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Geographical indications, *terroir*, and socioeconomic and ecological sustainability: The case of tequila

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A B S T R A C T

In this paper, we use the case of tequila to examine the potential for geographical indications (GIs) to contribute to socioeconomic and environmental sustainability. GIs are place-based names (e.g., Champagne, Roquefort) that convey the geographical origin, as well as the cultural and historical identity, of agricultural products. The GI for tequila was established by the Mexican government in 1974, making it the oldest GI, and one of the best-recognized, outside of Europe. Here, we examine the social, economic, and ecological impacts that the agave–tequila industry has had on one community in tequila's region of origin, the town of Amatitán. We show that persistent cycles of surplus and shortage of agave and changing production relations in the agave–tequila industry have led to: (1) economic insecurity among farm households; (2) increased use of chemical inputs, at the expense of more labor-intensive cultivation practices; and (3) overall declines in fertilizer application, especially during periods in which there is a surplus of agave. We argue that the negative effects of the agave–tequila industry on the local economy and environment are due to the failure of the GI for tequila to value the ways in which the *terroir* of tequila's region of origin have contributed to its specific properties. We conclude by using this case to discuss more generally the relationship between the protection of place-based products (known collectively as geographical indications) and social and environmental sustainability.

1. Introduction

Geographical indications (GIs) are place-based names (e.g., Champagne, Roquefort) that convey the geographical origin, as well as the cultural and historical identity, of agricultural products.[1] GIs are protected under a wide range of institutions and arrangements and are found throughout the world. Although the oldest and most well-developed systems of GI protection are found in Europe (France, Italy, Spain), in recent years, developing countries have increasingly begun focusing on GIs as a tool to foster rural development and protect local products and traditions. Mexico was the first non-European country to establish a system of GI protection, in 1974. More recently, Brazil and Peru passed legislation on geographical indications in 1996, followed by South Korea and India in 1999, Columbia in 2000, and Chile in 2005, to name just a few. In 2007, Colombian coffee (*Café de Colombia*) became the first non-European product to be granted GI status in the European Union.[2]

Because GIs root production in a particular place, they are framed as sources of resistance against the homogenizing effects of "placeless" food production systems. Recent studies have focused on the positive effects of GIs on farmer livelihoods, local communities, and the environment (van der Ploeg et al., 2000; Belletti and Marescotti, 2002; Albisu, 2002). Yet while the theoretical and/or macro-level benefits of GI protection have been thoroughly outlined, very few studies have investigated the effects of GI protection at a local level. In this paper, we use the case of tequila to explore the contradictory social relations and processes that are unfolding at the local level as a result of GI protection. More specifically, we examine the effects of GI protection on the local community and environment in tequila's region of origin, the Amatitán-Tequila valley.

Tequila is a particularly influential case; not only is it the oldest GI outside of Europe, it is also recognized as one of the most economically successful non-European GIs. The tequila case is viewed as a model by many Latin American countries that are trying to establish or have recently established GI protection

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[1] Place-based products are protected under different names according to the nature of protection and the place in which the protection is based. In Mexico, place-based products like tequila are actually protected as *denominaciones de origen*. However, in this paper, to avoid confusion, we will use the term "geographical indications," that employed by the WTO, as an umbrella term encompassing the different forms of place-based protection for agricultural products.

[2] *Café de Colombia* is recognized as a "protected geographical indication" (PGI) by the European Union.

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schemes. However, our research indicates that the GI for tequila has largely failed to benefit the local population or environment in tequila's region of origin. The GI for tequila has been largely appropriated by transnational liquor companies, and the agave farmers have been excluded from the supply chain altogether. As local actors have lost control of the tequila industry, this has led to increased environmental degradation, reductions in the quality of tequila, and a gradual elimination of traditional practices.

In this paper, we examine in detail the social, economic, and ecological impacts that the agave–tequila industry has had on one community in tequila's region of origin, the town of Amatitán. We show that persistent cycles of surplus and shortage of agave and changing production relations in the agave–tequila industry have led to: (1) economic insecurity among farm households; (2) increased use of chemical inputs, at the expense of more labor-intensive cultivation practices; and (3) overall declines in fertilizer application, especially during periods in which there was a surplus of agave. Moreover, we link these effects to the design and structure of the GI for tequila. We argue that the negative effects of the agave–tequila industry on the local economy and environment are due to the failure of the GI for tequila to protect or value the link between the *terroir* of tequila's region of origin and the quality of tequila. We conclude by using this case to discuss more generally the relationship between the protection of geographical indications, *terroir*, and social and environmental sustainability.

2. Literature review

In recent years, researchers and policymakers have increasingly focused on emerging "alternative," "quality," and/or "local" food networks as providing a "way out" of the industrial agricultural model, which is associated with food safety concerns, environmental degradation, and rural poverty (Murdoch et al., 2000; van der Ploeg et al., 2000; Renting et al., 2003; Parrott et al., 2002). Food safety pressures (e.g., "Mad Cow" disease, salmonella, and *Escherichia coli* outbreaks in fresh vegetables) and mistrust of the standardized foods produced by industrial agriculture have led to g consumer reflexivity and given added salience to transparency and quality in agricultural production practices (Goodman, 2004). Moreover, quality has come to be seen as intrinsically linked to the "localness" of production (Murdoch et al., 2000). Drawing on Polanyi's (1957) concept of "embeddedness," some scholars argue that the market, instead of being the dominant and encompassing element of the economy, is also embedded in systems of social norms and institutions that channel its effects (Barham, 2002). "Values-based labels" provide a challenge to the "abstract capitalist relations that fuel exploitation in the global agro-food system," primarily by challenging market competitiveness based solely on price (Raynolds, 2000). The development of socially embedded or value-laden commodity chains offers the potential to better valorize local resources and internalize the social and environmental costs of production (van der Ploeg and Renting, 2004).

All values-based labels increase consumer access to information about the quality attributes and processing methods of food products (Marsden et al., 2000). Most of these labels, however, elaborate *how* the product was processed, but not necessarily *where*. GIs, on the other hand, are connected to a specific place. In this way, GIs "hold the potential of re-linking production to the social, cultural, and environmental aspects of particular places, further distinguishing them from anonymous mass-produced goods and opening the possibility of increased responsibility to place" (Barham, 2003). Social scientists have identified three primary benefits of GI protection schemes. First, economists note that GI products sell for higher prices than their industrially-produced counterparts, and so help farmers to remain competitive in the face of globalization (Babcock and Clemens, 2004). Second, because GIs are linked to a particular territory, and because GI protection is collectively owned, GIs are credited with having feedback effects throughout rural economies (Belletti and Marescotti, 2002; Albisu, 2002). Finally, by "short-circuiting" industrial supply chains, GIs are said to better connect producers and consumers, providing information (about the place of production, the people involved in production, and the methods employed) that allow the true environmental and social costs of production to be accounted for (Marsden et al. 2000, Renting et al. 2003, Van der Ploeg and Renting, 2004).

In much of the literature on GIs, the theoretical associations between GI protection, local environmental resources, and rural livelihoods are mediated through the concept of *terroir*. The fundamental argument advanced by the notion of *terroir* is that "the special quality of an agricultural product is determined by the character of the place from which it comes" (Gade, 2004). To put it more simply, as Starbucks did in advertisements for their origin-labeled coffees, the idea of *terroir* asserts that "geography is a flavor" (Starbucks Coffee, 2008; Helm, 2007). *Terroir* is linked to the unique biophysical properties of particular places—for example, altitude, microclimate, native plant species, and soil type—and GI schemes that privilege *terroir* can be designed to protect these resources, which are seen as essential to the specificity of the product (Bérard and Marchenay, 2006; Bureau and Valceschini, 2003). *Terroir* is also associated, however, with the cultural practices that have maintained these biological resources over several generations (and in some cases, hundreds of years). Bérard et al., (2005) state that *terroir* is a spatial and ecological concept that "links the actors, their histories, their social organizations, their activities, and, most importantly, their agricultural practices. The traditional knowledge and the technical practices have an influence on the biological diversity that they sustain." In other words, although the French word "*terroir*" is literally translated as "terrain, soil, land, ground, or earth," the cultural concept of *terroir*, as it relates to food and wine, is understood as the product of *interacting* natural and human factors.[3] The deeply rooted traditions and cultural practices that have contributed to the development and evolution of particular foods and flavors are thus also viewed as central to *terroir* (Trubek, 2008).

