

Mexican Greenhouse Tomato Industry

Mexico is the largest producer and per capita consumer of fresh tomatoes in North America. Therefore, its fresh tomato industry and domestic market figure prominently in the dynamics of the North American fresh tomato industry. To understand the evolution of the rapidly growing Mexican greenhouse tomato industry, it is important to put it in the context of the total Mexican fresh tomato industry. In Mexico, field growers play a key role in the greenhouse tomato industry, and field production dwarfs greenhouse production. The Mexican greenhouse tomato industry is also characterized by much more geographic and technological diversity relative to its NAFTA partners.

Exports are very important to the Mexican tomato industry. In 2003, Mexico exported 46 percent of its fresh tomatoes, with over 90 percent going to the United States, and most of the rest to Canada. While sizable volumes of field tomatoes grown by export-oriented growers may be sold domestically when domestic prices are more attractive, low domestic demand limits the share of greenhouse tomatoes that remain in Mexico to about 15 percent—often due to lower quality rather than as a strategic marketing choice. Because of Mexico's heavy emphasis on the United States as its primary export market for all tomatoes, significant changes in Mexico's field and greenhouse industries affect U.S. supplies. With this in mind, it is important to understand the nature of the Mexican field and greenhouse tomato industries by region, season, product mix, and grower type.

Seasonal and Geographical Concentration of Fresh Market Tomato Production

Mexican fresh field tomato production, excluding production for processing, totaled 1.8 million metric tons in 2003, more than 12 times the level of greenhouse tomato production (see table 1). While tomato production exists throughout Mexico, large volume commercial field tomato production is seasonally concentrated in a few locations, most prominently, the northwestern coastal State of Sinaloa (and to a much lesser extent southern Sonora) in December through April. The State of Baja California (formerly known as Baja California Norte) ships field tomatoes in the summer through fall. In the 1990s, the State of Baja California Sur emerged as a new but still lesser player than the State of Baja California in the field tomato industry, targeting a late winter/early spring market window that has since narrowed with the development of greenhouse production throughout North America. A few States in central Mexico, such as Morelos, San Luis Potosí, Michoacán, and Jalisco, produce fresh field tomatoes in the summer/fall, all with a domestic rather than an export market orientation.

A relatively small cohort of export-oriented, high-yielding producers serve as the principal players in the Mexican fresh tomato industry in their respective seasons, for both export and domestic use. Traditionally, Sinaloa and Sonora accounted for at least 70 percent of Mexican fresh tomato exports, while the entire Baja California peninsula accounted for most of the remainder. The bulk of Mexican field growers converting part of their area to protected culture are located in Sinaloa and the Baja California peninsula. Growers that

locate greenhouses close to their field tomato bases of operation extend their shipping seasons only marginally; hence, shipping seasons remain similar.

The Sinaloa Fresh Tomato Industry

The Sinaloa field tomato industry includes a cluster of around 40 high-technology export-oriented producers with extensive field tomato growing and marketing experience. Many of these producers are forward-integrated grower-shippers with sales operations in Nogales, Arizona. These growers are some of the best capitalized in the Mexican horticultural sector. Most of Mexico's processing tomato production is in Sinaloa, with product moving between fresh and processed markets according to relative prices.⁷ The bulk of the State's production is centered in Culiacán, which enjoys freeze-free winters, making it a principal source of winter supply to the North American fresh tomato market. In April, production from Los Mochis and Guasave in northern Sinaloa typically supplants declining volumes from the Culiacán area. Because of the longstanding economic strength of this cluster of innovative tomato growers, the input industry is very strong in Sinaloa, contributing to the relative competitiveness of Sinaloa growers.

According to the Confederación de Asociaciones Agrícolas del Estado de Sinaloa (the statewide growers' organization known by its acronym CAADES), 2003/04 tomato area (both fresh and processed) totaled 25,584 ha. The industry is still overwhelmingly field oriented, but with substantial experimentation with protected culture. Much of the protected culture is shade house, but plastic greenhouse tomato operations range from under 5 ha to a few in the 40 to 60-ha category. Growing in soil is more common than using hydroponics. While Sinaloa's warm, humid climate is not suitable for year-round greenhouse production, its benign winter climate enables it to target the lucrative winter fresh market for both field and greenhouse tomatoes. Well-capitalized, innovative field growers ensure an interest in and the capacity for the development of protected culture tomato production, if it proves to be economically viable.

