

The Changing Structure of Pork Trade, Production, and Processing in Mexico

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Executive Summary

The structure of the pork production, slaughter, and processing sectors in Mexico has changed significantly since implementation of the North American Free Trade Agreement (NAFTA) and with rising income and increased urbanization. Today, Mexico's pork industry has become more integrated and achieved greater production efficiencies in response to increasing demand for better product quality and stricter sanitary practices in production and processing pork for both the domestic market and for export. However, despite these improvements Mexico's pork industry has not kept up with the rising domestic demand, and Mexico has become an increasingly important market for the United States. A key to the development of increased trade in both live animals and pork is growth of federally inspected or "Tipo Inspección Federal" (TIF) plant production, as well as development of marketing channels and product promotion that support high-quality consumer meat products.

Keywords: live hogs and pork trade, Mexico, NAFTA, pork industry, pork slaughter, TIF plants.

THE CHANGING STRUCTURE OF PORK TRADE, PRODUCTION, AND PROCESSING IN MEXICO

Introduction

The North American Free Trade Agreement (NAFTA) has allowed competitive market forces to play a predominant role in establishing agricultural trade flows between the United States and Mexico. During the phase-in period for NAFTA, which began in 1994, Mexico applied a system of gradually less restrictive safeguard quotas and tariffs on live hogs and pork from the United States and Canada. With full implementation in 2003, the quotas and tariffs were eliminated, giving U.S. pork producers increased access to the Mexican market. Throughout this period, Mexico has become an increasingly important market for U.S. live hogs and pork products.

At the same time that Mexico's market for imported pork has increased, the domestic pork industry has modernized. Firms have built many large, vertically integrated production systems, which are being complemented by modernizing slaughter and processing sectors. As Mexico's production systems become more comparable to those of the United States, the relative costs of processing and fabricating pork in Mexico will become a major factor in determining the amount and type of pork shipped to Mexico.

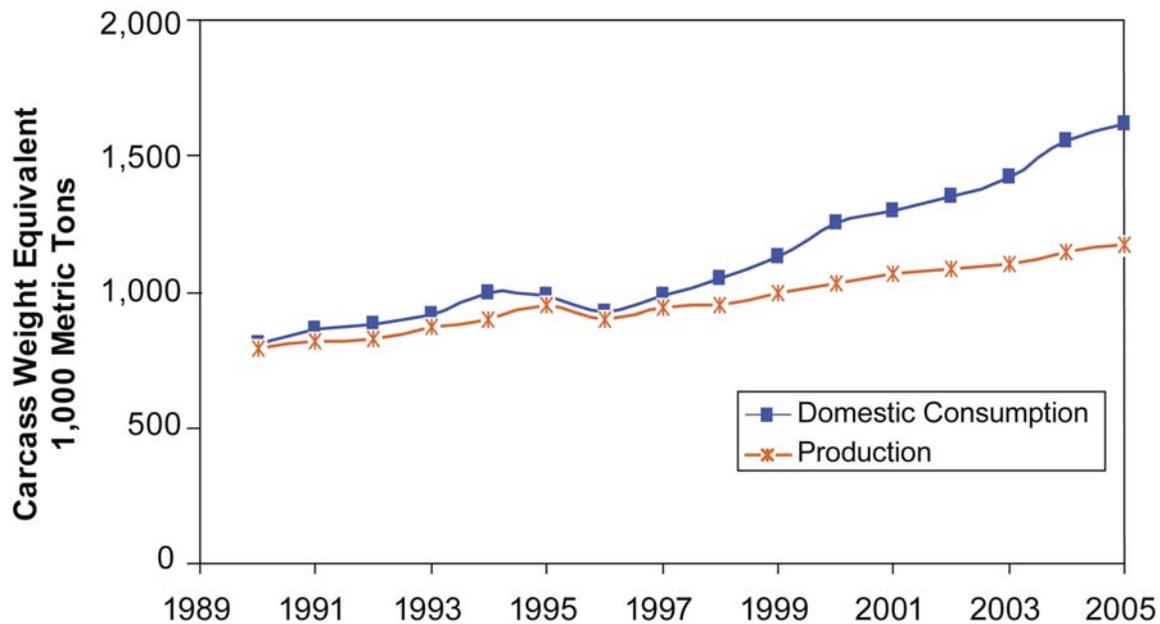
This study examines the changing structure of the pork production, slaughter, and processing sectors in Mexico to better understand the competitiveness of Mexico's industry relative to that of the United States. The paper proceeds by presenting recent trends in Mexican trade of pork and live hogs. This is followed by an overview of Mexico's pork industry, including information on hog production costs in Mexico and the United States, transportation issues and costs, and changes in the slaughter and processing industry, distribution channels, and retail sector. The final section provides some conclusions about the future of Mexican slaughter/processing plants and trade implications for Mexico and the United States.

Trends in Imports and Exports

Pork Imports

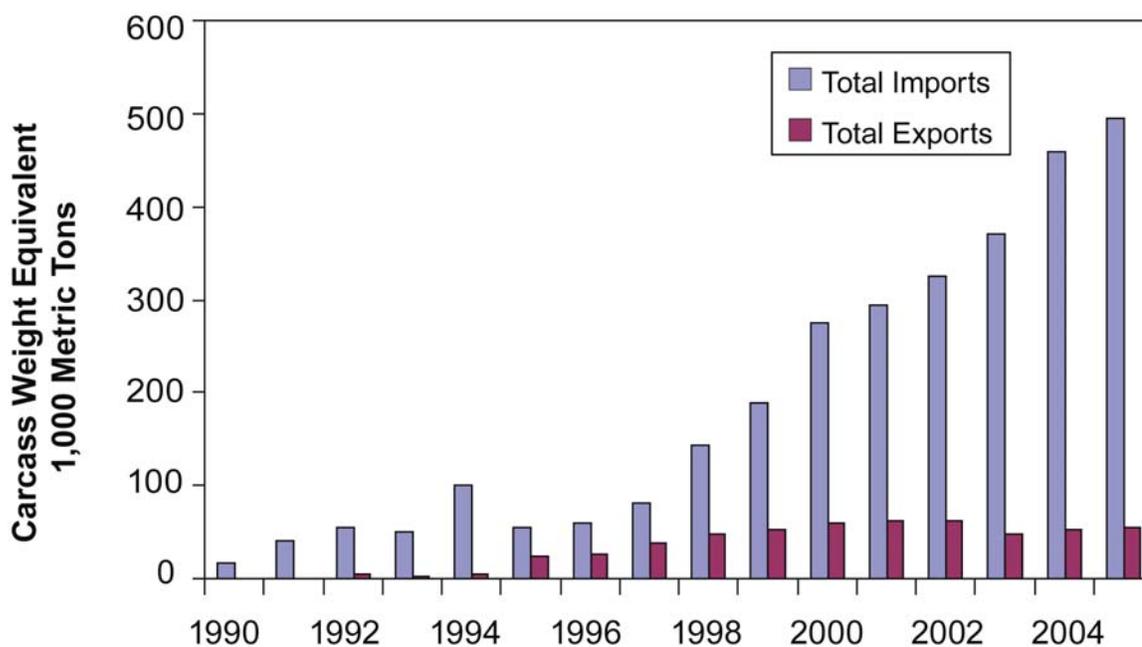
Pork has always been an important part of the Mexican diet, although among meats, per capita consumption ranks third after chicken and beef. Pork per capita consumption increased by about 20.2 percent between 1995 and 2002, to a level of 14.3 pounds per capita in 2002 (SAGARPA, 2004). This growth is attributable to several factors, including a growing middle-income class, overall population growth, increased processing demand, and expansion of demand for imported pork among higher-income consumers. As shown in Figure 1, domestic pork production has also increased but less rapidly than consumption. Despite improvements in the Mexican pork industry, the gap between consumption and production continues to widen. By the end of the NAFTA phase-in period, Mexico's pork deficit was estimated to be 30 percent (U.S. Meat Export Federation, 2002).

