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Fruit and Tree Nuts Outlook: Economic Insight

Fresh-Market Limes

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Lime Overview and Varieties

Limes, along with lemons and citrons, are a species in the common-acid fruit group. Common-acid fruits have high citric-acid content and an elliptical shape with a nipple end, distinguishing them from other species within the Citrus genus. These fruits are believed to have originated in the Northeast India, Indo-China region, and followed westward trade routes to the Mediterranean and onward to the Americas. Limes are highly freeze-intolerant and require long periods of heat to suitably mature, so production is limited to areas with mild to warm winters (subtropical to tropical). Like most citrus crops, limes are ever-bearing and harvest typically occurs multiple times throughout the year, with mature fruit occurring in January-February, June-July, and September-October (Reuther, et. al., 1967).

There are three major commercially-produced lime varieties: the Persian lime, the key lime, and the makrut lime (table 1). The Persian and/or Tahitian lime is the most widely produced lime globally with Mexico being the largest producer. The fruit is medium-sized, with an oval-oblong shape (resembling a small lemon), smooth skin, thin rind, juicy and very acidic with “true” lime flavor. The Persian lime has lower heat requirements for fruit to reach maturity and size preference, and is also slightly more cold/freeze tolerant (Reuther, et. al., 1967). This lime is preferred by Americans, due to large size and high juice content.

The key lime, also known as the West Indian lime or Mexican lime, is produced heavily in India and parts of Mexico, where it is the preferred variety for domestic use. It is very smooth-skinned with a thin rind, round, juicy, highly acidic with a strong aroma (Reuther, et. al., 1967). The tree is thorny and light on foliage, with a high heat requirement for ideal fruit development, and tends to be less vigorous and less robust than Persian lime trees. When the key lime is grown in the Mediterranean climate of California, it often produces smaller fruit that must be sold at a discount, due to the occasional cold snap and lower temperatures experienced (Reuther, et. al., 1967). But it grows well in tropical environments such as those in Mexico where they are produced heavily.

Table 1: Major lime varieties and description

Lime type	Other names	Appearance
Key lime (<i>Citrus x aurantiifolia</i>)	West Indian, Bartender's, Omani or Mexican	1-2 in diameter, high acidity, strong aroma, tart and bitter, 7-8 percent citric acid
Persian lime (<i>Citrus x latifolia</i>)	Shiraz Limoo, Tahitian, Bearss (Seedless)	2.5 in diameter, slight nipped end, ripens to yellow but sold green
Makrut lime (<i>Citrus hystrix</i>)	Kaffir	2 in. diameter, rough-bumpy skin, thick rind. Aromatic leaves used in cooking

Source: Reuther, et. al., 1967.

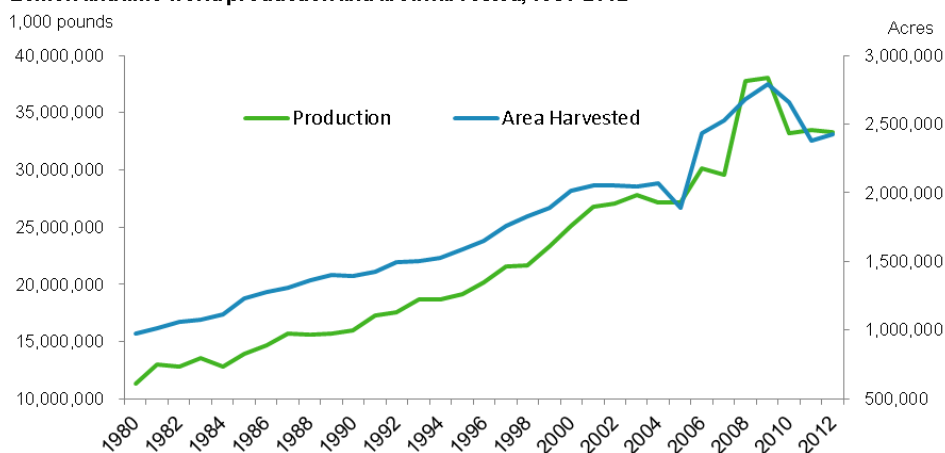
The makrut lime is a lesser-produced but well-known lime variety that is popular in Southeast Asian cuisine, distinguished by its small size, rough, bumpy skin and aromatic leaves which are also used in cooking (Reuther, et. al., 1967).