The Baja California Peninsula Fresh Tomato Industry

The bulk of the Baja California peninsula tomato industry consists of around 50 growers in the State of Baja California, mainly in the coastal San Quintín Valley, marketing through about 12 shippers. Most tomato growers remain open field for the majority of their production, though some are experimenting with protected culture, primarily shade house (see box, "Spanish Protected Culture Tomato Industry" for a comparison). San Quintín is located about 150 miles south of the U.S. border and has a relatively dry climate with winter temperatures too low for field production. Hence, the region is contra-seasonal to Sinaloa, with growers shipping field tomatoes to both domestic and export markets from summer through fall, unless disease conditions cut short the season. The Baja California field tomato shipping season overlaps with those in California and the U.S. eastern seaboard, Florida in the fall, and also competes with central Mexican field tomato production in the domestic market. Baja California Sur competes with all these regions in the fall. The region's protected

⁷ Unlike the U.S. industry, the Mexican fresh field tomato industry is not a dedicated industry. Rather, it produces for both the fresh and processing markets, with the vast majority of production sold for fresh use. Most tomatoes sold for processing are grown in Sinaloa, and secondarily in southern Sonora.

Spanish Protected Culture Tomato Industry

The conversion in Mexico from field production to lower technology-protected culture production is similar to that occurring in recent decades in Spain, the principal off-season greenhouse tomato supplier to Europe. In 2001, Spanish tomato protected culture area was over 16,400 hectares (about half concentrated in Almería), the vast majority of which is passive shade house systems, but with technology continuing to improve. Despite the Netherlands being the global leader in greenhouse technology and yields, Spain's lower technology and lower-cost approach, benefited by natural seasonal and climatic advantages, has succeeded in eroding the Dutch share of the European greenhouse tomato market. This example is likely relevant to Mexico's evolving role in the North American industry. Spain has succeeded in competing effectively with the Dutch greenhouse tomato industry with average protected agriculture tomato yields of 93 metric tons per hectare, compared with 456 in the Netherlands (Ministerio de Agricultura, Pesca, y Alimentación, 2004; Productschap Tuinbouw, 2004). While Spain targets a winter market, it now exports year-round. Hence, the Mexican protected agriculture average tomato yields (156 metric tons per hectare) have already surpassed Spanish yields.

culture production overlaps with summer/fall greenhouse production throughout North America as well.

Baja California growers have shifted away from round to roma tomatoes, a product in which they have more of a competitive advantage relative to U.S. shippers. Roma export shipments increased as a share of total Baja tomato shipments from 45 percent in 1997 to 68 percent in 2003. Roma tomatoes are more suited to the region's growing conditions and require less capital investment. Hence, much of the experimentation with protected culture there has focused on romas, making Baja California an exception in the North American industry.

Production regions in the State of Baja California Sur are located around 700 miles from the U.S. border. Field tomato production has been relatively limited and traditionally focused more on the late winter and early spring periods, when prices are higher and can better support the additional transportation costs to the border. There are fewer than ten major tomato growers and exporters.

In Baja California Sur, climate conditions permit growers to produce in the winter with relatively low-technology greenhouses. In the early 1990s, a major Sinaloa field tomato grower started a large plastic greenhouse operation in Baja California Sur, capable of shipping in the fall through late spring. The climatic conditions that enable the Baja California Sur greenhouse industry to target the fall through spring window likely help explain the location of the largest greenhouse exporter in the Baja California peninsula in the southern part of the peninsula (the Todos Santos area), rather than in the San Quintín Valley.

In contrast to growers in Sinaloa, field tomato growers in the Baja California peninsula face compelling water, land, labor, and disease constraints.

As a result, production tends to be more erratic from year to year, resulting in less well-capitalized growers on average than in Sinaloa, perhaps contributing to the slower development of protected culture production there. As summer/fall shippers, the growers of Baja California tend to have lower season average prices than do growers in Sinaloa, who target the higher priced winter market. This tends to reduce growers' ability to recoup the higher investment costs associated with protected production. Growers in the State of Baja California require high fall prices to earn a favorable return, whether production is open field or protected culture. Disease problems have limited fall open-field volumes in recent seasons, making it of interest to consider protected culture to ensure volume during the fall when prices are typically above the summer levels.