While the theoretical associations between GIs, *terroir*, and local environmental and cultural resources have been explored by a number of scholars (Bérard et al., 2005; Bérard and Marchenay, 2006), very few empirical studies have closely examined the relationship between GI schemes and sustainability on the ground. In one of the first (and only) comprehensive studies of the environmental effects of GI protection, Riccheri et al. (2006) compared eight GI systems and found positive results in reference to biodiversity conservation and maintenance of cultural landscapes. However, at the same time, they also found that processes of intensification (e.g., farm specialization, mechanization, increased reliance on inputs)—with visible environmental impacts—are present and possible under GI protection. Many GI goods are no longer produced as artisanally as their images suggest (Barjolle and Sylvander, 2002). Because of the conflicting evidence on the environmental impact of GI labels, Riccheri et al. (2006) conclude that "despite *a priori* assumptions influenced by an idealized characterization of GIs, GIs … show a relatively neutral effect on environmental quality." The relationship between GI production and environmental sustainability thus warrants further exploration.

In an attempt to add greater theoretical and empirical substance to these issues, we use the case of tequila to examine the effects of

[3] For example, the 1958 Lisbon Agreement, the first major international agreement on GIs, defined "appellation of origin" as the "geographical name of a country, region, or locality, which serves to designate a product originating therein, the quality and characteristics of which are due exclusively to the geographical environment, including natural and human factors."

GI protection on economic and ecological sustainability in one community in tequila's region of origin, the town of Amatitán. Actors in the tequila supply chain have largely failed to acknowledge or protect the link between *terroir* and the quality and specificity of tequila. This disjuncture, in turn, has contributed to the exclusion of the agave farmers, the erosion of traditional farmer knowledge and practices, and the degradation of local environmental resources. We recognize that notions like "*terroir*" and "authenticity" are socially constructed and can be employed to privilege certain actors and modes of development (Moran, 1993; Gade, 2004; Banks and Sharpe, 2006).[4] However, at the same time, we argue that *terroir* can represent a discursive tool that effectively ties production to particular territories and in doing so, allows local actors (e.g., small farmers) to better retain control over production.

In the tequila case, although Mexican GI legislation explicitly requires that GI products exhibit a link to *terroir*, the demonstrable link to *terroir* has not been enforced in practice. The tequila GI is virtually limited to just specifying the boundaries of production. The norms for tequila production do not specify appropriate agricultural practices or include measures designed to protect the local environment, which is progressively being degraded. Furthermore, because tequila companies tend to source their agave from across the very large, biologically heterogeneous GI region, the link between particular places and the quality and taste of tequila has been eroded. Finally, many supply chain actors (including, most importantly, the most powerful actors—the large tequila companies, the CRT, and the National Chamber of the Tequila Industry) do not value the cultural practices that have influenced the evolution of tequila over the past 400 years, and traditional agave cultivation techniques (i.e., intercropping with corn or beans, manual pruning) and artisanal tequila production processes (i.e., the use of wood-burning ovens to roast the agave and stone wheels known as *tahonas* to crush it) are threatened. Overall, we conclude that the negative effects of the agave–tequila industry on the local economy and environment are due in large part to the failure of the GI for tequila to value the ways in which the *terroir* of tequila's region of origin have contributed to its specific properties and taste characteristics.

3. Historical and current context: the tequila industry in Mexico

3.1. History and description of industry

Considered by many to be Mexico's national drink, tequila is made by fermenting and distilling the roasted heart of the blue agave plant (*Agave tequilana Weber*). It is estimated that "agave liquor" was first distilled in the mid-1500s (Limón, 2000), and the first documented reference to the production of "mescal wine" (essentially modern-day tequila) in Jalisco dates from 1608 (Murià, 1996). The largest and most powerful tequila companies (Cuervo, Sauza, Herradura) were established by large hacienda owners in the 18th and 19th centuries (Limón, 2000). Before the land reform that took place in Mexico between 1917 and 1940 (see Warman, 2001), the tequila companies produced their own agave (Luna Zamora, 1991). However, after the land redistribution, the tequila companies became dependent on *ejidatarios* (the small farmers awarded land in the land redistribution) for the supply of agave.

Today, the tequila industry is comprised of three main groups: the agave farmers, the tequila distilleries, and the bottlers and distributors. The last several generations of agave farmers cultivated the agave and then sold it to the tequila companies, often through intermediaries known as *coyotes*. The cultivation of agave is more complex than that of most crops, however, because blue agave takes 6–10 years to mature after being planted, which has historically complicated supply and demand patterns. As a result, the tequila companies now increasingly rely on contract arrangements with the agave farmers to ensure their supply of agave, and some firms have started to rent the smallholders' land and grow the agave themselves. The National Chamber of the Tequila Industry estimates that in 2006, 12,000 agave farmers, 11,200 day laborers, and 3400 field workers (mostly employed by tequila companies) were associated with the production of agave (CNIT, 2006).

After being harvested and delivered to the tequila distilleries, the heart of the agave plant is roasted and pressed to obtain the juices, which are fermented and distilled to produce tequila. One hundred and twenty-four firms are currently registered to produce tequila (CRT, 2008a,b). The third group of actors, the tequila bottlers and distributors, is comprised of companies primarily in Mexico and in the United States, which accounted for 74% of tequila exports in 2005 (CNIT, 2005).

The GI for tequila was established by the Mexican federal government in 1974, and is the oldest legally recognized GI outside of Europe.[5] All Mexican GIs,[6] including the GI for tequila, are the property of the Mexican government; the Mexican Institute for Industrial Property (IMPI) is the organization responsible for authorizing their use. The tequila GI states that that in order for a product to be marketed as "tequila," it must be made from at least that least 51% *Agave tequilana Weber* (blue variety),[7] grown within the boundaries delimited by the federal government (Fig. 1).

The GI region is very large (11,194,600 hectares) and includes 181 municipalities in 5 states (all of the state of Jalisco, plus parts of Guanajuato, Michoacán, Nayarit, and Tamaulipas).[8] The GI protects two basic types of tequila: tequila that is made from 100% blue agave; and tequila that is made from 51% blue agave alcohol and 49% alcohol from other sugars (generally sugar cane), known as *tequila mixto*. Tequila made from 100% blue agave, which is of higher quality and sells for a higher price, must by law be bottled within the GI region. However, *tequila mixto*, which comprises the bulk of tequila exports, is often sold in bulk and bottled outside of Mexico, to save on transportation costs. In addition, the tequila norms define four age categories for tequila: *blanco* or *joven* (aged

[4] For example, Trubek (2008) discusses the ways in which the concept of *terroir* has been consciously advanced and promoted in France, and how it has served to consolidate the economic power of the food and wine sectors in France, as well as France's international reputation as the arbiter of good taste (see also Gade, 2004). *Produits du terroir* comprise a €17 billion industry in France (INAO, 2008). Citing evidence from Australia, Banks and Sharpe (2006) criticize simplistic conceptualizations of *terroir* that make assumptions about the "naturalness" of wine regions ignoring the influence of political, economic, cultural, and historical factors (although they fail to acknowledge the emphasis placed on natural and human factors in many definitions of *terroir*).

[5] Importantly, the GI for tequila was largely ineffective until it was endorsed by the United States and Canada in 1994, and by the European Union in 1997. This gave it international standing, protected the tequila producers from competition from producers of imitation tequila in places such as Spain and South Africa, and shifted all of the responsibility for production of blue agave to Mexico.