Global Lime Production

World lemon and lime production¹ has been increasing annually since 1980, with world production reaching 33.3 billion pounds in 2012, up almost threefold from 1980's production of 11.3 billion pounds (fig. 1). For lemons, Argentina, Turkey, the United States, Spain, Italy and South Africa are the largest producers as of 2012 (U.S. International Trade Commission, 2013). For limes, Mexico and Brazil are the world's largest producers (United Nations, Food and Agriculture Organization (UN/FAO), 2003). Both countries produce large quantities of key limes, with Mexico producing Persian limes as well. However, constrained by the lack of refrigeration, key limes are the preferred lime in Mexico due to its longer shelf life (Spren, 2000). Many countries produce limes but consumption tends to remain in their respective domestic markets with little product exported.

With respect to combined global lemon and lime production, China accounted for roughly 17 percent of 2009-12 total average volume, India with 15 percent, and Mexico 13 percent (UN/FAO, 2014). For the same period, the United States came in at just 5 percent of total lemon and lime production (fig. 2). Most countries that are capable will produce small amounts of lemons or limes to meet domestic demand. Only three countries account for more than half of the world's lemon and lime harvested acreage (fig. 3). India is the largest, averaging 609,196 acres, during 2010-12 (about 25 percent of global acreage), followed by Mexico with 637,012 acres (15 percent of global acreage) and China with 292,312 acres (12 percent of global acreage). Brazil and Argentina account for 5 percent and 4 percent of global harvested acreage, respectively, rounding out the top five. The remaining 40 percent of harvested acreage is spread among 103 other countries (UN/FAO, 2014).

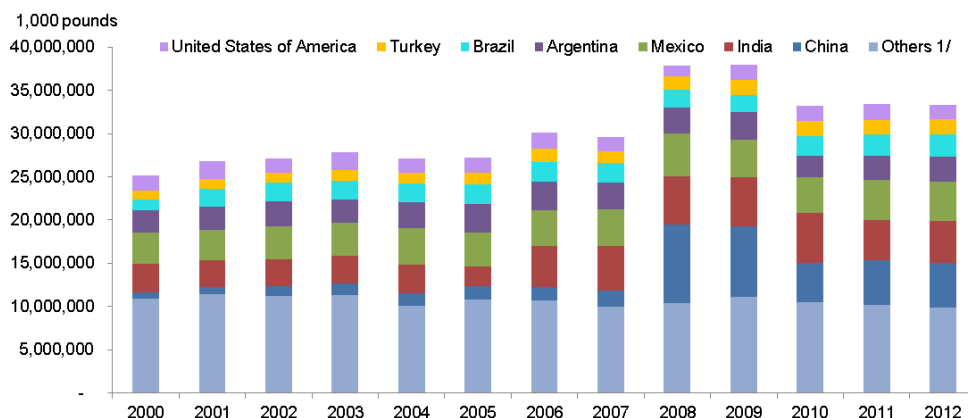
Figure 1
Lemon and lime world production and area harvested, 1980-2012



Source: United Nations, Food and Agriculture Organization, FAOSTAT.

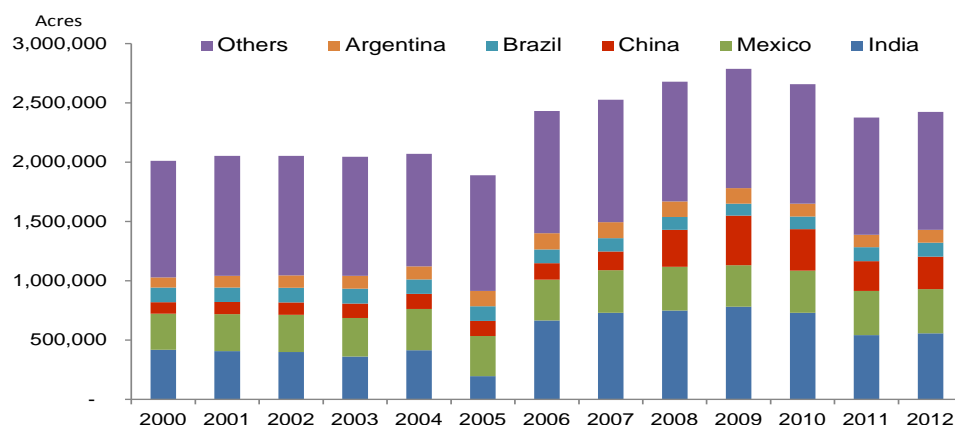
¹ Most global production figures have lemons and limes grouped together.