The tariff and quota changes under NAFTA and the large supply shortage caused by increased consumption have created increasing demand for pork from the United States and Canada. As shown in Figure 2, Mexican pork imports have dramatically increased



Source: USDA-FAS, 2005c.

FIGURE 1. Mexican pork production and consumption



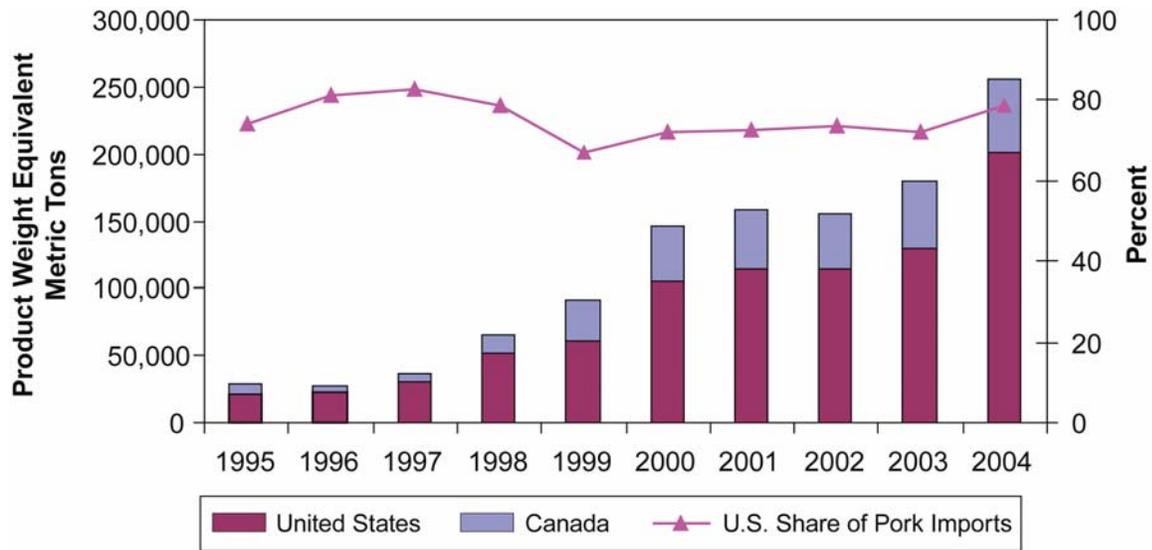
Source: USDA-FAS, 2005d.

FIGURE 2. Mexican pork exports and imports

since the mid-1990s. However, Mexican pork imports are highly sensitive to changes in consumer income and other market forces. Figure 2 illustrates the decline in pork imports that accompanied the Mexican peso crisis in 1995 and the subsequent slow recovery of the Mexican economy that brought about increased pork imports.

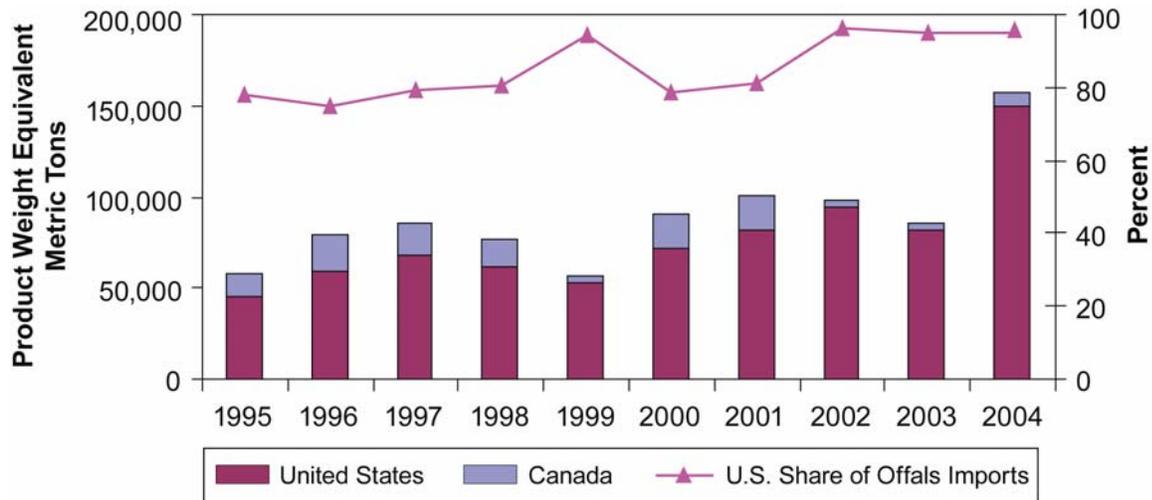
More recently, pork imports have increased in response to a ban on selected U.S. beef products following the discovery of a case of BSE (bovine spongiform encephalopathy) in the state of Washington in December 2003. In 2003 and 2004, cases of avian influenza in several countries led Mexico to impose bans on poultry meat imports that induced an increase in demand for pork products. In addition to these events, however, it is the trade liberalization allowed under NAFTA that has played the most important role in the rapid expansion of pork imports by Mexico.

Preferences for different pork cuts and pork variety meats in Mexico relative to preferences in the United States have created a highly complementary export market for the U.S. pork industry. As shown in Figures 3 and 4, Mexico's imports of pork and pork variety meats are supplied mainly from the United States and Canada, and the United



Source: USDA-FAS, 2005c, and Agri-Food Canada, 2005.

FIGURE 3. Mexican imports of pork from the United States and Canada and U.S. share of imports



Source: USDA-FAS, 2005c, and Agri-Food Canada, 2005.

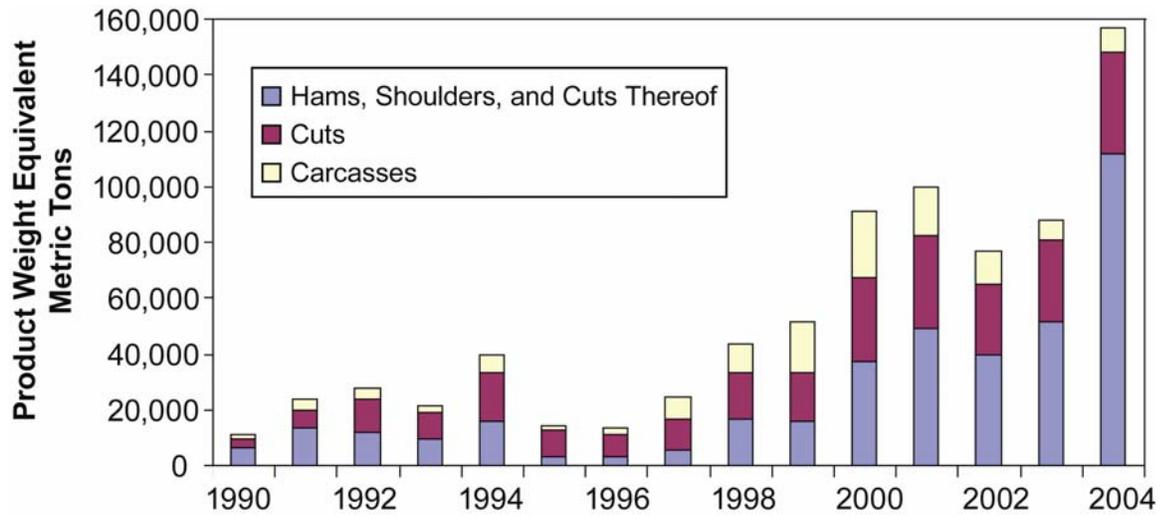
FIGURE 4. Mexican imports of pork variety meats from the United States and Canada and U.S. share of imports

States is the largest supplier. From 1995 through 2004, of the total Mexican imports of pork and pork variety meats from the United States and Canada, on average, the U.S. supplied between 75 and 85 percent of the pork and pork variety meats, respectively. In 2004, Mexico imported 351,665 metric tons¹ of U.S. pork and pork variety meats, representing a 67 percent increase from the previous year.