[6] Mexico currently has 11 protected GIs—five for spirits/liquors (tequila in 1974, mezcal in 1994, bacanora in 2000, sotol in 2002, and charanda in 2003), two for coffee (café Veracruz in 2000 and café Chiapas in 2003), two for craft products (olinalá in 1994 and talavera in 1995), one for fruit (mango ataulfo del Sononusco de Chiapas in 2003), and one for a semi-precious stone (ambar de Chiapas in 2000). In Mexico, applications for GI protection are submitted to the Mexican Institute for Industrial Property, which, after a 2-month waiting period, reviews the applications and makes a decision on whether protection should be granted (Rodríguez, 2001).

[7] The minimum proportion of agave required to produce tequila has decreased over the last 50 years, from 100% blue agave in 1949 (when the first official norm for tequila was established), to 70% blue agave in 1964 and finally to 51% blue agave in 1970.

[8] As we discuss later in the article, the definition of the GI boundaries has been a persistent point of conflict within the tequila industry, and the inclusion of several municipalities in the state of Tamaulipas, which is on the eastern coast of Mexico and not contiguous to the rest of the GI territory, has been particularly controversial.

Fig. 1. Area protected by the GI for tequila. Source: Consejo Regulador del Tequila, 2008.

less than 2 months), *reposado* (aged at least 2 months), *añejo* (aged at least 1 year), and *extra añejo* (aged at least 3 years).

The official norm that governs the tequila production process is created by the federal government, in consultation with supply chain actors. The agave–tequila supply chain is managed by the Tequila Regulatory Council (CRT, according to its Spanish acronym), a private organization created in 1994. The primary functions of the CRT are to protect the GI for tequila in Mexico and internationally, and to verify and certify compliance with the norm for tequila production. The CRT's directive council is comprised primarily of the three groups of actors mentioned above (the agave farmers, tequila producers, and bottlers and distributors), as well as governmental representatives.

3.2. Evolution and trends in the tequila industry

In the last 15 years, the tequila industry has experienced impressive growth. Production of tequila more than doubled between 1995 and 2005, reaching 209.7 million liters of tequila in 2005 (CNIT, 2005). Unfortunately, however, supply chain actors have been unable to successfully coordinate the supply of agave with the demand for tequila. The entire history of the tequila industry has been characterized by cycles of shortage and surplus of agave.[9] As shown in Fig. 2, beginning in the late 1990s, the tequila industry experienced a particularly devastating shortage of agave.

Due to a fungal infection that struck in the mid-1990s and an early winter frost in 1997, as well as the cycles of surplus and shortage that normally accompany agave production,[10] from 1997 to 2000 the blue agave population in Jalisco decreased by 50.7% (González, 2002). The shortage was exacerbated by skyrocketing demand for tequila, caused by the increased popularity of tequila in domestic and international markets (particularly in the United States and Europe) and strengthened by the ratification (by the United States and Canada in 1993 with the North American Free Trade Agreement (NAFTA), and by the European Union in 1997) of the GI for tequila. The average price of agave skyrocketed, shooting from $1.57 pesos per kilogram in 1998 to $19.08 pesos per kilogram in 2000 (prices expressed in real 2007 terms; Macías Macías and Valenzuela Zapata, 2007) and pushing many smaller tequila companies out of business. Because of the constraining effect that the agave shortage had on the continued growth of the tequila industry, as Fig. 3 illustrates, it was not until 2004 that tequila production levels began to rebound.

The agave shortage prompted several changes that have had important effects on production relations in the tequila industry. First, agave production expanded into new areas, areas that are within the production zone defined in the GI for tequila, but that do not have a historic tradition of agave cultivation (Macías Macias, 2001; Bowen and Gerritsen, 2007). Second, in order to better insulate themselves from the risks associated with the cycles of surplus and shortage, the largest tequila companies expanded their control within the supply chain by becoming more self-sufficient in their supply of agave (Bowen, 2008). Many tequila companies now obtain 80–90% of their agave needs through their own plantations and through contract arrangements (Bowen, 2008; Leclert, 2007). As a result, it has become increasingly difficult for independent agave farmers to sell their agave, especially now that the agave market has again entered a period of surplus (see Fig. 2).[11] Furthermore, the tequila industry is becoming more and more concentrated—in 2005, four firms (Cuervo, Sauza, Herradura, and

[9] The cycles of abundance and shortage that have been present throughout the history of the tequila industry are mutually reinforcing. During a period of surplus, agave prices fall so low that farmers do not have the necessary capital or the incentive to begin planting another crop of agave. In addition, when the price of agave is low, farmers neglect to monitor their agave plantations closely for pests and/or disease, which often leads to an outbreak. The combination of increased incidences of disease and pest infestation and decreased planting of new crops leads to a shortage cycle 6–10 years later. During a period of shortage, agave prices become artificially high, which incites new producers to enter the agave market and encourages existing producers to expand their agave plantations, leading to another surplus cycle down the line.

[10] See the note above for a description of the cycles of surplus and shortage that characterize the industry.

[11] In 2006, 1.2 million tons of agave were harvested, but the tequila industry was only able to consume 769,000 tons of agave. Many producers were forced to let their agave rot in their field. By 2006, the price of agave had dropped to $2.07 pesos per kilogram (Macías Macías and Valenzuela Zapata, 2007), near or below the estimated costs of production. The price dropped further in 2007, to $1.70 pesos per kilogram (Macías Macías and Valenzuela Zapata, 2007), and the CRT estimates that the surplus will continue through at least 2009 (author interviews, 2006).

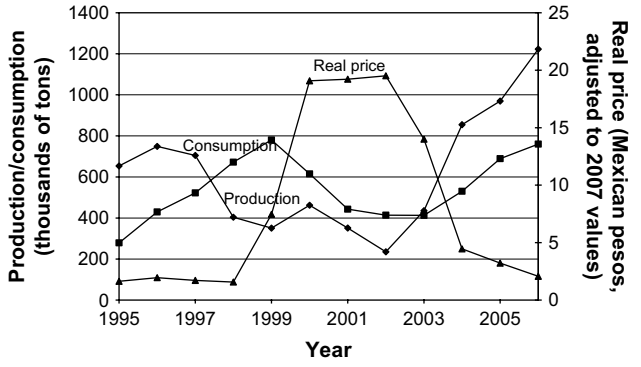

Fig. 2. Cycles of surplus and shortage of agave, and associated changes in price. Source: Macías Macías and Valenzuela Zapata, 2007.

Cazadores) controlled approximately 67% of the total tequila market (*El Financiero*, February 9, 2005)—and formerly Mexican-owned firms are increasingly establishing partnerships with or being bought out by multinational liquor firms (Casas, 2006).

In sum, the case of tequila provides an example of a GI that is not being managed in a way that effectively promotes rural development. The rapid expansion of the tequila market over the last 15 years has been driven by a shift in control and ownership of the major tequila companies to transnational liquor companies, and has been accompanied by the concentration, industrialization, and standardization of tequila production. Chávez (2006) states that the transnational liquor companies are leading a process of "globalization from within" in the tequila industry, in which a traditional product and the practices and local knowledge associated with its production become the subject of global marketing. The process by which the globalization of the tequila industry has been achieved, however, has completely excluded and marginalized the agave farmers, and as Chávez notes, "bares the disquieting signs of the decomposition of the social compact of a State that was already dysfunctional." Revisions made to the norms have predominantly gone in the direction of lowering quality standards and reducing costs, and the norms that regulate the tequila industry have done little to preserve traditional tequila production methods or the environmental specificity of tequila. Thus, tequila is evolving into a generic, mass-produced liquor; and the farmer knowledge, artisanal production practices, and environmental resources that are associated with the specificity and heritage of tequila are being degraded. All of these trends threaten the social, cultural, and ecological resources that comprise tequila's region of origin, the Amatitán-Tequila valley. Throughout the rest of this paper, we analyze the long-term socioeconomic and ecological impacts of the agave–tequila industry, providing a theory of the factors that threaten the sustainability of the industry and the tequila GI.