Figure 2
Lemon and lime global production by country, 2000-2012



1/ Others includes Spain, Iran, Italy and 103 other countries that reported lemon or lime production between 1980 and 2012.
Source: United Nations, Food and Agriculture Organization, FAOSTAT.

Figure 3
Lemon and lime global acreage by country, 2000-2012



Source: United Nations, Food and Agriculture Organization, FAOSTAT.

In terms of productivity, Israel had the highest average yields per acre during the 2010-12 period, with 33,264 pounds per acre, followed by Turkey with 33,090 pounds per acre. Yields in the United States (lemons and limes) ranked No. 3, with 31,670 pounds per acre on average while Argentina averaged 26 percent below this at 25,090 pounds per acre. Yields in Mexico averaged only 12,226 pounds per acre. While Israel's yields are over 2.5 times greater than Mexico, Mexico's large acreage makes it a larger producer.

Florida's Role in U.S. Lime Production, Historical to Present Day

Lime production, similar to other citrus fruits, has always been climatically limited in the United States. Historically, the main production areas were in South Florida. The key lime variety was introduced to the Florida Keys as early as 1838, where they eventually became naturalized; hence the name which is most commonly used in the United States. The commercial industry developed in Florida but was always relatively small, and after a hurricane in 1926, most commercial key lime production in the State was lost (Reuther, et. al., 1967).

After the loss of the key lime industry, Florida planted Persian limes (Tahitian) which have greater tolerance for cold weather and lower heat requirements, adapting better to the sub-tropical growing environment in the region. Most of the lime production was centered in Miami-Dade County, which extends south to Homestead, Florida along the Southeastern coast.

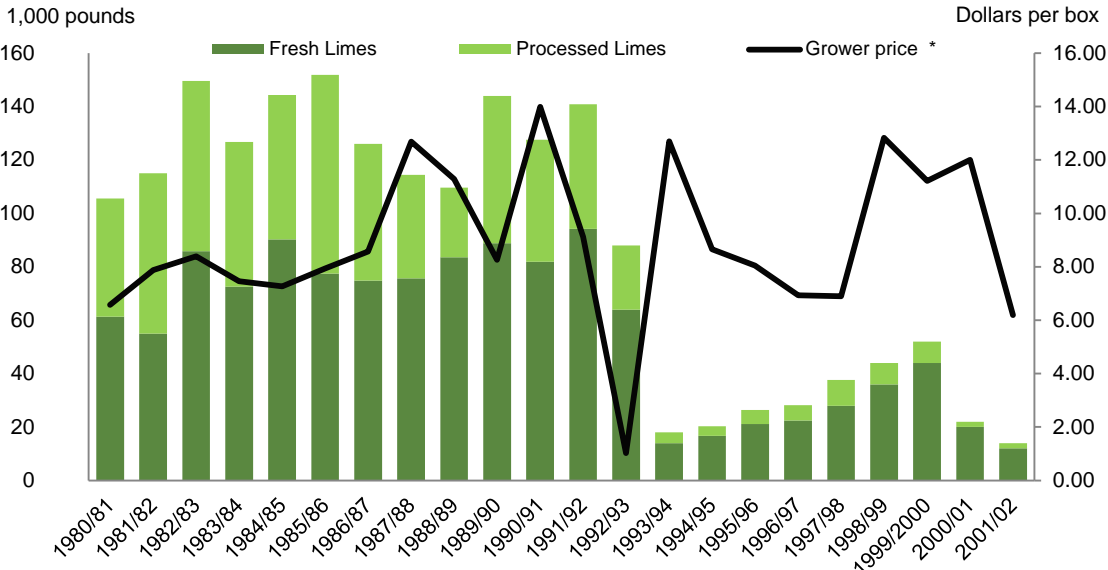
Florida’s total lime production peaked in 1985/86, with 152 million pounds, equal to just over 1 percent of the 10,710 million pounds of oranges produced during the same period. Florida’s lime production was mostly geared toward the fresh market, in contrast to the State’s orange crop, which is produced primarily for processing. On average, over 51 percent of lime production went toward fresh use during 1970-79 (fig. 4). This share rose to 72 percent during the 1990’s, the same time that only 5 percent of Florida oranges went to the fresh market. Lime production was increasing through most years, with some fluctuations attributable to a mid-January freeze in 1977, loss of acreage to urban sprawl, and tree removal from citrus canker.