Figure 5 shows Mexico's imports of fresh, chilled, and frozen pork from the United States from 1990 through 2004. As shown, hams, shoulders, and cuts thereof account for the majority of the increase in import volume over the period. Imports from this category totaled 111,763 metric tons in 2004, up more than 1,500 percent from 1990, and most of the increase was in the form of bone-in product. This heavy volume of imports reflects the strong demand for hams and shoulders for manufacturing and other uses, and low labor costs make labor-intensive processing such as cutting and deboning economical to perform in Mexico. Imports of fresh, chilled, or frozen pork cuts also increased beginning in the mid-1990s, reaching 36,632 metric tons by 2004. In response to these increasing imports, various segments of the domestic pork industry have convinced the Mexican government to initiate anti-dumping investigations, including a recent investigation against U.S. hams. To date, these investigations have been resolved without penalty against U.S. pork.

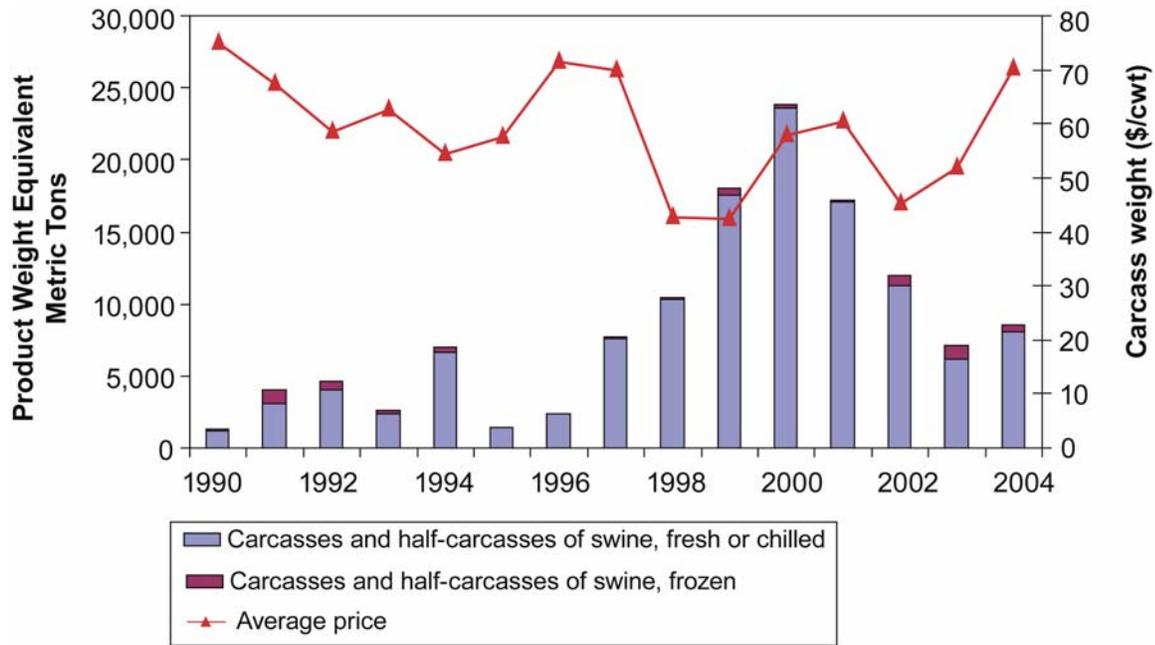
During the same period, imports of fresh, chilled, or frozen pork carcasses peaked at 23,892 metric tons in 2000. Figure 6 illustrates the sensitivity of carcass imports to U.S. carcass prices; however, the U.S. price is not the only factor that influences imports. For instance, prices in 2000 were relatively higher than in 1999, but imports increased mainly because of a relatively low exchange rate and other favorable economic conditions in Mexico (e.g., low interest rates).

Mexican imports of prepared and preserved pork products from the United States have grown since 1990, and especially since 2001. As shown in Figure 7, imports in the category "other salted, brined, dried, and smoked products" rose sharply beginning in 2002 and accounted for 67 percent of prepared and preserved pork imports from the United States by 2004. During 2002-04, the second largest category of imports was bacon, which accounted for 18 percent of U.S. exports in this category in 2004.



Source: USDA-FAS, 2005c.
 Note: Excluding variety meats.

FIGURE 5. Mexican imports of U.S. fresh/chilled/frozen pork export by type



Source: USDA-FAS, 2005c. Prices are from Lawrence, J.D. "Chartbook," Table 19A (Market Hog Prices Monthly Average and Seasonality Index).
 Note: To convert average hog prices "live weight equivalent delivered to the plant" to "carcass weight" (\$/cwt) we divided by 0.74.

FIGURE 6. Mexican pork carcass imports from the United States and average U.S. carcass price

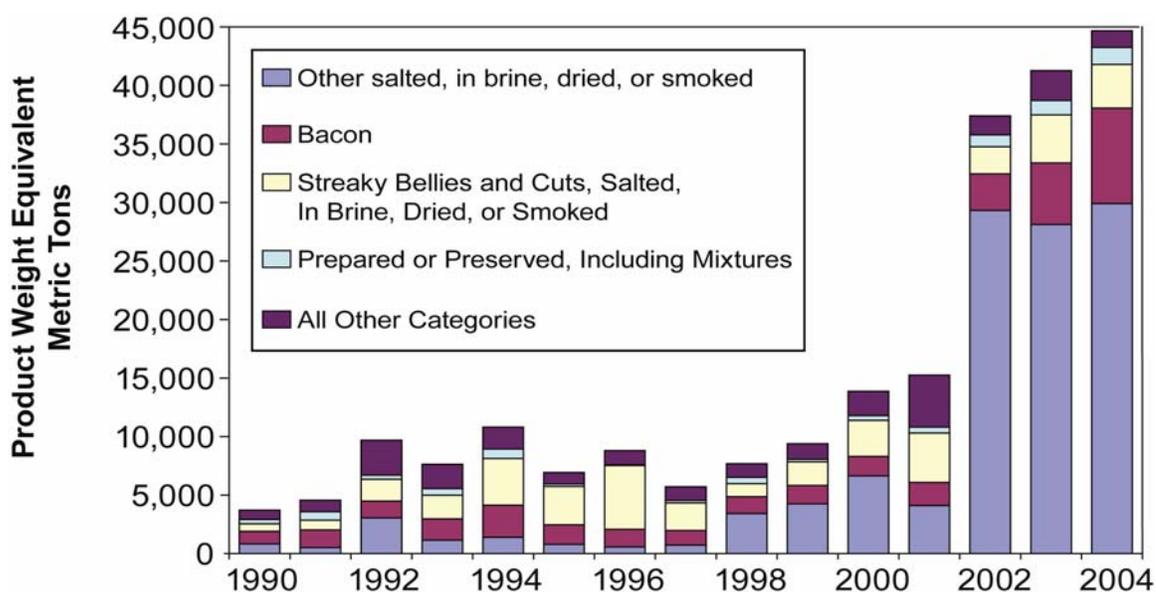


FIGURE 7. U.S. exports of prepared and preserved pork to Mexico, by type

Pork Exports

Although Mexican pork exports have also been increasing, this trade is relatively small compared to the level of imports (see Figure 2). Sanitary and phytosanitary (SPS) concerns in the United States and elsewhere have limited live hog and pork exports from Mexico. In recent years, the government of Mexico has worked to eradicate export-limiting swine diseases and to upgrade slaughter and processing facilities to meet the standards required for export.

With regard to disease, classical swine fever (CSF) prevented exports until Mexico was able to regionalize CSF-free states. Under regionalization, the Mexican government recognizes 13 Mexican states as CSF-free. Of these states, the U.S. Department of Agriculture (USDA) recognizes eight—Baja California, Baja California Sur, Campeche, Chihuahua, Quintana Roo, Sinaloa, Sonora, and Yucatan (USDA-APHIS, 2005)—as low-risk or free of CSF and allows these states to export pork, pork products, live swine, and swine semen into the United States under special restrictions (see Figure 8). The USDA is reviewing regionalization requests for the states of Coahuila, Durango, Nayarit, Nuevo Leon, and Tamaulipas (USDA-AMS, 2005; National Archives and Records Administration, 2005).²



Source: SAGARPA, 2005a; INEGI, SICAM, 2001.