4. Methodology

In this study, we conduct an in-depth examination of one community in tequila's region of origin, the community of Amatitán, located in the Amatitán-Tequila valley (where tequila production originated in the mid-16th century), in Jalisco, Mexico. Amatitan is approximately 40 km from the city of Guadalajara (the second-largest city in Mexico) and less than 10 km from the city of Tequila. The area is characterized by tropical luvisol soils, derived from volcanic parent material, and the total annual precipitation averages 931.5 mm (INEGI, 1997). In 1995, the town of Amatitán had a population of 8140 residents (INEGI, 1997), with another 3177 residents living in the smaller *pueblos* that are scattered throughout the larger municipality of Amatitán (INEGI, 1997). The people of

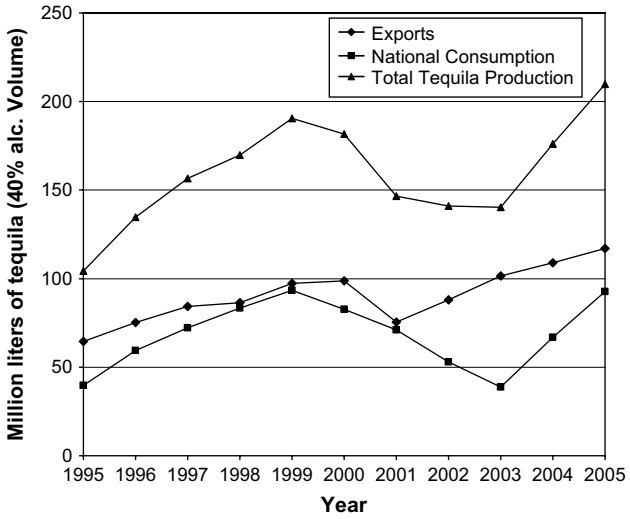

Fig. 3. Trends in tequila production, 1995–2004. Source: Cámara Nacional de la Industria Tequilera, 2005.

Amatitán are integrated into the tequila industry as employees and owners of the tequila companies, as agricultural day-laborers, and especially as agave farmers. In 1990, almost half (48%) of the working population was employed in the agricultural sector (INEGI, 1997). By far the dominant crop in the region is agave; of the 8179 hectares of agricultural land in the municipality, 76% (6223 ha) were used to cultivate blue agave in 2004 (SAGARPA, 2004). Another 17% of the working population was employed in manufacturing in 1990 (INEGI, 1997). Major tequila distilleries such as Herradura (one of the largest tequila companies in Mexico) and La Regional are located in Amatitán, and in 2005, 15,313 million liters of tequila (7.3% of total production) were produced in Amatitán (CNIT, 2005).

Our analysis of the socioeconomic and ecological effects that the tequila industry has had on the community of Amatitán relies on three primary sources of data. First, in 2003, semi-structured interviews and workshops were conducted with 20% of the *ejidatarios*[12] in Amatitán ($n = 18$) to evaluate the ecological sustainability of agricultural production systems. The MESMIS framework was used to engage farmers in participatory research that allowed them to evaluate the sustainability of their management systems and to define new agricultural strategies (Masera and López-Ridaura, 2000; López-Ridaura et al., 2002). Sustainability was defined according to a number of attributes, including productivity, stability, resilience, adaptability, equity, and self-sufficiency (Masera and López-Ridaura, 2000; López-Ridaura et al., 2002). Working together, farmers and researchers used a point-based system to evaluate management practices and to create a sustainability index to compare current and past management systems.

Since the first phase of this research focused on the ecological sustainability of the agave–tequila industry, a second round of interviews was conducted in 2006 in order to better understand the social and economic sustainability of the agave–tequila industry. Semi-structured interviews ($n = 27$) were conducted with randomly-selected agave farmers (*ejidatarios*, *propietarios privados*, and farmers who rented agricultural land) in Amatitán. Each interview focused on the household's socioeconomic profile, the farmer's

[12] *Ejidatarios* are members of Mexican *ejidos*, collective landholding units first established following the Mexican revolution (Lewis, 2002). Although the 1992 amendment to Article 27 of the Mexican Constitution legalized the rental and sale of previous inalienable *ejido* land, a large proportion of smallholders in Mexico are still organized into *ejidos*.

Table 1
Socioeconomic characteristics of households in Amatitán (source: author interviews, 2006)

ID	Adults	Children	Primary economic activity	Rented or shared	Owned	Land with agave	Agave plants managed by smallholder	Estimated total income ($)	Estimated per capita income ($)	Estimated income from agave cultivation (or land rental) ($)	Estimated income from primary activity ($)
1	1	0	Agave cultivation	0	526	83	39000	−47175	−47175	−17300	−17300
2	2	0	Agave cultivation	14	0	14	31000	−21338	−10669	−24938	−24938
3	2	0	Agave cultivation	0	8	8	22000	−21000	−10500	−28000	−28000
4	2	0	Agave cultivation	0	15	15	35000	−1252	−626	−3202	−3202
5	5	0	Agricultural day laborer (agave)	1	3.5	2	4000	3170	634	−16975	17280
6	2	3	Agave cultivation	27.5	0	27.5	81000	37640	7528	−35060	−35060
7	2	3	Jimador (agave harvester)	3.5	0	2.5	8000	39338	7868	−3120	28800
8	3	3	Agricultural day laborer (agave)	0	5	5	9000	51700	8617	7900	15000
9	4	0	Plum cultivation	6	7	1	6000	37400	9350	−9040	2000
10	3	1	Agave cultivation	0	19	14	10000	38208	9552	−3900	−3900
11	3	1	Agricultural day laborer (agave)	0	6	6	0	44934	11234	0	14400
12	2	3	Works for the family of one of the tequila companies	13	4	17	40000	63120	12624	−60000	120000
13	7	2	Agricultural day laborer (agave)	2	0	2	6000	118970	13219	−9230	39000
14	2	4	Jimador (agave harvester)	0	4	4	5648	86660	14443	−6700	92160
15	4	6	Construction worker	0	6.5	6	13050	165769	16577	−4001	72000
16	3	1	Agricultural day laborer (agave)	0	3	3	8472	80840	20210	29000	25920
17	3	0	Bricklayer	0	1.5	1.5	0	68875	22958	1000	26250
18	3	0	Retired	0	28	17	0	100188	33396	−80000	78408
19	5	2	Agave cultivation	5	40	35	60000	311371	44482	94706	94706
20	3	1	Agave cultivation	56	100	156	280000	265111	66278	459778	459778
21	2	0	Agave cultivation	0	84	63	220000	301151	150576	324251	324251
22	2	4	Agave cultivation	24	0	24	58500	–	–	–	–
23	5	0	Agave cultivation	3	10	13	–	–	–	–	–
24	1	0	Retired	0	30	5	30000	–	–	–	–
25	2	3	Pharmacist	0	8	8	–	–	–	–	–
26	3	3	Municipal judge	0	3	3	8472	–	–	–	–
27	2	0	Agave cultivation	0	48	48		–	–	–	–

Agricultural expenses and expenses related to family businesses were also included in the analysis, but household expenditures (e.g., food, clothing) were not included. All sources of income and expenditures are listed in Mexican pesos. Costs of family labor (i.e., on-farm labor) were not included, although labor mobilized through the market (i.e., paid work) was included in the analysis. Since quantities and costs were self-reported and roughly estimated, the economic analyses are used mostly to reflect general trends and for comparison purposes.

history of production of agave and alternative crops, and the farmer's perceptions of the ecological and social impacts of the GI arrangement. As part of the economic analysis included in this phrase of the research, each household was asked to estimate all sources of income for the 2005 calendar year, including: income from agricultural production, wages from formal employment, profits from family businesses, governmental subsidies, remittances, and credit.

