an eyewitness can truthfully testify that there are individuals nearly one hundred years old who I know favor a swallow of it now and then. Therefore, I have reached the conclusion that its moderate use causes no harm."

Nentvig also corroborated the medicinal uses of *vino de mezcal*, indicating that the liquor, when applied externally to wounds or bruises caused by blows or falls, is very efficacious.

At the same time in the 18th Century, Father Clavigero (1944: 83) wrote about the properties of the mescal plant to alleviate other problems:

> "In the plant they also had an efficacious remedy for many diseases, especially those related to urine. Even today is one of the most appreciated and advantageous product for Spaniards."

Nowadays, there are not many medicinal uses associated with *penca de mezcal*, although *serrana* people rediscovered medicinal properties of bacanora as indicated by my fieldwork. There are some people who would argue that bacanora alleviates almost every disease, and they are ready to show the proofs. Although that is the extreme case, many people do believe in the healing properties of bacanora and use it to treat specific diseases.

Some people prepare a syrup made with bacanora, honey, and lemon, convinced

that it is good to alleviate throat infection and irritation. Other remedies include the use of bacanora for people who suffer a terrible *susto* (fear). It is said that it is good for *empacho* (problems associated with excess eating). It also alleviates blood pressure problems, thereby reducing the risk of a heart attack.

Some men consider bacanora to be an aphrodisiac. They claim that taken very early in the morning, after a night of *parranda* with bacanora, and still with the effect of the hangover, bacanora increases sexual appetite. As many men told me, "bacanora is better than viagra."

A study of *A. angustifolia* in Oaxaca indicates a high level of steroids (40 % hecogenin and 60 % tigogenin), a potential source for the pharmaceutical industry (Sánchez-López, 1989). Jado (1971) found also important anti-tumor agents from the plant.

It is important to indicate the changes in uses of the plant before and after the Spanish conquest. Before the conquest the remedies and medicinal uses of the plant were associated with the plant itself and preparations made from it. The plant was valuable mainly because it provided food and medicine. However, with the introduction of the distillation practices, the food and medicinal properties of agaves were less valuable as the beverage grew in importance and a culture emerged for and by bacanora. The new culture valued most the liquor while other properties of the plant became less important, since the value of a gallon of bacanora provided more cash than could be earned from the remedies obtainable from the plant. However, the Mayo community from Southern Sonora recognizes comparable values for the leaves used for medicine and fiber and the head used

for food (David Yetman, personal communication).

3.4.2. Observations on the customs, rituals, and meanings of bacanora

Approaching bacanora from a different perspective, several customs, rituals and meanings associated with its consumption are described based on direct interviews, personal experiences and observations that I obtained from living in San Pedro de la Cueva, a community where many people are involved in the production, distribution, and consumption of bacanora. Some of these customs, rituals, and meanings truly reflect rituals created for and by bacanora in many towns of the sierra of Sonora.

Many people believe that bacanora stimulates their appetite. Others believe that having a bottle of bacanora is like having the spirit of their hometowns and ancestors trapped inside. Custom dictates that the bottle has to be of glass (preferably dark). "Dark bottles reduce the entrance of sunlight into the bacanora, thus preserving the liquor longer and better," said one old man. "The glass favors the taste of bacanora, while plastic reduces the quality in very short time," he added.

Another said: "h*ay que tratar bien a los invitados para que regresen. Por eso es común recibir con un trago a cualquier invitado que venga para la casa.*" [We have to welcome any guest so they come back again. That is why it is common to offer a shot to any guest coming to your house.] From interviews I perceived that when bacanora is shared it has the meaning of offering not only a shot of liquor, but also a way to say: "This is what I drink, this is what my ancestors used to drink. Through bacanora I identify myself, my values." One interviewee said: "*yo no tomo tequila ni otras cochinadas, eso es*

para los alcoholitos del jardín Juárez, yo tomo bacanora porque soy de Sonora...el bacanora es para hombres...mi padre y mi tata, que en paz descansen, también tomaban bacanora...un trago todos los días." [I don't drink tequila and that sort of things, that is for alcoholic men begging in the Juarez plaza, I drink bacanora because I am from Sonora ... bacanora is for men ... my father and my grandpa, both resting in peace used to drink Bacanora ... a shot every day.]

People from the sierra now living in the city say: "I am from the sierra, I still have my roots there. That is why I always have and drink bacanora. I still maintain our traditions." As a person from the sierra of Sonora frequently says: "*vamos a tomarnos un trago para acordarnos de cuando eramos ricos y teniamos el ranchito.*" [Let's drink some bacanora to remember the time when we were rich and had our little ranch.] For people who left the sierra to live in large cities, having a bottle of bacanora is like having a piece of their land at home. It gives them a sense of belonging. It is a validation of their social links. An individual I interviewed said: "*cuando destapo la botella, el olor del bacanora me hace acordarme de la casa de mis jefes en el pueblo porque mi papa jimaba, me acuerdo de la gente, de los bailes. Por eso cuando me visitan amigos del pueblo nos tomamos unos tragos y nos acordamos de allá, de lo bien que la pasabamos.*" [Every time I open a bottle, the smell of the bacanora reminds me of our house in our town because my father used to make bacanora, I remember the people, the dances. That is why every time I have friends here we have some shots and remember everything, what good times we used to have there.]

The most common ritual is to drink from a small transparent glass where the

drinker usually checks the pearls formed, smells the strong and smoky flavor, and sees the color trying to find suspended particles in the liquor. However, from very poor people one will more likely be given bacanora served in a metal cup *despostillada* (scrapped, scratched).

It is a widespread custom that guests in *serrana* houses are received with a shot of the host's best bacanora. Bacanora therefore functions as an instrument to increase the warmth of the welcome, and also to reduce unnecessary words that "men are not allowed to talk" such as personal sentiments and deep emotions.

It is still customary to store bacanora in the *cuarto de los cachibaches* (the storage room), which is a small, dark room found in many *serrana* houses. This perhaps serves as a way to protect the beverage from heat which may increase the alcohol content of the liquor, as a reminder when bacanora was illegal, or because the cooler temperature and the darkness help to preserve it longer and better. Hiding the bacanora in such place was probably a way to protect the family from visiting *judiciales*, in the same way that any forbidden item is hidden in the darkest place. Dark bottles are preferred to clearer ones because dark bottles reduce the exposure of the liquor to bad direct sunlight.

3.5. Bacanora, social relations, and power

In the book *Sugar and Power*, Sidney Mintz (1985) describes how power relations are constructed around a single commodity (sugar in his case study), explaining the intricate web of relations created between producers, distributors, and consumers associated with a good that has a high value because of its limited production or its high

demand. Beer is an example in Mexico. Its demand is such that beer companies bribe municipal and state authorities to obtain permits for *bailes* (dances) and to get exclusive selling rights in similar events, as most Mexican people know.

The literature of the conquest of Sonoran Indians by the Jesuit missionaries includes an example of the uses of fermented and later distilled beverages among Indians. I hypothesize that even when the Jesuits were aware of the negative effects of excess drinking among Indians, and with probably few exeptions, they sometimes consciously relaxed their divine laws to let them drink in order to have more control over them. However, Indians were frequently punished for immoderate drinking (Pérez de Ribas, 1968).

In the Sonoran literature there is an interesting case that describes how a *pisteada* or drinking in excess might have changed the future of a community. Sheridan (1988: 155) describes how a "very well prepared and competent" engineer was sent to Cucurpe to survey and demarcate communal lands after a conflict between large private ranchers and small-scale *comuneros*, and the way he was bribed by using alcohol and money.

> "Unfortunately for the comunidad, however, the engineer had one major weakness -a strong taste for alcohol and an inability to stop drinking once he started. When he left Cucurpe, measurements and recommendations in hands, he stopped at a hotel in Magdalena where all the rich men were waiting for him. [...] the wealthy ranchers got him drunk and then drove him to Nogales where they bought him clothes and gave him money. By the time he sobered up, he had lost all of the documentation concerning the comunidad."

Bacanora can be considered an instrument for negotiation. As an example Sahuaripa recently had a delegation of federal authorities accompany the governor of Sonora to

discuss the possibility of constructing a paved road from Sahuaripa to Moctezuma. The mayor of Sahuaripa told me how every guest obtained a half-gallon of bacanora, relaxing the visitors to a level of communication where everything was plausible and negotiable. They obtained the funds for the road. Perhaps some individuals might argue that bacanora was not the reason why money was obtained for the construction of the road, but bacanora surely helped.

3.6. Bacanora as an ethnic/class/gender marker

Father Nentvig (1980) provides insights about eating roasted agave in Sonora. He reported that Sonoran poor folk obtained food in times of scarcity from the roasted stalk. Ordinarily it is the nourishment of those who are little inclined to work, said Nentvig.

Following Mintz's observations, the consumption of bacanora can be approached as it relates to many customs and beliefs. As Mintz (1985: 13) wrote:

> "What people eat expresses who and what they are, to themselves and to others. The congruence of dietary patterns and their societies reveals the way cultural forms are maintained by the ongoing activity of those who "carry" such forms, whose behavior actualizes and incarnates them."

In the sierra the consumption of bacanora clearly classifies people. It marks clear lines between individuals and groups. Who consumes bacanora and why can be traced by using Mintz's perspective. My fieldwork and interviews suggest that widowed, lonely men, and the poor become heavy consumers of bacanora. Mintz might say "bacanora is the opium for the poor in the sierra."

In public fiestas mostly poor males consume bacanora, while more affluent people

drink beer. This takes us to the issue of bacanora consumption as class and/or ethnic marker. If someone who enjoys good economic status is seen drinking bacanora in a public fiesta people might say *que bajo ha caído* [how low he has fallen], where bacanora consumption is the defining criterion. However, a different situation exists if bacanora is consumed at home, while enjoying a chat with a friend with all the customs and rituals involved. Then individuals have class. They have style. And to be recognized as such, the consumer shares and drinks bacanora with individuals with a social status as high or higher than his. This takes us to the issue of ambitions:

> "...a spirit of equality (...) arises a strong emulation in all the several stations and conditions to vie with each other; and a perpetual restless ambition in each of the inferior ranks to raise themselves to a level of those immediately above them (Forster, as cited in Mintz, 1985: 181)."

Bacanora is therefore a creator of social links, a symbol of social status.

Fieldwork and interviews reveal that women usually do not drink bacanora in public. Consumption of bacanora is clearly associated with men. There are stories told by Sonora's old folks about some houses in the sierra where women used to sell *tragos* of bacanora. The women were widows, single, and/or abandoned. The prototype of men going to such places was the lonely man, the widower, the abandoned, and the young and bohemian man who wanted to learn about women. It was a place where men could talk, trade, get information, and learn. Such places were replaced by the institutionalized, tax paying *cantina* and *billar* (bar and billiard) better accepted by the government.

Bacanora drinking also defines classes within a town; it might differentiate indigenous people from *Criollos*, and large ranchers from poor peasants, depending of

course on how bacanora is consumed and the rituals involved in the consumption, and as mentioned before, the place, the partners, and the occasion.

CHAPTER IV. CURRENT METHODS OF BACANORA PRODUCTION

"El mejor tequila es el que tiene uno enfrente"
(Popular saying)

4. Introduction

The production of bacanora is an old activity in Sonora, and its technology general principles have not developed much throughout the 20th Century due to more than 80 years of being an illegal activity. Some recent changes are that now metal or plastic drums replace the old copper or zinc-lead pots, and a car radiator sometimes replaces the copper coil.

This chapter describes the traditional method for producing bacanora and the technology associated with its production. I will provide a cost-benefit analysis in which actual costs of production are compared to actual revenues. Revenues minus costs will yield the profitability of the bacanora system at current prices.

I designed a questionnaire that included 77 open-ended questions to determine producer perceptions of their activity. Ten questionnaires were administered in Bacanora and six in San Pedro de la Cueva. These questionnaires were pre-tested at the end of 1998 in Bacanora to determine the time required for completion (estimated at 1 hour 40 minutes each) and the validity of the questions. This field trial resulted in several modifications to the original questionnaire.

All individuals answering the questionnaire were males between 23 and 58 years old. I administered seven questionnaires and research assistants administered the remaining. One participant was assisted in answering the questionnaire because he did not

know how to write.

The information collected from such a small sample size was not used to obtain statistical data on producer perceptions. Instead it was used to validate qualitative information obtained from direct communications and informal interviews with bacanora producers all over the sierras.

4.1. The effect of harvesting on *Agave angustifolia* populations

The harvest intensity, and hence to some extent the population dynamics of *A. angustifolia* in Sonora, depend on government alcohol policies. Historic records and ethnographic evidence indicate that the resource has not been exploited intensively, nor at a constant rate throughout the 20th Century. There were 68 bacanora producers registered in a 1915 census, but a decree issued by the governor of Sonora on August 8, 1915, prohibited the manufacture and commercialization of alcoholic beverages in the state (*Ley Seca*). As a result of this decree, bacanora producers were heavily penalized, reducing their activity to clandestine, small-scale operations scattered all along the Sonoran sierra. The distilleries were hidden in canyons and densely tree-covered hillsides. The *Ley Seca* contributed to reduced harvesting pressure on agaves.

However, the 1982 oil crisis, frequent devaluation of the Mexican peso, a rapid increase in Mexican foreign debt, increasing unemployment, and recurrent financial crises that directly affected the agricultural economy, drastically reduced real income for rural Mexican people. Consequently, many Mexicans sought opportunities in black markets and underground economies. One important opportunity for *serrana* people with limited

choices in Sonora was the clandestine production of bacanora. Bacanora operations were developed under the shadow of federal slogans such as "self-employment", an easy way to promote employment and to avoid civil disorders. As I expected, pressure on the agave resource increased steadily from this time, according to reports from my interviews.

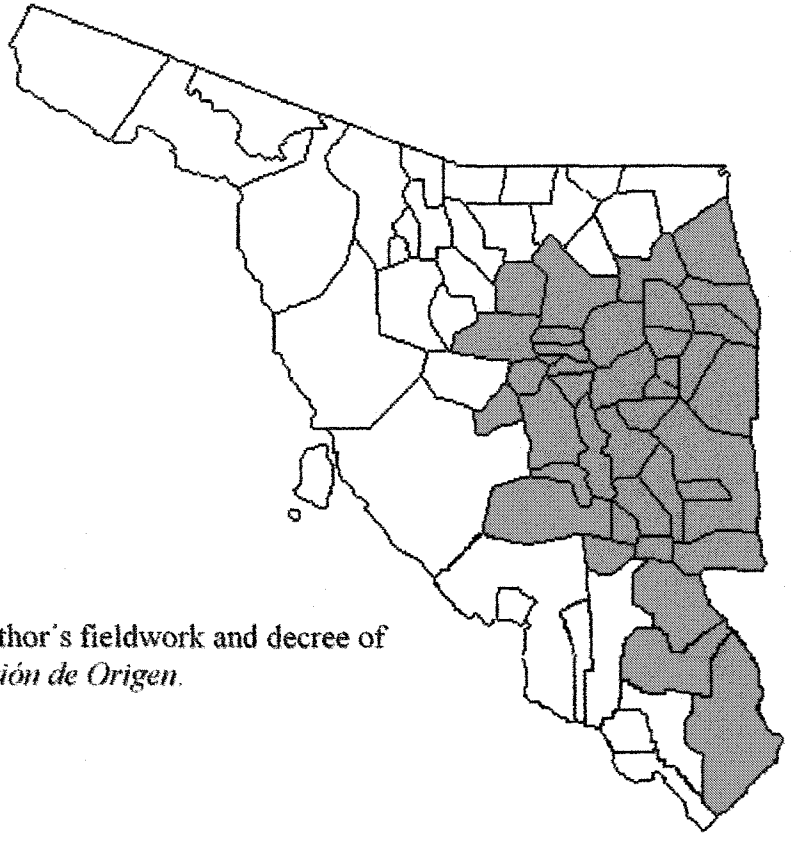
At the beginning of the 1990s, large ranchers with inordinate influence in the state government exerted pressure to reform the alcohol law and in 1992 the production and sale of Bacanora was legalized. The news spread quickly and many bacanora producers, freed from fear of prison or fines, decided to increase operations. The result was further pressure on already scarcer agave populations. More small-ranchers and non-employed *serrana* people entered the bacanora industry to diversify their livelihoods or as a new way of making a living.

My fieldwork indicates that in areas of major bacanora production the agave resource was depleted quickly. Locations where agaves were found in the wild ten or twenty years ago have been stripped of plants. Initially the areas more affected by overcollection were those in or near *ejidos* or rural communities, as stated by several bacanora makers. The *ejido's* or *comunidades'* land tenure system, wherein any member may harvest its resources, creates incentives to collect as many agaves as possible before other members might do the same. As an example, in Nácori Chico, on private property wild agave plants are abundant. However, in Nacori Chico's and Huépari's *ejidos,* agaves were cleared from the *ejido* land. In both areas *ejidatarios* have to request permission from private ranchers for access to their lands to harvest agaves in exchange for a *tercia* or *media* (one third or one half of the bacanora produced). My information indicates that

in places such as Bacanora, San Pedro de la Cueva, Cumpas, Moctezuma, Sahuaripa, and the towns located in the Río Sonora, plants are hard to find. In these areas the *jimador* or agave collector now has to walk farther and to higher elevations and deeper canyons to get enough agaves to produce bacanora. However, in places where the predominant land tenure is private property, such as Nácori Chico, Bacadéhuachi, some areas of Sahuaripa, and Huásabas, agaves are still abundant. In these areas, large ranchers who sell calves are not so dependent on bacanora production. For these ranchers, granting a permit to collect agaves on their properties provides them access to bacanora in return, prestige in the community because they are supportive bosses, and additional income for their cowboys. Although there are some *ejidatarios* who request permits from private ranchers to collect agaves, other *ejidatarios* prefer to steal them, and still others cheat on the production of bacanora by mixing it with sotol (*Dasylirion wheeleri* S. Wats.), a species found nearby.

I have found no data indicating population density for *A. angustifolia* in Sonora. However, anecdotal evidence collected from locals suggests that it was easy to find agave plants 15-20 years ago, but it is much more difficult now. Demographic studies are required to better understand the population sizes and dynamics of the resource, which also might provide insight into locating and establishing the best areas to cultivate the plant. Figure 1 illustrates 38 municipalities with potential for the cultivation of the species and the area of 35 municipalities that obtained the *denominación de origen* for bacanora.

Figura 1. Sonora: Some municipalities with potential for the domestication of *Agave vivipara* and current area of *denominación de origen* for bacanora.



Source: Author´s fieldwork and decree of *Denominación de Origen*.

Aconchi
Alamos
Arivechi
Arizpe
Bacadehuachi
Bacanora
Bacerac
Banámichi
Baviácora
Bavispe
Colorada, La
Cucurpe
Cumpas
Divisaderos
Granados
Huachinera
Huásabas
Huépac
Mazatán
Moctezuma
Nacori Chico
Onavas
Opodepe
Quiriego
Rayón
Rosario
Sahuaripa
San Felipe de J.
San Javier
San Miguel de H.
San Pedro de la C.
Soyopa
Suaqui Grande
Tepache
Ures
Villa Hidalgo
Villa Pesqueira
Yécora

4.2. Gathering the agave

Gathering agave plants is a labor-intensive process known as *jimada*, carried out by bacanora makers, known as *jimadores*. Although no formal division of labor is identified in this process in Sonora, the sons of a *jimador* often assist in the gathering process. Usually, the bacanora distiller is the same person that gathers the agaves.

The *jimada* is done on agave plants previously identified and *desquiotadas* (removal of the emerging flower stalk). In a good season the *jimada* begins in February and ends in May. This activity is preferably done on a dry day.