For all Mexican protected culture growers, attractive economic returns are highly dependent on selling at a price premium relative to open-field product. For growers in the Baja California peninsula, there are some special considerations in this regard since their tomatoes enter the United States through California. To achieve price premiums, some Baja growers have marketed their shade house tomatoes as greenhouse. In September 2004, the State of California put in place a new regulation covering greenhouse tomatoes handled or marketed in California, which is where tomatoes from the Baja California peninsula enter the United States. The regulation defines greenhouse tomatoes as tomatoes grown in fixed structures using hydroponics. Since this definition excludes shade house tomatoes and tomatoes grown in plastic greenhouses (fixed structures) without hydroponics, it may limit the ability of growers in the Baja California peninsula to obtain price premiums relative to field tomatoes. This rule change may cause growers to reevaluate the potential net returns from protected production. Growers may choose to market their protected culture tomatoes as hothouse, in which case it will be up to the market (largely commercial buyers) to decide if there is a significant point of differentiation relative to those meeting the greenhouse definition. Hothouse simply implies some type of protected culture and the lack of any formal definition allows for substantial flexibility in its use and application.

Central Mexican Fresh Tomato Production and Beyond: Greenhouse Becomes a Factor

Most of the field tomato production in central Mexico still occurs primarily in the summer and remains oriented almost exclusively toward the domestic market rather than the export market. Summer production in central Mexico is subject to either an abundance or shortage of rain, adversely affecting tomato quality and yields and the ability of growers to ensure consistent shipments of field tomatoes. Furthermore, many field tomato producers in central Mexico are smaller farmers, not well capitalized and without significant investments in packing, cooling, marketing, and food safety infrastructure.

Not surprisingly, investments in greenhouse tomato production in temperate central Mexico are largely coming from outside the region's traditional field-grown tomato sector, and include new entrants to agriculture. Investors are attracted by the yield potential of greenhouses located at relatively high

altitudes (around 2,000 meters), with good light conditions and dry, mild climates. The temperate climate allows for year-round production, increasing the likelihood of positive returns on investments in technology. Hence, the greatest investments in greenhouse technology and the highest yields tend to occur in central rather than coastal Mexico. Central Mexico has experienced a gradual expansion in medium- and high-technology greenhouses for over a decade, with the rate of expansion accelerating in recent years. With its favorable conditions, central Mexico will likely play a major role in the evolution of the country's greenhouse tomato industry. Most operations are less than 12 ha but two are in the 40-ha range.

As in other major growing regions, there is heterogeneity within the central Mexican greenhouse tomato industry. The largest exporter of greenhouse tomatoes in Mexico is Desert Glory, a U.S. firm operating in Jalisco and Colima with low-technology plastic greenhouses specializing in cherry TOVs. Desert Glory is also the largest greenhouse tomato operation in North America, in terms of area. Jalisco's mild climate enables Desert Glory to ship tomatoes year-round, but its low-technology operations result in low yields.⁸

Investors seeking tomato growing areas relatively close to the U.S. border and capable of year-round shipping are exploring high-altitude sites in north central locations, such as Chihuahua and Zacatecas. Medium- and high-technology greenhouse operations have been started in high-altitude locations near Mexico City, such as a 40-ha Bionatur TOV tomato project in the State of Mexico, outside of Toluca, and in parts of what is known as the Bajío, such as Querétaro.⁹ While operations in this area are disadvantaged by high costs to ship to the U.S. border, they are well positioned to serve the emerging demand from Mexico's rapidly growing supermarket sector for premium quality products with improved food safety characteristics. Market diversification may prove increasingly important for operations in the region as the U.S. market becomes saturated.

A still small but growing cluster of high-technology operations using glass greenhouses has emerged in the northern Sonora desert in the Imuris area, near the border with Nogales, Arizona. Part of the expansion in this sector has come from Sinaloa-based growers aiming to extend shipping seasons and invest in areas more suited to greenhouse production. This location is convenient because Sinaloa tomato growers ship their product through Nogales and have their marketing operations there, too, making it a source of consolidated supply for buyers. Although its climate is dry, Imuris is less than 900 meters in altitude, meaning that the summertime desert heat impedes year-round shipping. A few growers, following the lead of a nearby firm in Arizona, are investing in expensive pad and fan cooling systems (appropriate only in dry locations), in the belief that the potential economic benefits warrant the cost. Whether northern Sonora succeeds as a source of consistent year-round tomato shipments will in part depend on summer average price trends and their effect on profitability.

