

Citrus focus

Argentina's Lemon Industry

The history and future growth of citrus in this top lemon-producing country

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In the northwest corner of Argentina, in the province of Tucumán, lies an agricultural area that has become the world's No. 1 producer of lemons and lemon byproducts in the past 30 years. The area, which is the smallest and one of the poorest in Argentina, is blessed with abundant natural rainfall in the summer and a basically dry climate in the winter that enables a bountiful and continual harvest.

History

Citrus fruits first arrived in Tucumán with the conquistadors in the 1600s. The industry didn't really get its start, however, until the Italian and Spanish immigration (from 1910-1930s), and the introduction of their custom of using lemons as a condiment. At this time, the citrus industry took hold in the areas of Tafi Viejo and Yerba Buena, west of the city of Tucumán. The farms were very small: The average farm was 5-10 hectares, and large farms were only 30 hectares.

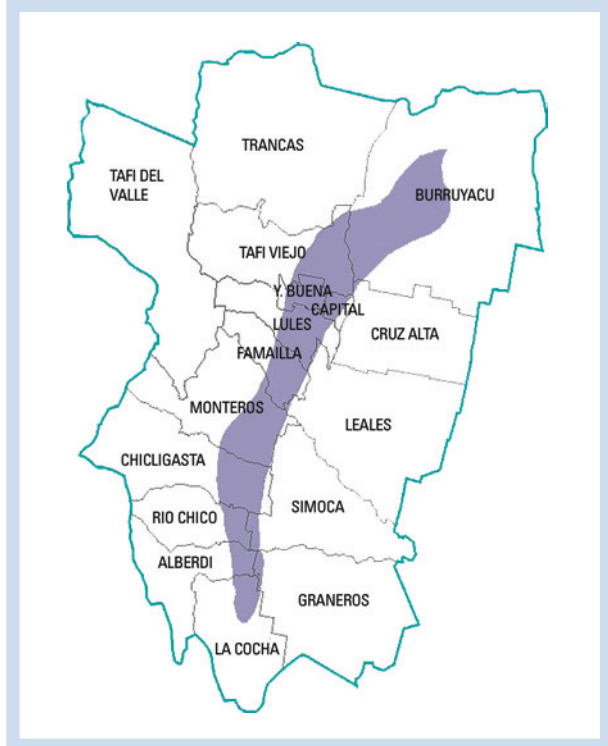
At the end of the 1940s, a type of tristeza virus attacked all citrus trees that were grafted on rootstocks of bitter orange, resulting in the death of the trees. Due to this, the national and local governments prohibited the growing of sweet oranges, grapefruit and mandarins that were grafted on sweet oranges. This



Grafting the scion onto the rootstock; the scion and rootstock determine the type of tree and characteristics of the fruit.

The citrus-producing regions in Tucumán, Argentina

F-1



decimated the small farms, farmers and industry for the next 20 years. The only citrus plant that survived was the lemon.

In the 1960s, with the importation of more advanced technologies from overseas, lemons began to be grown commercially in Tucumán. It was at this time that the first facilities to process lemons were opened in the area, including Citroil's Citromax S.A.C.I. facility. The first packing houses and exportations of fresh lemon fruit began in 1972. In the past few years, the most productive lands have moved away from the city of Tucumán to areas further north and south (see F-1). These lands all remain in the shadows of the Andes Mountains, which help to prevent freezes and encourage rainfall.

Due to the tristeza virus, the citrus industry no longer uses bitter orange as a rootstock. Instead, a variety of hybrids is used, such as citrumelo (swingle) and citrange troyer. The varieties used for scions are almost exclusively eureka frost, lisboa frost, genova and limoneira. One of the most important changes in the past 10 years is the current industry trend of developing dwarf tree rootstocks, such as flying dragon. This makes the harvesting and maintenance of the orchards easier, because these trees rarely grow more than 6 feet tall. Additionally, because these



A lemon tree in full bloom.

trees are much smaller than the ones used previously, they can be planted in a denser pattern and eventually will be able to increase yields on a per-acre basis.