Third, also in 2006, semi-structured interviews ($n = 41$) were conducted with actors throughout the agave–tequila production chain, including tequila producers and distributors, government officials, and leaders of farmer associations. Interview informants were purposively selected to obtain a broad cross-section of the most important actors in the agave–tequila commodity chain. Although in this paper we focus mostly on the results of the two sets of farmer interviews, the commodity chain interviews were used to situate the agave farmers in their broader political economic context.

5. Results: socioeconomic and environmental sustainability in Amatitán, Jalisco

5.1. Indicators of socioeconomic sustainability

In the Amatitán-Tequila valley, the tequila industry is seen by the local population as bringing job opportunities, value-added agriculture, and tourism to a depressed area that would have a hard time surviving without it. Not surprisingly, we found that the tequila industry was central to the livelihoods of a large portion of the smallholders interviewed. About three-quarters of interview participants depended directly on the agave–tequila industry as their family's primary source of income. Agave cultivation (either on one's own land or as an agricultural day-laborer) is the dominant income-activity in this region.[13] More generally, the tequila industry constitutes the backbone of the local economy in the Amatitán-Tequila valley. However, the long-term ecological and economic sustainability of the industry and the region are threatened by the enduring conflicts that exist between the agave farmers and the tequila companies, and by the related cycles of surplus and scarcity of agave.

First, the high degree of dependency of the local population on the agave–tequila industry (and in particular, on agave cultivation) is potentially dangerous, because the incomes associated with the industry vary greatly (Table 1), both between households and from year to year. Household incomes ranged from a per capita net

[13] 44% (12) of interview participants stated that agave cultivation (on their own land) was their primary economic activity, and another 19% (5) stated that work as an agricultural day laborer (on another person's or company's agave fields) was their primary economic activity. 11% (3) depended on off-farm employment within the tequila industry (mainly as *jimadores*—agave harvesters—or in the tequila factories) as their primary activity.

income of $150,576 pesos[14] to a net income of less than zero. Total landholdings and land cultivated with agave also varied considerably between households. Land cultivated with agave (by the smallholders, either independently or through a contracting arrangement) ranged from 1 to 156 ha. Some of the poorer smallholders did not cultivate agave at all; they had rented out their land to one of the tequila companies or a large agave farmer for the cultivation of agave, or had sold their agave plantation (by the plant, before the agave had matured) during a period of financial hardship. The better-off households were more likely to purchase a large share of the land on which they cultivated their agave, whereas poorer households were more likely to rent (or sharecrop) their agricultural land.

More concerning than the fact that incomes varied between households is the fact that considerable fluctuations exist from year to year. Almost 20% of farm households reported net annual incomes of less than zero (author interviews 2006), which reflects both the long cultivation cycle of agave in general, and the state of the market at the time of the interviews. Because of the high degree of variation in the price of agave from year to year, smallholders, especially independent agave growers, face substantial risks. The shifts in price that characterize the industry make it difficult for farmers to plan or to assure a stable income from agave cultivation. It is hard to predict what the price of agave will be 6 years later, especially since neither the government nor the CRT publish farmer-accessible information on the annual agave inventory or predicted future prices. Furthermore, smallholders who decide to plant agave must have sufficient capital to cover the costs of maintaining their agave plantations during the long cultivation cycle of agave. This is particularly difficult for small and/or poor farmers, given that credit can be very difficult to obtain, and extremely expensive, in Mexico.

Second, changing production relations in the tequila industry (in particular, the tequila companies' increased self-sufficiency and use of contract arrangements), which arose in large part out of the agave shortage of 1999–2003, have further threatened smallholders' ability to earn an adequate income from the cultivation of agave. The increased use of reverse leasing arrangements,[15] in which the tequila companies rent land from smallholders and take over the entire agave production process, is particularly concerning (Bowen and Gerritsen, 2007). González (2002) argues that because reverse leasing arrangements exclude smallholders from the productive process, they have very little positive impact on farmer incomes and fail to stimulate agricultural productivity; yet these are the arrangements that the tequila companies are overwhelmingly choosing to adopt. Often, the tequila companies choose to implement these reverse arrangements in areas in which farmers do not have a tradition of cultivating agave, because the smallholders in these areas are more likely to accept lower rents and other contract terms that are unfavorable to farmers. In areas like Amatitán, most farmers did not want to participate in reverse leasing arrangements, which would have excluded them from the production process that their families had been part of for several generations. These farmers had no choice but to continue cultivating agave as "*agaveros libres*" (farmers who sell their agave on the open market). Of the 27 smallholders interviewed, only two (7%) had an established (advance) purchase agreement with one of the tequila companies (author interviews 2006).[16] These purchase agreements are by far the best arrangement for agave farmers, since they provide the security of an established buyer, while allowing the farmers to continue managing their land; yet they are becoming almost impossible to obtain.

Most *agaveros libres* are forced to sell their agave through intermediaries known as "*coyotes*," who buy agave at very low prices and then resell it to the tequila companies. Associations of agave farmers have also been organized during periods of crisis. However, the collective organizations that have been formed have been weak and characterized by corruption, and have not been able to sustain organizational or membership continuity over the long-term.[17] The farmer associations have thus generally not been effective at facilitating the sales of significant quantities of agave for the independent *agaveros*.

It is important to note that although many agricultural commodities (e.g., coffee) are similarly characterized by "boom and

[14] Incomes, prices, and other economic data are reported in Mexican pesos. The average exchange rate in 2005 (the year for which the economic analyses were conducted) was $1 USD = $10.89 Mexican pesos (calculated using data from the Foreign Reserve Statistical Release, http://www.federalreserve.gov, accessed on July 9, 2007). The dollar sign ($) is also used in Mexico to designate the Mexican peso. Therefore, throughout this paper, we list prices by using both the dollar sign and the word "pesos" (i.e., $10.00 pesos). A "centavo" is 0.01 of a peso.

[15] Under these arrangements, smallholders rent their parcels to contracting companies (often affiliated or directly owned by the major tequila companies) who bring in capital, machinery, labor, and other inputs needed for agricultural production (Bowen and Gerritsen, 2007). Smallholders do not have access to their land, nor do they make any of the management decisions (Bowen and Gerritsen, 2007). The smallholder receives an annual rent for the use of his or her land and/or a percentage of the final harvest (Bowen and Gerritsen, 2007). By transferring the management of the land and the production process from landowners to tequila companies, reverse leasing arrangements potentially allow firms to externalize environmental costs and to adopt unsustainable management techniques (e.g., intensive application of agrochemicals) (Bowen and Gerritsen, 2007; Martínez et al., 2003; Gutiérrez, 2005).

[16] Of the 27 smallholders included in our study, 18 were "*agaveros libres*" who did not have any type of agreement with one of the tequila companies to buy their agave, 3 had rented out all of their land to another farmer or one of the tequila companies, and 4 had a mix of some of their land rented out and some agave cultivated independently (without any type of contract or agreement). Just 2 had an established (advance) purchase agreement with one of the tequila companies.