FIGURE 8. Classical swine fever status and percentage of pork production and human population, by state

In addition to CSF-free areas, Mexico has two other CSF zoo-sanitary areas: eradication areas and control areas. Eight states in central Mexico comprise the eradication area, where vaccination for CSF is prohibited because most vaccines allow “maintenance of sub-clinical infection with virulent strains” (University of Georgia, 2005). Response to outbreaks in the eradication area uses a stamping-out approach with “depopulation of infected pig herds and infected contact or neighboring herds, epidemiological investigation, clinical and virological investigations, movement restrictions for live pigs, pig meat and other vectors that can transmit the disease” (University of Georgia, 2005). CSF is considered endemic in the control area of Mexico, an 11-state region in southern Mexico. Here, vaccination is used continuously to reduce pig production losses.

The Mexican pork industry would like make the metropolitan Mexico City area a CSF-free region (Mexican Meat Council, 2005). More than 22 million people (about 22

percent of the country's total population of 106.2 million people) reside in the Distrito Federal and state of Mexico, making this area an enormous market for pork products (see Figure 8). Only 2.9 percent of the country's pork is produced here, so CSF-free status would allow the movement of CSF-free pork and products into and out of this area. However, both the Distrito Federal and state of Mexico are CSF eradication areas, and gaining CSF-free status will require an end to vaccination and implementation of stringent controls on the movement of pork and live hogs from adjoining eradication and control states.

In 2004, Mexico exported 725 metric tons of pork to the United States. As required by U.S. food safety import regulations, pork and pork products exported from Mexico to the United States must meet all safety standards applied to pork and pork products produced in the United States (USDA/FSIS, Regulations and Policies). While Mexico's food regulatory systems need not be identical to the U.S. system, Mexico must use equivalent sanitary measurements that give the same level of protection against food hazards as those achieved in the United States (USDA/FSIS, Regulations and Policies). We address changes in Mexico's sanitary standards in pork production and processing later in this paper.

Mexico's main pork export market is Japan, and Mexico is expected to increase exports of pork to Japan as a result of a free-trade agreement (FTA) signed in 2004 between the two countries. Exports under this FTA began in April 2005, with a low-tariff quota starting at 38,000 metric tons in JFY 2005 and increasing to 80,000 metric tons by JFY 2009. A 2.2 percent tariff applies to pork valued at more than 393 yen/kg, and Japan's gate price system will continue to apply to pork below minimum quota value (USDA-FAS, 2005b).

Live Hog Imports

Mexican imports of live hogs have been erratic over the last 15 years, although imports of hogs weighing over 50 kilograms (hogs for slaughter weighing 110 pounds or more) have consistently been greater than any other category of live hog imports into Mexico (Figure 9). Despite anti-dumping tariffs on live hogs between February 1999 and May 2003, imports of live slaughter hogs have increased since 2001 and are projected to continue to expand as domestic processors seek to increase slaughter numbers (USDA-

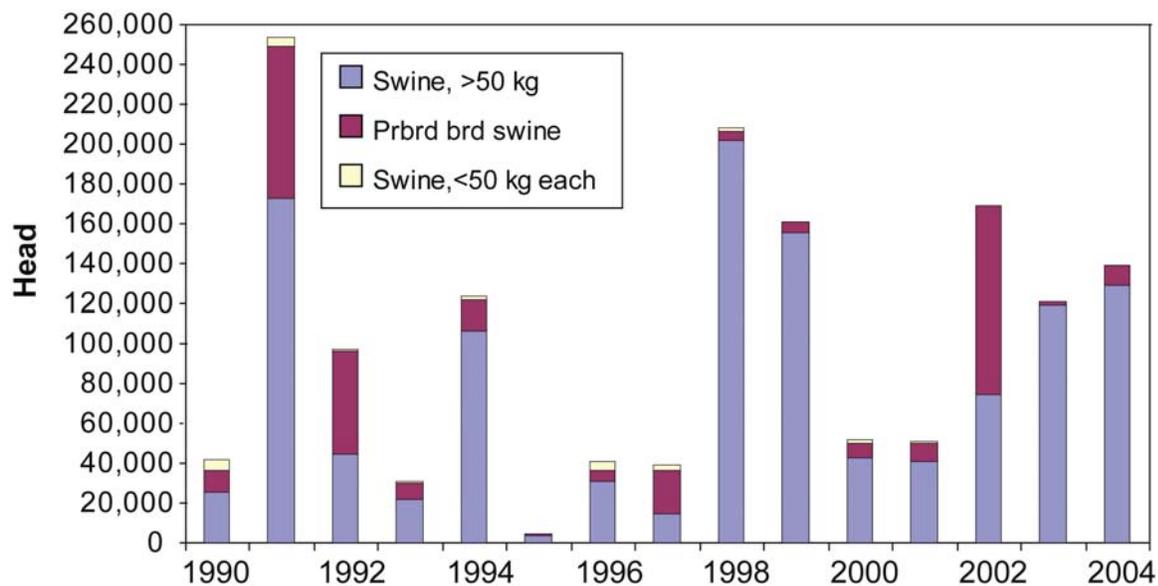


FIGURE 9. Mexican imports of U.S. live hogs

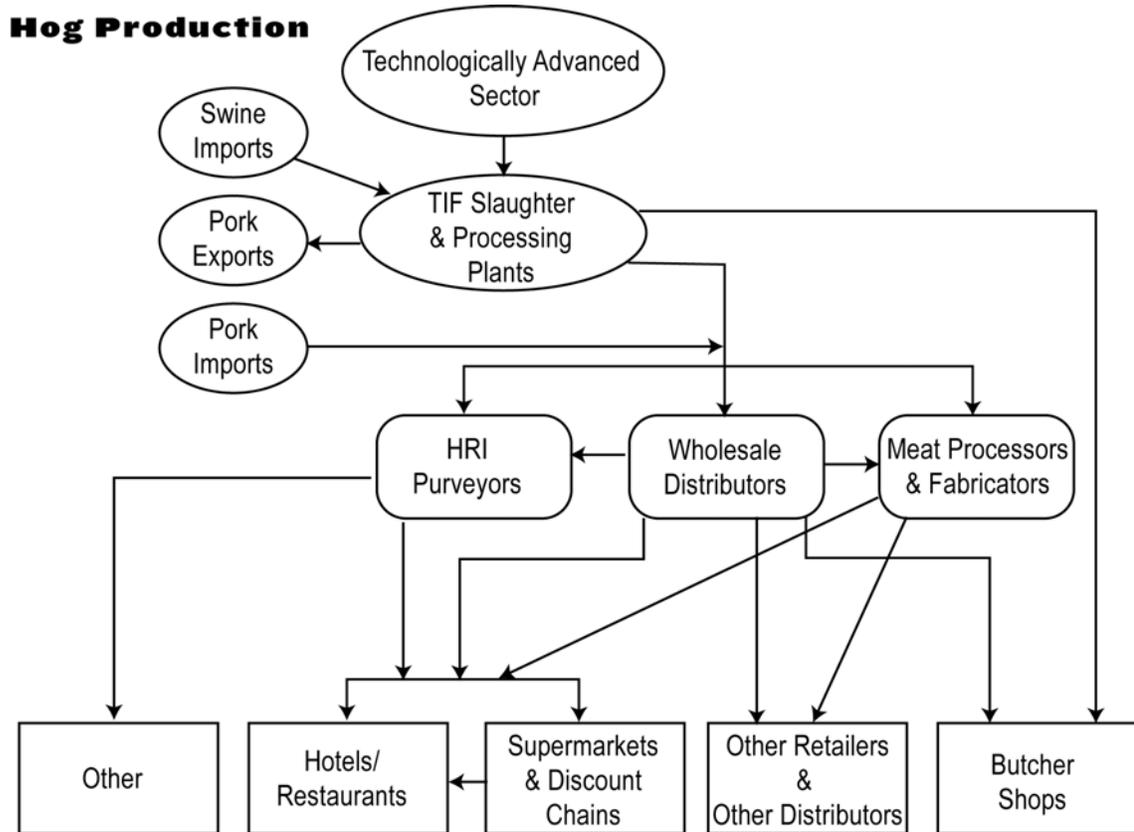
FAS, 2005a). As discussed later, the underutilization of packing capacity and lower packing costs in Mexico create the potential for much greater imports of live hogs from the United States.