Jimadores leave their town very early in the morning bringing a burro, a *jaibica* (ax with a long handle), a machete, and sometimes a steel bar to pull out the heads (rosettes) of the *desquiotada* agaves. Or the *jimadores* park their trucks along the nearest road to which they can bring the heads, thus making transport to the *vinata* easier. The gathering is hard manual labor, and the strength of the *jimador* is very important. They often must walk long distances through difficult, almost inaccessible terrain to get only two or three heads of agave.

Once the *jimador* finds an agave capped the previous season, he cuts off the leaves with a machete and a *jaibica*, being cautious to avoid impaling himself on the sharp spines of the plant. All the leaves are cut off except for three or four from which spines are removed. These leaves are macerated, so they can be used as ropes to tie the head to the donkey. Once all the leaves have been cut off, the *jimador* inserts the metal bar at the base of the crown (between the head of the agave and the soil) and levers the head out of the

ground. Depending on the size of the head, sometimes this process may have to be repeated several times.

Once the agave is freed from the ground, the *jimador* ties it to the donkey and searches for the next *desquiotada* agave, repeating the same process until a suitable load is made. A donkey load can be composed of one single big head halved with the ax, or five to ten smaller heads. Sometimes the burro is left in a flatter area so that the *jimador* must bring the heads to the burro. This process also requires caution because the fresh cut agave may exude fluids containing sapogenins and organic acids which may cause irritation to the skin of the *jimador* or the burro, ranging from a rash to severe burn-like skin irritation and blisters. *Jimadores* wear long sleeve shirts and put a piece of fabric on their back to reduce contact with the agave tissues. Many *jimadores* who gather both *Agave palmeri* and *A. angustifolia* say that the former species is more irritating and that the rash and irritations can last for weeks. In some cases, medical help has been required.

4.2.1. Necessary conditions for gathering agave plants

During the summer rainy months, bacanora makers constantly search for new *quiotes* (the inflorescence emerging from the center of the agave rosette), an indicator of an agave that will be ready for harvesting in the following season (March to May next year). They cut the *quiote* from the plant with a machete or a rope as close to the base as they can, being careful to not slice into the head of the agave. Many *jimadores* argue that it is better to cut it with a rope because there is less damage to the plant, there is less chance of being pierced with the spines, and a clean cut to the base cut of the emerging

flower stalk results in a more tasteful head. Once capped, the plant needs no additional care, but the *jimador* must remember where he found it in order to relocate and collect it the following year.

In most cases, the *jimador* collects an agave capped the previous season. However, many *jimadores* now collect young, uncapped agaves to fill a load. Expert *jimadores* maintain that the spines and spine bases in reproductively mature agaves are black colored, the basal sections of the leaves become thicker and the leaves acquire a shiny color. Many *jimadores* argue that one should never be guided by the size of the plant because it is common to find 2-kg mature plants as well as 100-kg immature plants. Another indicator for the maturity of the plant is its sweetness. The problem with this is that the bacanora maker will not know how sweet the agave is until it is roasted.

No diseases or insect pests (*plagues*) have been studied for Sonoran *A. angustifolia* growing in the wild. However, field observations indicated that a larva drills holes in the heads and the bases of leaves of some mature plants. This larva is known as *gusano del maguey*, or maguey worm (*Acentrocneme hesperiasis*). It is very likely that this pest will increase when the agave is cultivated. I also observed the effect of stress of excess heat and drought in some small plots where agave plants were cultivated in Moctezuma and Arivechi in mid June. Water stress transformed the color of the plants from the common green to an opaque dark-reddish color.

4.2.2. Harvest season

According to bacanora makers, the lifecycle of an agave is 7-8 years from the time

the seed germinates to when the agave flowers, a process known as *enquiotado* (when the agaves develop the inflorescence). Once mature, agaves usually flower right after the June-July rains, and the growth of the inflorescence is a quick process that usually lasts about 10-15 days-- an impressive growth rate of about one foot per day.

Many producers say that about seven years after a plant germinates and establishes, the *quiote* emerges from the center of the plant, usually, but not always in the rainy months of June and July. The agave is then capped and in the following March-May, the *jimador* returns to collect the agave. Although *jimadores* do not have a scientific explanation for *desquiote*, they know from tradition that a capped plant will yield a sweeter bacanora. The *jimadores* know that rains affect the harvest, causing the heads to become bitter. However, they also suggest that hot and dry weather from March through May following a rainy year will yield good, juicy plants suitable for making the best of the bacanoras.

4.3. *Jimando* bacanora

Agaves for bacanora are collected from January to May in Sonora, before the summer rains. However, a few bacanora producers say that good agaves are also obtained from October to December, right before the *equipatas* or winter rains, contradicting what most other bacanora makers say. Although agaves are harvested in both seasons, the collecting window from March to May is more widespread. Producers I have interviewed claim that during that time the plant has higher sugar content because the plant is subject to the greatest water stress.

As mentioned before, the process of collecting agave from the wild or harvesting it from plantations is called *jimar*. Once an agave is *jimado*, the *vinatero* (bacanora maker) will bring the collected agaves to his facilities, a place called the *vinata* or *vinatería* in Sonora.

4.4. Facilities and equipment used in traditional production of bacanora

The facilities used for the production of bacanora include rudimentary equipment such as *el tren* (the train), a name given to the fully connected distillation equipment. It includes a pit in the ground about 2 m deep, with an opening about 1 m wide and a wider bottom part at about 1.5 – 2 m. This hole, called an *horno*, is used to roast the heads of agaves. There are some carved mesquite logs called *canoas* that are placed in the ground and which are used to shred the heads once they are roasted. *Canoas* are usually about 30 cm wide, 60 cm long and 5 to 10 cm thick. The basic technology includes two or three holes, called *barrancos*, which are used to ferment the *saite*, a mix of roasted and shredded heads of agaves. In all the places I visited, the equipment is hidden under the shadows of large trees, in canyons, or beside large rocks, out of the towns.

The site selection for the installation of a bacanora production facility evolved before and after the legalization of the activity. Before the legalization bacanora makers selected production sites in hidden and remote places, being narrow canyons (also called *barrancos*) the perfect location, providing a safe place, pure water, rocky soil, and privacy. Most *vinateros* report that a rocky soil is important for the construction of an *horno* because, although they are harder to build, these *hornos* keep the heat longer.

The required equipment now used for bacanora making is rudimentary. For the *jimada* one or two burros are required, *fustes* (saddle), rope, a *jaibica*, a water container, a *cencerro* (bell for finding the burros), a sharpening stone, and a pair of good *teguas* (shoes made of leather, common in the sierra of Sonora). The equipment required for bacanora processing includes a few 50 gallon drums, a copper coil, a copper or palm- lid called a *sombrero* (hat) to collect alcohol vapors, a *gargantón* (used to conduct the vapors from the hat to the coil), a couple of *baldes* (buckets), a metal cup, an *embudo* (funnel), and a 10-gallon aluminum keg.

Some of the changes that have occurred in the traditional production of bacanora since the legalization of the activity are that now the site selection for a *vinata* can be closer to the towns; some *vinateros* use diesel or electric powered mills; and pickup trucks substitute for burros in the transportation of agaves, water (sometimes brought from the towns), and firewood to the *vinata*. However, burros are still used in inaccessible places.

4.5. Steps for traditional production of bacanora

Once the heads are collected and transported to the *vinata*, they are placed in the *horno*, which was previously prepared by burning firewood, preferably mesquite or ironwood, on top of a pile of rocks within the hole. When the coals are ready, the heads of agave are then placed inside the *horno*. The *horno* is closed with a sheet of metal and sealed with mud, which is added to the edges of the metal lid to avoid loss of heat. After two to four days, the cooked heads are taken out of the hole. At this time, the color of the heads has changed from white-yellow to a dark brown. Some people cut slices of the head

at this stage and sell them as *pencas de mezcal* or *maguey tatemado*. The product is a fibrous slice of roasted juicy agave with a sweet and smoky flavor reminiscent of molasses.

Using a *jaibica* (axe) that has a head like a hammer on one side and a sharp edge at the other, the heads are carefully shredded in the *canoas*. Once shredded, the fibrous heads are placed in the *barranco* with or without water covering the pieces. A lid is placed on top of the *barranco* to protect it from dust and other impurities. Then begins a process of natural fermentation that takes from five to ten days depending on the quality of the water used and the environmental humidity. It is said that the longer the fermentation, the better the bacanora obtained. However, there is a danger of spoiling the *saite* if the fermentation process takes too much time. When this happens the *saite* is called *avinagrado*, meaning that the *saite* has been transformed into vinegar.

When the mix or *saite* is fermented, it becomes dark and foamy. The *saite* is taken to a container, usually a 50-gallon metal drum, to be distilled. A special lid made of copper or carved from a palm tree is placed on top of the drum. This lid, called *el sombrero* (the hat), is connected to a copper coil placed inside another drum. A *gargantón*, which is a copper pipe or a hollowed branch of a tree, makes the connection between the drums. The coil is cooled with fresh water. Firewood is burnt under the *saite* container, and the distillation process begins. The vapor generated by the boiling is trapped in the hat and conducted through the coil. The cool water around the coil condenses the vapor and the liquid drips into a container at the end of the coil.

The initial product obtained is called *chuqui* (the best, the purest). From this, the first part of the distillate called the *cabeza* or the head, and the last part, called the *cola* or

the tail, are separated because the high methanol content of the former makes it dangerous for human consumption. The *chuqui* is again placed carefully in the drum now cleaned with water, and is mixed with some *cabezas* and some *colas* depending on the desired flavor and alcohol content. This latter process is called *la segunda pasada* (the second round), which is a process to set right the bacanora.

Some bacanora makers mix good bacanora with distilled water and cane sugar to increase yield. This is bacanora *rebajado* (or altered); although it increases income for some of them, selling it ultimately taints the reputation of the *vinatero*, who may have problems selling his product in the future.

The yield obtained varies depending on the biomass of the agave. Some studies assert that to make 40 liters of bacanora, 60-70 maguey heads are required (Bahre and Bradbury, 1980; Granado-Sánchez, 1993). Several informants said that 40 big heads or 180 small heads equivalent to 500 kg to 600 kg of agave are enough to produce 10 gallons.

4.6. Scaling up bacanora production

For decades bacanora makers continued manufacturing the liquor on a small scale because 1) the activity was prohibited; 2) producers had to work in hidden and almost inaccessible places; and 3) the supply of agaves was not constant. Due to the small-scale and clandestine nature of the operations and the absence of agaves in a predictable and sufficient supply, the technology for the production of bacanora did not improve. Now

that the laws have been changed and agaves can be planted commercially, a steady supply of agaves might become a reality.

There have been few attempts at commercial agave plantations in Sonora, and most bacanora producers still rely on wild agave plants. In addition to the hundreds of small-scale bacanora producers spread along the sierra of Sonora, there have been several commercial attempts at producing bacanora. One is an enterprise based in the town of Cumpas that produces "Bacanora Real"; the other enterprise established reception centers in some *serrana* towns to purchase the liquor from small, informal producers. The liquor was mixed, bottled, and sold under the label "Bacanora de Sonora".

The "Bacanora Real" processing plant initiated an ambitious production and commercialization program. However, the owners were forced to close operations by the tequila industry because they made use of the term "tequila-bacanora" on the label, thus violating the *denominación de orígen* that protects the tequila industry.

The "Bacanora de Sonora" enterprise follows a different path by pursuing the *denominación de orígen* for bacanora, and initiating a small-scale experiment to cultivate agaves. The goal is to establish plantations to secure a reliable source of agaves and uniformity of the product.

Before the legalization of bacanora, the Sugish family, a Yugoslavian family that immigrated to Sonora and dedicated itself to agriculture and the sale of alcoholic beverages, sold a bottled distillate from 1934 to 1974. They established their operations in Mayo land under the label "Yocogigua" (*donde comió el tigre*)--where the tiger ate. This is interesting because bacanora production and commercialization was banned at that time,

suggesting that there must have been a concession from the government of Sonora to the family. A liquor distilled from *A. angustifolia* was marketed in many liquor stores in southern Sonora such as in Guaymas, Empalme, Obregón and Navojoa. There is no evidence that "Yocogigua" was sold in Hermosillo and other northern cities of the state. A source with vast experience in mescals in Sonora informed me that "Yocogigua" liquor was of a very poor quality (Armando Noriega, personal communication).

The Sugish family began a plantation of agaves on their farmlands, which included several species (David Yetman, personal communication). However, the plantation and facilities were abandoned after the distillery was expropriated.

4.7. Incentives and technology to scale up

In addition to increasing the quantity of available agave plants, another way to increase bacanora production is the introduction of technological innovations (Stevens and Jabara, 1988), such as more efficient roasters, e.g., autoclaves; improved fermentation techniques, e.g., use of selected strains of yeast; and more efficient distillation technologies that reduce waste. All these could contribute to an increased bacanora production at a lower cost per unit of bacanora produced. However, bacanora producers are usually resource-poor farmers who cannot afford such technology. Additionally, the introduction of modern technology might affect the taste, smell, and quality of the traditional bacanora. The reduction of hazardous compounds such as methanol would be an important achievement. The use of autoclaves instead of traditional firewood roasting pits could alter the flavor given to bacanora, if that flavor is affected by the minerals and

bacteria found in the soils, as Gentry (1982) suggested.

From the perspective of factor costs, the opportunity cost of land for small *ejidatarios* and *comuneros* is almost zero, since ranching activities require a lot of land per animal unit compared to that needed for agave production. Labor costs are also low and many *ejidatarios* from the region prefer to migrate temporarily to the United States rather than accept a Mexican minimum wage of 34 pesos a day (about US $3.40). At this time and scale of operations the manufacture of bacanora is a good business as long as the producer does not have to hire labor. During fieldwork interest rates were very high, at about 40%. Thus, capital costs were also high. Consequently, the purchase of new technology and the introduction of technical change is impractical for many current and potential small bacanora producers.

Additional ways to increase the production of bacanora would be to temporarily eliminate taxes once the product becomes registered, to subsidize inputs used in agave plantations, or to subsidize interest rates for agave growers and bacanora makers. The idea of such policies is to help the development of the emergent bacanora industry.

4.8. The quality of bacanora

Bacanora still does not have an official standard, as is the case of tequila or mescal. The tequila standard permits the introduction of 49% other sugars, and mescal allow for up to 20%. For the emergent industry of bacanora, the commission formed to deal with all issues related to the liquor decided to ban the introduction of other sugars, in order to have a specialty liquor as is the case of cognac from France.

From the producer's perspective, a bacanora maker with about ten years experience commented that "an excellent bacanora is distilled at no less than 50°, and when the bottle of bacanora is shaken it forms bubbles called *perlas*, that last from 30 to 60 seconds." Another producer said that bacanora "must be smooth but with a strong flavor of roasted *penca de maguey*." One bacanora maker mentioned that "1/4 liter of a good bacanora is enough to make a person drunk, or less if the person does not have drinking experience." A very old and respected bacanora maker, with more than 35 years of experience, said that "*entre mas tiempo se añeja, mejor se pone*" (the more time the bacanora is aged, the better quality is obtained).

According to several bacanora producers, an altered bacanora can be easily detected because when the bottle is shaken the *perlas* formed are too big and disappear too quickly. The flavor also helps to identify adulterated bacanoras which taste more like alcohol and/or sugar. And, the longer it is stored, the worse the flavor.

The Sonoran Institute for Environmental Studies (IMADES) conducted research to analyze and optimize the production of bacanora in a pilot plant constructed at the Centro Ecológico in Hermosillo. They made a physical and chemical analysis of four different types of bacanora: 1) the bacanora that IMADES research team produced at their pilot plant; 2) a sample from a traditional producer from Bacanora; 3) a sample from 'Bacanora de Sonora' brand; and 4) a sample from 'Bacanora Real' brand. The results were compared with values issued by the *norma oficial* that regulates the tequila industry.

The physical and chemical properties of the bacanora produced at IMADES pilot plant were within the parameters issued by the *norma official* of tequila. However, the

flavor was different from the characteristic flavor of bacanora. Methanol content was lower in the pilot plant bacanora than in the other bacanoras. In all other cases, methanol content was higher than that permitted by the *norma oficial*. The research team wrote that the reason for lower methanol content in their pilot plant might be the result of using juices from stainless steel fermented agave in controlled environment, instead of a typical fermentation in *barrancos* (IMADES, 1998).

Recently I submitted a proposal through the chemistry team of CIAD, A.C. to conduct a project designed to characterize bacanora and to establish standardization and a norm. The project was submitted for financing and was approved.

4.9. Costs and benefits analysis

A cost analysis indicates that bacanora production is not a capital-intensive activity under the current methods of production. There is only a small cost associated with the collection of agave plants, and bacanora makers do not incur the costs of raising the agaves, a resource that they take for granted. This cost-benefit analysis will not consider the costs of growing the plant under plantation schemes, because currently there is no information for cultivated agave in Sonora. Thus, I will analize the costs and benefits of an average traditional small-scale bacanora producer.

The costs presented here are average costs expressed by the 16 bacanora producers interviewed. Such costs were averaged in terms of quantity requirements of every item used for the entire process, as the quantities varied according to particular needs. The answer to the question about the list of the equipment used for bacanora

making was invariably the same from the producers in the two areas surveyed. Capital costs were divided into equipment for *jimada*, and equipment for processing.

For the *jimada* process the essential equipment and costs are:

• Two burros	$800.00 pesos
• Two *fustes* or cargo accessories for burros	$300.00
• Ropes	$ 50.00
• One *jaibica* or ax	$150.00
• One *anfora* or water container	$125.00
• Two *cencerros* or bells for burros	$ 80.00
• One *piedra de afilar* or a sharpening stone	$ 40.00
• A good pair of *teguas*	$180.00
SUBTOTAL	*$1,725.00*

The basic equipment and costs required per year for agave processing in a typical *vinata* are:

• Six 50 gallon metal drums	$150.00 pesos
• One *culebra* or copper made coil	$500.00
• One copper or palm-made *sombrero* or hat	$300.00
• One copper-made *gargantón*	$150.00
• Two *baldes* or buckets	$ 60.00
• One *sarten de colita* or a metal cup	$ 30.00
• One *embudo* or a funnel	$ 25.00
• Two 10 gallon aluminum *barricas* or drums	$750.00
SUBTOTAL	*$1,965.00*

Operating (labor) costs per round for the whole system are:

• Jima	5 days at $100 pesos/day	$500.00
• Firewood collection	1 day	$100.00
• Roasting	1 day	$100.00
• Shredding	1 day	$100.00
• Fermentation	5 - 10 days waiting or *jimar* during that time.	
• Distillation	2 days	$200.00

10 days at $100.00 pesos/day make $1,000.00 pesos for labor.

SUBTOTAL $1,000.00 / 1 round

Or in a year (5 rounds) *$5,000.00*

TOTAL PRODUCTION COSTS (year 1) **$8,690.00**

As indicated above, the initial investment for a new producer of bacanora is $3,690.00 pesos. Once the bacanora maker purchases the equipment, the labor costs will be the only costs incurred for several years. Labor cost is the opportunity cost of making bacanora versus working as a cowboy, attending a *parcela*, or working as a *jornalero*. Labor costs used here are an average of what farmers said they would earn in other activities. Sometimes a family member, usually a son or the person who will inherit the processing facility and the techniques, assists the bacanora maker.

In the Sonoran sierra, traditional small bacanora makers produce about 250 to 300 liters per year, requiring about five rounds of labor at a cost of $5,000.00 pesos. Producers set the price of a liter of bacanora at $100.00 pesos. Gross revenue for an average producer is about $25,000.00 to $30,000.00 pesos per year. Because there are no taxes or any other budgetary transfer from their revenues, the gross revenue becomes total revenue for bacanora makers.