[17] For example, in response to a severe surplus of agave, in 1976, farmers in the Amatitán-Tequila valley created the Unión de Productores e Introductores de Mezcal Tequilero (Llamas, 1999). Their strategy focused on blocking the entrances to distilleries that relied on intermediaries (*coyotes*) instead of buying agave from independent farmers (Llamas, 1999). In late July and early August 1976, the union took control of 22 distilleries over a period of 3 days, and they prolonged the blockages for 2 months at Cuervo's and Sauza's factories (Llamas, 1999). These efforts succeeded in increasing the price of agave, from 60 to 90 cents per kilogram, and the union obtained official recognition from the factories as their main agave supplier—the agreement signed at the end of conflict prohibited the factories from buying agave outside of the union (Llamas, 1999). However, by 1989, the union has dissolved into various local organizations that were incapable of working together as a unified association of producers, and their capacity for negotiation within the tequila industry was thus very weak (Llamas, 1999). The pattern was repeated during the surplus that occurred in the mid-1990s. In 1995, the tequila industry had the capacity to consume only 43% of the agave harvested (Macías Macías and Valenzuela Zapata, 2007); the *coyotes* contributed further to the problem by engaging in speculative behavior and encouraging the *agaveros* to sell their agave up to one year in advance, at very low prices (Llamas, 2000). The federal government offered almost no support for the agave farmers during the crisis. Before they turned to confrontation, the *agaveros* looked for support from local governmental agencies and the current major union, the Unión Agrícola Regional de Productores de Mezcal Tequilero; however, these solutions offered little help (Llamas, 2000). El Barzón de Agave was born when, on May 23, 1995, more than 250 farmers demonstrated against the continued use of *coyotes* with a march through Tequila (Llamas, 2000). Llamas states that a major strength of the El Barzón de Agave movement was the "injustice" frame that was employed in El Barzón's discourse—most importantly, the injustice associated with the tequila companies' refusal to buy directly from producers and the fact that they had started to cultivate their own agave (Llamas, 2000). El Barzón gained strength very quickly; just five months after it was formed, it represented 81% of the agave farmers in the Amatitán-Tequila valley (*Siglo 21*, October 24, 1995, as cited in Llamas, 1999). The movement also focused mainly on blocking the entrances to factories and demonstrating in Tequila and Guadalajara. In 1997, after more than two years of conflicts and negotiations, El Barzón de Agave succeeded at increasing the price of agave to 850 pesos per kilogram (up from a low of less than 500 pesos per kilogram in 1995). However, many farmers were still forced to let their crops rot in the fields, and, due in part to the fact that many farmers stopped monitoring for pest and diseases, Jalisco suffered a massive pest infestation in the mid- to late-1990s that killed up to 25% of the agave population (Ramírez, 2002).

bust" cycles, GI schemes provide a potential means of using collective strategies to regulate supply and stabilize relations between actors. In the tequila case, however, instead of using the structure of the GI scheme to stabilize the supply of agave, the tequila companies have begun producing their own agave, effectively eliminating the *agaveros* from the supply chain. Efforts to establish a base price of agave or to engage in collective planning efforts have failed repeatedly. Instead, solutions proposed by governmental officials and the CRT focused on the individual farmers' responsibility for establishing contracts with the tequila firms before planting, while at the same time absolving the tequila companies of their role in contributing to the current surplus (Bowen, 2008).

5.2. Indicators of ecological sustainability

In the previous section, we discussed how the cycles of surplus and scarcity that characterize the agave–tequila industry and the changing production relations in the industry (e.g., increased adoption of reverse leasing arrangements) increase farmers' economic insecurity and threaten their ability to earn a livelihood from agave cultivation. In this section, we discuss the effects of these processes on the long-term ecological sustainability of the industry. We rely primarily on in-depth interviews and sustainability workshops conducted with eighteen *ejidatarios* in Amatitán in 2003. The *ejidatarios* collectively defined the optimal management system and then compared current and past practices to the optimal model.[18] Table 2 summarizes the major changes that have taken place in the *ejidal* (small farmer-dominated) system of agave cultivation in Amatitán in the last twenty years; Table 3 evaluates the past and current systems according to indicators of ecological sustainability.[19] The main sustainability indicators emphasized were soil fertility (related to application of fertilizers, length of fallow periods, and intercropping), and the presence of pests and disease (related to pruning, application of pesticides). *Ejidatarios* did not perceive genetic erosion due to monocropping or the vulnerability of tropical volcanic soils caused by continuous cultivation strategies as threats to sustainability. Therefore, these points are not integrated into the results, even though the cultivation of *Agave tequilana Weber* in monoculture and in particular the clonal (asexual) propagation of the agave plant have contributed to genetic erosion and a reduction in resistance to pests and diseases (Valenzuela Zapata, 2003, 2005).

Two major changes give cause for concern. First, farmers increasingly substitute more traditional, labor-intensive practices with more chemical-intensive but labor-efficient practices. This is due to several factors. Smallholders imitate the "technological packet" (Landeros, 2005) required by the tequila companies (Valenzuela Zapata, 2003). In addition, labor shortages arise as household members migrate to Guadalajara or to the United States (Herrera and Araceli, 2004). Moreover, there is a growing trend within the agave–tequila industry to value the application of chemical inputs as prescribed by trained engineers over the expertise of experienced but uneducated agave farmers. This trend is also related to the tequila companies' increasing self-sufficiency in their supply of agave and their refusal to buy agave from the independent farmers who have cultivated agave for generations in the Amatitán-Tequila valley. The second major change is that farmers' rates of application of inputs (particularly, those designed to maintain soil fertility) vary significantly according to the price of agave, and in the last 20 years, application rates have declined overall.

As shown in Tables 2 and 3, as part of the shift toward a more input-intensive agave cultivation system, modern agave cultivation systems are characterized by (1) increased use of pre- and post-emergent herbicides to control weed growth, which has reduced vegetative soil cover and increased soil erosion, (2) increased use of pesticides and fungicides, (3) increased presence of pests and disease. These practices have come at the expense of traditional practices such as controlling weeds by pruning the leaves of the agave plant, intercropping agave with corn or beans, and leaving the land fallow for several years in between cultivation cycles. Of the 18 farmers who participated in the sustainability workshops, 14 stated that they used gliphosates (post-emergent pesticides) to control pests, while 2 used pre-emergent pesticides. These treatments have resulted in decreased vegetative cover during the rainy season, which contributes to increased soil erosion and soil compaction. In the past, farmers used a variety of practices to control for weeds and pests (e.g., pruning the leaves of the agave plant, controlled burning, and the use of herbicides); now, herbicides and pesticides have almost completely replaced alternative practices. Traditional practices such as allowing a fallow period in between crop cycles and intercropping the agave with other crops are also becoming less common. Only 2 farmers had allowed their agave fields to remain fallow for the maximum recommended period of time (3 years). Another 8 farmers had allowed their fields to remain fallow for 2 years, while 4 had allowed their fields to remain fallow for 1 year, and 4 had immediately planted another crop of agave. The short fallow period between cycles of agave plantings negatively affects soil fertility. Furthermore, farmers have largely stopped intercropping agave with other crops (i.e., legumes, which contribute to increased soil fertility) in the first years of the agave cultivation cycle. Intercropped agave cultivation systems began to disappear in the 1980s because the tequila companies prohibited intercropping in agave cultivated under contract.

Despite, and most likely because of, the shift from traditional, labor-intensive cultivation practices to more chemical-intensive practices, incidences of disease and pest infestation have actually increased over the last 20 years. Especially after the massive pest infestation between 1993 and 1999 that killed 25% of the agave population in Jalisco (Ramírez, 2002), the application of pesticides, herbicides, and fungicides has continually increased. However, because most farmers did not have access to information about appropriate rates of pesticide and herbicide application, they based their application rates on the recommendations of the agrochemical venders, who have an interest in encouraging farmers to apply high rates of their company's product even when it is not the best product for the particular problem. Farmers interviewed stated that they were concerned because they had found "new symptoms" in their fields, such as deformed or yellow tissues in the leaves of their agave plants, but did not know if these were symptoms of disease or effects of the agrochemicals. In large part, the agave farmers lacked training and information concerning agave cultivation practices, although groups of farmers had started to form small

[18] This methodology, in which the farmers themselves identified the most relevant sustainability indicators, gives the *agaveros* the opportunity to express their concerns and vision for the future. Of course, it is important to note that notions such as "traditional" and "authentic" are socially constructed and representative of power inequalities and political objectives (Bessière, 1998; Ray, 1998). In emphasizing the importance of returning to a more traditional, labor-intensive production system, the small farmers may simply be trying to reassert their role in the supply chain. However, at the same time, the tequila companies' refusal to regulate the quality of the agave or the methods that are used to produce it is also reflective of power relations within the tequila supply chain. This methodology is unique in that it explicitly considers the issue of "sustainability" from the perspective of the farmers that (historically) comprised the backbone of the industry.