The Changing Pork Industry in Mexico

The production of live hogs and pork products in Mexico occurs under different types of production and processing systems, and these systems are undergoing important structural changes. In general, technology, resources, and location separate the different live animal production systems and channels from which consumers purchase pork and pork products in Mexico. Figures 10 and 11 provide an overview of the pork industry structure in Mexico.

Hog Production Systems

Since the phase-in period of NAFTA beginning in 1994, the Mexican swine industry has been undergoing structural changes, as producers adapt to increasing domestic demand for greater pork volume and better pork quality and to competition from both imported pork and imported poultry meat products that substitute for pork in many processed products. Hog producers in Mexico operate under three different types of production systems:



Pork Consumption

Notes: Some TIF plants may produce some processed products and therefore may import pork.

HRI purveyors = hotel, restaurant, and institutional purveyors.

Other =government agencies, street vendors, and small meat markets.

Supermarkets & Discount Chains may sell also to Other Retailers.

FIGURE 10. Structure of the pork industry for the technologically advanced sector in Mexico

technologically advanced, small commercial (semi-technically advanced), and traditional backyard. These systems are differentiated by the level of technology employed, degree of vertical integration, and quality of hogs produced (see Table 1).

Among the changes that have occurred since NAFTA, many small commercial producers have exited the industry because of their inability to both produce animals more efficiently and meet the quality standards required by their buyers. As a result of the exit of smaller producers, the scale of production has increased and the industry has become more highly integrated. This reduction in small commercial production and expansion of technologically advanced production has taken place alongside continued production using traditional backyard methods (Sagarnaga Villegas et al., 2003).

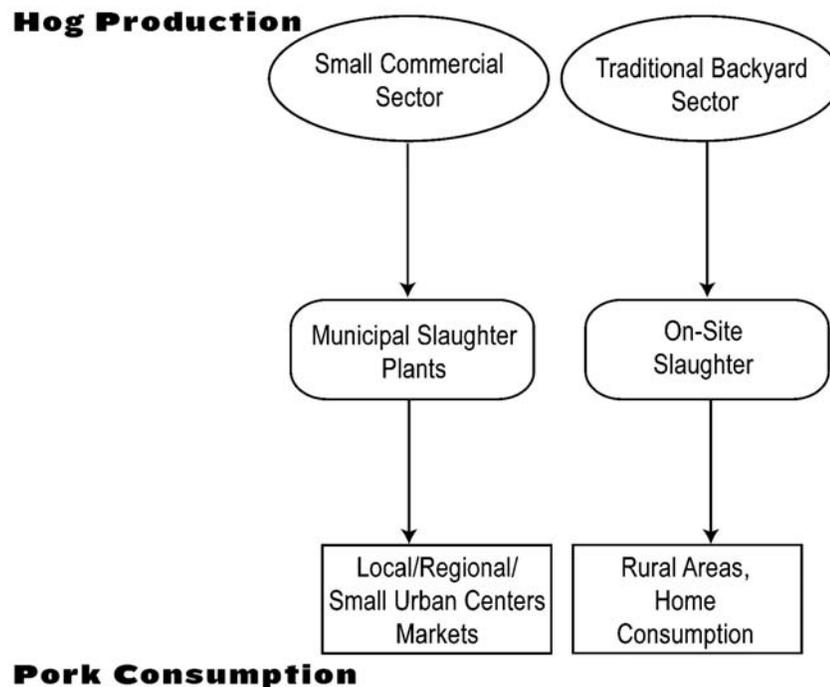


FIGURE 11. Structure of the pork industry for the small commercial sector and the traditional backyard sector in Mexico

TABLE 1. Comparison of hog production systems in Mexico

Characteristic	Technologically Advanced	Small Commercial	Traditional Backyard
Average herd size (average number of sows)	300 - 1000	150 - 500	10-50
Share national pork production (%)	57	15	28
Age and weight at weaning	26-35 days, 6-8 kg	35-45 days, 7-12 kg	45 days, 8 kg
Slaughter weight (kg)	95-105	90-100	80-90
Days to market	150-170	170-180	more than 180
Feed efficiency (kg)	2.8-3.2	3.2-4.0	n.a
Piglets per sow/year	18-22	16-18	<16

Source: Hernandez Moreno, 2001; and FAO, 2003.

Firms that operate technologically advanced production systems raise hogs on specialized sites, use advanced breeding methods, and operate under strict sanitary controls. Most of these vertically integrated firms control the whole process, from hog production through pork distribution. The slaughter plants used in vertically integrated systems are likely to be federally inspected or “Tipo Inspección Federal” (TIF) plants, and the markets they serve are located in metropolitan areas (USDA-ERS, 1999).

As shown in Table 1, small commercial operations produce fewer pigs per unit than do the technologically advanced producers. The small producers may use breeding stock similar to that of the technologically advanced firms; however, their sanitary controls and marketing systems are generally deficient with respect to those of technologically advanced producers. Since these small operations cannot consistently provide high-quality hogs, they do not meet the standards of federally inspected slaughter plants; therefore, their hogs are slaughtered in slaughterhouses with less strict sanitary controls, such as municipal slaughter facilities (USDA-ERS, 1999).

Traditional backyard production is still quite common and found throughout the rural and semi-urban regions of the country. This source supplies pork in areas where there are few or no formal commercial channels, and production is oriented mainly to family (subsistence) consumption. Hogs are slaughtered on site or in local slaughterhouses. This production system does not follow any established sanitary control procedures, and live animal and pork quality is poor. However, this system is an important source of pork for many consumers because of its low price and the perception that freshly slaughtered meat is preferable to chilled or frozen product; therefore, this type of production is likely to remain a part of the Mexican pork industry for some time to come.

Historical data for live hog production indicate that during the 1980s, technologically advanced hog producers accounted for 40 percent of total production, whereas the small commercial producers and the traditional backyard producers each accounted for 30 percent of production (FIRA, 1997, as reported in Sagarnaga Villegas, 2003). More recent data indicate that technologically advanced producers account for about 50 percent of Mexican hog production, small commercial producers generate about 20 percent of production, and traditional backyard producers provide the remaining 30 percent (SAGARPA, 1999).

Hog Production Costs

Table 2 presents estimated hog production costs in Mexico for 2004. As shown, the largest production cost for Mexican hog producers was for feeds, which accounted for 56 percent of total production costs for technologically advanced producers and 64 percent of costs for small commercial producers. And, despite the efficiencies of technologically advanced producers in Mexico, average hog production costs are higher in Mexico than in the United States. Production costs for technologically advanced producers totaled 13.91 pesos/kilogram (\$55.93/cwt), compared with 19.19 pesos/kg (\$77.16/cwt) for small commercial producers (as shown in Table 2). These production costs are similar to those reported in other studies (e.g., Hahn et al., 2005) and compare to an average production cost of \$40.76/cwt for U.S. market hogs (51-52 percent lean, 260 pounds) produced in Iowa in 2004 (Lawrence, 2006).

In a study comparing U.S. and Mexican costs of producing 12-pound feeder pigs in hog-farrowing units, Ochoa and Zahniser (2003) found that Mexican feeder pigs cost \$2.20 more per head to produce than do U.S. feeder pigs. In both countries, the largest cost component was feed cost, which was 68 percent higher in Mexico than in the United States and reflected Mexico's higher cost of feed-grain production and strong dependence on imported feed grains. Ochoa and Zahniser found that corn and soybeans were each 46 percent more expensive in Mexico than in the United States.