Assuming that the equipment for the *jimada* and for processing has a lifetime of five years and the salvage value of the assets is zero, and by using a straight-line depreciation method (Zerbe and Dively, 1994), I calculate that the bacanora maker can charge $1,000.00 worth of depreciation each year.

The average net benefit for typical bacanora maker after discounting $5,000.00 pesos for labor costs and $1,000.00 pesos for depreciation totals $19,000.00 to

$24,000.00 pesos per year. Although not a big sum, this amount becomes an important complement to the wages earned in the sierra by a typical cowboy or small-scale rancher who sells a couple of calves a year.

The results of the costs-benefit analysis indicate that the production of bacanora is a profitable activity. The diversification from traditional ranching activities into bacanora production is one alternative to deal with the low productivity and financial problems that affect rural families in Sonora, while family specialization is another. Few individuals in a town master the techniques for producing bacanora. Such techniques are learned from parents and closest relatives. In the same way, knowledge and experience is passed on to descendents. The future bacanora producers of the towns, however, will face different challenges such as agave scarcity and increased competition motivated by the lack of regulation for the emergent industry.

4.10. Potential uses and by-products of *Agave angustifolia*

Considering the many uses that agaves have, this section discusses potential by-products, beyond bacanora, that might be derived from *A. angustifolia*. The idea is to explore whether the species could be cultivated not only for the production of liquor, but also for fibers and drug extraction. This knowledge is important for farmers when deciding the best possible use for a crop. Consequently, a farmer could decide to cultivate 3 hectares of agave plants a year for bacanora, or only 1/3 of a hectare for drug extraction. Additionally, he might prefer a species that yields wide and large leaves, if the agave is cultivated for fiber production. This process of decision making helps in the allocation of

resources in agriculture.

Fiber production from agaves has a long tradition in Mexico. *A. sisalana* Perrine and *A. fourcroydes* Lem. are the principal species used for this purpose. Both species are native to Mexico and the fibers are known in international markets as sisal and henequén, respectively. Henequén production is small and limited to Mexico, Cuba and some South American countries. In contrast, the production of sisal is large, with Brazil, Kenya, Tanzania and Mozambique as the largest producers in the world.

Since the introduction of sisal into African countries, world production grew steadily and reached a maximum of about 660,000 tons, from which East African countries produced about 220,000 tons by the late 1960s, and Brazil 230,000 tons by the late 1970s. However, the introduction of synthetic fibers adversely affected sisal production all over the world, thus reducing its production to about 300,000 tons in 1994 (FAO, 1995).

Both sisal and henequén yield coarse hard fibers, which are excellent for the production of twines and cordage. Sisal fibers are also used for specialty paper production for industries such as cigarettes, bank notes, filters, and Bibles (Judt, 1993; Clark, 1965). The pulp derived from sisal has high tear strength, good porosity, high bulk, high absorbency, and high folding endurance. Additionally, sisal pulp can be mixed with other hardwood pulps to increase their strength, folding resistance, and porosity (Wood, 1997).

Sisal requires a tropical climate with moderate atmospheric humidity. *Agave sisalana* develops better in regions with 1000-1250 mm per year of precipitation, and like almost all agaves, requires well-drained soils. It is planted in densities ranging from 4000

to 5000 plants per hectare. However, sisal production is labor intensive because harvesting and processing are done manually.

It will be very important to study the *fibres* obtained from *A. angustifolia* to find out what potential that the fiber might have in the specialty paper and cordage industries. Analyses to determine tear strength, porosity, absorbency, and fold endurance will be required to conduct a cost-benefit study to learn about the profitability of the fiber. Finding the best use, defining the profitability, and understanding the markets for fibers from *A. angustifolia* could create an important alternative for agave growers in Sonora.

Agaves (primarily *A. sisalana*) also produce steroids from which hormones are extracted. From the steroids produced by agaves, cortisone is the most important compound. Agaves also produce saponins, a product that when mixed with water produces soapy foam. Saponins are the result of a combination of steroids and sugar. Saponins have hemolytic properties (break red blood cells). As a result of such knowledge an experiment was conducted in the University of Arizona in 1970 with the objective of finding a more effective anti-tumor substance extracted from *A. angustifolia* (Jado, 1971). Substantial amounts of saponins from the species were extracted using hot water. Jado (1971) separated the saponins into two and identified one as hecogenin and the other as tigogenin. Although saponins are toxic in blood, they are not toxic if eaten (e.g., sarsaparilla).

However, new studies are required to assess the steroids found in *A. angustifolia*. An evaluation of some compounds found in the species, not only from a chemical and biological, but also from an economical perspective, will determine if it has potential as a

medicinal raw material.

CHAPTER V. COMMERCIALIZATION PRACTICES AND ASSESSMENT OF MARKET POTENTIALS

"Borrachita de tequila llevo siempre el alma mia..."

(Popular Mexican song)

5. Introduction

The lack of a sound marketing study, an inadequate market assessment, the underestimation of market competitors, and a poor demand analysis are key elements that reduce producers' certainty. This chapter will review several aspects related to the potential commercialization of bacanora and provide an evaluation of the potential markets based on statistics provided by the tequila industry. This information will be useful to understand and estimate the full potential of the bacanora industry.

The marketing section included in this chapter offers an interpretation of current formal, informal, and potential markets for bacanora in Sonora. Additionally, a pilot survey was applied in Hermosillo and Bacanora to learn more about consumer's preferences and tastes. The survey was applied to 51 individuals divided into three groups: industrial workers, agricultural workers, and university graduates. From randomly selected informants, only individuals who have consumed bacanora were asked to answer the survey, based on the assumption that individuals that have not tried bacanora would not be able to provide useful answers about preferences and tastes of bacanora as compared to other liquors.

Industrial workers were selected from a randomly selected factory located in an

industrial area in Hermosillo. The surveys were given outside the workplace during a lunch break. The survey was answered and returned immediately. For this category, 15 surveys were completed.

The surveys of agricultural workers were administered in the town of Bacanora. The selection criteria were to choose people who had drunk bacanora and who worked as farmers, a very easy task in the sierra. Once selected, they were called to an office to respond the survey. The survey was administered in the afternoon when rural workers came from their work. For this category, 24 surveys were completed.

The surveys applied to university graduates were handed out in their office and collected the following day. The selection criteria were that the targeted subject had a university degree, had consumed bacanora, and was willing to participate in the survey. For this category, 12 surveys were completed.

A trial survey was applied at the end of 1998 and was corrected to adjust the questions. The average time required to answer one survey was 5 minutes and 30 seconds. In all cases the respondent answered without any help. The subject received a copy of the survey and a pen only, indicating that all the respondents knew how to read and write.

5.1. Marketing bacanora

Marketing is defined as the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational goals (Pride and Ferrell, 1991). A marketing strategy will be fundamental to achieve success in the bacanora project. It is precisely here where

many rural projects targeting small farmers fail due to the prevalence of segmented or incomplete markets (Monke and Pearson, 1989), and lack of market knowledge predominates in many rural areas. Market knowledge gives power to farmers (Timmer et al., 1983) to negotiate a reasonable or a competitive price for their crops.

A bacanora marketing strategy must be consistent with the marketing policies implemented at the macroeconomic level by the federal and state governments. As such, the government should have the objectives of: a) protecting bacanora makers and consumers from traders who in many cases distort prices; b) contributing to the stabilization of bacanora prices through output price policies, by creating incentives to increase competition, and if necessary, through temporary government intervention; c) pursuing the reduction of marketing margins by narrowing the gap between consumer and producer prices; and d) establishing and improving minimum standards for quality of bacanora, as well as providing improved information to marketing system participants (Ellis, 1992; Monke and Pearson, 1989).

The goal should be to create a regulatory frame rather than incentives for governmental intervention. In general, providing an environment for increased competitiveness and efficient market operations should be the final goal of bacanora marketing policies.

In a deregulated and free open economic environment, firms, not governments, compete for markets (Porter, 1990). The marketing strategy of the emergent bacanora industry should include the selection and analysis of the target market, creating and maintaining an appropriate mix (product, distribution, promotion, and price) that will

satisfy targeted consumers. Thus, a marketing strategy should elaborate a plan to meet the objectives of the firm and maximize its resources (Pride and Ferrell, 1991; Churchill et al., 1990).

5.1.1. Some elements for a bacanora marketing strategy

Culture, beliefs, and identity of targeted consumers are fundamental elements of a marketing strategy. Additionally, the firm and the product must identify a culture, beliefs, needs and mysticisms. Immigrants coming from the sierra heavily populate Sonoran cities while conserving and recreating cultural patterns inherited from their parents and ancestors. Homesickness (*añoranza*) and feeling that they are part of a community are characteristic of such migrants. *Serrana* people also consider hard work and manual labor, the direct contact with their land, and their communities as important elements that bind them. All these elements are valuable in the planning and execution of a bacanora marketing strategy targeting Sonoran consumers.

A national level bacanora marketing strategy should target Sonoran people living outside the state. The strategy should consider some of the elements mentioned before, but an aggressive marketing strategy should also include regionalism and identity. For Sonorans living outside the state the strategy should target them as potential consumers sharing values that identify Sonoran people in the country.

5.1.2. Current domestic markets

The marketing channels for bacanora can be classified into formal or informal

depending on whether or not the market transactions are made by using regulated or unregulated distribution channels.

Informal markets play a very important role in Mexico. They provide much of the rural income to small farmers. Informal markets are the result of economies where official prices and rigid market regulations have driven supplies underground (Timmer et al., 1983).

Even though the production of bacanora is now legal, marketing channels are still informal, since the commercial infrastructure has not developed. In the informal market, bacanora is produced, distributed, and consumed illegally since none of the agents involved in the marketing channel pay taxes in any stage of the process.

5.1.2.1. Formal marketing channel

Formal production of bacanora means that producers have the required permits and meet the minimum governmental regulations. Bacanora is produced formally and legally in Cumpas and in the towns of Bacanora and Sahuaripa. Searching for the product in the formal market, I found the liquor for sale under one brand in two places: at the airport and at one liquor store in Hermosillo. It is possible that the liquor is currently sold in other liquor stores in other large cities of Sonora.

The business operating in Cumpas sells the brand "Bacanora Real." They have a processing plant and make use of agaves collected from the wild, although the owners are making efforts to establish agave plantations. I did not find the brand "Bacanora Real" in domestic markets. However, a Douglas-based distribution company was selling the liquor

in some cities of Arizona (Jesús Enríquez Burgos, personal communication).

Bacanora producers usually do not have incentives to sell their bacanora to the *centros de acopio*. However, in bad times of the year and in emergencies they may have to sell a few gallons to get some cash. Two producers of bacanora confessed to me that they produce two bacanoras: one for self-consumption and direct selling and the other for *centros de acopio*. The latter bacanora is a cheaper spirit of lower quality and sometimes with sugars added for faster fermentation. The producers harvest immature agaves, and may add *sotol*, a distilled beverage made from *Dasylirion wheeleri*, a very abundant member of the beargrass family (Nolinaceae).

The bacanora is filtered, standardized at 42% of alcohol, and checked for methanol content in a laboratory in Hermosillo. The liquor is then bottled and marketed in a 750-ml glass bottle. This product is marketed in two forms; enclosed in a leather-hinged pine box, and without the box. The label on the bottle has a Yaqui Indian dancing the *danza del venado*, similar to that found in the seal of the state of Sonora. In the store that I checked, the bottle without the box had a retail price of $104 pesos (US $10.40), and the bottle in a pine box had a retail price of $154 pesos (US $15.40) at the beginning of 1999. I was unable to locate other sizes or brands in the market. The business that collects and purchases the bacanora from bacanora makers in Sahuaripa pays local *vinateros* $180 pesos (US $18.00) per gallon.

The brand "Bacanora Rancho el Trigo" is marketed by a former mayor of Sahuaripa. When interviewed he mentioned that he produced bacanora in a very traditional way. He said that he has many agaves in his 8000-hectare ranch named *El Trigo*, located

east of Sahuaripa. He claims to use artesian water obtained in his ranch. Production in 1998 was estimated at 500 gallons (Manuel Valenzuela, personal communication).

Mr. Valenzuela said that he will not establish any commercial plantation because he does not have a problem with agave scarcity in the short run. "Our strategy," he argues, "consists in the following. Every time we cut the inflorescence of an agave, we found 4 or 5 more small agaves around the original one." He thinks that because of this vegetative reproduction, and the care they take during the *jimada* process, they will never have problems with lack of raw material. He estimates that the population in his ranch has increased substantially in the last 4 years as a result of such vegetative reproduction. However, he thinks that in the future he will pursue the agave plantation scheme if the results in the domestication project in Bacanora are successful.

The bacanora "Rancho el Tigre" is sold in half-gallon bottles at a price of $250 pesos. The product is sold in the town of Sahuaripa and many times there are buyers who come to purchase it to take to Hermosillo. His bacanora was taken to Europe by a group of business students who gave out free samples in bars.

The label does not show a permit. Manuel said that he will not get a permit because he is mayor and he does not need it at this time. Inspecting the bottle reveals several impurities, probably the result of an ineffective filtering method. Alcohol content is 45 % but he said that they are trying to standardize the product at 42 %.

5.1.2.2. Informal marketing channel

Bacanora produced without permits can be found in most small towns of the

Sonoran sierra. Even though the vast majority of bacanora makers operate illegally, contacting them is easy. In the informal market, bacanora can be purchased from small quantities to a barrel although the standard measure for bacanora is one gallon. The price for one gallon ranged from $300.00 to $500.00 pesos in 1999, depending on the quality (*chuqui*, tail, or a mix with *sotol* or *lechuguilla* (*Agave palmeri*)), the availability of the product, and other factors (e.g., friendship, and the occasion).

5.2. Potential domestic market and consumer preferences and tastes

Bacanora has a potential market because the product is part of the culture of a region, a culture that reinforces an identity of an important sector of the Sonoran population. To increase the share of bacanora in the national markets, the bacanora promoters should design a marketing strategy focusing in its differences from tequila of Jalisco, such as counterexploiting the *machismo* message associated with tequila drinking.

Additionally, to increase markets a diversification of the bottle sizes, color, labeling, and year of production is required. A detailed study should be done to find a mix of bacanora with other beverages or inputs to create a characteristic drink, as is the case with tequila and margaritas. The traditional mixes can be adopted as part of an international marketing strategy as well.

The results of the survey on consumer preferences and tastes are given in Table 5.1. In the absence of a more comprehensive market analysis with an adequate sample size, this survey is a preliminary contribution to the study of demand for bacanora, as well as the first attempt to measure what the bacanora consumers think about bacanora.

Table 5.1. Results of Preliminary Bacanora Market Survey among Agricultural Workers, Industrial Workers, and University Graduates.
Chi Chi-square (χ^2) tests for differences between groups; N.A. = not applicable.
With 2 degrees of freedom, a $\chi^2 > 5.99$ corresponds a $p < .05$.

Question	Agricultural Workers	Industrial Workers	University Graduates	X^2
Know the price of bacanora?				
Yes	21	6	3	16.01
No	3	9	9	
Buy bacanora in stores?				
Yes	24	13	12	4.99
No	0	2	0	
Pay premium for bottled bacanora?				
Yes	24	13	12	4.99
No	0	2	0	
Color of bottle?				
Clear	18	2	11	22.19
Dark	4	12	1	
Have you mixed bacanora?				
Yes	21	1	0	36.49
No	3	14	12	
Buy less if price of bacanora increase?				
Less	24	8	6	15.55
Same	0	7	6	
Buy more if price of bacanora decrease?				
More	0	9	3	18.49
Same	24	6	9	
Buy more bacanora if income increases?				
More	0	0	4	14.11
Same	24	15	8	
Buy less bacanora if income decreases?				
Less	6	12	12	22.51
Same	18	3	0	
Buy more bacanora w/tequila price increase?				
More	0	5	0	12.96
Same	23	10	12	
Buy more bacanora w/tequila price decrease?				
More	0	0	0	N.A.
Same	23	15	12	
Buy less bacanora w/beer price increase?				
Less	3	0	3	4.48
Same	21	15	8	
Buy more bacanora w/beer price decrease?				
More	0	0	0	N.A.
Same	24	15	11	

One hundred percent of the industrial workers identify themselves with the sierra, compared to only 25% of university graduates. The results confirm the frequent assumption that many *serrana* people coming to Hermosillo end up working in industry. Of those surveyed, 80% of industrial workers and 25% of university graduates have relatives in the sierra. The fact that many workers still have bonds with the sierra indicates they may be potential bacanora consumers who might respond to homesickness or identity signals.

The liquor consumption results indicate that industrial workers and university graduates prefer beer to bacanora. To the question: "what liquor do you consume more?" 38 % of surveyed agricultural workers chose beer. However, the relationship is completely different in the city where bacanora is scarcer and beer is abundant. The results show that 60% of industrial workers and all university graduates surveyed consume more beer than bacanora or any other liquor, with bacanora as their second choice. The frequency of consumption results indicate that bacanora is consumed somewhat less frequently in Hermosillo. Twenty-seven percent of industrial workers responded that they have consumed bacanora within the last six months. University graduate responses indicate that 50 % have consumed bacanora within the last year.

To obtain insights about the smell and flavor characteristics of bacanora, the following question was included in the survey: "what do you like the most about bacanora? Flavor, smell, color, lack of hangover, other (specify)." From all responses, the flavor was the most important characteristic selected.

The results show that all agricultural workers would buy bacanora if it were sold in

convenience stores. This entire group also answered that they would gladly pay a premium price for the liquor if they could find it bottled. The results were highly significant. The case for industrial workers was similar. About 87 % of them answered that they would buy bacanora from convenience stores, and the same percentage would pay a premium price if it were sold in bottles. All university graduates responded that they would buy bacanora if sold in convenience stores, and they would pay a premium price if it was sold in bottles. There are already consumers willing to pay a premium for the bacanora if available in convenience stores.

The answers to the question regarding the size of the bottle were that the 1-liter presentation was most preferred, followed by the 500-ml bottle. However, to the question regarding the preferred color for the bottle, my hypothesis of a dark bottle preference by agricultural workers and university graduates was rejected. They preferred the transparent bottle instead (75 % and 83 %, respectively). The results were highly significant. The reason probably lies in the importance that the appearance of the product has for consumers. A consumer will have more confidence if he or she can see what they are buying. In this sense the dark bottle, even though it is said to better conserve the characteristics of bacanora, is not preferred over the clear one.

The answer to the question "have you ever drunk bacanora mixed with other beverages?" yielded unexpected results. My hypothesis was that urban individuals would be prone to mix bacanora because of their familiarity with mixed drinks made out of tequila, brandy, whiskey, and so forth. However, agricultural workers answered that they have mixed bacanora with different types of soda. Only 13% of agricultural workers have

not consumed bacanora mixed with soda. All industrial workers and university graduates have consumed bacanora without any mix. This is perhaps because agricultural workers sometimes might like to drink a cold alcoholic beverage, such as beer, but if they cannot afford beer, they might mix bacanora with a cold soda.

In response to the question "do you know some medicinal properties of bacanora?" all agricultural workers answered that bacanora cures high blood pressure and arthritis. Industrial workers answered that bacanora cures colds, bone pains, and arthritis. However, all of university graduates answered that they do not know about any disease cured by bacanora. For university graduates as well as many urban individuals, bacanora is liquor, while for rural people as well as for people who identify with the sierras, bacanora is more than liquor to get drunk with. The spirit of the bacanora has a real meaning for many people who believe and have faith in bacanora's healing powers.