Some State governments in Mexico have encouraged greenhouse projects as a way to offer greater employment opportunities to low-income rural households. The labor-intensive (relative to crops like field corn and beans) and indoor working conditions of greenhouses are an attractive option to governments in high-unemployment areas with minimal high-value field agricultural alterna-

⁸ Cherry TOVs also have substantially lower yields than beefsteak or regular TOVs.

⁹ The Bajío is a temperate, high altitude plain north of Mexico City centered around the States of Querétaro and Guanajuato, and comprising parts of Michoacán and Aguascalientes. It is one of the richest agricultural areas in Mexico.

tives. While constrained State budgets limit direct support, Mexican greenhouse industry experts indicate that in some cases investors can receive loan guarantees as well as local tax and other investment incentives.

Mexican Greenhouse Tomato Industry Structure and Size

Currently, Mexico has some greenhouse tomato production in almost half of its 31 States. Greenhouse industry expansion is coming not only from field tomato growers, but from existing as well as new greenhouse tomato growers, including investors new to agriculture. Based on interviews with growers and industry experts, Mexican greenhouse tomato production in 2003 is estimated at 148,300 metric tons (see table 5). The Mexican greenhouse tomato industry overtook the U.S. industry in area planted in 1995 and surpassed the Canadian industry in 1999, reaching about 950 ha in operation in 2003.¹⁰ These area estimates exclude most shade house operations and focus on greenhouses (fixed structures) whether or not production is in the soil or using hydroponics.¹¹ In 2003, additional shade house tomato area in production may have totaled as much as 350 ha. Since the end of the 1990s, a combination of rapid growth in Mexican area and improving technology has combined to erode the gap in total production volume relative to that of the U.S. greenhouse tomato industry.

However, Mexico lags behind each of its northern neighbors in terms of technology and yields due to a combination of factors, including location/climate, and product mix. Around 30 percent of Mexico's greenhouse tomato area is comprised of low-yielding greenhouses growing cherry TOV in Jalisco and Colima. Much of the remaining area is in warm, coastal, seasonal field tomato areas at low altitudes (Sinaloa and the Baja California peninsula), which do not produce greenhouse yields comparable to those obtainable in temperate zones for similar technology levels. In 2003, Mexico's average greenhouse tomato yield is estimated at 156 metric tons per ha, compared with nearly 500 metric tons per ha in the United States and Canada. When cherry TOV production is excluded, Mexico's average greenhouse yield increases to 181 metric tons per ha in 2003.

Table 5—Estimated Mexican greenhouse tomato area, production, and exports, 1998-2003

Item	1998	1999	2000	2001	2002	2003
<i>Metric tons</i>						
Production	28,000	46,200	54,000	86,450	120,960	148,300
<i>Hectares</i>						
Area	280	420	450	665	864	950
<i>Metric tons</i>						
Exports to the United States ¹	26,600	43,889	51,300	82,128	102,816	125,970

¹ We assume that all Mexican exports are destined for the United States although a small share go on to Canada.

Sources: Industry interviews conducted by Cook and Calvin; the Asociación Mexicana de Productores de Hortalizas en Invernaderos (AMPHI).

¹⁰ Total greenhouse constructed area is somewhat higher, but some tomato operations were out of production in 2003.

¹¹ The Mexican greenhouse grower association, Asociación Mexicana de Productores de Hortalizas en Invernaderos, A.C. (AMPHI), estimates that all protected tomato area, including shade house and greenhouse, may surpass 1,500 ha in 2004. AMPHI is a voluntary trade association of greenhouse vegetable growers. It has no regulatory power but provides a forum for information exchange and representation.

Although Mexico's greenhouse tomato industry has many small operations with less than 5 ha, the industry structure is already highly concentrated. According to estimates by Cook and Calvin, three mostly low-technology firms controlled about 535 ha, or around 56 percent of total greenhouse tomato area (excluding shade house) in Mexico in 2003. The three firms are based in Jalisco, Baja California Sur, and Sinaloa. In 2003, each firm had a minimum of 60 ha. The next tier of producers is in the 40-ha range, with all regions of the country represented. In 2003, the estimated eight-firm concentration ratio in Mexico's greenhouse tomato industry was 74 percent.