TABLE 2. Production costs of Mexican hog producers, 2004

Expense Category	Technologically Advanced Producers		Small Commercial Producers	
	U.S.\$/cwt	% of total	U.S.\$/cwt	% of total
Feed	31.49	56	49.14	64
Medication	5.15	9	5.03	7
Salaries	0.89	2	2.61	3
Financing	12.79	23	12.18	16
Other	5.63	10	8.20	11
Total	55.93	100	77.17	100

Note: Calculated by averaging monthly estimates of production costs from SAGARPA, reported in *Situacion Actual y Perspectivas de la Produccion de Carne de Porcino en Mexico 2005*, p. 37 (SAGARPA, 2005b.). U.S. currency values are based on a currency exchange rate of 11.28 pesos per U.S. dollar.

However, after full liberalization of U.S.-Mexico corn trade on January 1, 2008, restrictions that limit the amount of corn that can be imported by Mexico from the U.S. are scheduled to disappear. Without these restrictions, corn and feed substitute prices in Mexico may decline and the Mexican hog producer may become more cost efficient, particularly among technologically advanced producers.

Currently, management and labor costs at the Mexican farrowing facilities are about 52 percent and 71 percent lower, respectively, in Mexico than in the United States. Farm labor wages in Mexico range from \$0.70 to \$1.20 per hour, compared with \$5.50 to \$7.50 in the United States. Overall, total production costs at farrowing facilities were found to be about 11 percent higher in Mexico than in the United States (Ochoa and Zahniser, 2003).

Transportation Costs for Live Hogs

Because storage space and refrigerated transport in some regions of the country are limited, pork in Mexico is mainly transported as live hogs. This practice reduces the competitiveness of Mexico's pork industry because transportation costs are high and there is a high incidence of hog mortality and losses due to hog weight reduction during transportation (Sagarnaga Villegas et al., 2003).

Ochoa and Zahniser (2003) have stated that transport via Mexican highways is very expensive and insufficient. As shown in Table 3, the longer distance from farms to market, very high highway toll costs, and much higher costs of fuel for transportation in Mexico make the cost of transporting live hogs much higher than in the United States. In the cost comparison of producing feeder pigs discussed in the previous section, Ochoa and Zahniser found that loading and hauling costs averaged \$0.03 per feeder pig in the United States, compared with \$0.90 per feeder pig in Mexico.

TABLE 3. Comparison of transportation costs in the United States and Mexico

	United States	Mexico
Distance to market, round trip (miles)	250	410
Toll cost per trip	\$5.00	\$140.91
Fuel cost per gallon	\$1.40	\$1.79

Source: Ochoa and Zahniser, 2003.

Pork Slaughter and Processing

Another important structural change in Mexico's pork industry is occurring in the slaughter and processing sectors. Mexico has three types of slaughter: TIF plants, municipal plants, and traditional on-site slaughter. These types of slaughter differ mainly by the degree of technology used, the size of capital investment, and the services the plants offer.

TIF Packing and Processing Facilities. TIF slaughter plants use state-of-the-art technologies and have the highest sanitary standards and most advanced technological processing levels in Mexico. These plants are certified and federally inspected by the Livestock and Rural Development Branch of the Secretariat of Agriculture. TIF plant services include slaughtering, carcass handling, packaging, refrigerated storage, and fabricating processed products (e.g., hams, salamis) for both domestic and imported pigs and pork.

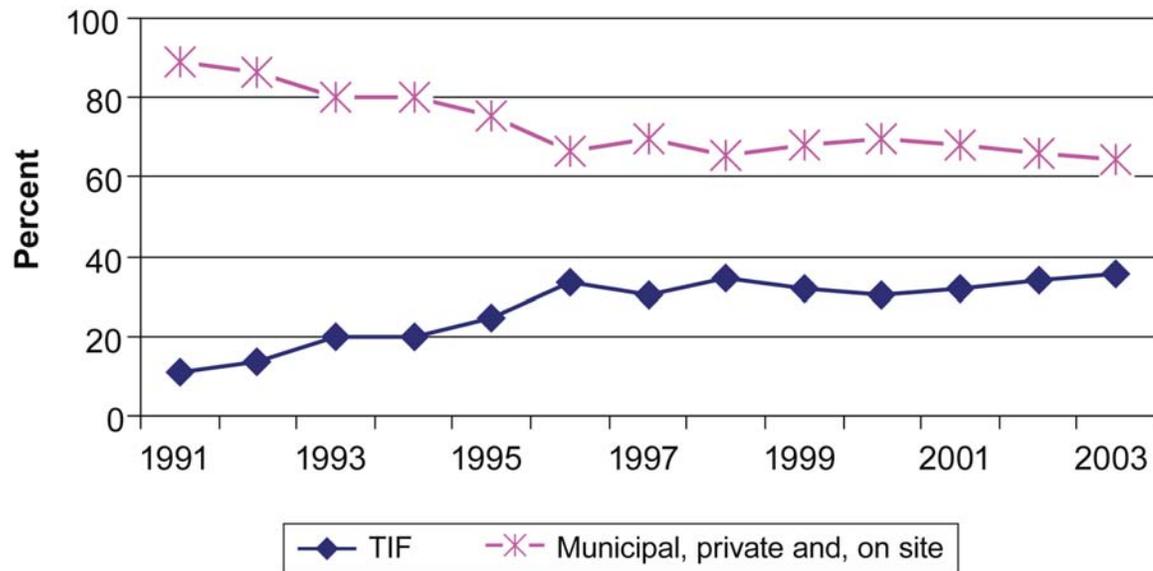
TIF slaughter plants generally obtain hogs from technologically advanced, vertically integrated production systems that produce animals raised to meet high quality standards for domestic and international markets. These plants also slaughter imported live hogs because Mexico restricts the slaughter of imported hogs to TIF plants. TIF fabrication plants use raw materials from TIF slaughter plants and imported product. The products from TIF slaughter and fabrication plants are mainly sold in large urban areas, and a small percentage is exported. Only pork slaughtered in TIF plants can be exported, once the importing country has accredited that the TIF plant complies with its sanitary controls.

Though TIF plants have existed in Mexico since 1947 (SAGARPA, 1999), there has been a pronounced increase in their use in recent years. In a 1999 report, SAGARPA (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación or the Agricultural, Livestock, Rural Development, Fishery, and Food Secretariat) indicated that there were 33 TIF slaughter plants that processed hogs and had a combined capacity to process 21,950 head per eight-hour shift, or 6.8 million head per year. In 2005, there were 160 pork slaughter TIF plants in Mexico, representing an increase of 385 percent from the number of TIF plants reported in 1999 (SAGARPA, 2005c). This percentage is expected to increase because the 1994 Law on Animal Health requires that all new slaughter and meat plants built in Mexico be TIF plants (Aceves Avila and Lopez Lopez, 1998).

In 2004, 12 of Mexico's 32 states slaughtered hogs in TIF plants, although most slaughter operations were concentrated in 4 states. About 43 percent of all hogs slaughtered in TIF plants were slaughtered in the state of Sonora, 21 percent in the state of Mexico, 14 percent in Guanajuato, and 11 percent in Yucatan. Eight other states accounted for the remaining 12 percent of TIF slaughter (Conferacion Nacional de Organizaciones Ganaderas, 2005).

Figure 12 shows the volume of pork slaughtered in Mexico according to the type of slaughter plant used. In 2003, the volume of hogs slaughtered in TIF plants was about 4.7 million head, an increase of about 271 percent with respect to the 1991 volume. The share of hogs slaughtered in TIF plants with respect to total hogs slaughtered in Mexico also increased. In 1991, only 11 percent of all slaughtered hogs were slaughtered in TIF plants, whereas in 2003 about 36 percent of all hogs were slaughtered in these plants.

Despite this trend, some of these plants are working below their capacity levels (Sagarnaga Villegas et al., 2003). TIF plants are using about 55 to 60 percent of their total capacity (Lastran Marin and Peralta Arias, 2000). As noted earlier, imported live hogs must be slaughtered in TIF plants. From 1998 to 2004, on average, only 2 percent of all hogs slaughtered in TIF plants were finished hogs from the United States. The underutilization



Source: SAGARPA (Mexican Secretariat of Agriculture), 2004. 2003 is estimated.