Bacanora is most popular during winter or Holy Week fiestas. One hundred percent of agricultural and industrial workers prefer to consume bacanora during Christmas, 38 % during Holy Week. Fifty percent of the university-graduate group preferred Christmas time and Holy Week, with the "any other time" answers being their second choice. As expected, bacanora is consumed more during the fiestas when most people get together for celebration. The *gente de bien* or *gente de razón* (people of good mind) drink it in the company of friends or relatives during the fiestas, preferably in cooler seasons.

About 92 % of surveyed agricultural workers preferred the sierra as the place to drink bacanora. They responded that they consume more bacanora with friends in the

borracheras. Weddings and baptisms are the second-most preferred occasions. In fact, many *serrana* people store bacanora for years for such special occasions. Industrial workers responded that they would prefer drinking bacanora in the sierra also, although they also like to do so at the beach. This group responded that gatherings with friends and weddings are preferred events for bacanora drinking also. Finally, university graduates consider funerals as the most appropriate event to drink bacanora, with hanging out with friends the second choice.

How each group would respond to a bacanora price increase was addressed in the survey. All agricultural workers surveyed responded that they would buy less. Forty-seven percent of industrial workers responded that they would buy the same quantity, while the remaining 53 % responded that they would reduce their consumption. Fifty percent of the university graduates responded that they would buy the same quantity, while the other 50 % would reduce consumption.

Following a bacanora price reduction, agricultural workers would remain indifferent, buying the same quantity. Forty-percent of the industrial workers would buy the same amount, while the rest would increase consumption. Finally, 75 % of the university graduates would buy the same quantity of bacanora if it price were reduced, while only 25 % would increase consumption.

If personal income increased, all of agricultural and industrial workers would remain indifferent in their consumption of bacanora. However, 33 % of university graduates responded that they would increase consumption with personal income increase. In response to the question of personal income decrease and bacanora consumption, 75 %

of agricultural workers would not change their consumption behavior, but 80 % of the industrial workers would reduce consumption. Industrial workers have very low wages in Mexico, and they are very susceptible to wage fluctuations. All university graduates would reduce consumption if income decreased.

To the question of how bacanora consumption would be affected by a reduction in the price of tequila, the survey indicated that all participants would remain indifferent. No one surveyed would reduce bacanora consumption if tequila price dropped. That means that bacanora consumers differentiate very well between the taste of bacanora and tequila. Something similar would happen between bacanora and beer. If the price of beer were reduced, bacanora consumption would remain unchanged in all cases.

The above results are indicators of preferences for bacanora from the perspective of a very small sample taken from agricultural workers, industrial workers, and university graduates. Nevertheless, many of the differences between groups were statistically significant. The responses to changes in consumption by increasing or reducing prices for bacanora, changes in personal income, and liquor substitutes support the idea that consumers would respond to market changes according to their status in the economy. Such responses also indicate an important degree of fidelity and loyalty to a specific liquor.

5.3. Potential international market

Production of tequila was 169.8 million liters in 1998 (CRT, 1999). If only a small fraction of the tequila market can be captured by the bacanora industry, the enormous

potential that the bacanora industry has is straightforward. This section will analyze the production and markets for tequila as a point of reference for the emergent bacanora industry.

The production of tequila has been increasing steadily in the last years, from 104.3 million liters in 1995 to 169.8 million liters in 1998. From this total production, 100 % agave tequila grew from 15.6 million liters in 1995 to 58 million liters in 1998. Meanwhile, regular tequila production grew from 88.8 million liters in 1995 to 111.8 million liters in 1998 (CRT, 1999).

Of the total tequila produced in Mexico, 34.1 % was 100 % agave and 65.9 % regular tequila. To reach this production, 672.1 million kg of agave plants were required. Of this, 55.9 % was used for 100% agave tequila, and 44.1 % for regular tequila. The above numbers indicate that on average 6.47 kg of agave made one liter of 100 % agave tequila, while 2.65 kg of agave made one liter of regular tequila. The regular tequila required 43.9 million kg of other sugars in addition to the agaves consumed (CRT, 1999).

Total tequila exports have increased steadily in the last years from 64.6 million liters in 1995 to 86.5 million liters in 1998. However, most of the recent increases in exports are accounted for by 100 % agave tequila, a market that grew from 1.2 million liters in 1995 to 5.1 million liters in 1998, about a five-fold increase. Meanwhile, regular tequila exports grew from 63.4 million liters in 1995 to 81.4 million liters in 1998, about a 20 % increase (CRT, 1999). International sales of tequila *joven* (young tequila) were 54.2 %, white tequila 36.6 %, aged tequila 3.2 %, and tequila *reposado* 6 %.

Fifty-one percent of total tequila production was exported. From total tequila

exports, 5.9 % was 100 % agave. The United States purchased 69.3 million liters (80.1 %). Germany, Holland, Belgium, and France purchased together 8.65 million liters (10 %), and 57 countries purchased the remaining exports (CRT, 1999). Raw tequila exports increased from 58 million liters in 1995 to 73.6 million liters in 1998, about a 20 % increase. However, bottled tequila exports increased from 6.6 million liters in 1995 to 12.9 million liters in 1998, a 100 % increase in 4 years (CRT, 1999).

These statistics indicate the importance of the production of the 100 % tequila in export markets, a production that has been increasing steadily in the last years. Considering the dynamism of the markets, bacanora makers should learn from this in order to negotiate a *norma oficial* based on the production of bacanora that is 100 % agave.

These data also highlight the importance of the United States market for the tequila industry (80 % of total exports), a situation that makes tequila producers vulnerable. Therefore, the efforts of bacanora producers should keep targeting the United States, although, a greater effort is required to access other high-income countries. It is also important for the bacanora industry to enter international markets with bottled bacanora, avoiding the exports of raw bacanora. The objective is to add value to the product in Mexico, generating more jobs.

CHAPTER VI. THE CULTIVATION OF *AGAVE VIVIPARA* IN SONORA

"Aún estoy hermoso,
con hojas verdes sentadas en la base de mi corona,
tengo frutos negros preparados en pie"
(Yaqui song)

6. Introduction

This chapter discusses relevant findings of selected studies conducted on various species of Agavaceae, such as *Agave deserti* Engelm, *A. fourcroydes*, *A. tequilana*, *A. mapisaga* Trel., *Hesperaloe funifera* (Koch) Trel. and *H. nocturna* Gentry. This work can provide information useful to the development of *A. angustifolia* in Sonora. *Hesperaloe* is relevant not only because it is a member of the Agavaceae with similar morphology and physiology, but because there is an ongoing effort to domesticate it in an arid environment, as we are attempting with *A. angustifolia*. A perennial crop cultivated in Arizona for its fibers, *Hesperaloe* may substitute for imported hard fibers obtained from abaca, sisal, and other tropical crops (McLaughlin et al., 1999).

The main purpose of this chapter is to review the literature pertinent to Agavaceae species with the intent to understand potential problems associated with producing *A. angustifolia* under cultivation. Topics addressed in this chapter include biology, associated species, soil-water-plant relationships, climate, and habitat of the species.

6.1. Taxonomy and Morphology of *Agave angustifolia*

The genus *Agave* (from Greek: admirable or noble) was first described by Linnaeus in 1753 who recognized four species, including *A. americana* L. *Agave* is the largest

genus in the monocotyledonous family Agavaceae in North America. *Agave* includes 136 species, 54 grouped in the subgenus *Littaea* and 82 in the subgenus *Agave*. These species are divided into twenty generic groups (Gentry, 1982).

The common agave of the Pacific slope was first described as *A. pacifica* by Trelease (in Standley, 1920-1926). Shreve and Wiggins (1964) followed this treatment, but Gentry (1982) considered *A. pacifica* to be a synonym of *A. angustifolia* Haw. However, Wijnands (1983, cited in Forster, 1992) considered *A. angustifolia* as a synonym of *A. vivipara.*

Prior to completion of this dissertation, however, Garcia-Mendoza and Chiang (2003) reviewed the recent work of Wijnands and others and determined that they had made some fundamental taxonomic and nomenclatural errors. *Agave angustifolia* and *A. vivipara* are in fact distinct species. The latter is native to the Caribbean area, and the former is the correct name for the widespread species extending into the Sierra Madre of Sonora.

Gentry (1982) discussed the variability of the *A. angustifolia* complex, listing seven varieties occurring within its range, including *A. angustifolia* var. *angustifolia*, *A. angustifolia* var. *deweyana* Trel., *A. angustifolia* var. *letonae* Taylor ex Trel., *A. angustifolia* var. *marginata* Hort. ex Gentry, *A. angustifolia* var. *nivea* Trel., *A. angustifolia* var. *rubescens* Salm., and *A. angustifolia* var. *sargentii* Trel. (Gentry, 1982). Forster (1992) also includes *A. angustifolia* var. *variegata* Trel.

To differentiate *A. angutifolia* from other agave species, Gentry characterized it as "short-stemmed plant, with multiple sword shaped leaves, [known as *espadín* or sword in

Sonora], with radial rosettes" (Gentry, 1972: 143). Gentry describes *A. angustifolia as* follows: "these agaves are 1 to 1.5 meters tall and 1.5 to 2 meters in diameter with leaves up to 50 to 120 centimeters long and 4 to 8 centimeters wide. The leaves are linear, rigid, straight, ascending, green or glaucous green to yellow green, with margins nearly straight. The teeth of the leaf margin are regular, generally 3 to 6 millimeters high and 15 to 30 millimeters apart, displaying dark brownish to black leaves with cusps flexed upward. The spines at the leaf tip are 15 to 20 millimeters long, dark brown, and flattened above the base. The inflorescence or panicle is 3 to 6 meters tall with 6 to 20 horizontal to ascending, short lateral branches on the upper one third to one fourth of the shaft, with long, triangular bracts measuring 5 to 12 centimeters" (Gentry, 1972: 143).

Gentry describes the flower as: "greenish yellow, glaucous lavender to brownish red or pale green in the bud, 45 to 65 millimeters long. The ovary is 20 to 30 millimeters long, including the short neck, 6-grooved at the apex, and pale green in color. The tube is 6 to 12 millimeters deep, 10 to 13 millimeters in diameter, 6-grooved from the tepal sinuses and pale green. The tepals are 15 to 24 millimeters long, 4 to 5 millimeters wide. The filaments are 35 to 45 millimeters long, inserted in mid-tube. The anthers are 18 to 30 millimeters long, eccentrically affixed. The capsules are 35 to 50 millimeters by 20 to 26 millimeters, ovoid to oblong and short beaked at the apex. The seeds are large, from 8 to 10 millimeters by 5 to 8 millimeters, shiny black, oblique, with a broad outcurving wing at the margin" (Gentry, 1972: 143-144).

Agaves are rosette perennials characterized by a long vegetative growth period prior to flowering. Although some agaves show prolific sexual reproduction, many others

appear to rarely or never set viable seed (Gentry, 1982). In the U.S., agaves are commonly called "century plants," because of a misconception about their longevity (Nobel, 1994).

As with all plants, roots are critical for agaves, not only for water absorption, but also for acquisition of essential nutrients that are obtained via the roots from the soil. Roots act as an anchor for the plant, as well as a storage reservoir for carbohydrates. Agaves have relatively straight roots originating from the base of the stem. The roots are generally thin, and have thinner lateral roots. The development of new roots can be influenced by soil moisture. Nobel (1994) found that infrequent rainfall contributes to the emergence of new lateral branches from old roots in many agave species, instead of creating new roots. However, during droughts, the new lateral branches are less capable of surviving.

One feature of agaves is the development of shallow roots in porous, gravelly or rocky soils, which is an ecological survival strategy in low rainfall areas. In arid and semiarid regions, the typical light rains do not wet the soil very deeply, and thus shallow roots are ideally situated to respond quickly. Additionally, the water conservation properties of the agave shoots help maintain a high water content in the plant during dry seasons (Nobel, 1994).

6.2. Ecology of *A. angustifolia*

Agave angustifolia has the most wide-ranging distribution of agaves in North America. It grows naturally from Costa Rica to Tamaulipas and northwestern Sonora, on

both Atlantic and Pacific coasts. The common plant communities where *A. angustifolia* is found are tropical savanna, thorn forest, and the tropical deciduous forests, ranging from sea level to about 1,500 meters (Gentry, 1982). This agave survives in the extreme arid habitats of the Sonoran Desert where average annual precipitation is about 250 mm or 10 inches, as well as the higher elevation of the pine-oak forest habitat where the average rainfall is 1,680 mm or 56 inches (Gentry, 1982). The typical habitats are sandy, gravelly, and rocky soils of the basin and range province (Gentry, 1972).

A. angustifolia is the most common agave of Sonora, and is also abundant in the coastal thorn scrub forest of Sinaloa and in general in the West Coast of Mexico (Gentry, 1972). The species is widely scattered in the tropical deciduous forest of the Sierra Madrean foothills in Sonora below the oak woodlands. It is, however, thinly scattered in the more arid desert of northwestern Sonora (Gentry, 1972).

A. angustifolia reproduces better in open sites than in shaded areas. However, plants occur frequently under the light shade of trees and shrubs with protection from animals and excessive heat (Gentry, 1982). Rocks or other vegetation provide shelter to agaves during the delicate seedling stage when droughts and browsing or trampling from herbivores may threaten them (Gentry, 1972). Once established, agaves are well adapted to the extreme climate variability characteristic of arid lands. They develop defences including bitter leaf juices, teeth, and spines to protect themselves from predators in such harsh environments (Shreve, 1936).

Competition occurs between agaves and other plant species, particularly in the earlier life-history stages. The seedlings of many agaves are vulnerable to herbivorous

insects and mammals, and to high temperatures near the soil surface. As the protected seedlings grow larger, they compete more intensely for nutrients, water, and sunlight with adjacent plants that originally provided shelter, thus potentially reducing the productivity of the latter. An example of this competition has been demonstrated between *Agave deserti* and *Hilaria rigida* Steud. (Franco and Nobel, 1988; Nobel, 1994). The plants with which *A. angustifolia* is most commonly associated in Sonora are mesquite (*Prosopis glandulosa* Torr. or *P. velutina* Woot.), *chirahui* (*Acacia cochliacantha* Benth.), *mauto* (*Lysiloma divaricatum* Benth.), *tepeguaje* (*Lysiloma watsonii* Rose), *torote* (*Bursera fagaroides* Brandeg.), and *uña de gato* (*Mimosa distachya* Benth. or *Acacia greggii* Gray).

Agaves exhibit crassulacean acid metabolism (CAM) characterized by nocturnal stomatal opening and CO_2 uptake (Nishida, 1963; Nobel and García de Cortazar, 1987). CAM is important for water conservation and a fundamental feature that enable agaves to survive in warm, moisture-stressed environments. Nobel and Harstock (1976) and Bidwell (1983) state that this metabolism is an adaptation that facilitates photosynthesis in arid lands. Prior experiments performed with CAM plants indicate that this photosynthetic pathway is associated with slow growth rates (Turner et al., 1966).

6.3. Environmental requirements

6.3.1. Soils

Agaves prefer sandy, gravelly, and rocky soils with good drainage and lack of

salts. Agaves "pioneer on hot rock surfaces and the geologically transient rubble of talus and outwash slopes" (Gentry, 1972: 2). Rocks and large boulders at the soil surface may enhance soil water potential in the rooting area of agaves (Nobel, 1994) by increasing the penetration of rainfall into surrounding soil by diverting water to their periphery. Local soil temperatures are different in the presence of rocks because soils and rocks have different thermal conductivities and heat capacities. Infiltration of rainfall and retention of soil moisture can both be increased by rocks at the soil surface (Agassi and Levy, 1991).

An experiment done with *A. deserti* in the Sonoran Desert indicated that the number of lateral roots per unit length of main root was 11 times higher under rocks and six times higher alongside rocks than in rock-free regions (Nobel, Miller and Graham, 1992; Nobel, 1994). This study suggests that rocks play a fundamental role in root proliferation for agaves in arid environments where soil water availability is a major limiting factor over long periods. In addition, large sand and gravel particles in the soil facilitate the penetration of rainwater, with a consequent diminished loss by evaporation and runoff, ensuring a better plant water supply than would occur with clay soils (Nobel, 1977; Walter and Stadelmann, 1974).

Agave angustifolia, as most agaves, grows best on well-drained and non-saline soils. Most of the plants of this species I observed during fieldwork grow in gravelly and rocky soils on the slopes and mountains all along the sierra. *A. angustifolia* thrive on high clay soils of Sonora.

The slope of a soil and its acidity are characteristics that have to be considered when selecting a site for an agave plantation. The slope of soils and their acidity influence

the rate of growth of agaves through their effect on erosion, nutrient uptake, and diseases (Valenzuela-Zapata, 2000).

6.3.2. Temperature and elevation

In general, extreme temperatures affect plant survival and distribution. According to Hadley (1970), temperature at the soil surface is about 30° C higher than the temperature of the air on a summer day. The soil temperature may reach 70° C in the Sonoran Desert (Jordan and Nobel, 1979), profoundly affecting the survival of seedlings. Although it has been demonstrated that with age, agaves become more tolerant to high temperatures, thermal tolerances must be considered when evaluating seedling establishment (Nobel, 1984a).

Soil temperatures also affect root respiration rate. Laboratory growth experiments with *A. deserti* simulated field environments characteristic of the Sonoran Desert. These studies determined the rate of root respiration for attached roots by measuring CO_2 efflux from the plant, and indicated that as root temperature increased during the day, the root respiration rate also increased (Palta and Nobel, 1989), thus reducing plant dehydration.

In nature agave seedlings sheltered under larger plants or among rocks are protected from high temperature damage at earlier stages. By intercepting sunlight, nurse plants can lower the maximal temperatures of the seedling tissues by more than 15° C (Nobel, 1994). Larger adjacent rocks also favor seedlings. Such rocks act as insulators (Jury and Bellantuoni, 1976). As a seedling grows, its leaves are extended into the air, experiencing lower temperatures than those found adjacent to the soil surface. Once

agaves mature, they become the most tolerant of high temperatures of all plant species (Nobel, 1994).

Some agave species may also be susceptible to frost and freezing conditions. This has also been suggested by experiments with *A. sisalana* in Arizona (McLaughlin and Schuck, 1991). Most agaves can tolerate cold temperatures when the air temperature gradually decreases over a period of days or weeks. The lowering of the temperature at which cell death occurs is a phenomenon termed *low-temperature acclimation* or *hardening* (Nobel, 1988; Nobel, 1994).

Below-freezing temperatures induce agaves to release heat through exothermic activity (Nobel, 1994), which leads to a temporary phenomenon referred to as *supercooling*, or maintaining the water inside the plant in a liquid state by raising the tissue temperature by the same amount of heat required to melt the ice crystals formed on the surface of cell walls surrounding the chlorenchyma cells. As the air temperatures continue decreasing, irreversible damage or death can occur to the plant as formation of extra cellular ice crystals leads to cell dehydration. An important low temperature adaptation of agave is the increase of sugars (glucose, fructose, and sucrose) to protect various cellular constituents during exposure to freezing temperatures (Nobel, 1994), an event that can affect a commercial plantation of *A. angustifolia* established in low temperature areas.

Temperature is also crucial for seed germination, a critical life-history stage in arid and highly competitive environments. Although no data are available for *A. angustifolia* in Sonora, seed germination experiments carried out for *A. deserti* and *A. lechuguilla* Torr. showed that 21° C was the optimal germination temperature. At this temperature 92% of

seeds germinated in six days, while at 34° C germination was drastically reduced to 31%, and at 11° C only 27% of seeds germinated. On the other hand, reports on *A. deserti* showed that root growth and expansion of cotyledons was greater near 30° C (Jordan and Nobel, 1979; Freeman, 1973).