Citrus Diseases and the Demise of Florida Limes

Citrus canker is a bacterial disease that was introduced to the Southeastern United States around 1910-1912 from imported Japanese seedlings but was declared eradicated from Florida and neighboring states in 1933 (Gottwald, 2002). Canker affects most commercial citrus varieties and causes lesions on fruit, stems, and leaves. As the infection worsens, plants can experience defoliation, severely blemished fruit, early fruit drop, twig and limb die back, and overall tree health decline, usually leading to removal of trees from commercial production (Schubert and Sun, 2003). There is no known cure for citrus canker and most trees are removed once they become infected (Dewdney, et. al., 2001 (revised 2013)). Key limes, along with grapefruit and trifoliolate orange, are highly susceptible to all citrus canker pathogens (Schubert, 2002).

Canker was absent in Florida until 1986, when it was discovered in Manatee County, Florida, south of Tampa Bay, in less common lime-production land. By 1994, this infection was declared eradicated (Gottwald, 2002). In 1995, a separate, new canker finding in Miami was reported with infestation dated back to 1992-93, potentially introduced via Hurricane Andrew in August 1992. Wind and rain increase the chances for the disease to spread, especially over short distances with tropical storms, hurricanes, and tornadoes spreading canker for several miles (Polek, et. al., 2007). Another difference with this new infestation was the introduction of citrus leafminer, which creates further entry points for canker, but also attacks the same newly emerging leaves where canker thrives as well (Polek, et. al., 2007). This East Coast outbreak created a response from Florida government agencies and the USDA. However, despite their efforts, several other canker outbreaks occurred in both residential and commercial citrus in counties all along the southern portion of Florida. Even with the removal or cutting back (removal of infected portions of trees)

Figure 4
United States lime production and season-average grower price, 1980/81-2001/02



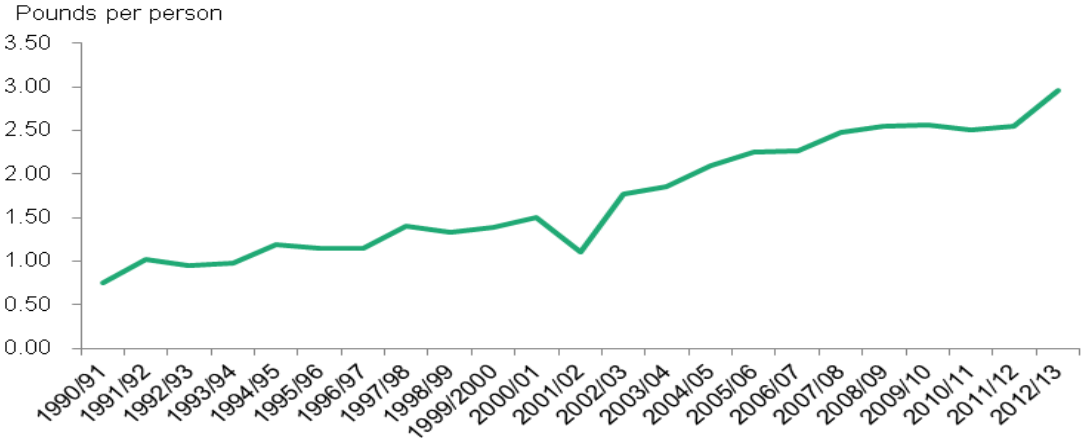
* Grower price is on-tree equivalent per 88-lb box.
 Source: USDA, Economic Research Service, *Fruit and Tree Nuts Yearbook*, various issues.

of over 1.56 million commercial trees, the infected area increased from just 14 square miles in 1995 to over 657 square miles as of early 2002 (Gottwald, 2002). By 2002, USDA’s commercial lime production estimates were discontinued and by 2006 the eradication effort for citrus canker ceased, as all major citrus producing counties consider canker endemic (Skaria and da Graça, 2012; Polek, et.al, 2007). Florida’s commercial lime production never fully recovered since the 1995 canker finding in Miami. It was the perfect storm of canker, leafminer, hurricanes/tropical storms, and legal litigation brought about by the removal of trees on residential properties that slowed the eradication effort that truly reduced the viability of lime production in the United States. The years after 1995 witnessed an increase in production but direct competition for land and water (due to population growth in the Miami-metro area) and low-priced lime imports reduced the economic feasibility of a domestic lime industry (Spren, 2000).