[19] The classifications and relative weightings in Tables 2 and 3 were determined collectively in a series of workshops with the *ejidatarios* in Amatitán. The MESMIS framework was used (see Masera and López-Ridaura, 2000; López-Ridaura et al., 2002). The *ejidatarios* discussed and voted on the sustainability indicators and weightings. The researchers leading the discussions also participated.

Table 2
Characterization of the ejidal system of agave cultivation in the Amatitán-Tequila during two periods of time (source: author interviews, 2003)

	1983–1985	2000–2003
Cultivation system	Cultivation of agave in monoculture; occasionally intercropped with maize, beans, or peanuts in the first 2 years	Cultivation of agave in monoculture
Technology employed	Traditional, with agrochemicals	Higher mechanization of cultivation practices, higher use of agrochemicals, low use of technical assistance
Labor employed	Family	Family and temporary workers
Fertilization	Application of urea (nitrogen fertilizer)	Greater reliance on chemical fertilizers Less intercropping Very few farmers incorporate fertilizers
Soil conservation practices	Soil conservation practices such as stone terraces are used; specified fallow periods and crop rotations are not used.	Soil conservation practices, specified fallow periods, and crop rotations are not used.
Management of pests and disease	Application of fungicides and insecticides Leaves are pruned to control for pests	Higher application of fungicides and insecticides Increase in presence of pests and disease Presence of unknown symptoms in agave plants (e.g., deformed or yellow tissues in plant leaves) Leaves are still pruned, but on a reduced scale
Weed control	Manual control of weeds (pruning plants with the *coa*) Controlled burning of dried weeds in winter Application of post-emergent herbicides	Application of pre- and post-emergent herbicides; soils are left without vegetative cover Complementary manual control of weeds (pruning plants with the *coa*) on an occasional basis
Tillage	Variable but minimal use; sometimes animal traction is used	Variable but minimal use by small growers; intensive use by large-scale owners
Characteristics of producers and organization of production	*Ejidal* organization Objective: profits Small farms	Weak *ejidal* organization Objective: profits Small farms

groups in which they discussed alternative cultivation practices (e.g., composting, use of bio-fertilizers) and supported farmers who wished to take a view of agave cultivation that contradicted that which was offered by the tequila companies.

The second major threat to the ecological sustainability of the agave–tequila industry in Amatitán is related more directly to the cycles of surplus of shortage of agave. Maintenance of soil fertility is a significant concern when discussing the long-term sustainability of the agave cultivation system. However, in our analysis of how agave cultivation systems have changed over the last 20 years, we found that, although applications of inputs intended to maintain soil fertility (e.g., fertilizers, lime, and animal manure) improved during specific periods, such as when the price of agave was high or when governmental support for farmers was implemented, the overall tendency over the 20-year period was towards a reduction in inputs used to maintain or improve soil fertility.

In general, applications of fertilizers and lime increased when the price of agave was high, and decreased with the falling price of agave. For instance, in the interviews we conducted in 2003, when the price of agave in Amatitán averaged $7.53 pesos per kilogram, the vast majority of farmers (more than 80%) had applied some type of fertilizer (lime, organic fertilizer, or chemical fertilizer) to their

Table 3
Indicators of sustainability for the ejidal system of agave cultivation in the Amatitán-Tequila valley (retrospective comparison) (source: author interviews, 2003)

Indicator	Optimal	%	1983–1985		2000–2003	
				%		%
(1) Intercropping with leguminous crops	First 2 years	100	First year	75	None	50
(2) Fallow periods	2 years	100	Variable	50	Variable	50
(3) Tillage	1 per year	100	1 per year	100	>1 per year	50
(4) Application of organic matter	3 cycles	100	0	50	1 cycle	75
(5) Lime application	1 cycle	100	0	30	1 cycle	30
(6) Application of NPK fertilizer	2 cycles of NPK application; incorporation into soils	100	Lower levels of NPK application; fertilizer is not incorporated	50	Higher levels of NPK; fertilizer occasionally incorporated	80
(7) Application of pesticides	2 cycles	100	1 cycle	50	>1 cycle	25
(8) Presence of pests and disease	<5%	100	>5%	100	>5%	50
(9) Weed control	With cover	100	More soil cover	50	Less soil cover	50
(11) Weed burning	No	100	Yes	50	No	100
(12) Technical assistance	Yes	100	Partial	50	Partial	25
(13) Manual pruning	Frequent pruning	100	Occasional pruning	100	No pruning	80
(14) Technical training	Yes	100	No	20	No	20
(15) Commercialization	Yes	100	No	50	No	50
(16) External inputs	Low levels	100	Low levels	80	High levels	60
Total		1500		905		795

Applications of NPK, organic matter, and lime were higher than average in the period 2000–2003, because this was a period characterized by extremely high prices of agave. Overall, during the 20-year period (1983–2003) rates of fertilizer application declined (see also Valenzuela Zapata, 2005).

fields within the prior 3 years. However, in interviews conducted with farmers in the Amatitán-Tequila valley in 1997, when the price of agave hovered around $0.80 per kilogram, Aceves Rodríguez et al. (2001) found that only 15% of parcels had received an application of urea, and less than 5% had applied nitro-phosphate fertilizers or organic fertilizer. Similarly, many of the farmers interviewed in 2006 stated that because the price of agave was so low, they had stopped applying fertilizer to their fields. During periods in which the price of agave is very low, farmers are also likely to be less vigilant in monitoring pest and disease infestation and in attempting to prevent diseases from spreading (Valenzuela Zapata, 2003, 2005).

6. Discussion and conclusions

The continued cycles of surplus and shortage, combined with changing production relations in the industry, contribute to economic insecurity and environmental degradation in tequila's region of origin. The contracts drawn up by the tequila companies prescribe a "technological packet" (i.e., prescribed applications of pesticides and herbicides, and prohibition of certain practices), and are resulting in a replacement of traditional agave cultivation techniques with a more mechanized, chemically-intensive system of agave cultivation. The increased use of contract arrangements and the greater self-sufficiency of the tequila companies are also making it more difficult for the independent farmers to sell their agave and foster the marginalization of small farmers and widespread rural poverty.

The emergence of a more chemically- and capital-intensive production system and the associated environmental and social effects (i.e., economies of scale, concentration, environmental degradation) are not unique to the tequila industry. In general, agricultural production is becoming progressively more industrialized, and the increased scales of production that are required for technology adoption both require and facilitate the concentration and centralization of capital (Magdoff et al., 2000). According to McMichael (2000), production of agricultural goods has essentially become an industrial enterprise, in which hybrid seeds are combined with chemical inputs and information technology is used to coordinate multiple production sites, spread across the globe, for a year-round supply of fresh produce.

However, very importantly, tequila is protected by a GI, a tool that can theoretically be used by local actors to counter many of the negative effects of globalization (e.g., excessive price competition, "race to the bottom" in environmental standards, homogenization of local cultures and traditions), by linking production to particular (local) places, while at the same interacting with broader extralocal markets. In recent years, GIs have gained considerable economic and political power. The protection of GIs has taken center stage in debates over agricultural trade in the WTO, and GI promotion was one of the main foci of the 2003 reforms to the European Union's Common Agricultural Policy. The Organization for an International Geographical Indications Network includes more than two million registered GI producers from over 30 countries. Because GIs are by definition collective products managed by a group of local actors, GI labels are tied to a code of practices designed to protect the local environmental resources, farmer knowledge, and cultural practices that have interacted in the evolution of particular products. Yet, the tequila case demonstrates the way in which GIs can be co-opted by extralocal actors, and the importance of paying attention to the wider regional, national, and international networks in which GIs are embedded. Although an emerging body of literature has documented the theoretical benefits of GI protection and the ways in which GIs constitute "short food supply chains" (Renting et al 2003), very little empirical research has considered the inequalities in the distribution of costs and benefits of GI protection, or the underlying power relations. This case study thus provides insight into the potential limitations of GI protection and the degree to which GI schemes can be manipulated to benefit powerful extralocal actors while excluding the farmers and rural regions that GIs are theoretically designed to protect.