According to Whittaker (1975), plant distribution is related to the elevation gradients of temperature and precipitation. This is the case in Sonora, a state characterized by elevations ranging from sea level in the west, to high mountains in the eastern sierra of 2400 to 2700 m. Nobel and Harstock (1986a) say that at higher elevations the temperature decreases and rainfall increases, affecting the establishment of new seedlings. Elevation is, therefore, another parameter that defines the range where agaves can best grow and accounts for differences in the productivity of agaves.

A. angustifolia grows in a broad elevation range from a few meters above sea level to the top of high mountains in the Sierras (Gentry, 1972). I observed plants growing on ranches near Hermosillo at elevations of 150 to 200 meters, in Empalme below 80 to 100 meters, along the road from Nácori Chico to Mesa Tres Rios at 1300 meters, and in the mountains between El Novillo and Bacanora at 1200 to 1250 meters, occurring there with *A. palmeri.*

Although more studies are required to characterize the optimal elevation range for *A. angustifolia*, field observations indicate that it is approximately 400 to 900 m. However, correlating elevation with other variables, such as type of soil, air temperature, and precipitation should provide additional insight for site selection for cultivation under intensive schemes.

6.3.3. Precipitation

In general, an arid region in temperate climates receives an annual rainfall of less than 250 millimeters (10 inches), while a semi-arid region receives 250 to 450 millimeters (10 to 18 inches) of rain. Both arid and semi-arid regions are found in Sonora. The most arid regions of the state are located in the center and northwestern coastal areas, while many parts of the sierra are semi-arid regions.

Studies demonstrate the importance of elevation on agaves as directly influenced by temperatures and precipitation (Nobel and Hartsock, 1986a; Nobel, 1988; Nobel, 1984b). Nobel and Hartsock (1986a) determined the productivity of *A. deserti* over its elevation range in the northwestern Sonoran Desert. They showed that elevation accounts for an important part of the species' distribution, and that water, rather than temperature, was the main factor influencing the productivity of the species.

Gentry (1982) noted that *A. angustifolia* can survive on as little as 250 millimeters of average annual rainfall, as is the case in the Sonoran Desert, as well as up to 1,680 millimeters of rain in the pine-oak forest region near Uruapan, Michoacán. However, INIFAP's (National Institute for Research on Agriculture and Forestry) field observations indicate the species prefers environments with annual rainfall averaging 700 to 1000 millimeters, as was derived from surveying several areas of the state where agaves have an important presence in the landscape (Teodoro Cervantes, personal communication). For example, in areas northeast of Sahuaripa, west of Bacanora, northwest of San Pedro de la Cueva, south of Moctezuma, east of Bacadéhuachi, and northwest of Nácori Chico, the

precipitation reaches 850 millimeters per year (Comisión Nacional del Agua, 1999), and the species is relatively abundant. However, the species is also plentiful in coastal thorn scrub with 350 millimeters of annual rainfall (David Yetman, personal communication).

Using the number of new leaves emerging as a parameter to estimate productivity, Nobel (1984b) experimented with *A. deserti* utilizing his environmental productivity index (EPI). The EPI is the product of the water index, the photosynthetically active radiation (PAR) index, and the temperature index measured on a monthly basis. Each of these indices has a value of 1.0 under conditions supporting maximum leaf production rates. The results indicate that water accounted for 97% of the monthly variation in the EPI. However, an experiment with *A. lechuguilla* in the Chihuahuan Desert suggests night temperatures had a more significant effect on EPI variation than water (Eickmeier and Adams, 1978). The EPI would have difficulty in predicting CO_2 uptake for irrigated *Hesperaloe funifera*, "since temperature and light do not interact in a simple multiplicative manner in this species" (Ravetta and McLaughlin, 1996: 221). In fact, irrigating wild *A. lechuguilla* on a weekly basis for two years increased shoot dry weight by 40% and root dry weight by 75%, which nearly doubles the weight increment of a plant receiving only rainfall (Nobel, Quero and Linares, 1989).

6.4. Management practices

Cultivated agaves in arid regions require different management practices than agaves cultivated in temperate and tropical regions due mainly to the differences in climate, topography, and soils. Mexican agave regions in Jalisco, Oaxaca, and Yucatán

have developed different management practices according to their specific physical characteristics and constraints. New agave producers in Sonora will have to develop their own management practices considering the biological and physical limitations and the experience obtained from other cultivated Agavaceae.

Currently there are three commercial plantations with more than three years of experience in Sonora. One is in the region of Cumpas, another is located 25 km east of Moctezuma, and the last one is in Bacanora. Additionally, agronomists working in the agave domestication project assisted producers in the establishment of several other commercial plantations during the year 2000. The plantations and their locations are: *La Huerta* ranch, located about 10 km south of Moctezuma (1,100 plants); *San Isidro* ranch, 23 kilometers southwest of Moctezuma (2000 plants); *La Pista* ranch, about 15 km south of Nácori Chico (3000 plants); *El Sauz* ranch, about 20 km south of Nácori Chico (600 plants); *El Molino* ranch, about 10 km east of Nácori Chico (600 plants); and finally, *El Bajío* ranch, about 5 km northeast of Nácori Chico (2960 plants). The new plantations were established using techniques based on commercial and experimental plantations in Jalisco, Oaxaca, and Arizona.

6.4.1. Soil preparation

The soils for agave plantations have to be carefully prepared to facilitate root growth, and nutrient and water uptake by the plants. In Jalisco, the soil is typically prepared using a tractor. Soils with high slope angles require contour shaping to reduce soil erosion. Additional recommendations include: intercropping with beans, peanut,

garbanzo or corn to reduce erosion and add nutrients to the soil, furrows to increase soil water absorption, and small dams with rocks called *cadenas* to reduce the erosive flow of water during the rains (Valenzuela-Zapata, 2000).

In Oaxaca, new soils for agave cultivation are prepared by using the slash and burn method. Although not good for the environment, this method is recommended for the fertilizing properties of burned tree and bush ashes (Sánchez-López, 1989). In the burning process, much of the nitrogen and sulfur are lost through volatilization while calcium, magnesium and phosphorous are returned to the soil surface in the ash.

In the newly established Sonoran commercial plantation of *La Huerta*, the chosen field had been previously cultivated with alfalfa. The soil was prepared plowing a furrow about 25 centimeter depth every 5.5 meters since the field was to be irrigated with water from the river. The producer decided to cultivate alfalfa again between the rows of agaves. The soil was prepared with a slight slope that drains excess water to the river.

In the remaining agave commercial plantations, the plants were placed in the soil without major preparations. Producers usually dig holes (*cajetes*) around individual plants to acummulate rain water or to irrigate agaves with a bucket during the drought season. In two plantations, ripping by a tractor pulling a metal shear was required because the fields were previously uncultivated. In one of the two fields (*San Isidro*) the soil was plowed prior to the planting.

6.4.2. Plantation design

Agave plantations should be designed to optimize light, water, and nutrient uptake

by the plants. However, the design of an agave plantation is also influenced by economic considerations. Producers in Jalisco cultivate their agaves under two different systems: monocropping and intercropping. Monocropping is widespread in the *tequilera* region. However, many small-scale agave producers intercrop agaves with garbanzos, beans, corn, peanuts, and other seasonal crops as a short-term strategy that produces extra income. These strategies affect the design of the plantation. In monocropping schemes, the producer can cultivate from 2500 to 3500 plants per hectare. Intercropping is recommended if the companion crop facilitates the agave, that is, if it has a short cycle, is a legume, is harvested on time, and does not damage the agaves. Valenzuela-Zapata (2000) recommends leaving 4-m spaces every 100 m to have room to reduce potential fire damage, to apply fertilizers and herbicides, and to facilitate harvesting.

Sánchez-López (1989) explains that in Oaxaca, the plantations of *A. angustifolia* for mescal production are designed in three different ways: for intensive cultivation, for semi-intensive cultivation, and for non-intensive and specialized cultivation. In intensive cultivation schemes, the small plants are placed in the ground every two meters. In semi-intensive schemes, the plantation is designed in parallel rows with wide spaces between rows so the producer can grow other crops during the first four years. In non-intensive schemes, the agaves are planted in *terrazas,* or beds, cut in the slopes of hills at 2 to 3 m between plants in rows 8 to 15 m apart with the objective of growing corn, bean, or squash between the rows. The non-intensive method incorporates juvenile agaves between rows of older agave at later stages of the plantation so the producer can replace harvested adult agaves with seedlings (Sánchez-López, 1989).

A commercial experiment with *A. angustifolia* in Moctezuma, Sonora has a design similar to those found in Jalisco. The plantation was designed with 5.5 m between the rows and 1.0 m between plants with the idea of cultivating alfalfa between the rows, and 5.5 m is the width of the mechanized alfalfa harvester. Plant density is 1800 plants per ha. The plants were planted on top of the bed because the soil does not have adequate drainage. The rows are East-West oriented to facilitate irrigation following the slope of the field.

In La Pista, in Nácori Chico, another commercial plantation of *A. angustifolia* was established cultivating 2 to 3 year-old offsets. Plant density is 2400 plants per ha. The agaves were planted during the first to the third week in August. Immediately following plantation establishment, the herbicide 2-4-D was applied to control broadleaf weeds. Local residents say that leaving the grass is a way to retain soil moisture (Teodoro Cervantes, personal communication).

6.4.3. Stand establishment of *A. angustifolia*

A. angustifolia can be propagated in four different ways: *bulbillos* (bulbils), *semillas* (seeds), *hijuelos* (offsets), and cloning (in vitro). If the inflorescence is not cut off, it will produce flowers. Bulbils develop from axillary buds on the sides of pedicels when flowers abscise (Szarek et al., 1996). Once bulbils are vigorous enough (3 to 4 cm high) they can be cut off and transplanted into a nursery. With proper care, these plants can be ready for transplanting into an open field the following year. This method is widely used in Oaxaca for *A. angustifolia* propagation. One implication of cloning is that it yields

a population with very low genetic variability.

An *A. angustifolia* plant can produce from 6 to 10 thousand seeds (Teodoro Cervantes, personal communication). Incipient experiments in Bacanora with 6,000 plants propagated from seeds indicate that with proper care and watering 90-95% of the seeds germinated in a nursery. The problem with this propagation method is the enormous genetic variability obtained in a single plantation, which might yield a broad variety of sizes and maturities of among plants, adversely affecting harvest efficieny.

Offsets or pups, which are produced at the base of the mother plant, provide another means of propagation. Valenzuela-Zapata (1997), based on her experience with *A. tequilana*, says that collecting pups for transplanting is more effective than planting with seeds as the time before harvesting is reduced. However, she also discusses the importance of genetic variability, recommending the use of bulbils to produce a more homogeneous population. Unlike seeds, bulbils from the same plant are not genetically variable (Ana Valenzuela-Zapata, personal communication).

Propagation *in vitro* or cloning is the most effective reproduction method to secure fast production of plants. Unfortunately, this method is also the most expensive, making it almost impossible for many small farmers to afford its costs.

Although *A. angustifolia* can be reproduced by these four different methods (seeds, offsets or pups, bulbils, and tissue culture) each reproduction pathway has unique production costs and consequences for the overall productivity of the agave. However, varied stand establishing methods have not been evaluated for *A. angustifolia*. Offsets transplanted from the wild, plants transplanted from germinated seeds, and transplanted

bulbils are the stand establishment methods currently used. No successful experiments are known that used direct seeding techniques in the open field in Sonora.

McLaughlin et al. (1999) evaluated two planting dates, April 5 and June 13, respectively for transplants and direct seeding methods for *Hesparaloe funifera* in Arizona. For both planting dates, seeded *H. funifera* was slow to emerge in the field, taking 14 to 28 days to achieve 50% stands, while in the field planting, weeds covered the entire plot area within three weeks after planting (McLaughlin et al., 1999). Transplant survival was higher when planting in April (95%) than in June (80%). They considered that the higher mortality of seedlings planted in June was probably related to the very high air temperatures and low humidity that occurs at that time.

The research by McLaughlin et al. (1999) suggests that it may be advantageous to transplant *Hesperaloe* seedlings to the field in October or November in central Arizona because it allows seedlings time to become established before they are subjected to high temperatures. Subjecting seedlings to cooler temperatures, lower humidity and less frequent irrigation, should harden them.

6.4.3.1. Seeds

A. angustifolia has been reproduced by seeds with 95% rate of germination in Bacanora (Sergio Moreno, personal communication) and 80% rate of germination in Moctezuma (Teodoro Cervantes, personal communication). Sánchez-López (1989) reports a rate of germination of 85 to 90% for *A. angustifolia* in Oaxaca. Such differences appear to be more closely related to the planting season than the method used. In

Moctezuma, the seeds were planted in October-November, and the small and weak plants did not survive the winter. In Bacanora, the seeds were planted at the beginning of the summer rains, so when winter arrived, the plants were vigorous enough to survive.

Although this reproductive method has very low costs, it presents two problems for the agave producer: the large genetic variability obtained by this method and the long time required for the plant to mature. The large genetic variability directly influences harvesting time of the agave in a plantation. Consequently, some plants mature in a period of nearly 4 years while others from the same field required longer periods (Valenzuela-Zapata, personal communication). This variability increases production costs due to the additional expenses incurred in hiring people in different seasons for the same field. Additionally, *A. angustifolia* reproduced by seeds require a period of time 4 to 5 years longer than plants reproduced by offsets and bulbils (Sánchez-López, personal communication), lowering profits.

6.4.3.2. Offsets

The offset reproduction method is the most widely used in commercial plantations of *A. tequilana* (Valenzuela-Zapata, 1997) and frequently utilized in commercial plantations of *A. angustifolia* in Oaxaca. This technique is the least expensive for agave producers in both regions.

Valenzuela-Zapata (2000) recommends the use of offsets provided by healthy, young, and vigorous mother plants. The first generations of offsets produced by a mother plant are preferred in Jalisco. Sánchez-López (1989) recommends the first and second

generation of offsets for *A. angustifolia* in Oaxaca, since they are more vigorous. The offsets must be planted in lots by size for cost effective harvesting in the long run.

6.4.3.3. Bulbils

The bulbil reproduction method is frequently used in Oaxacan agave commercial plantations. Many *A. angustifolia* plants that reach adult life are isolated to allow them to produce flowers. When the inflorescence emerges, the flowers are cut off in a process called emasculation. Weeks later, the inflorescence produces small agave shoots vegetatively called bulbils which are carefully removed and replanted in a nursery to provide them with water and care for proper development before transplanting to the open field (Sánchez-López, 1989).

Although Sánchez-López (1989) states that an *A. angustifolia* can produce from 2500 to 3500 bulbils in Oaxaca, recent experiments in Sonora and in Arizona show that *A. angustifolia* produced just 450 to 600 bulbils (Szarek et al., 1996; Teodoro Cervantes, personal communication).

For this reproduction method, the lack of genetic variability is considered favorable because all the offspring of a single parent plant develop homogeneously. If all the parent plants are genetically similar, the harvesting can be made in one year, as plants in a plantation would reach maturity in the same season. However, genetically uniform plants are more susceptible to diseases that can affect entire plantations.

6.4.3.4. Tissue culture

Tissue culture is a relatively new way of plant reproduction. It consists of cloning cells of a plant in a laboratory. The cloned plants obtained and the source plant (from which the cells were acquired) may have identical characteristics. Somatic mutations, however, often reintroduce genetic variation in the progeny. This method might be adequate if the purpose is a rapid reproduction of a plant to obtain massive production.

Experiments developed in different labs around the world with *A. fourcroydes* (Eastmond, Herrera, and Robert, 2000; Robert et al., 1987), *A. arizonica* Gentry & Weber (Powers and Backhaus, 1989), *A. parrasana* Berger (Santacruz-Ruvalcaba, Gutiérrez-Pulido and Rodríguez-Garay, 1999), *A. angustifolia* (Moreno-Salazar and Martínez-Heredia, 1996), and *A. sisalana* (Das, 1992; Binh et al., 1990) among others, indicate that this method is possible in agaves. However, Vasil (1991) states that this reproduction method is much more expensive than others, although, as production becomes more mechanized and automated, these costs will decrease significantly.

This tissue culture reproductive method can accelerate the development of improved products by speeding their release into the market and the quality of the products and their commercial value can be effectively enhanced by the generation of products with value-added features (Chu, 1986, as cited in Vasil, 1991) such as a reduced life cycle and fast reproduction of cultivars. However, the crops produced by this method are restricted to those species for which the protocols are economically viable and the costs of tissue culture are high compared to those of conventional methods (George and Sherrington, 1984, as cited in Vasil, 1991).

Experiments developed in Sonora show that *A. angustifolia* can be reproduced satisfactorily (Moreno-Salazar and Martínez-Heredia, 1996). The Centro de Investigacion en Alimentacion y Desarrollo (CIAD) and the Centro de Investigaciones Cientificas de Yucatan (CICY) research centers in Sonora and Yucatan respectively, conducted *in vitro* propagation of the species and estimated a reproduction cost of $5 pesos (year 2000) per plant on average (Martín Esqueda and Manuel Robert, personal communication).

Robert and García (n.d.) consider that tissue culture can contribute to reduce the life cycle of agaves, a desirable characteristic in commercial plantations. However, mass propagation of a single genotype requires prior identification of superior genotypes, which are often not known for a new crop such as *A. angustifolia.* Random selection of a genotype for clonal propagation by tissue culture is unlikely to produce a crop with the most valuable or necessary traits for successful production under cultivation.

6.4.3.5. Plant selection and preparation

For *A. tequilana*, plants are selected by two criteria: the time when the offsets are produced by the mother plant (the first production is highly recommended) and the size and weight of the offset. The first generation of offsets will provide healthy and more vigorous plants. Offsets adequate for transplanting should be 1.3 to 2 kg, ranging from an orange to a grapefruit in size (Valenzuela-Zapata, 2000).

The offsets are separated from the mother plant in a process where the rhizome is cut off to force the plant to develop its own roots. This process is done about three weeks before the summer rains in the region of Tequila and Los Altos in Jalisco. Then the agave

is placed under the shadow of trees for 2 to 3 weeks. During that time the plant develops a callus in the fresh cuts that protect it from insects and diseases that can enter by the root system (Valenzuela-Zapata, 1997).

When the offsets are ready, they are transplanted to nursery facilities in the open field protected by fences. In these areas, the offsets receive water and special care for approximately one year. After a year, the plants are vigorous enough for transplanting in commercial plantations.

In Oaxaca, the plants are obtained mainly from offsets and bulbils. As in Jalisco, the offsets are separated from the mother plant and exposed to the sun for several weeks to form a callus until they are ready for transplanting in plantations (Sánchez-López, 1989). For bulbils the case is similar. The bulbils are obtained from the inflorescence and planted in nurseries where they are properly cared for. The plants are transplanted to commercial plantations once they are vigorous enough to survive.

For *Hesperaloe* species in Arizona, McLaughlin et al. (1999) suggest that seedlings in the 3 to 5 leaf stage appear to be optimum for transplanting, as larger seedlings may become root-bound in the seeding flats, making them more difficult to remove from the cells and more likely to be injured when mechanically removed.

Researchers working in the agronomic component of the bacanora projects in Sonora are following the procedures described by Valenzuela-Zapata for Jalisco's agave producers. The offsets are obtained from the mother plants during the summer rains and placed under the shadow of a tree. The plants selected are usually of three different ages and sizes: one, two, and three years old. After a week the plant develops a callus and is

ready to be planted in open fields. Other experiments with seeds and bulbils are yielding plants for the first time in the nursery established in Moctezuma. However, the plants are very small, so it is impossible to discuss plant selection and preparation at this time.