With the decline of domestic production, lime supplies were sourced from Mexico and smaller neighboring countries. Even in 1990, Mexico supplied 95 percent of total limes imported to the United States, with most of the remaining share coming from the Bahamas (3 percent) and Honduras (1 percent). Eleven other countries supplied limes to the United States in 1990. By 2010, Mexico’s share of total U.S. lime import volume inched up to 97 percent, followed by Guatemala with just under 2 percent and El Salvador with less than 1 percent. The United States imported an average 912 million pounds of limes from 2011 to 2013, still mostly from Mexico. Over 90 percent of U.S. lime imports from Mexico were Persian limes, the remainders were key limes. Persian limes are grown in Mexico mostly to meet the export market demand, particularly in the United States. Mexico also supplies the bulk (over 94 percent of the 2011-13 average key lime volume) of key lime imports in the United States, accounting for over 94 percent of the 2011-13 average key lime import volume of 75 million pounds. Even as domestic production declined, domestic per capita use increased steadily (fig. 5).

In 1990/91, Americans used 0.75 pounds of limes a year per person. By 2000/01, this estimate doubled to 1.50 pounds per person, and by 2012/13 per capita use reached 2.96 pounds. This trend is not expected to decline as limes remain popular in both beverage and food choices across the United States, in Europe and in Japan (USDA, Foreign Agricultural Service (USDA/FAS), 2013). Part of the increased demand for limes over time reflects the growing Hispanic American population and the influence of Latin American cuisine in America. The United States dependence on imported limes for consumption and use will continue, especially as additional Mexican lime plantings and acreage is brought into production (USDA/FAS, 2013), illustrating market confidence in export demand to the United States and other countries.

Figure 5
United States per capita lime use, 1990/91-2012/13



Source: USDA, Economic Research Service, *Fruit and Tree Nuts Yearbook*, various years.

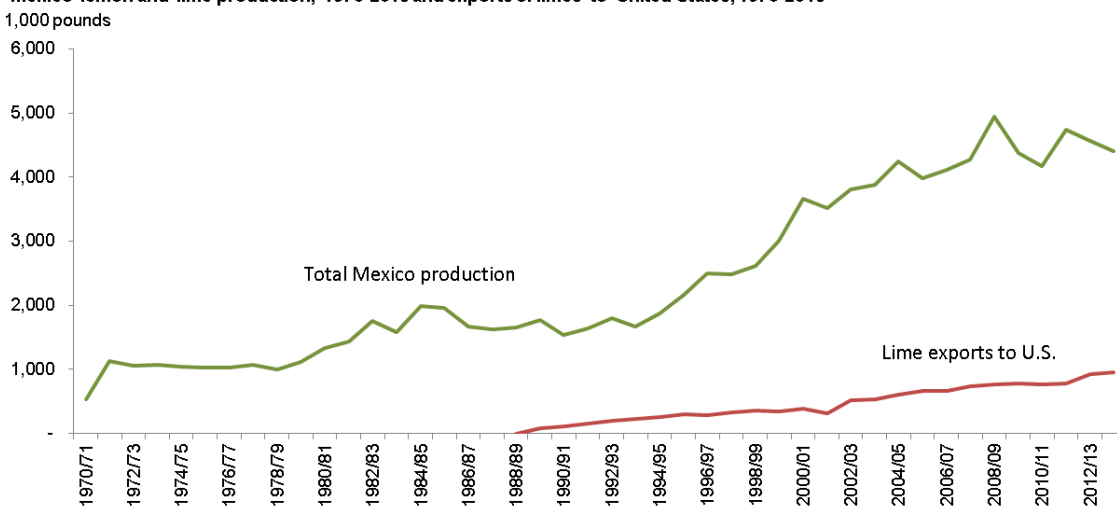
Mexico: Top Global Producer and America's Lime Supplier

Mexico is one of the largest citrus-producing and -consuming countries in the world, along with the United States (USDA/FAS, 2014; Spreen, 2000). Both Persian and key limes are very economically important in Mexico. As discussed earlier, key limes are preferred for domestic consumption and are grown mostly on the southern Pacific coast of Mexico. The key lime is produced in the states of Colima, Michoacán, Guerrero, and Oaxaca, with the former two being the largest producing States. Michoacán's winter weather provides an excellent production window, allowing limes to enter the domestic market early between December and February (USDA/FAS, 2013). Key limes mostly remain in the Mexican domestic market for consumption, but exports have been increasing (USDA/FAS, 2013).