FIGURE 12. Share of hogs slaughtered in Mexico by type of slaughter plant

of slaughter and processing capacity in Mexico should help encourage more live hog imports when other market conditions such as U.S. hog prices and currency exchange rates are favorable. Despite the incentives to use TIF facilities, several factors limit the use of TIF plants and segregate the market between the TIF plants and municipal slaughter plants and associated small (semi-technically advanced) commercial producers. First, shipping of meat in refrigerated containers makes transportation of meat products from TIF plants to markets relatively more expensive than meat produced, processed, and marketed in the local market channels. A second factor that limits the use of TIF plants is their geographical location. Even though the TIF plants are located near major hog production areas, they are inaccessible to many producers dispersed throughout the country because of high transportation costs in Mexico and other logistical problems.

A third factor is that many small producers do not meet the standards of the federally inspected slaughter plants because of lower animal quality, less-uniform animals, and the lower sanitary conditions in which they operate. In addition to difficulties in meeting sanitary and other quality sourcing requirements of the TIF plants, the smaller producers have traditionally sent their animals for slaughter to municipal and/or private slaughterhouses (USDA-ERS, 1999). The costs of slaughter are about 30 to 40 percent lower than those of the TIF slaughter plants (Aceves Avila and Lopez Lopez, 1998). The lower costs of production and processing are passed on to consumers, at least in part, through lower prices of meats sold in local, regional, and small urban center markets.

Municipal Packing Facilities. In contrast to TIF plants, municipal slaughter plants offer limited services, namely, slaughtering and carcass handling (cutting). These plants do not follow strict sanitary controls, yet they are the main processors of hogs in non-metropolitan areas of the country (Sagarnaga Villegas et al., 2003). According to some estimates, there are 1,300 municipal slaughter plants in Mexico. Most of these plants are old and have not received proper maintenance. They lack the equipment and resources necessary to dispose of by-products properly and therefore are a source of contamination, particularly underground water contamination (Lastran Marin and Peralta Arias, 2000). Municipal slaughter plants are located throughout the country and are inspected by the Mexican Health Secretariat.

On-Site Slaughter. A sizeable proportion of producers still use the traditional type of slaughter in Mexico, which is known as on-site slaughter. These slaughter practices correspond to a traditional/ancestral slaughtering system practiced in Mexico even before the Spanish colonization. On-site slaughter can be attributed to the lack of slaughter plants in rural areas and is used by traditional backyard producers. In 1997, about 36.1 percent of hogs were slaughtered on site (SAGARPA, 1999).

Comparison of Hog Processing in Mexico and the United States

The future of a more technically advanced (industrialized) pork processing industry in Mexico will be highly dependent on the development of TIF plants. Consequently, the slaughter, processing, and packaging costs incurred by TIF plants in Mexico can serve as indicators of competitiveness relative to the U.S. pork and processing industry. This competitiveness will have a major influence on the growth rate of U.S. live hog exports to Mexico.

Relative Competitiveness

Major factors that influence per unit processing costs in the pork slaughter and processing industry are economies of size, the level of technology in plants, number of shifts, labor costs, carcass size and leanness, and regulatory costs (Hayenga et al., 1998). Over the last 20 years, the U.S. packer/processing industry has undergone substantial structural changes that have allowed U.S. packers and processors to pursue scale economies that have lowered per unit costs. By maximizing slaughter numbers year-round, the U.S. slaughter and processing industry has supported large capital investment in plant capacity and reduced per unit costs (Haley, 2004).

Regarding variable costs, some studies have found that U.S. meat industry labor costs typically account for approximately 50 percent of total in-plant and administrative costs in pork slaughter and processing, of which 50 to 60 percent corresponds to labor costs for production workers. Packaging (Cryovac or similar vacuum packaging) was about 10 percent of variable costs in the mid-1990s. Factors that have tended to increase variable costs in the U.S. are additional processing and fabrication of pork products in the plant (mainly due to the increased labor costs), high turnover of labor force, and meeting higher quality and food safety requirements. Other factors that contribute to labor cost

variation are degree of automation (increasing automation reduces variable costs though it increases fixed costs), experience level, and wage and fringe benefit level (Hayenga, 1997). In contrast, the pork industry in Mexico is still undergoing major structural changes, and only about 57 percent of pork production comes from the technologically advanced production sector, which can meet the requirements of TIF plants. Although the costs of slaughter, processing, and packaging may vary widely and are not available in official statistics, the industry structure, the capacity at which the processing plants work (number of animals handled per hour), number of shifts, carcass size and leanness, and regulatory costs and labor costs per hour are important indicators for determining the relative efficiency of the pork slaughtering/packing industry.

Assuming that the most influential variable cost in slaughter plants in Mexico is labor, Mexico's plants would be expected to have lower variable costs than U.S. plants, since wages and fringe benefits in Mexico are much lower than in the United States. As an indicator, in 2003 the Mexican compensation costs for production workers in the food, beverage, and tobacco product manufacturing were \$2.24 per hour compared to \$18.61 per hour in the United States (U.S. Department of Labor, 2005). However, as noted previously, labor is only one of at least six major factors that influence per unit processing costs in the pork slaughter and processing industry. Capital costs and variable costs such as water, electricity, and other utilities may differ, and additional information is required before one can fully compare the per unit processing costs in the pork slaughter and processing industry in Mexico with those of the United States.

As mentioned, Mexico's TIF slaughter plants are operating at about 55 to 60 percent of their total capacity (Lastran Marin and Peralta Arias, 2000). These plants could become more competitive by operating closer to capacity. Fixed costs per head for plant and equipment vary in direct relation to the percentage of capacity utilization. Plant capacity essentially equates to line speed, that is, the maximum number of carcasses that a production line can process in an hour (Hayenga et al., 1998). Many factors can contribute to increased production levels in TIF plants in Mexico and are therefore likely to reduce average fixed costs. Ongoing consolidation and concentration in the pork industry in Mexico as firms become more vertically and horizontally integrated will lead to opportunities to assure higher numbers of hogs sent to the plants. In addition, urbaniza-

tion, rising incomes, increased distribution of meats through large retailing chains, and increased consumer demand for higher quality and food safety in meats will also contribute to increased demand for meat produced by TIF plants.

Government Programs to Increase Demand for TIF Pork and Products

Slaughter and fabrication in TIF plants are both more expensive than in municipal plants or backyard production. Thus, in order to support the modernization of the meat industry sector, the Mexican government has implemented programs to encourage slaughter and processing at TIF plants and registered slaughtering plants in the process of becoming certified TIF plants. In 2003, for example, producers (and feeders) received approximately \$7 per head (on average) for slaughtered hogs (SAGARPA, 2005a). This monetary assistance covered the difference in cost charged by TIF plants and the cost charged by those plants that do not have the same kind of modern slaughtering equipment (SAGARPA, 2003). TIF plants participated in this program by receiving a program application form from producers and paying monetary support to producers (SAGARPA, 2005a).

In 2004, SAGARPA continued covering the slaughter cost differential between TIF plants and municipal plants. For the 2004 year, the differential was about \$4.63 per processed animal (SAGARPA, 2005b). Programs like this, if implemented on a regular basis, are likely to have a significant effect on promoting the use of TIF plants. In addition, increases in the Mexican import of live hogs would also contribute to reducing the excess capacity of TIF plants due to the requirement that all imported slaughter hogs must be processed in TIF plants (SAGARPA, 2005b).

Pork Distribution Channels

The distribution and commercialization of pork is highly fragmented and carried out through several different types of firms in Mexico. The meat marketing system involves several levels, and there is a substantial amount of trading among firms, particularly at the wholesale level before the meat products get to the retail and restaurant level (Dietrich and Smalley, 1999). Most companies distribute only locally or regionally.

Generally, pork distribution is most complex in the case of imported pork and pork from TIF plants. Many U.S. trucking companies drop semitrailers at the border to be

picked up by Mexican semitractors, and some companies send both the tractor and trailer into Mexico. However, a substantial proportion of imported meat is unloaded into cold storage facilities at the border and reloaded into Mexican trucks for delivery into Mexico. Once loads cross the border, pork can arrive in northern metropolitan areas in a matter of hours (e.g., four hours from Nuevo Leon to Monterrey).