Originally, Sinaloa field growers who ventured into protected culture tomatoes focused on production of beefsteak tomatoes, a product similar to their field tomatoes. But the TOV share of total production has grown, reaching 15 to 20 percent of all Mexican greenhouse tomato production in 2003. Some growers are also diversifying into specialty tomatoes, such as Campari tomatoes. As Mexican growers gain experience with greenhouse tomato production, they are likely to follow the market trend toward a more diversified product mix.

As more new players enter Mexico's greenhouse tomato market, the development of effective marketing channels will become more of an issue. Marketing channel fragmentation is a threat to profitable marketing for firms in all three countries. U.S. and Canadian greenhouse firms are increasingly seeking marketing alliances with Mexican greenhouse producers to supplement or provide them with the majority of their winter supplies. The challenge in these alliances is to constructively market the volumes of Mexican partners during the shoulder seasons (seasonal overlaps) and for year-round Mexican producers during the summer as well. Since supply is abundant in Canada and the United States during these periods, the growers supplying these firms may view the Mexican product as competition. Positioning of product, in part based on minimizing transportation costs from each production region to specific markets, can help these alliances to improve efficiency and market coverage for all parties.

An alternative may be the eventual emergence of large Mexican greenhouse shippers that consolidate volumes among several Mexican greenhouse growers in different regions to achieve consistent year-round volumes, imposing strict quality control, and developing direct linkages with key U.S. buyers. Growers in Ontario follow this strategy. Attitudes among Mexican greenhouse growers and large shippers and their ability to collaborate will influence the likelihood of such ventures. The growers in the best position to lead a collaborative effort are Sinaloa-based growers, due to their high level of industry organization and an industry structure centered on forward-integrated grower-shippers who operate their own distributorships in Nogales, Arizona (Calvin and Barrios, 1998). Of course, leaders may emerge among greenhouse-only players as well.

Protected Culture Technology and Other Considerations

In general, Mexican greenhouse tomato growers attempt to adapt technology packages, structures, and seed varieties from Spain, the Netherlands, Israel,

Canada, the United States and elsewhere, substituting local inputs where possible and desirable. While Mexican growers benefit from foreign research and development, they still face the challenge of identifying their own area-specific appropriate technologies, largely without the support of domestic public research and development. Not surprisingly, greenhouse suppliers have a strong influence on the technology decisions made in Mexico. Industry sources report that decisions are sometimes made based on the availability of supplier credits rather than the best technology package for the location. Governments of the Netherlands, Israel, and Spain are active in promoting adoption of their country's technology via preferential credits and other assistance. A scarcity of capital, experienced greenhouse management personnel, and technological know-how in Mexico is reportedly to blame for investments in less-than-ideal technology packages, with many initial attempts at greenhouse tomato production generating disappointing results.

According to the Asociación Mexicana de Productores de Hortalizas en Invernaderos (the Mexican greenhouse growers' association known by its acronym AMPHI), Mexico's protected culture area comprises plastic greenhouses (52 percent), shade houses (44 percent), glass greenhouses (2 percent), and other (1 percent). In the United States, winter producers need to use glass to maximize light transmission during the short days and to facilitate heating. For year-round producers in Mexico with longer winter days and less extreme winter weather, plastic structures may be more appropriate than glass. High-technology systems in plastic structures are proving to be capable of producing tomato yields of around 450-500 metric tons per ha and even higher in the ideal locations. But as of 2003, AMPHI estimated that only 13 percent of Mexico's protected culture tomato area had active environmental control systems. According to estimates by Cook and Calvin, the share of greenhouse area with active environmental control systems is higher, at about one-third.

In Mexico, glass greenhouses use hydroponics, but only a few plastic greenhouses do, though the number is growing. Industry suppliers estimate that only around 30 percent of hydroponics systems in Mexico use the high-cost imported rock wool as a growing medium. Most systems use cheaper yet effective substrates such as tezontle.