6.5. Fertilizing

Fertilizing is of fundamental importance in agave plantations, contributing to a faster and healthier growth of the plants. Prior to fertilizing in a plantation, a soil analysis is recommended to determine soil nutrient deficiencies and soil acidity. Complementarily, a study indicating nutrient requirements of *A. angustifolia* will determine if the plant will require extra fertilizing and when the fertilizing should occur.

According to Valenzuela-Zapata, agaves are fertilized with organic and synthetic nutrients, depending on the producer (Valenzuela-Zapata, 2000). To reduce fertilizing costs Valenzuela-Zapata recommends that organic fertilizers (composts) are prepared for agaves by previously drying and milling and, if necessary, adding up with chemical fertilizers (Valenzuela-Zapata, personal communication).

In the case of synthetic fertilizers, the recommendation is to make a soil assessment to determine the required doses of nitrogen, phosphorous, and potassium. Additionally, Valenzuela-Zapata (2000) recommends avoiding applying fertilizer to the stalk of unfolded leaves, called the *cogollo*. The fertilizer should be applied in the soil surrounding the plant.

According to Sánchez-López (1989), the fertilizing practices recommended for *A. angustifolia* in Oaxaca include organic fertilizers provided by the slash-and-burn method

and chicken manure for plantations and bulbil production. In the latter the manure is applied to the location where the mother plants are transplanted for bulbil collection (Sánchez-López, 1989).

Experiments with *A. lechuguilla* indicate that the application of 100 kg of nitrogen per hectare increased shoot dry weight by 51% over a two year study period with no effects on root dry weight. Additionally, the application of 500 kg of phosphorus per hectare increased shoot dry weigh by 40% but unfortunately decreased root dry weigh by 37% in the same study period (Nobel, Quero and Linares, 1989), thus reducing the plant capacity of uptaking nutrients.

Nutrient-deficiency symptons for *A. angustifolia* are not known and need to be determined experimentally. Excess fertilization—application of fertilizers beyond the crops capacity for nutrient uptake—is likely to stimulate excessive weed growth.

6.5.1. Macronutrients

Plants obtain nutrients from the soil via root uptake. Plant nutrients are generally divided into two categories based on the relative amount required, macronutrients and micronutrients. Nutrient requirements for agaves are very similar to those of other plants (Nobel, 1988). Nitrogen is often the soil element most limiting for growth, both agronomically and in natural environments, followed by phosphorous and potassium (Nobel, 1994).

Nobel (1989) determined that the most common macronutrients in agave tissues on a dry weight basis were nitrogen (1.2%), phosphorous (0.21%), potassium (1.8%),

calcium (3.7%), and magnesium (0.7%).

Although agaves are important for many uses, their nutrient responses have not been studied extensively under controlled conditions. Nobel and Harstock (1986b) examined nitrogen responses of seedling and adult plants of *A. deserti*. Growing seedlings in a hydroponic system with high amounts of potassium, phosphate, and nitrate increased their growth rate. The optimal growth for seedlings occurred in soil containing 0.1% nitrogen by dry weight and a pH between 6 and 8. Mature plants doubled their leaf-unfolding rate when the experiment went from irrigation with no added nutrients to full-strength Hoagland solution in soil. Field studies on adult plants of *A. sisalana* (Lock, 1962), *A. lechuguilla* (Nobel, Quero and Linares, 1988), and *A. fourcroydes* (Carrión, 1981) indicate that growth can be enhanced by nitrogen rather than phosphorous. For *A. lechuguilla*, the application of nutrient levels that greatly stimulated leaf unfolding (100 kg N ha^{-1} or 500 kg P ha^{-1}) led to large increases in CO_2 uptake over a 24-hour period (Nobel, Quero and Linares, 1988).

Experiments with *H. funifera* in Arizona demonstrated elevated nitrogen requirements. Soil samples indicated that the species apparently scavenged nitrate from the soil at surprisingly high rates (McLaughlin, 1995).

6.5.2. Micronutrients

No field experiments have been done for *A. angustifolia* to measure productivity increases due to soil micronutrient additions. However, evidence from other agave species indicates the importance of micronutrients for increasing plant productivity. Studies with

CAM plants indicate that among the micronutrients, boron appears to be the most important element to enhance the growth of agaves, depending of its level in the soil (Nobel, Quero and Linares, 1988).

Experiments with *A. sisalana* indicate adequate levels of manganese, copper, zinc, iron, molybdenum, and boron are important for the optimal development and productivity of the plant (Pinkerton, 1971).

Nobel (1994) states that the most common micronutrients and average levels in agaves are manganese (30 ppm), copper (4 ppm), zinc (26 ppm), iron (77 ppm), and boron (24 ppm). Additionally, sodium (43 ppm) is also common at low levels in agaves. Higher levels of sodium negatively affect seedling establishment, as demonstrated in experiments with *A. deserti*. Determination of nutrient-deficiency symptoms for micronutrients is particularly important for detecting limiting levels of these resources.

6.6. Irrigation

Irrigation clearly increases productivity of all crops in arid and semi-arid regions. An experiment conducted with *A. salmiana* near Mexico City, which consisted of daily watering via rainfall or irrigation, indicated that the productivity far exceeded the level reported for nearby rain-fed natural ecosystems, crops and trees (Nobel, García-Moya and Quero, 1992; Nobel, 1991). These data were confirmed by studies conducted on *A. fourcroydes*, *A. mapisaga*, and *A. tequilana*. These species exhibited annual productivities ranging from 16 to 26 tons ha^{-1} yr^{-1} when irrigated, exceeding most agronomic crops (García-Moya and Nobel, 1990). Agaves probably achieve these high productivities,

despite their low photosynthetic rates, because of the influence of long growing seasons and high leaf-area indices.

The irrigation practices in established agave plantations of *A. tequilana* in Jalisco and *A. angustifolia* in Oaxaca are not well documented. Although in commercial plantations artificial irrigation is important at early stages, at later stages the crop is expected to rely solely on the rains (Valenzuela-Zapata, personal communication).

To increase water available to the agave crop, specialists from Jalisco recommend digging canals to increase water absorption, as well as building small rock dams to reduce the speed of the water flowing during the rains, thus reducing erosion (Valenzuela-Zapata, 2000). The construction of *cajetes,* dug around the plant to retain more rainwater, is a frequently used method in Oaxaca (Sánchez-López, 1989).

Hesperaloe funifera also is a CAM species (Ravetta and McLaughlin, 1993; Ravetta and McLaughlin, 1996), and CAM crops do have low water requirements, consistent with their nocturnal gas exchange (Doorembos and Pruitt, 1977, as cited in McLaughlin, 1995). Irrigation water requirements for the species were 7.3, 5.0, and 5.7 cm Mg^{-1} in low, medium, and high-density treatments, respectively (McLaughlin, 1995). During stand establishment, the crop used irrigation water inefficiently due to its slow growth rate. However, during the fifth year, the application of 41 cm to the medium density treatment and 83 cm to the high density treatment produced standing crop increments of 56.1 and 77.2 tons of fresh weight per ha, respectively. These results indicate that after stand establishment, *Hesperaloe* appeared to use water three to five times more efficiently than highly productive C_3 crops (McLaughlin, 1995).

In the experiments with *A. angustifolia* in commercial plantations in Sonora, the agaves are planted at the begining of the summer rains to ensure adequate water to the plant for a long period of time, as is the case in Jalisco and Oaxaca. In places with lower precipitation, *cajetes* are dug around the agaves to avoid run off and to increase water availability to the plant. However, there are two documented cases where pumped water is added to an agave plantation: one in Moctezuma included a costly drip irrigation system installed in 1999. Unfortunately all the plants died because of a frost. The second case is a commercial plantation in Bacanora where the crop "gets water only when the plants need it," said the person in charge of the plantation. The plants are vigorous, although the water contributes to an increase of undesirable weeds (Guadalupe Parra, personal communication).

6.7. Pests and diseases

In cultivated agaves under commercial plantations, the rainy season becomes critical because conditions favor the proliferation of insects and other organisms that attack agaves (Valenzuela-Zapata, 2000). However, not all insects are harmful to the plantation, thus a crop evaluation is recommended before applying any pesticide. According to Valenzuela-Zapata (1987, 2000) and Sánchez-López (1989), the most important insects attacking cultivated *A. tequilana* in Jalisco and *A. angustifolia* in Oaxaca are soil larvae and nematodes (*Anomala* sp., *Ciclocephala* spp., *Macrodactylus* spp., *Phyllophaga* spp., and *Diabrotica* spp.), which damage the roots of young plants. The plants become weaker and change color from the typical blue to a reddish-purple. Plant

growth is halted and no new leaves unfold from the *cogollo*. Preventive measures include winter plowing to reduce insects in the soil, while control measures require the use of insecticides applied to the plant or the soil, or using natural enemies of the plague.

The drilling worm (*Acentrocneme hesperiasis*) is a butterfly larva that attaches to the tip of the leaves for gestation. The larva makes its way to the base of the stem, forming a cavity with a reddish material around it. The larva rests there until adulthood when it leaves the plant. The larva can cause the death of young plants and reduce the quality of older plants. To prevent this, the producer must keep the agave plantation free of weeds, and check for the larvae in the fall season. If the larvae are present, the producer cuts the damaged leaves preventing them from entering the head of the agave. If the larvae are found within the head of the plant, no chemical can expel them.

Another not yet identified pest is the *escarabajo* (beetle). This beetle attacks one year-old or younger agaves. The beetle drills into the ground around the head of the agave eating the sides of the head, hurting the root tissues. After a short time the plant dies.

The *grana* or *cochinilla* (*Dactylopius coccus*) is an insect resembling small balls of cotton that lives inside the head of the agave between the bases of the leaves. When pressed it yields a red liquid. When the *cochinilla* attacks, the leaves become drier beginning at the base of older leaves continuing toward younger leaves. This is considered temporary damage since this pest prefers young plants and their offsets. To protect the plant from *cochinilla*, the producer keeps the plantation free of weeds and checks for dry leaves. Application of insecticides in the head of the agave assists in pest control.

The *escamas* (flakes), which are not a common problem, affect the vigor of the

plant when they cover the leaf surface. The *algodoncillo* or *piojo harinero* is a common insect that attacks vigorous plantations at the end of the rainy season. It is found in the area of the *cogollo* in younger leaves and does not produce significant plant damage. The insect adheres to the leaves with a sticky yellowish substance. The damage is seen as very small pale circles. To prevent this, the producer again keeps the plantation free of weeds. Control measures include the application of contact insecticides.

The *cortador del cogollo* is an insect that inflicts damage to the base of the *cogollo* by making a cut similar to the cut made by a machete. It prefers young plants with tender *cogollos*. Prevention measures are again similar to other pests; e.g. keeping the plantation weed-free. If found in more than 15% of plants, Valenzuela-Zapata (2000) recommends applying insecticides with an adherent directed toward the base of the *cogollo*. The *larvas del cogollo* are larvae that occasionally install themselves inside the *cogollo*, eating it. The larva causes the death of the *cogollo* and adjacent leaves. Preventive measures include minimization of weeds while pest control entails cutting the tips of the *cogollo* slightly as well as applying insecticides.

The *trips* (thrips) and *pulgones* are insects that attack the tender areas of the *cogollo*. The leaves become dry and change to a dark green color when attacked by *pulgones*. The *trips* weaken the *cogollo*, and the leaves develop a pale yellowish-green hue with very small circles. To minimize infestation, the producer has to keep the plantation free of weeds and cut the leaves slightly to promote greater ventilation and sun exposure. If the damage is minimal, a cut to the tip of the leaves might be enough. If the damage is significant, the leaf tip cut must be followed by the use of specific insecticides.

The waxy characteristic of the leaves and the high percentage of fibers found in agaves make the plant more resistant to diseases that affect plants. However, many diseases in agaves are a direct result of excess humidity and acidity, which accentuate fungal diseases. Additionally, nutrient deficiencies contribute to the incidence of diseases. Finally, insects that attack the *cogollo* can be carriers of diseases that affect agaves. Therefore, if dead plants are located, the producer should eliminate them quickly to reduce transmitted diseases. According to Valenzuela-Zapata (1987, 2000) and Sánchez-López (1989), the most devastating diseases affecting cultivated *A. tequilana* in Jalisco and *A. angustifolia* in Oaxaca include the *mancha marginal* and *punta seca* (*Fusarium* sp.). This fungal disease referred to as *mancha seca* changes the leaf margin color from green to purple. The effects of this disease are localized and extensive damage to the leaf area is rare. The dry tip, or *punta seca,* is common during the winter. Valenzuela-Zapata (2000) considers this disease as a consequence of the damage inflicted upon the plant by *trips* and other insects. Although both diseases, *mancha seca* and *punta seca,* reduce the leaf area, they do not kill the agave. Older *agaveros* used to cut the tips of the leaves right after the winter as a remedy.

The *pudrición seca del pie* (*Phytophthora* sp. and *Fusarium oxyosporium*) is a fungal disease that invades the whole head of three-year-old or older agaves. The leaves closer to the soil start to fall, and as the disease continues, it affects superior leaves. Researchers speculate the cause to be a fungus that affects the roots and offsets. They associate this disease with excess soil acidity and fertility losses. The *pudrición blanda del pie* (*Aspergillus* sp.) is a disease that begins in the base of adult plants (3 years or older)

and consists of a dryness of older leaves. As the disease advances it goes to superior leaves. The dead tissue causes the plant to lean until it falls. The dead tissue is soft and smells like humus. The *pudrición del cogollo* (*Phytophthora* sp. and *Erwina caratovora*) is a disease that affects younger leaves, those close to the *cogollo*. If the damage is new, the *cogollo* is weak and has a putrid smell in its interior. If the disease is advanced, the *cogollo* changes to a dark purple color. The *cogollo* falls from the plant and the disease continues invading the head. This disease is frequent in humid areas.

The *anillo rojo,* or red ring, is a disease associated with nutrient deficiencies and a reddish scar circumscribing the leaf margin characterizes it. If observed from above, it looks like a ring. Infected plants do not grow but instead develop small, defective leaves. The *secazón* (*Erwinia* sp.) is a common fungal disease in agaves. The *secazón* is first observed in the *cogollo*. The leaves close to it become dry and speckled. Dryness affects the plant in general and the *cogollo* may become putrid. The disease is followed by reddish exudates at the base of the leaves. The damage is greater when the plant is stressed due to the lack of water, as during the dry season (Valenzuela-Zapata, 2000). Knowing this information is important to prevent fungal diseases in commercial plantations of *A. angustifolia*.

6.8. Weeds

Weeds are present in every plantation and effective control of this cohabitant is essential for plantation success. Weeds grow faster than agaves, thus representing significant competition for water and nutrients from the soil. As a succulent species from

semiarid lands, *A. angustifolia* optimizes CO_2 uptake and water loss by the distinctive physiological process known as CAM photosynthesis. CAM species, such as *Hesperaloe* have a slow growth rate during stand establishment (McLaughlin, 1995). Consequently, CAM species do not compete successfully with weeds in early establishment stages, thereby retarding or precluding establishment, growth, and development of field grown plants (McLaughlin et al., 1999)

In addition, weed management becomes fundamental to the reduction of several pests and diseases that negatively influence agave growth (Valenzuela-Zapata, 1997; Sánchez-López, 1989). However, excess weeding will cause soil erosion and soil compaction with long-term complications of nutrient deficiencies and lack of water retention. Therefore, frequent weeding practices are highly recommended to obtain an adequate balance in the agave system. Valenzuela-Zapata (2000) recommends leaving a weed cover between rows to protect the soil.

Agave angustifolia plantations in Oaxaca require two weed controls during the first three years, one immediately following the July rains and, and the second by the end of September. During the second and third year, the soil is plowed to achieve an optimal plant development and to reduce the incidence of insects (Sánchez-López, 1989). The use of a *coa* and a *yunta* pulled by an ox, are common ways to clean the plantations in small areas, although tractors are frequently used in large agave plantations.

Herbicides available for control of weed species occurring in furrow-irrigated desert agriculture included those used in pineapple, a plant distantly related to *Hesperaloe* and agaves, and other effective herbicides widely used on commercial crops in Arizona

(McLaughlin et al., 1999), provided they are not toxic to the agave. Herbicides lacking phytotoxicity to *Hesperaloe* might also be appropriate for use in *Agave angustifolia.* Research on *Hesperaloe* in Arizona indicate that the species is highly sensitive to pre-plant incorporated herbicide and soil applied pre-emergence herbicides (McLaughlin et al., 1999). The results showed that germinating seeds lacked tolerance to metolachlor, trifluralin, oryzalin, and pendimenthalin at such low rates that would not even provide adequate weed control in the field. On the other hand, *Hesperaloe* seedlings had better tolerance to bromacil when applied pre-plant incorporated at rates of 0.75 to 2.25 lb. active ingredients per acre (McLaughlin et al., 1999: 70-71).

Field tests of pre-emergence herbicides applied in *Hesperaloe* plantations indicate that Goal™ applied after bed formation and before transplanting, and Prowl™ applied over-the-top of the beds after transplanting, provided the best weed control. Both herbicides were activated by the heavy irrigation employed after the transplanting operation was completed (McLaughlin et al., 1999: 71-74).

6.9. Harvesting recommendation

The *desquiote* (cutting off the inflorescence), is an important process in producing bacanora. The objective of the *desquiote* is to force the plant to concentrate sugars in the head rather than in the inflorescence. Experts recommend this activity in February and March for *A. tequilana* in Jalisco to reduce sugar loses (Valenzuela-Zapata, 2000). One important recommendation for a homogeneous *desquiote* is a careful plant selection in terms of plant age. A proper selection and a homogeneous plantation reduce the costs of

harvesting since all plants will mature in the same season.

In commercial plantations of *A. tequilana* in Jalisco, approximately 8 to12 months following the *desquiote,* the agave is ready for harvesting. The instruments used for harvesting are the *coa* and the *barreta* or, metal bar. This activity is made by groups of expert *jimadores* who know how to harvest the plant quickly.

In Yautepec, Oaxaca, the *A. angustifolia* usually develops its inflorescence during its seventh year. The inflorescence is cut off as soon as it is seen in process of formation. Once an agave is *desquiotada,* the producer waits one to two years until harvest. Harvesting is done with a machete and an ax. The leaves are separated from the heart, exposing the heart, which is removed and transported to the mescal factory. Once the plants are harvested, the soil is fallowed for 3 to 6 years and then the slash and burn method is repeated. This method and the cultivation of agaves in steep slopes dramatically increase erosion. However, the recommendation for after the second and third cultivation in the same soil is that the agave be planted in a different site. The rationale for site rotation includes increasing productivity and decreasing incidence of insects and diseases (Sánchez-López, 1989).

Manual labor is used for harvesting in all agave plantations in Mexico. Mechanical agave harvesters are not in the market perhaps because labor costs are very low and labor force is abundant in areas of rural Mexico where agave grows. The low wages greatly reduce incentives to conduct research and development focusing on the development of agave harvesting technology.

CHAPTER VII. CURRENT ISSUES AND CONFLICTS ON BACANORA

"De Cocula es el mariachi,
de Tecalitlán los sones,
de San Pedro su cantar
de Tequila su mezcal..."
(Popular Mexican song)

7. Introduction

The bacanora development project has been increasing in importance concurrently with the development of this research. Although I believe that this project had great potential because it was economically viable and profitable, of great social impact, politically advantageous, and ecologically sustainable, I never imagined how fast events would unfold.

This chapter discusses the process of the institutional acceptance of the project and the many forces and interests centered on it. Inevitably, a project with such economic potential awakens passion, desire for power, and is perceived as an instrument to obtain hegemony. It becomes also a tool for negotiating. I am able to discuss it as a case study based on first-hand information. Many memorandums turned in to my advisor accompanied by many official documents constitute the backbone of this chapter.