Much of the pork from imports and from the TIF plants is initially purchased by wholesale distributors; hotel, restaurant, and institutional purveyors; and meat processors and fabricators. Often, imported meat arrives at the importer's facility and the boxes are broken down into smaller volumes, repackaged, and distributed to the retail level, including hotels and restaurants, supermarkets and discount chains, butcher shops, and other retailers and distributors (see Figure 10). In other cases, an importer takes possession of product only to transport and deliver it directly to a secondary buyer.

Although the level of intercompany trading and fragmentation within pork distribution has been extensive in the past, this situation is slowly changing. In recent years, large supermarket chains have streamlined the distribution process and are taking greater control of their supply chains. Many of the large chains use large, centralized distribution centers that distribute meat to the chain's individual stores. When possible, these chains purchase from one or more large suppliers and supplement stocks from smaller suppliers on an as-needed basis. However, because these facilities are expensive to build and maintain and because transportation costs are high, this type of centralized distribution is still quite small and generally used only by the largest and most efficient companies.

As noted, the pork from municipal slaughter plants is distributed directly in small local or regional urban center markets, including small butcher shops, processors, restaurants, and food vendors. Pork slaughtered on site is mainly commercialized in rural areas and used for home consumption (see Figure 11).

The Retail Sector

Although traditional markets continue to hold the largest market share for meat sales in Mexico, large supermarkets and superstores have increased their share of food sales as rising incomes and urban location allow more consumers to shop in these stores. In 2005, an estimated 40 percent of all food sold in Mexico was expected to be sold in supermarkets and 60 percent was expected to be sold in traditional markets. Within five years,

these percentages are expected to be reversed, with supermarkets accounting for 60 percent of total food sales (USDA-FAS, 2005e).

The percentage of food purchased in supermarkets varies by region, with higher patronage of supermarkets in northern Mexico and higher patronage of traditional markets in southern Mexico. In general, consumers in northern Mexico have higher average incomes and more exposure to U.S. foods and products than do consumers in southern Mexico, who have lower incomes and use more traditional foods and cooking methods. Differences also occur in demand for beef and pork, with greater demand for beef in northern Mexico and greater demand for pork in southern Mexico (USDA-FAS 2005e).

The expansion of supermarket sales has important implications for the pork sector. As noted, the pork from TIF plants is mostly sold into large metropolitan areas. In addition to implementing programs to encourage the use of TIF plants at the production and processing levels, the Mexican government implemented a program in the retail sector to increase sales of pork from TIF plants. Under the retail promotional program, the government provided a one-to-one match for money spent promoting meat slaughtered and processed in TIF plants. This match was available to anyone in the pork supply chain and targeted consumers through highly visible promotional materials and displays for both beef and pork in supermarket meat cases (see Figure 13).

The goal of the retail promotions was to increase demand for TIF-processed meat by making shoppers aware that TIF plants implement higher sanitary standards than do non-TIF facilities. To the extent that such promotions increase overall demand for pork in supermarkets, they benefit imports of U.S. live hogs and pork. Because U.S. live hogs must be slaughtered in TIF plants, the pork from these animals enters the Mexican retail and manufacturing sector as TIF-certified. In addition, imported U.S. pork that is cut, further processed, or fabricated at a TIF plant receives the TIF certification seal and is not differentiated from domestic product.

One result of the TIF promotional program has been that many retail outlets and TIF processing facilities now purchase meat only from TIF facilities. The resulting increase in demand for meat from TIF plants has encouraged managers of non-TIF plants to upgrade their facilities and become TIF-certified in order to retain access to the important retail and



FIGURE 13. Supermarket promotion of meat products from TIF plants in Mexico

processing sectors in metropolitan areas of Mexico. Further, some importers who previously had not done further processing were upgrading their facilities and applying for TIF certification so they could add value to imported pork by cutting, packaging, and otherwise further processing before selling it to other processors or end users.

The Mexican government's support of programs to improve supply and demand of pork processed at TIF plants has encouraged the domestic industry to improve product quality and safety, and U.S. pork has benefited from these changes. However, industry sources indicate that the higher cost of TIF-processed pork relative to pork from non-TIF sources and to substitutable product (e.g., poultry meat) continues to limit retail sales and the use of TIF-certified pork in manufactured products. With an estimated 40 percent of the population living below the poverty level in Mexico, the demand for very inexpensive sources of protein throughout the country remains strong (Central Intelligence Agency, 2005).

Conclusions

The phased implementation of NAFTA has allowed competitive market forces to drive pork and live hog trade between Mexico and the United States. At the same time, rising per capita pork consumption due to population growth, rising incomes, urbanization, and the expanding middle-income class in Mexico have created demand in Mexico that the domestic industry has been unable to supply. Mexican consumer preferences for products and cuts not preferred in the United States help drive this market for chilled and frozen pork, variety meats, and processed meats and specific cuts for manufacturing, food service, and retail sale. Mexico is also a strong market for live hogs, although live hog imports have been less stable than have imports of pork and variety meats. The fluctuations in live hog imports have been attributable in part to the anti-dumping tariffs imposed on U.S. live hogs between February 1999 and May 2003 and to the high sensitivity of imports to U.S. carcass prices.

During and since the period of NAFTA implementation, Mexico's pork sector has increasingly rationalized to create greater production efficiencies and to meet increasing demand for better product quality and stricter sanitation practices in production and processing of pork for both the domestic market and for export. Major changes in the pork industry have included greater technological efficiency in the hog production sector as well as greater use of federally inspected, or TIF, slaughter and fabrication facilities for both domestic and imported pork.

These ongoing structural changes will continue to occur as Mexico responds to the challenges of improving meat quality and safety. At the same time, opportunities for U.S. live hog and pork trade should remain strong. Under current market conditions, demand for pork will continue to increase more quickly than will domestic production. However, the market's high sensitivity to the price of pork and live hogs (and poultry meat as a substitute product), currency exchange rates, and continued adjustments related to livestock and poultry disease problems will continue to affect trade flows.

Despite increased production by technologically advanced hog producers in Mexico and government efforts to increase use of TIF slaughter plants, these plants are underutilized. Slaughter costs are already highest at TIF plants compared to municipal plants and on-site slaughter, and some of these TIF plants could benefit from increased imports of

live hogs, which would reduce per unit cost and increase operational efficiencies. When relative prices favor U.S. exports, we see increased live hog exports to Mexico, and this benefits U.S. hog producers. Even so, the proportion of imported finished hogs from the United States in relation to the total number of hogs slaughtered in TIF plants is relatively small, and this suggests that importing live hogs is not as profitable as importing pork for the Mexican market.

A key to the development of increased trade in both live animals and pork is growth of TIF plant production and development of marketing channels that support high-quality products. Rising consumer incomes, more consumer information about food safety, consumer willingness to buy packaged (not freshly butchered) meats, and more efficient distribution will help drive growth in the domestic market for pork from TIF plants. Continued government programs to encourage production and fabrication and retail-level promotion of pork and pork products from TIF plants will benefit both domestic and imported hogs and pork. At the same time, lower labor costs may favor growth in the Mexican processing industry that could allow increased exports of finished hogs and pork from the United States to Mexico, expand utilization of TIF plant capacity, and encourage the development and use of more modern distribution systems in Mexico.

Endnotes

1. Unless otherwise specified, volumes are stated in product weight equivalent and currency is expressed in U.S. dollars.
2. The USDA Animal and Plant Health Inspection Service implements special restrictions for live swine, pork, and pork products because even though some states in Mexico been determined by the USDA to be free of CSF, one or more of the following conditions occur (USDA-APHIS, 2005):
 - a. They supplement their pork supplies with fresh (chilled or frozen) pork imported from regions designated as being affected by CSF.
 - b. They supplement their pork supplies with pork from CSF-affected regions that is not processed in accordance with U.S. requirements.
 - c. They share a common land border with CSF-affected regions.
 - d. They import live swine from CSF-affected regions under conditions less restrictive than would be acceptable for importation into the United States.

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