As the Mexican industry grows, it is attracting more attention and investment from suppliers, and better quality, lower cost local alternatives are emerging. This development will help to reduce investment costs over time. Similarly, as growers determine the best locations (combining both market and yield considerations), investments should generate higher net returns. A few Sinaloa- and Baja-based field and protected culture growers have been constructing greenhouses in noncoastal areas capable of longer shipping seasons. If successful, these efforts will spawn more year-round operators focused on producing consistent, high-quality volumes with competitive costs.

In general, those coastal field tomato growers who have been experimenting with protected culture are tending to expand area and invest in upgraded technology and management, particularly in Sinaloa. Even though Sinaloa is not the best area for achieving maximum greenhouse yields, growers there may find converting a portion of their crop mix to protected production to

be an effective business strategy. However, in both the Baja California peninsula and Sinaloa, some field tomato growers have found greenhouse production to be much more demanding in technology and management than anticipated. Those that are further along on the learning curve have an advantage over newcomers and are better positioned to withstand any periods of low prices.

Although net returns for greenhouse production are not always higher relative to open field production, protected culture methods may reduce several types of risk. Greenhouses provide protection from rain and growers with greenhouses may be among the few with typical volumes of high quality tomatoes of any type during periods of inclement weather, enabling them to benefit from above average prices. Both shade house and greenhouse production generally increases substantially the export-quality share of production, improving average pricing. Where greenhouse production succeeds in boosting yields substantially relative to open field, it can dramatically decrease the number of workers for a given level of output. Growers view recruiting and managing fewer workers as an important advantage. Furthermore, in order to achieve superior quality, many greenhouse growers invest in greater worker training relative to open field growers. This can pay off in several ways, including lower worker turnover. Shifting to protected culture can also decrease food safety risk and offer greater food safety assurances to buyers. Indeed, responding to rising retail demand for greenhouse tomatoes fits into growers' greater emphasis today on customer service, potentially reducing market risk by creating greater customer loyalty.

The relative potential returns from alternative technology packages vary significantly by area (see appendix 2 for more detail on this topic). Rain is rare during the State of Baja California's shipping season, and shade houses may be sufficient to reduce risks and improve returns, without requiring investment in more capital-intensive greenhouses. However, risk of disease is greater in shade house than in greenhouse operations. Due to especially high disease risk during the fall in the northern part of the Baja California peninsula, growers could eventually determine that greenhouse production is required to ensure fall volumes. Currently, some growers are experimenting with what is referred to as "hybrid" structures, a combination of shade house and greenhouse technology. This may provide many of the benefits of greenhouses, including reduction of disease risk, at a lower cost. The process of identifying the most economically viable technology packages is newer and less advanced than in Sinaloa.

Greenhouse Tomato Exports

It is estimated that 2003 Mexican greenhouse tomato exports to the United States were 125,970 metric tons (see table 5). Appendix 3 provides details on problems with data. This approaches Canada's level, which was 130,154 metric tons in 2003. Although Mexico's total greenhouse tomato production remains much lower than that of Canada, Mexico's export share is estimated at 85 percent, compared with 60 percent in Canada.

Mexico's higher export orientation means that it is capable of surpassing Canada as the principal supplier to the U.S. greenhouse market before it surpasses Canada in total production volume. Indeed, if production in Mexico continues its current rate of growth, while production in Canada and the United States remains relatively stable, Mexico is set to eclipse the U.S. and Canadian greenhouse industries in the near term. Ongoing improvements in technology and yields in all Mexican greenhouse regions will generate better and more consistent tomato quality. Until now, lack of uniformity has sometimes caused Mexican tomatoes to receive price discounts relative to key supplying regions. As quality improves, Mexico will become a more formidable competitor in export markets. However, demand for greenhouse tomatoes should also be stimulated by a consistently high-quality North American product, regardless of origin.