Persian limes are grown mostly in the micro-climates of northern Veracruz, with some production in Tabasco, Oaxaca, Puebla, Jalisco and Yucatan—mostly on the Gulf of Mexico side of the country (USDA/FAS, 2013). Persian limes' peak harvest occurs between June and September. Comprised of large producers, about 25 percent of Persian lime production in Mexico is under irrigation (USDA/FAS, 2013). Roughly 50-60 percent of Persian limes are exported to the United States from Veracruz, while in total about 30 percent of Mexico's total Persian lime production is exported (fig. 6).

Strong international prices and low barriers to trade have led to increased plantings of both Persian and key limes in Mexico through 2012. Persian lime planted area increased 5 percent in 2012, accounting for 47 percent of total lime area in Mexico while key lime area decreased but make up half of total lime area. The remaining 3 percent is planted with Italian lemons. According to USDA/FAS, most producers in the country have suggested that both varieties are experiencing problems with over production. However, the state of Colima is experiencing reduced production due to citrus greening also known by the Chinese name of Huanglongbing (HLB). Key lime area in Veracruz has been planted at a lesser rate than Persian limes due to domestic price swings. However, in Michoacán, key lime acreage has increased due to the early harvest window (December to February), providing early market access before greater supplies reach market and reduce prices. Because current production is so high, this increase in key lime production could reduce prices but a common practice for Michoacán producers is to suspend harvest to prevent market saturation in hopes of preventing subsequent low prices (USDA/FAS, 2013). Prices also drop in Mexico when both varieties of limes are available, in the summer months usually, after which Persian lime prices gain ground in December due to export market demand and remain elevated until spring harvest in April (USDA/FAS, 2013).

Figure 6
Mexico lemon and lime production, 1970-2013 and exports of limes to United States, 1970-2013



* data is from USDA, Foreign Agricultural Service, *Production, Supply, and Distribution* data.
Source: United Nations, Food and Agriculture Organization, FAOSTAT.

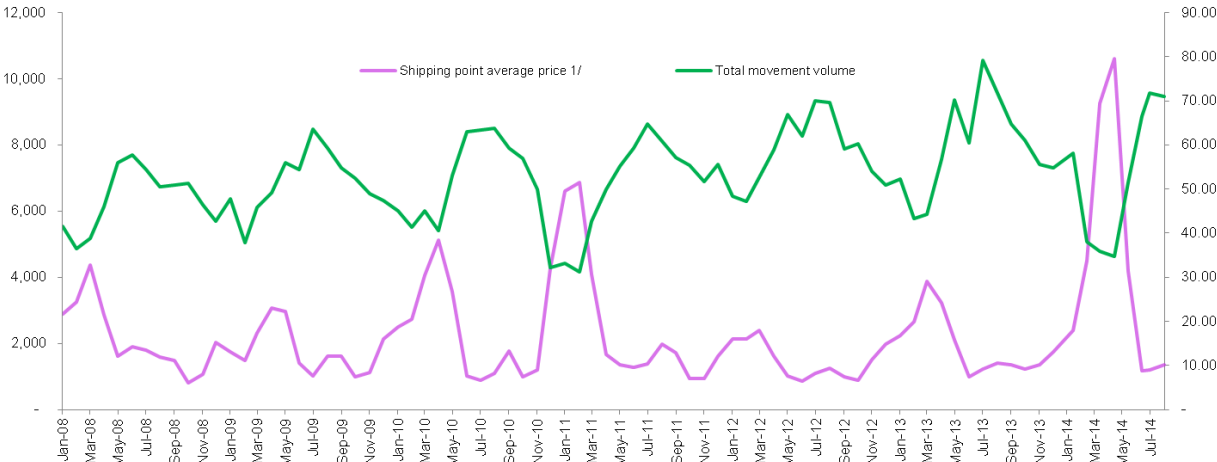
The North American Free Trade Agreement (NAFTA) has worked in favor of Mexico’s lime production, as demonstrated by post-1994 production increases immediately following NAFTA implementation. However, a majority of limes produced in Mexico serve the domestic market. Mexico, on average, consumed 59 percent of all lemons and limes produced in the country, according to USDA’s FAS, *Citrus World Markets* report from January 2014. While Mexico is the largest supplier of fresh limes into the United States, the country only exported an average of 19 percent of limes out of the total lemon/lime production during the 2008/09-2012/13 time period, based on UN/FAO’s production data and U.S. Census Bureau trade data. Lemons are included in the total production figure, but when measured by imports to the United States, lemons amount to just 6 percent of total in 2013.