This research offers two main contributions to the literature on GIs, rural development, and sustainability. First, at a more empirical level, the tequila case demonstrates how socioeconomic and ecological sustainability (or lack thereof) can be mutually reinforcing. When the price of agave is low, farmers are less likely to invest in crop maintenance, not only due to the disincentive that a low price of agave creates for farmers, but also because most farmers do not have access to credit and may not have sufficient capital to make the needed investments in maintaining their plantations. Farmers tend to stop or significantly reduce the amount of fertilizer applied to their agave fields. Farmers may also choose to hire fewer workers to help them with pruning the leaves of the agave plant, removing weeds, spraying for weeds and pests, and the other activities that are necessary to maintain their crops.[20] This contributes to declining soil fertility and can lead to pest and disease infestations. During these periods, farmers also lack the necessary capital to begin planting a new crop of agave, which sets the stage for another shortage.

It is also important to note that the cycles of surplus and shortage tend to hit the small farmers the hardest, meaning that the mounting ecological and economic problems associated with the industry are suffered disproportionately by poorer farmers. During periods of very low prices, the farmers who are better-off are more likely to have the money saved up to pay the costs of maintaining their plantations, and are able "wait out" the crisis. Conversely, the poorer farmers are often the ones forced to abandon their crops in the field or stop applying fertilizers, which leads to problems with soil fertility and disease and pest infestation. Poorer farmers are also less likely to have a guaranteed buyer for their agave (i.e., an advance purchase contract), meaning that the economic effects of the surplus period affect them disproportionately. The continued cycles of surplus and shortage are therefore associated with increased economic differentiation and concentration in the Amatitán-Tequila valley.[21]

Second, at a more theoretical level, our findings suggest that many of the economic and ecological problems associated with the agave–tequila industry are related to the failure of the GI to valorize the link between the *terroir* of the region and the quality of tequila. Moreover, *terroir* here is defined as reflecting not only the environmental characteristics of the region, but also the cultural practices that have evolved to maintain these resources over time.

To start, the structure of the tequila GI (the large size of the GI region, the way that agave is sourced, the lack of norms related to the quality of agave) obscures the link between the biophysical properties of tequila's region of origin and the taste and quality of tequila. The GI region is very large and includes areas that do not

[20] The most recent agave shortage (1999–2003) was caused in part by a massive outbreak of disease in the 1990s that killed up to 25% of the agave supply in many areas. This outbreak of disease, in turn, was due in part to the fact that prior to this, the price of agave fell to below $1.00 pesos per kilogram and farmers chose to or were forced to leave their agave to rot in the fields rather than paying the costs of maintaining it.

[21] This trend, of course, is not unique in agriculture; small and/or poor farmers tend to be most vulnerable to price fluctuations and "boom and bust" cycles. It is significant, however, that no provisions have been made within the rules and institutions that define the GI for tequila (e.g., CRT, tequila production norms, etc.) to anticipate or respond to these cycles of surplus and shortage. The CRT and the influential actors in the supply chain rely completely on the laws of supply and demand to regulate agave volumes, and in doing so, they are allowing the tequila companies to push the *agaveros* out of the supply chain while at the same time transferring most of the risk associated with selling agave to the farmers.

have a cultural tradition or appropriate biophysical conditions for cultivating agave. Because the GI for tequila does not outline any rules for defining the quality of agave, and because the GI region is characterized by substantial heterogeneity in terms of soil and climatic conditions, the quality and composition of the blue agave used in the production of tequila can vary greatly. Most tequila companies source their agave from across the GI region, basing their decisions on price and transportation costs, instead of according to environmental or taste characteristics. When agave from a number of very distinct places is blended together to produce tequila, it becomes impossible for consumers to identify or taste the specificity associated with a particular region's *terroir*. The size of the GI region also makes it difficult for the farmers to organize, and allows the tequila firms to adopt a "frontier" production strategy, externalizing ecological and social costs and moving on to another area after resources have been exhausted.[22]

Furthermore, the norms that regulate tequila production fail to protect traditional agricultural practices. As responsibility for agave production shifts from small farmers to the tequila companies, traditional agave cultivation techniques are being replaced with more mechanized, chemically-intensive production systems. There is a growing trend within the agave–tequila industry to value the application of chemical inputs, as prescribed by trained engineers, over the expertise of experienced but uneducated agave farmers. Because most of the actors in the tequila supply chain do not attribute the specificity of tequila to traditional agave cultivation practices, they are largely unconcerned by the shift in control from the local smallholders to the tequila companies. The tequila firms do not see the traditional cultivation methods and local farmer knowledge as a resource to be valued or promoted. The small agave farmers, such as those we interviewed in Amatitán, are forced to imitate the methods required by the tequila companies and in many cases are being pushed out of the supply chain altogether. The shift toward a more chemically-intensive, mechanized system of agave cultivation contributes to lower levels of organic matter and soil fertility and increased incidences of pest and disease infestation (Gobeille et al., 2006).

We argue that, in the end, what makes GIs both politically feasible and operationally effective is the notion of *terroir*—the link between the biophysical properties of particular places, the traditional practices and culture that have evolved in these places, and the specific tastes and flavors of the foods produced there. In the tequila supply chain, *terroir* has not gained any salience because dominant supply chain actors (the large tequila distilleries and transnational liquor firms) understand *terroir* as a threat to their economic power. An appreciation of *terroir* in the tequila industry would necessarily have to recognize the contributions of the small agave farmers in maintaining the link to *terroir*. Instead, the large tequila companies source their agave from across the entire GI zone, pitting different regions against each other, and have begun to produce their own agave, to reduce their vulnerability to the cycles of surplus and shortage. The connection to *terroir* and the local environmental and cultural resources in tequila's region of origin will continue to be degraded in the absence of intervention from the Mexican state. GI legislation in Mexico technically requires a demonstrable link to *terroir*; therefore, the Mexican government needs to become more active in protecting the relationship between the *terroir* of the region and the quality of tequila, in order to maintain the authenticity and specificity that are part of tequila's shared heritage.

If GIs are to make concrete contributions to long-term environmental conservation and rural development, the specification of sustainable production practices within the legal framework of GIs is essential. We argue that within GI supply chains, the preservation of the link to *terroir* is both a critical strategy for local actors and a guarantee of the diversity and specificity of the product. *Terroir* represents a discursive tool, in that it ensures that production stays within a particular territory and allows producers to retain control vis-à-vis extralocal actors (i.e., by valorizing the traditional methods involved in the production of a good). Very importantly, the preservation of *terroir* also has a tangible effect on the product itself. By valorizing and protecting *terroir*, GI supply chains provide an alternative to homogenized, standardized flavors and celebrates the diversity and unique flavors of foods and drinks.

[22] No comprehensive studies have proven that the tequila companies are adopting a "frontier" production strategy. However, the large tequila companies have clearly enlarged their "agave basins," the regions in which they grow and purchase their agave, over the last 10 years. Southeastern Jalisco has emerged as a growing center of agave cultivation. In the two districts in southeastern Jalisco, land cultivated with agave increased from 490 ha (2.3% of total agave production in the state) in 1999 to 22,775 ha (18.5% of total agave production in the state) in 2006 (SAGARPA, 2006). The local citizens and governments in southern Jalisco have criticized the tequila companies for overapplying agrochemicals and causing environmental degradation (Bowen, 2004; Bowen and Gerritsen, 2007). In 2003, the municipal government of Autlán filed a complaint with the Secretary of the Environment and Natural Resources, in which they accused one of the large tequila companies operating in the area of causing "deforestation, desertification, and erosion of the local environment" and of killing thousands of *guamúchil* trees planted close to the agave fields (La Jornada, October 10, 2003). In 2004, the complaint was rejected for lack of supporting evidence (Público, June 4, 2004).

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