The Impact of the Greenhouse Tomato Industry on the Fresh Field Tomato Industry

The greenhouse tomato industry is having an impact on field tomato growers, whether they diversify into greenhouse production themselves, or just have to adapt to more market competition as the share of greenhouse production increases. Total U.S. fresh tomato imports from Mexico temporarily peaked in 1998, before beginning to rise again in 2001 and reaching a historic high in 2003 (table 6). Market-driven product diversification into greenhouse, grape, and roma tomatoes has likely contributed to Mexico's recent export growth. Since total imports from Mexico did not

Table 6—Mexican fresh tomato exports to the United States, by type

Year	Tomato type ¹					Total
	Cherry	Grape	Greenhouse ²	Regular ³	Roma	
<i>Metric tons</i>						
1990				352,312		352,312
1991				353,577		353,577
1992				183,116		183,116
1993				400,494		400,494
1994				376,032		376,032
1995	40,889			391,797	160,377	593,063
1996	41,975			429,710	213,992	685,678
1997	39,281			409,229	212,098	660,609
1998	50,307			415,848	267,899	734,053
1999	49,980		3,728	303,970	257,467	615,145
2000	37,834		27,468	277,995	246,585	589,882
2001	40,249		33,398	312,077	293,495	679,219
2002	39,291	16,915	42,140	309,262	315,817	723,425
2003	32,379	25,086	58,357	323,456	345,892	785,170

¹ The roma and cherry tomato codes were established in 1995, greenhouse in July 1999, and grape tomatoes in 2002. Prior to the establishment of these codes these tomatoes would have been reported as regular tomatoes.

² This table uses official DOC data which underreport actual volumes due to tariff code misclassification. Actual greenhouse imports may be around 67,000 metric tons higher in 2003.

³ The "regular" category captures any tomatoes, not specified in another separate tariff code category. As other categories have been added, this category is increasingly just round tomatoes—both vine ripe and mature green tomatoes.

Source: U.S. Department of Commerce.

surpass the 1998 level until 2003, the growth in greenhouse tomatoes up to that time simply displaced part of the decline in field tomato volume, without a net gain. However, given the relatively recent creation of the tariff codes for roma, cherry, greenhouse, and grape tomatoes (and continuing misclassification problems with the existing codes), it is not possible to measure the true changes in shares over time, by tomato type, of U.S. imports of Mexican fresh tomatoes.

But the expanded codes provide an improved snapshot of the shares in 2003, as calculated by the official DOC data. These data show that greenhouse tomatoes represented 7 percent of U.S. imports of Mexican tomatoes, significantly lower in share than round field tomatoes (41 percent) or romas, but higher in share than either cherry or grape tomatoes. If estimated miscoded greenhouse tomatoes were included, the greenhouse share of total U.S. imports of Mexican tomatoes could rise to 16 percent (based on a total of 125,970 metric tons, as noted earlier), and the round field share could decline to 33 percent.

As the importance of greenhouse tomatoes increases, growers in Sinaloa, the undisputed leaders of the fresh tomato export industry, face increased competition from greenhouse growers in other regions. In addition to contributing to a changing product mix, the emergence of the geographically dispersed greenhouse tomato industry in Mexico has begun to reduce the market share of total fresh tomato exports entering in Arizona, as measured by DOC crossings data. In 2003, 66 percent of Mexico's fresh tomato exports crossed in Arizona, primarily Nogales (down from 70 percent a decade ago), compared with 28 percent entering into California from the Baja California peninsula and 7 percent crossing the border in Texas (table 7). Since much of the greenhouse volume from central Mexico crosses in Texas, these data put in perspective the still-small share of greenhouse volumes from this region compared with the combination of field and greenhouse production from the traditional industry leaders Sinaloa and Baja California.

DOC import crossing data only reflect total imports at any port of entry from Mexico, with no indication of volume by growing region. Sinaloa's share of Arizona imports can be estimated by comparing DOC data with tomato export data from the State of Sinaloa, as reported by CAADES. In 2000, 85 percent of Mexican tomatoes exported through Arizona were from Sinaloa; in 2003, Sinaloa's share plummeted to 56 percent.¹² These data highlight the emergence of new competition for Sinaloa tomato growers, both field and greenhouse, also exporting through Nogales. Those vying for shares include the high-technology and high-yield growers in Sonora and lower-technology greenhouse growers in west central Mexico, Jalisco in particular. Sinaloa's dramatic drop in share reflects an absolute decline in its exports during a period of export growth for the country as a whole. Analysis of tomato export data for the State of Sinaloa shows that total tomato exports, all types, declined from 348,113 metric tons in the 1999-2000 season to 272,993 metric tons in 2003-04 (CAADES, 2004). The decline in Sinaloa's tomato exports, both in absolute and relative terms, is clear evidence that the emerging greenhouse industry is already having a competitive impact on Sinaloa.