Many lessons can be learned from the history of tequila and mescal industries in Mexico, and their experience indicates that the bacanora industry will have to deal with a variety of opportunities and challenges as the industry consolidates and expands. The social, political, and economic consequences will vary throughout the regions of the state, thus representing uncertainties for the future of the bacanora project. Many problems will

arise which constitute an inherent part of economic development and growth in a country plagued with conflicting interests. The effects will be perceived as positive or negative depending on any individual's point of view and interests.

Forecasting might be a futile exercise at this stage. However, based on the experience of the Sonoran agricultural sector and current trends, I anticipate that in general, the economy will benefit as investment, employment, and income will be generated from bacanora production. It is also important to recognize that the emergence of the activity is already creating groups with particular and well-defined interests in Sonora, as will be discussed below.

As has been happening in the recent history of Mexico, the long-term beneficiaries will be the many large farmers and businesses that will turn to bacanora activities in their search for expansion, as it becomes more profitable. As observed in the last years, many small rural businesses will be displaced in favor of the large ones because NAFTA [North American Free Trade Agreement] and the amendments to the law regulating foreign and domestic investments favor large capital. It is possible that not only domestic capital but also direct foreign investment and joint ventures, driven by higher returns, will be attracted to the industry.

7.1. Finding the right people to back the bacanora project

When the dissertation project was ready for fieldwork, I visited several mayors in the sierra with the idea of promoting the project and facilitating fieldwork in the towns visited. Some mayors were interested in the project and others were not. One said that he

does not care about it because he has been successful with his bacanora production (he was producing *Bacanora Rancho el Trigo*) and his agave reproduction technique was excellent.

Another *serrana* mayor received my proposal and listened carefully to my explanation, but made no comments at all. He did not understand many ideas or probably thought that it was a long-term project and he was not going to 'harvest' the fruits of his effort. I was expecting to receive a call within the days following my visit but never did.

After that experience, I decided to visit a mayor in the sierra of Sonora and former governor of the state. He said that my project was very interesting, although, he suggested a visit to his good friend Ricardo Rivera, the mayor of Bacanora, who surely was going to be very interested in the project as he was also planning something similar for his municipality.

I went to Bacanora and talked to Ricardo Rivera. He mentioned his idea of doing something to help bacanora producers in his municipality. I asked for a copy of his proposal and he said that everything was in his mind, nothing written. He listened carefully to my proposal and said that he was very interested. However, he wanted to find out what I was expecting in return. I said that it was my dissertation project and I hoped I would get my doctorate degree with the results obtained. He liked the idea of not having to pay a peso and receiving an organized proposal and we decided to work together on this venture.

However, the dissertation project was designed to serve a specific purpose: to obtain an academic degree. Therefore, I decided to design and implement an economic

development strategy based on the emergence and development of the bacanora industry. But what was to be done? What steps were required to establish the bacanora industry? Suddenly the town of Bacanora became too small for the newly conceived project and the idea of including all *serrana* towns was gaining my attention.

7.2. Designing the projects

The first step needed was to determine the extent to which the domestication of the agave was possible. The strategy was not economically feasible if the agave resource was not available in sufficient quantities. Additionally, several authors warned about the decline of the species in a short-term, corroborated by my own field observations and interviews. I did some research on the need to domesticate the agave and wrote a program. Once written I immediately called for a meeting with several researchers from INIFAP, IMADES (Sonoran Environmental Institute), UNISON (University of Sonora), and CIAD (Research Center for Food and Development) to discuss it. The result was an improved version of my original "*Programa para la Domesticación del* Agave angustifolia *en la Sierra Sonorense*."

The next thing to do was to get funding for the project. To facilitate this I enlisted the mayor of Bacanora who signed on as a beneficiary of the project, giving the project a new extra academic dimension. The research team decided to send the project to Fundación Produce Sonora, A.C. for funding.

To get public attention for the project, and to put pressure on the evaluation committee, I decided to call a press conference. One full page from *El Imparcial* (1 de

Mayo, 1999) and another from *El Inversionista* (12-18 de Junio, 1999) newspapers were issued discussing the project for domestication of agave and how it might help to reduce poverty of many small ranchers in the sierra. It was also presented as a project that might help to diversify the cattle-based economy of the sierra. A few days latter, the "*Programa para la Domesticación de* Agave angustifolia *en la Sierra Sonorense*" was approved and the money was made available.

The project to domesticate *Agave angustifolia* includes three stages. The first stage was to build a nursery facility to reproduce agave plants by several methods based on the experience from other states in Mexico. The second stage was to determine the best technique for transplanting agaves into open fields. For this purpose, it was decided to conduct experiments in Bacanora, Moctezuma, and Huásabas. The third stage consists of organization of producers and transfer of technology.

However, I conceived the domestication project as one targeting large ranchers, and the *ejidos* were left aside for another more specific project. Once the domestication project was secured I immediately prepared and launched another ambitious project: "*Programa de Reforestación de Agave para la Region Sierra-Centro de Sonora.*" The re-establishment project targeted small ranchers specifically. I decided to call it re-establishment because *ejidatarios* work and have access to communal land. Therefore, agave plants introduced under a re-establishment scheme would benefit *ejidatarios* as more agaves would be available in their land.

The re-establishment project was supposed to complement the domestication project. It consisted of an increase of the scale of the nursery to produce from 125,000

agave plants (as specified in the domestication of agave project) to 1,000,000 plants. The additional agave plants would be planted in different parts of the sierra region according to an another proposed study that would show the areas where the agaves were located before harvested. After such areas were determined, the re-establishment process would take place in a two-year period.

For this purpose, I requested money to increase the scale of the nursery. However, some additional money was also required to pay rent for machinery to prepare the places for planting the agaves, purchase hand equipment (shovels, etc.) for planting, pay workers, purchase a truck to move the plants and workers, and bring specialists in re-establishment to teach local people.

For the presentation of the re-establishment project, Ricardo Rivera and I invited SEMARNAP (Sonoran Delegate for Environment, Natural Resources and Fishery), INIFAP, SEDENA (National Defense Ministry), and SEDESOL (Ministry of Social Development). Additionally, we invited several directors of federal and state agencies. We called the meeting supported by letters from several mayors from the sierra.

The meeting, held on June 1, 1999, was well attended because everyone appreciated the potential of the bacanora projects. However, there was a problem: although everyone in the meeting applauded my domestication project and commented that the re-establishment project was also a good idea, nobody made financial or other commitments to re-establishment. The prevailing argument was that there have been several attempts to replant with different species in the sierra and all attempts have failed.

The reality of the replanting project was revealed only after I talked to directors of several institutions and ministries. The domestication project was immediately accepted for financing because it would directly benefit large ranchers. The re-establishment project, however, was rejected for financing because it was implicitly designed to target *ejidatarios* and small bacanora makers. The idea was that *ejidatarios* would participate in the re-establishment program and since the re-establishment would occur on *ejido* and communal land, they could get access to free plants for their production of bacanora.

However, a priority for Sonora and our project was to learn more about agaves. For that purpose and with money from the domestication project, I organized the First Seminar for the Domestication of Agaves in Sonora. I invited Ana Guadalupe Valenzuela Zapata, author of "*El Agave Tequilero: su Cultivo e Industria.*" The idea was to hear about her experience in the field with *Agave tequilana* and tequila. Many researchers were invited to attend the seminar along with several well-positioned high-level directors. The seminar included a two-day trip to the sierra to observe agave fields, bacanora production facilities, and the agave in the wild. At the end of the seminar Valenzuela Zapata made several suggestions about what methods should be used to domesticate *A. angustifolia,* and concluded that the project would be successful if we combined domestication with re-establishment. Now we had a team of researchers with better ideas on how to start the domestication of the plant.

7.3. Organizing the "Grupo de trabajo para la evaluación y seguimiento de proyectos de agave y bacanora:" the emerging conflicts

Although the presentation of the re-establishment project was well prepared, the results were not as I hoped. One good result of that presentation was that it brought together many high-level government officials at a single table to discuss not only the project itself, but also many other issues related to bacanora. I recommended to Ricardo Rivera the idea of meeting regularly and inviting the same people to have a forum for discussion of new issues related to bacanora.

The second high-level meeting was called and Ricardo and I proposed the creation of a *Grupo de Trabajo* or a working group to discuss the advances in the domestication project as well as developments in parallel negotiations. For that we invited two people from SEDEPRO (Ministry of Economic Development and Productivity) and one researcher from IMADES to report what was happening in the negotiations with the *denominación de origen*, as well as with the Mexican *norma oficial* for bacanora. In that meeting, we proposed the formalization of the group. Ricardo Rivera was elected President of the group and I was elected State research coordinator. The group was finally integrated and included the Ministries of *Ganadería*, *Agricultura*, and *Desarrollo Económico*.

After the first official group meeting the interests of different individuals became public. The discussion of the *denominación de origen* directed by the researcher from IMADES created a conflict because it included 26 municipalities from the state, excluding two very well know municipalities in which the agaves occur and which produce bacanora,

Cucurpe and Cajeme. The argument for the exclusion was not convincing and everyone became suspicious about the reliability of the information provided by IMADES. I suggested that we decide on this matter once we had more information.

We spoke to the two representatives of SEDEPRO about their Mexican *norma oficial* for bacanora. They proposed a standard to SECOFI (Mexican Ministry for Commerce and Industry) that permitted the inclusion of 20% of other sugars in the production of bacanora. The researcher from IMADES supported the idea. I rejected their proposal and requested one month to study the pros and cons of the incorporation of other sugars in the bacanora. The group agreed and we set a meeting for the following month. At that meeting I presented the results and only three people defended with passion the use of other sugars. We learned later that they were receiving money from a large private bacanora trader. At that meeting, the vast majority decided not to include other sugars in the production of bacanora, and to insist that the *norma oficial* would have to consider our proposal. My proposal was published in a journal to inform *serrana* people and other government officials about our position in that matter and I received greater support.

Other conflicts arose. Ranchers and farmers began to quarrel over who would be the intellectual proprietors of the domestication project. The winner stood to benefit considerably. Additionally, the leaders of large ranchers and the leaders of small ranchers, *ejidatarios* and *comuneros* began to squabble as well. The project had created more interest and problems than I had expected.

7.3.1. Intersectoral conflicts: ganaderos vs. agricultores

Two conflicting interest groups in rural Sonora lobby and push the state government to get support for their activities: the ranch and the farm sectors. Both sectors have representatives to lobby the government, and both have associations always ready to back up proposals benefiting them, and ready to object to any proposal that is prejudicial to them.

After the "*Programa para la Domesticación del* Agave angustifolia *en la Sierra Sonorense*," was submitted for financing, the Ranchers Association of Sonora, the Ministry of *Ganadería*, and many individual large ranchers with an important presence in the state government gave their support. A few questions were asked about the project objectives and goals, but no questions at all were asked about the amount requested. Money was not the important issue; instead, the focus was how organized ranchers (and especially their representatives) were going to benefit from the project. Surprisingly, they saw an enormous potential and support for the project grew rapidly.

The project was then presented to the governor of Sonora, who agreed that it was a viable alternative for the sierra of Sonora. He contacted and called SEDESOL (Ministry of Social Development), *Secretaría de Fomento Agrícola* (Ministry of Agriculture), and SEDEPRO (Ministry of Economic Development). The latter ministry was brought into the negotiation to obtain the *denominación de orígen* and the *norma oficial* for bacanora "in the least time possible."

In a state divided by two strong primary production sectors, both well organized and competing vigorously for scarce financial resources, the domestication program

initially resulted in a fight for control. However, because of the targeted geographic area and high-level decisions, the project was assigned to the ranchers' sector, supported by the Ministry of *Fomento Agrícola* and the Ministry of Economic Development for the technical aspects of the crop production, the financing and industrialization, respectively.

7.3.2. Intrasectoral conflicts: large ranchers vs. small ranchers-*ejidatarios-comuneros*

As explained before, the experience I gained with the project for the domestication of *Agave angustifolia* led to my decision to design and implement another project, "*Programa de Reforestación con* Agave angustifolia *en la Region Sierra Centro de Sonora*" aimed at providing agave plants to small ranchers, *ejidatarios*, and *comuneros*, so they could have cheaper access to the resource.

I presented the project before the state government cabinet. The discussion centered on the importance of the domestication project and the replanting project was not discussed. In fact, the re-establishment with agave was hampered by several previous unsuccessful projects. Our project was turned down, although, at the same time SEMARNAP did establish a nursery in Sahuaripa reproducing 40,000 plants, using the methodology outlined in the re-establishment project.

It seems likely that the project was not accepted by the cabinet (yet was not rejected either) because it would not benefit important sectors of the economy with presence and representation at high governmental levels. The project was specifically targeted to small-scale private ranchers, *ejidatarios*, and *comuneros* --a sector lacking lobbyists in the state government. Recently, I submitted a project to organize small

producers of bacanora with the objective of transferring technology, helping them to obtain financing, and representing them before the *Grupo de Trabajo de Agave y Bacanora* in all future negotiations.

7.4. Discussing the *Denominación de Orígen* and the *Norma Oficial Mexicana* for bacanora

I became fully involved in the *denominación de orígen* and the *norma oficial* for bacanora. IMADES (Environmental Institute of Sonora) proposed a region to be included in the area where bacanora will be produced. I proposed a greater area supported by my studies on the topic and we agreed to evaluate the proposal. Additionally, IMADES proposed a 20% sugar content for bacanora. Supported by many high-level government officials (individuals who I know were born in the sierra, and who share the same sentiments of *serrana* people) we rejected the proposal and decided that bacanora with added sugar was unacceptable, recommending a 100% agave content for all bacanora produced in Sonora. My arguments were centered on the prestige enjoyed by the bacanora, the market effects, consumer preferences, assurance of a premium price, and especially important, my conviction that there will be a favorable impact on the economy of many small-scale bacanora makers. I consider a *norma oficial* of 100% agave would benefit local agave producers, while permitting 20% sugar, or any other sugar content, would benefit only the industrialists.

Finally, the research led us to an interesting finding. In the case of the tequila industry, the 100% agave tequila is dramatically increasing its market share compared to a

relative market reduction in the regular or blended (sugar incorporated) tequila. With so exclusive a market high quality has to be maintained, as is also the case with cognac in France. The final purpose of the initiative was to regulate the production of bacanora by maintaining the prestige that characterizes it.

CHAPTER VIII. DISCUSSION

"Quién no llega a la cantina
exigiendo su tequila
y pidiendo su canción..."
(Popular Mexican song)

8. Introduction

In this final chapter I deal with four political issues that confront the development of the bacanora industry and ultimately affect the economic development of the *serrana* region. First, I discuss regional political issues regarding conflicts or competition for resources between the coast and sierra, the two most important regions of Sonora. Specifically, it discusses how these conflicts have affected efforts to expand the bacanora industry.

Second, I address equity issues in the *serrana* region of the state, particularly, with regards to the beneficiaries from the economic development of bacanora. This analysis is accompanied by a discussion of steps to insure that benefits accrue to the small producers who have kept this industry alive for decades, and who, ultimately, are most in need of economic development opportunities.

Third, I include a discussion of the constraints to increased bacanora production, including the quantity available of mature plants ready to process, the lack of planting materials due to unsustainable harvest of wild agave, the distillation technology available to the small producers, the competing demand for mescal, and the extreme price variability for the liquor.

As a solution to some of these constraints, a final section of the chapter discusses the advantages and disadvantages of using genetically uniform—possibly cloned—planting materials. This strategy is contrasted with some of the short and long-term risks of depending upon planting materials derived from seed stock. However, a strategy that depends upon cloned, potentially more expensive materials has the potential to create additional political issues. These issues have entered debates within research centers in Sonora such as CIAD. These issues will be addressed as a final portion of the chapter.

8.1. Regional political issues

Sonoran political parties, regional groups and bacanora industry beneficiaries frequently clash over their share of the public sector budget. Predictably, these conflicts have become a significant force driving the distribution of bacanora development funds. In local- and regional-level conflicts for power, and given the absence of economic and social alternatives to the traditional calf raising economy, a development project based on the production of an alcoholic beverage can be valuable (Nuñez-Noriega, 2002).

High-ranking officials of the *Partido Revolucionario Institucional* (PRI), the most influential party in Sonora and Mexico for the past 70 years, have discussed in newspapers and speeches (Frescas, 2000; Angulo, 2000; Frescas, 2001; Millan, 2002), the importance of the bacanora development project, not only to maintain the PRI in the *serrana* region, but to strengthen the regional-level power of the party for the foreseeable future. Struggling to reap great benefits from this endeavor, PRI candidates in the 2000 election included studies of the project's potential in their political platforms. As a result,

candidates made many promises regarding government support for the establishment of agave nurseries, commercial plantations, and subsidies for emergent bacanora producers (SEMARNAT, 2001; Valenzuela and Cervantes, 2000). The two other important political parties in the state, the *Partido Acción Nacional* (PAN) and the *Partido de la Revolución Democrática* (PRD) are not publicly seeking political benefits from this project.

The expansion of the bacanora industry of Sonora is constrained by intra-regional competition for resources between the sierra and coastal regions. This competition between regions derives from particular interests between political and economic groups (Vázquez-Ruíz, 1988). In fact, producers in both regions are organized to lobby the government in order to benefit personally from public projects and programs. The *Unión Ganadera Regional de Sonora* (UGRS) represents organized ranchers from the sierra (Wong, 1993), an association that not only helps ranchers to get as much public resources as possible, but also gives them a voice at federal, state, and local levels. Often, members of the association maintain the privilege of holding positions in the state and federal Congresses or in the state government. Farmers from the coast have their own associations with similar interests. The *Asociación de Organismos Agrícolas del Norte de Sonora* (AOANS) and the *Asociación de Organismos Agrícolas del Sur de Sonora* (AOASS) represent most agricultural producers (Aradhyula, Tronstandt, and Wong, 1997) and association leaders lobby the government to allocate shares of the public budget for their sector in the coastal region of Sonora.

Most leaders of both farming and ranching associations are traditionally strong supporters of the PRI (Vázquez-Ruíz, 1988). Consequently, they influence the

government to exert control for their party and to their personal advantage as well. The group in power defines state-level agricultural policies, influences the allocation of the public budget, and responds to the personal interests of the various governors and party. For example, organized ranchers from the sierra supported Samuel Ocaña to become governor of Sonora from 1979 to 1985, and while in power he openly lobbied for ranchers' interests (Samuel Ocaña, personal communication). Born in Arivechi, a small town in the high sierra of Sonora, Ocaña's agricultural policies favored ranchers and particularly those from his native region. Another excellent example of the PRI's power to affect agricultural trends is the governor Manlio Fabio Beltrones (1991 to 1997). During his tenure, Governor Beltrones' allocation for the coastal Cajeme region was substantially increased (Rello, 1993). The agricultural policies established by Beltrones reflected favoritism to produce wheat, vegetables, and fruits in the entire coastal region (Wong, 1993; Nuñez-Noriega and Salazar-Solano, 1997). The governor of Sonora, Armando López, a native of the mining town of Cananea, supported and encouraged the mining industry, bringing many new companies into the state since his election in 1997 (Traebecke-Zons, 2000). Interestingly, Vázquez-Ruíz (1988) reports that outside of the party in power, the governor largely defines the course of policy development and the allocation of public resources.