The 2014 Price Spike

In March of 2014, U.S. consumers and media took notice to the rapidly increasing retail lime prices at the grocery stores. Even wholesalers and distributors saw a jump in wholesale prices, leading some restaurants and bars to limit the use of limes. Using AMS’s data of shipping-point free-on-board (f.o.b.) prices for fresh limes coming from Mexico through Texas were at their highest levels since at least the winter of 2001 (fig. 7). F.o.b. prices seem to jump in early spring, at the same time there is a visible dip in supplies entering the domestic market. Usually these price spikes occur rapidly and dissipate rapidly, and are relatively minor jumps of up to double the price. Exacerbating the typical price pattern was heavy rainfall in Veracruz in the fall of 2013 which led to the smaller Persian lime harvest in Mexico² last winter, making what is usually just a slight jump in prices to a very steep spike (USDA/FAS, 2013).

The shipping-point f.o.b. average price peaked in April 2014 at \$79.65 per 40 pound carton, over 3-times higher than in April 2013. National average advertised retail prices reported by AMS show that prices climbed to \$1.02 per lime in April 2014, a 3.5 fold increase from April 2013’s price of \$0.29 per lime (AMS market news portal, accessed June 2014). By June 2014, the national average advertised retail price was \$0.45 per lime, a 56 percent drop from April’s peak price of \$1.02. The June 2014 price of \$0.45 per lime remained almost double the June 2013 price of \$0.24. Only 42 stores reported advertised retail prices to AMS in April 2014, with 3,100 stores in April 2013, demonstrating further supply shortage last spring.

Figure 7
Lime shipping point monthly average price and total movement from Mexico entering in Texas, January 2008 to August 2014



1/ Each monthly price point is the midpoint between the highest and lowest prices each month, including all sizes.
Source: USDA, Agricultural Marketing Service, Fruit and Vegetable Market News Portal, September 2014. <http://marketnews.usda.gov/portal/fv>

² The USDA/FAS Mexico Citrus attaché report will not be out until December with the final production figures for 2012/13 season that would include the final lime estimate.

In popular press, there was speculation of cartel involvement with the state of Michoacán being home to a large cartel. However, Michoacan produces mostly key limes which are not heavily exported to the United States. The decline in production for both Key and Persian limes, due mostly to unfavorable weather, was the main driver behind the price spike.

Summary

Three major lime varieties are grown commercially around the world, with Persian limes being of the most important to the United States consumer. While Key limes are consumed more heavily in Mexico and India, along with makrut limes, demand is growing for alternative lime varieties in the United States but the market remains dominated by Persian limes. Production is increasing globally, with demand remaining strong both in the United States and abroad. Mexico is the major supplier and producer of limes consumed in the United States while other Central and South American countries serve as minor sources. The United States lime industry once thrived as a niche market but after several years battling with the citrus canker disease and other complications such as cold weather, labor issues, inability to fully meet domestic demand, the acid lime industry ultimately contracted, having little to no commercial production remaining after 2002. U.S. lime imports from Mexico demonstrated strong growth since early 1990s, aiding in promoting consumption in the United States. Per capita use in the United States continued on an upward trend, reaching almost 3 pounds per person in 2012/13, an over-sevenfold increase compared to 1980/81 per capita of 0.42 pounds per person. Even with occasional price spikes related to weather and socio-economic issues in Mexico, U.S. demand remains high for limes and should continue to be an important commodity in the future, as the domestic population continues to diversify, especially with increased Hispanic citizens and American's growing love for exotic and healthy foods.

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