Not only has the competition increased, but the competition has a higher quality orientation and it extends to both export and domestic markets.

¹² Although rain during the Sinaloa season was likely a factor contributing to lower export volumes.

Table 7—U.S. imports of fresh tomatoes from Mexico, by type and State of entry, 2003

State	Type ¹	Volume	Share
		<i>Metric tons</i>	<i>Percent</i>
Arizona	Cherry	17,127	2.2
	Grape	19,304	2.5
	Greenhouse	30,916	3.9
	Regular ²	239,401	30.5
	Roma	210,117	26.8
Total		516,864	65.8
California	Cherry	12,340	1.6
	Grape	5,589	0.7
	Greenhouse	3,934	0.5
	Regular ²	78,639	10
	Roma	115,954	14.8
Total		216,456	27.6
Texas	Cherry	2,899	0.4
	Grape	213	0
	Greenhouse	22,937	2.9
	Regular ²	5,311	0.7
	Roma	19,700	2.5
Total		51,059	6.5
Other		608	0.1
Total		784,988	100

¹ Official greenhouse imports are estimated to underreport actual volumes due to tariff code misclassification. Estimated greenhouse imports were 125,970 metric tons in 2003, but the total tomato import volumes (all types combined) per State of entry were unaffected.

² Regular tomatoes are any tomato not elsewhere specified. In 2003, most regular tomatoes were vine ripe, with a small amount of mature green round tomatoes.

Source: U.S. Department of Commerce, as compiled by Cook and Calvin.

Greenhouse production may be export oriented, but some new greenhouse producers are still in the process of achieving the quality and consistency levels required to be competitive in the export market; tomatoes that do not meet export standards may be sold on the domestic market. Furthermore, as rapid growth in the Mexican supermarket sector creates demand for consistently high-quality fresh produce with food safety assurances, Mexican internal demand for greenhouse tomatoes will likely expand significantly over the next decade.

Field tomato growers in Sinaloa have the most experience with protected culture, the greatest financial resources to invest in technology, and the ability to shift between field and alternative protected culture approaches as markets evolve and send different price signals. Since Sinaloa can experience rain during its growing season, and if greenhouse tomatoes continue to receive price premiums, growers may come to favor plastic greenhouses over shade houses. However, given the relatively short shipping season and the high cost of hydroponics, much of this greenhouse production may remain in the soil, and marketed as greenhouse, without reference to hydroponics. The existence of several large forward-integrated grower-exporters already embarked on developing more direct linkages with buyers for field and greenhouse tomatoes provides a robust model.

In contrast, field tomato growers in Baja California generally have less experience with protected culture. Production in the northern part of the peninsula still targets the shoulder seasons and the summer rather than the winter when prices are highest. Baja experiences with plastic greenhouses have been mixed. Much of Baja is not viewed by greenhouse technology experts as offering the best conditions for greenhouse construction. On the other hand, water and disease pressures, longstanding labor shortages, and food safety concerns should all assure continued experimentation with protected culture.

Once winter greenhouse tomato production expands enough to meet market demand, the relative competitiveness of different Mexican export regions will become more important. The combination of higher transportation costs to the U.S. border and lower average yields relative to the mainland may cause the U.S.-landed per unit costs of Baja California Sur greenhouse tomatoes to be at a competitive disadvantage relative to Sinaloa and central Mexico products (or San Quintín if winter production were to emerge there). Nevertheless, within the next 5 years, the most profitable field versus protected culture technology packages in different regions of the Baja California peninsula should emerge.

However, some of the recent attempts to locate greenhouse operations in north central and central Mexico have to date not met expectations, sending less optimistic signals to outside investors and State governments about the potential returns from greenhouse investments. Although greenhouse location decisions in central and north central Mexico may continue to be partly influenced by the economic incentive programs of State governments, these programs may be less available, just as the availability of venture capital may decline in response to underperformance of some of the recent high-technology projects. Hence, while the Mexican greenhouse tomato industry will continue to expand, the recent explosion in area may be unsustainable. Yields will undoubtedly improve markedly in most regions, but since a large portion of the greenhouse investments is being made in coastal areas, the average national yield in Mexico is not expected to reach that of its northern neighbors.