Sonora's public budget provides for education, health, and infrastructure. Presently, all 35 mayors of towns within the *denominación de origen* area, have included in their budget support to the development of the bacanora industry (Presupuesto de Egresos, 2002), in the official government bulletin. Additionally, I arranged personal

meetings with one mayor of each political party regarding the bacanora industry. Monge (PRI), Flores (PAN), and Monge (PRD) all agreed that the bacanora development project was fundamentally important for their towns and communities in terms of employment and income generation. The three parties in the state Congress approved a budget to continue the bacanora project for both 2001 and 2002 fiscal years (Presupuesto de Egresos, 2002). Funds were used in research, project development, and investment. Overall, this municipal- and state-level budgetary support is a strong indicator that the political powers in Sonora agree in regard to the importance and feasibility of the bacanora development project.

However, despite support for the project, regional conflicts in an era of reduced state budgets threaten the project to some degree. Conflicts for public resources between the coastal and the *serrana* regions of Sonora are present as a result of reduced public budgets. Additionally, at the state- and national-level, the PRI is losing its hegemony in many municipalities, while other political parties are increasing their presence and power. This situation is creating more pressures for scarce financial resources. However, the bacanora development project continues to garner an increasing share of the state and municipal public budget. This is because of state governmental policy that targets the sierras. Politicians at different levels and from different parties believe that the bacanora development project could help to alleviate poverty in that area of Sonora.

8.2. Equity issues

It is difficult to say at this time if the bacanora development can truly respond to social and economic equity issues, or if it can be considered part of a state initiated strategy to eliminate poverty. Burwell (1995) expresses his concern regarding the benefits of bacanora development project for small-scale producers. Even when there is a strong desire on the part of researchers, government officials, and politicians to support small-scale bacanora producers, their future does not seem promising. Burwell (1995) argues that Sonora can expect a similar experience to that of the tequila industry in Jalisco, where the production of bacanora centralized in the hands of large, licensed distillers, and where the original, small-scale producers were relegated to wage laborers or suppliers of raw materials.

New producers, such as large ranchers, are currently entering the market by establishing commercial plantations. These plantations are now visible along the roads in the sierras. Most large-scale producers such as these benefit from state and federal cash, as well as in-kind support. Valenzuela and Cervantes (2000) comment that several large ranchers in the sierra have obtained governmental loans to start agave nurseries, to fence off areas for protection, and to pay laborers to collect wild stock. Meanwhile, experienced industrial producers from Jalisco, desiring to extend their business to Sonora, are gathering information from state agencies regarding costs of the land, available infrastructure, and market opportunities in the state. Lic. Roberto González, the Secretary of Economic Development for the state of Sonora, stated that there were several tequila

enterprises seeking investment opportunities in Sonora (Roberto Gonzalez, personal communication).

State government has also begun to actively encourage industrial-scale production and processing of bacanora. The development plan aims to provide indirect benefits for current small-scale bacanora producers, including training courses on new production techniques that will assure participants a privileged position in the emergent distilleries as a highly qualified labor force (Nuñez-Noriega, 2002). There are also targeted incentives provided by public programs that encourage small-scale producers to cultivate agave in their *temporales* (SEMARNAT, 2001), as well as the *Alianza para el Campo* program that gives small farmers approximately 50% to 70% reimbursement for the investment in infrastructure for the cultivation of agave (Nuñez-Noriega, 2002). Unfortunately, most of the grants are currently used by large ranchers, as they have the money to invest, and can wait to get the reimbursement.

Researchers working in public institutions have generated an agricultural technology package targeting small-scale and resource-poor farmers, focusing on low cost production alternatives (Nuñez-Noriega, 2002), such as experiments conducted to cultivate agaves in *temporales* (Valenzuela and Cervantes, 2000), and seed propagation methods (SEMARNAT, 2001).

Research, extension, training and economic incentive packages all contribute to efforts aimed at assisting current small-scale bacanora producers to receive some of the benefits of bacanora development in the sierra. In spite of these encouraging trends, the future still does not look good for small-scale producers. Although these efforts will give

small-scale bacanora producers an initial advantage in competition with large- and medium-scale farmers or ranchers entering the industry, I share Burwell's point of view, that given the trends observed in Jalisco and now Sonora, current producers will eventually be converted into wage laborers or suppliers of raw materials for large licensed distillers. One important challenge for researchers, politicians, state and local governments, as well as all involved in this effort is to generate an appropriate environment for small bacanora producers in this transitional stage, providing them with the knowledge and training that help them get the most benefits.

8.3. Constraints to increased bacanora production

Even when the production of bacanora depends on the agaves collected from the wild, the state of technology, and the price setting and price seasonal variation, the most important constraint to increased bacanora production is a lack of agaves. Current production is limited to the availability of wild agaves and, therefore, future bacanora production is dependent on the agave planting programs implemented today, since current production methods use wild agave—an extremely over-collected resource (Sheridan, 1988; Nobel, 1994).

The 1992 Sonoran reform to the *Ley de Alcoholes* (Law that Regulates Alcohol) resulted in several bacanora producers deciding to increase operations. The immediate result was a greater pressure on the wild agave population, creating serious ecological and soil conservation problems (Nuñez-Noriega and Esqueda-Valle, 2002; Valenzuela and

Cervantes, 2000). Many bacanora producers state that the wild agave population has been drastically reduced in recent years (Moreno-Salazar, 1995).

The lack of mature plants for processing brings new challenges to producers. The bacanora development project and any agave conservation efforts will need to focus on reproductive aspects of agaves. Alternative techniques such as collection of offsets, common in *A. tequilana* (Valenzuela-Zapata, 1997), are not economically viable because wild *A. angustifolia* are spread in large areas of the sierras, drastically increasing collection costs. Bulbils collection, a common practice in Oaxaca (Sánchez-López, 1989), is a labor-intensive and highly technical method that requires careful program planning and a greater time investment, as well as a large bank of flowering mother plants.

The many years that bacanora production was illegal reduced the possibility of technological improvement. However, the productivity of bacanora can be increased substantially by adopting a technology that increases the efficiency in the processing. State and national research centers located in Sonora are investigating processing techniques and technology alternatives to increase productivity.

In addition to the technological and environmental constraints, pricing and variability in the bacanora economy pose difficult challenges to participants in the industry. A recent study shows that the price of bacanora has been increasing over time in real terms (Salazar-Solano, 2002). However, the price of bacanora fluctuates during the year and from year to year, depending on the availability of the agaves, the absence of a fixed cost structure, and the seasonal demand of bacanora.

Consistently pricing raw materials is one important issue with regards to modernizing the bacanora economy and eliminating economic constraints on the industry. As agave plants are scarce in close proximity to towns, many producers charge an additional cost for having to walk farther in the *jimada* process. This is an indication that wild agave has a measurable cost for producers, a cost that is reflected in the final price of the mescal. Many small-scale bacanora producers do not track these kinds of expenditures, and therefore do not know their costs. This issue complicates research into the absolute value of the agave resource. In fact, each producer may have a different value for a plant. An indication of such cost is the "price" that a rancher charges a bacanora producer for use of the agaves. The *media* or the *tercia* then becomes a measurable parameter to estimate the opportunity costs of the agaves (Nuñez-Noriega, 2002). When added to existing expenditures, this reflects the true price of raw materials in bacanora production.

Price variability is another important constraint on the emergent bacanora industry. The price of bacanora fluctuates during the year, reaching its peak in December (Salazar-Solano, 2002). The higher price in December reflects both greater demand and shortage of supply. Because the mescal is preferred during the winter, and there are increased seasonal travels into *serrana* towns, consumption increases at this time (Salazar-Solano, 2002). Additionally, from October to December the small-scale production of bacanora reaches its yearly low-point, creating a shortage that increases its price. Such seasonal price fluctuations may be reduced when commercial agave plantations are harvested, and the

supply of raw material becomes large enough to keep the distilleries working year round, as happens in the tequila industry.

Even when producers of bacanora continue using inefficient processing technology in their operations and as pricing problems impact supply and demand on a yearly or seasonal basis, the most critical constraint to increased bacanora production is the scarcity of wild agaves in sufficient quantities. However, current use of wild stock is unsustainable in the long run. Thus, more efforts are required to secure a reliable supply of agaves. In fact, this constraint ultimately influences the investment in new production technology as well as the stabilization of pricing for the industry.

8.4. A strategy for the production of planting materials for *A. angustifolia*

The lack of consistently high-quality planting materials and mature plants for processing presents the most pressing concern for bacanora producers in Sonora. One obvious solution is to produce homogenous, high-quality planting materials by domesticating *A. angustifolia*. Any strategy for large-scale production of commercial-grade planting materials should focus on the generation of agaves that have high sugar-content, a fundamental component of mescals. Additional desired characteristics of *A. angustifolia* stock might include: high quality sugar, high biomass production, a short lifecycle, as well as pest and disease resistance. Some of these characteristics can already be found in wild plant materials. Therefore, any commercial plant production strategy must incorporate the best of wild genotypes. This selected material could be genetically improved by combining agaves that have ideal characteristics.

Research on genetic improvement and disease control on *Agave angustifolia* is scarce, perhaps because of its long life cycle. However, there are several lessons to be learned from the domestication of similar species. For example, agronomic and biotechnological research on henequen conducted by investigators at the *Centro de Investigaciones Científicas de Yucatán* (CICY) demonstrates that healthy, genetically uniform *A. angustifolia* may be reproducible by tissue culture (Eastmond, Herrera, and Robert, 2000). *A. angustifolia* has a long lifecycle, thus making evaluation of new materials a time and resource consuming endeavor. However, tissue culture could be a helpful method to researchers for the establishment of genetic improvement programs, not only to reduce the time to produce a new generation of agaves, but also because it allows the production of certified healthy material for propagation, the reproduction of uniform and fast growing juveniles, and the propagation of unlimited quantities of improved materials for plantations (Eastmond, Herrera, and Robert, 2000).

The selection of the best genotypes for domestication is an added challenge for researchers, especially given the difficulties involved in finding appropriate wild plant materials. When the plants do not come from a bank of previously selected material, geneticists have a hard task in selecting the agaves with the desired characteristics. In selecting the ideal agave from the wild, the researcher will expect that the selected plants are drought or cold tolerant (Bertin and Bouharmont, 1997), have a short life cycle, high yield, high sugar content, high quality sugar, as well as disease and pest resistant (Yang, Yang, and Huang, 1998).

Once agaves are selected from the wild, tissue culture is the reproduction method recommended for agaves because its reproduction is faster than other methods, as a result of a faster vegetative development of agaves in their initial stages (Eastmond, Herrera, and Robert, 2000), and the possibility of unlimited and identical reproduction of one plant--an impossible task with seed reproduction.

When a genotype with ideal characteristics for a specific region or environmental conditions is obtained, this agave should be propagated by bulbils or offsets, especially when costs are an important consideration for producers. These methods produce genetically uniform planting materials, thus resulting in homogeneous production cycles, and plants that reach uniform maturity for more efficient harvesting. The recommended strategy for agave reproduction in commercial plantations, as derived from the experience of Jalisco (Valenzuela-Zapata, 1997) and Oaxaca (Sánchez-López, 1989), is the use of offsets. The first generation of offsets produced by a mother plant is preferred in Jalisco, especially offsets provided by healthy, young, and vigorous mother plants (Valenzuela-Zapata, 2000). Researchers in Oaxaca recommend the use of first and second generation offsets from healthy *A. angustifolia* plants, since they are generally more vigorous (Sánchez-López, 1989).

However, in spite of the obvious advantages, there are some serious drawbacks to producing uniform, commercially-viable plants. First, the development of these genetically uniform plants is costly, at least at the onset. Initially, only elite growers would be able to afford these kinds of planting materials, unless their cost was heavily subsidized to the benefit of small-scale producers. Second, the technical requirements of growing such

commercial-grade plants are another hidden cost for small-scale bacanora producers, many of whom have little education or access to agricultural extension and training. Lastly, once genetically superior but uniform plants are produced for commercial use, the risk of unforeseen plagues or diseases will become a new challenge to growers.

Keeping some genetic diversity of the species or variety should be part of the strategy of the production of planting materials and the establishment of commercial plantations. Such genetic diversity is present in different areas of the sierras, governed by regional soil types, precipitation patterns, incidence of pests or diseases, and local cultivation. Wild agave stocks could be maintained as living plant materials in a botanical garden setting, as *in vitro* germplasm, as pollen, or as carefully preserved wild seed. Lastly, any conservation strategy must also include mechanisms for maintaining existing ecosystems and natural habitat for *A. angustifolia.*

8.5. Research institutions and final remarks

In closing it, is appropriate to clarify the research institutions in the state of Sonora that are in some way involved with bacanora research and development. The three most important state-wide institutions include: the *Universidad de Sonora* (UNISON), the *Centro de Estudios Superiores del Estado de Sonora* (CESUES), and the *Instituto del Medio Ambiente del Estado de Sonora* (IMADES). Other institutions cover the region or the nation in their research. The *Centro de Investigación en Alimentación y Desarrollo* (CIAD) serves the northwestern part of Mexico, and the *Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias* (INIFAP) has headquarters throughout

México. All the institutions compete for scarce research funding from state and federal sources.

The author of this dissertation has worked for CIAD since 1993. Every effort has been made to approach the issues in this dissertation from a reasonable and objective point of view as possible. As part of a three year exploration of bacanora development, CIAD is currently seeking government support to study *in vitro* production of agaves. While the goals of this research is to further the development of a bacanora industry in the sierra, the actual consequences for the variety of producers in the region is unknown.

It is this author's sincere wish that small-scale bacanora producers of Sonora are given every opportunity to raise their standard of living. Wherever the funds for this research are allocated, it is the author's hope that this will be for the maximum benefit of numerous Mexican farmers as well as future generations of rural *serranos* who help to shape the bacanora industry of Sonora.

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GLOSSARY

Aguamiel. A dense liquid extracted from the head of *Agave salmiana. Aguamiel* es fermented with fruits to make pulque.

Aguardiente. A distillate from sugarcane also called rum. At the beginning tequila was called *aguardiente de maguey* or *aguardiente de mezcal.*

Anfora. A small water container carried by the jimador in his travels.

Añejar. A process of aging the liquor consisting in placing the liquor in oak barrels for long periods. The añejado gives the liquor a specific golden color and a wood flavor.

Avinagrado. This phenomenom occurs when the fermentation time is exceeded, and the *saite* is transformed into vinegar.

Bacanora. It is a spirit beverage distillated by using traditional technology from *Agave vivipara* in the sierra of Sonora since the 17th Century. Bacanora is also the name of a town located 40 km West of Sahuaripa. The spirit derived its name precisely from the name of the town.

Balde. A bucket used to bring water to the vinata.

Barrica. A 10 gallon aluminum barrel used to store bacanora.

Barranco. It is a hole digged in the ground used to ferment *saite*. Barranco is also one side of a canyon, a place preferred to hide the distillery during the times when production of bacanora was illegal.

Billar. Billiard.

Borrachera. A party where everyone involved gets drunk.

Cabeza. Liquor with high methanol content that results from the distillation of roasted

agaves. The *cabeza* is the first liquor obtained from the distillation. Jimadores also use *cabeza* to refer to the heart or head of the agave when the leaves are removed.

Cajete. A hole dug around the plant to accumulate water available to the plant.

Canoa. A mesquite-carved log placed in the ground used to shred the heads once they are roasted.

Cantina. A bar.

Capar. Term used in Sonora for the process of cutting off the inflorescence of agaves.

Cencerro. A bell placed in the neck of cargo animals used to find them when working in the sierra.

Centro de Acopio. A business that buys bacanora from bacanora makers.

Chuqui. The best or purest of the bacanoras. Chuqui is sometimes refered as the liquor obtained from the first distillation.

Coa. A manual tool shaped like a metal bar, with a wide and sharp edge at the end, used to harvest agaves in Jalisco.

Cogollo. The stalk of tender, unfolded leaves emerging from the center of an agave.

Colas. It is a low proof bacanora obtained from the last part of the distillation process.

Comunero. An individual belonging to a *comunidad.*

Comunidad. A land property system where the community has access to and use of the resources collectively.

Cuarto de los cachibaches. A small, dark room commonly found in serrana houses used to store and hide bacanora as well as many other items.

Culebra. Term given by bacanora makers to a copper coil used to condense de vapors produced by the process of evaporation.

Denominación de orígen. A certificate issued by the Mexican government to protect the area where bacanora is produced.

Despostillada. A cup that is scrapped or scratched.

Desquiote. To cut off the inflorescence of agaves.

Ejidatario. An individual belonging to an *ejido*.

Ejido. A land property system where the land belongs to the government but the right of using it is granted to a group of farmers.

Embudo. Funnel.

Empacho. Stomach problems associated with excess eating.

Fuste. Cargo accessories for animals.

Gargantón. Copper pipe or hollowed branch of a dried tree used to conduct the vapors from the hat (sombrero) of the distiller to the coil (culebra).

Horno. A hole dug in the ground used to roast the heads of agaves.

Jaibica. An ax with a head like a hammer on one side, and a sharp edge at the other used to shread the roasted agaves.

Jimar. A process of collecting wild agaves (in Sonora) or from plantation (in Jalisco). In Sonora is also a process of peeling an ear of corn to obtain the grain.

Jimador. An individual who does the *jimada*.

Judiciales. State or federal police.

Lechuguilla. A distillated beverage similar to bacanora made from *Agave palmeri.*

Machucado. A hard process of shredding the roasted agave done by using a *jaibica* in Sonora.

Media. A distribution method used in the sierras consisting in distribuiting one half of a product (*i.e.*, bacanora, cows) for one party and one half for the other in exchange for a service.

Mosto. Name given by tequileros to the fermented product. The *mosto* is called *saite* by bacanora makers.

Norma oficial. An official standard for bacanora registered in and issued by the office of property rights containing the parameters that define bacanora.

Ofrenda. An present offered to the dead or saints in rituals and ceremonies.

Parcela. A small plot of land that belongs to an *ejidatario.*

Parranda. To drink liquor for several consecutive days.

Penca. A piece of roasted agave with high sugar content.

Perlas. Pearl-like bubbles formed in distillated beverages. For bacanora makers the size of the bubbles and the time the bubbles remain in a bottle indicate the quality of the product.

Pisteada. Excess drinking.

Pulque. A beverage fermented with fruits made from *aguamiel* extracted from agaves in south-central Mexico.

Quiote. The inflorescense that emerges from the center of agaves.

Rebajado. Altered liquor. A liquor that is fermented with other sugars to increase its

volume.

Rectificación. The liquor obtained from the second distillation or from the distilation of *vinaza* or *tequila ordinario*.

Reposado. A tequila rested in oak casks.

Saite. A dark and foamy mix of roasted-and-shredded heads of agaves with or without water.

Sombrero. A special lid made of copper or carved from a palm tree and placed on top of the distillation drum. This lid is used to conduct the vapors from the distillation drum into the coil via the *gargantón*.

Sotol. A distilled beverage made from *Dasylirion wheeleri*, a very abundant species in the high sierras.

Tatemada, cabeza. A roasted head of agave.

Teguas. Shoes from the sierra of Sonora made of leather.

Tequila. A distilled beverage made from *Agave tequilana* in Jalisco and other neightboring states.

Tequila añejo. Tequila that has been aged for more than 3 months in oak casks.

Tequila blanco. The primary product of the second distillation.

Tequila ordinario. Also called *vinaza*. It is the liquor obtained from the first distillation.

Tercia. A distribution method used in the sierras consisting in distribuiting one third of a product (*i.e.*, bacanora, cows) for one party and two thirds for the other in exchange for a service.

Trago. A shot of liquor.

Tren. Name given in Sonora to the fully connected distillation equipment.

Vinata. Facilities where the bacanora is produced.

Vinatero. Person who mastered the process of producing bacanora.

Vinaza. Term given by tequileros to the liquor obtained from the first distillation. It is also called *tequila ordinario*.

Yunta. A plow pulled by an ox.