Increase in planted surface of lemons in Tucumán

T-1

Year	Planted surface (in hectares)	Planted surface (in acres)
1993	21,340	52,283
1994	21,520	52,724
1995	23,390	57,306
1996	23,900	58,555
1997	27,000	66,150
1998	30,200	73,990
1999	31,400	76,930
2000	32,000	78,400
2001	33,000	80,850
2002	35,000	85,750
2003	37,000	90,650
2004	38,000	93,100
2005	39,000	95,550

Source: *Asociacion Tucumán Citrus*

Growth

In 1960, the total Tucumán province had only 1,630 hectares of lands planted with lemons; in 1970, this had grown to 6,800 hectares. By 1988, lemon orchards covered 16,600 hectares. In the past 10 years, the region has grown to produce 1.3 million metric tons of fruit per year, cultivated on a surface area of about 39,000 hectares, or approximately 95,000 acres (T-1).

The lemon industry is one of the main drivers of the economy in Tucumán, which is one of the poorest provinces in Argentina. The industry employs directly and indirectly up to 100,000 people, with 40 functioning packing houses and six processing companies.

Argentina produces every type of citrus that is grown in commercial quantities in

Lemon production in metric tons

T-2

	Year									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
World	3,474	3,800	3,958	3,964	4,024	4,288	4,624	4,346	4,695	4,150
Argentina	741	720	871	1,024	1,042	1,163	1,216	1,312	1,236	1,340

Source: *FAO*



Four juice centrifuges used to reduce pulp level of juice to the desired concentration.

the world, including oranges, mandarins, clementines (easy peel), lemons, limes and grapefruit. However, lemons are the dominant citrus for Argentina. With most of the production centered in Tucumán, the country grows 31.7 percent of the world's lemons and accounts for 45 percent of the world's processed lemon products (T-2).

Of the total lemons produced in Argentina, approximately 30 percent goes to the fresh fruit industry (both domestic and international), while 70 percent is processed into lemon oil, concentrated lemon juice, dried lemon peel and a variety of other byproducts. The fact that Tucumán boxes only 30 percent of its fruit and processes 70 percent leads Argentina to assume the No. 1 position in the world for processed product, and the standard for both lemon juice and lemon oil. T-3 shows the growth experienced by this industry in the past 10 years.

Products

The lemon is a very noble fruit; it flowers and produces fruit almost year-round. Even if neglected, the trees recuperate quickly once they are tended to again. T-4 shows the different harvests produced in Tucumán. The winter harvest, from April to October, is by far the largest, accounting for 85-90 percent of the fruit grown.

As discussed previously, once harvested, the lemon is either exported as fresh fruit or processed primarily into concentrated lemon juice, lemon oil and dried lemon peel. The juice is processed and concentrated to between 300 and 600 GPL (measured as grams of anhydrous citric acid). The breakdown of a typical Argentine lemon juice at 8° Brix can be seen in T-5.

Growth of lemon fruit production in metric tons

T-3

Year	Processed or crushed	Fresh fruit (exportation)	Fresh fruit (domestic market)	Total
1996	453,759	169,728	57,000	680,487
1997	549,664	183,324	61,000	793,988
1998	654,890	157,842	94,620	907,352
1999	698,000	194,653	46,792	939,444
2000	797,900	200,805	47,000	1,045,705
2001	812,000	241,989	79,781	1,133,770
2002	890,000	257,170	57,830	1,205,000
2003	749,000	339,770	50,000	1,138,770
2004	863,000	316,000	50,000	1,229,000
2005	890,000	366,000	50,000	1,306,000

Source: Asociacion Tucumán Citrus

The different harvests produced in Tucumán

T-4

Harvest season	Flowering	Harvest	Growing time in months
Green Fruit	July/August	February/March	6 to 7
Winter Harvest	September/October	April-July	7 to 8
2nd Winter Harvest	December/January	August-October	8 to 9
Summer	February/March	November-January	9 to 10

Source: Avance Agroindustrial, December 1994

Values	Quantity	Averages for years 2001-2005
citric acid	g/L	49.4-59.3
isocitric acid	mg/L	250-399
ratio citric acid/isocitric acid		170-207
malic acid	g/L	2.29-4.75
sucrose	g/L	1.2-2
glucose	g/L	5.2-8.9
fructose	g/L	4.4-5.8
ratio glucose/fructose		1.06-1.28
total sugars	g/L	10.9-18.6
extract-free sugars		63.7-71.4
ash	g/L	2.45-3.08
potassium	mg/L	1189-1595
sodium	mg/L	2-9
magnesium	mg/L	71-82
calcium	mg/L	43-88
phosphates	mg/L	243-344
proline	mg/L	105.5-422.7
water-soluble pectins	mg	
	Ac.galact/L	137-283
hesperidine (HPLC)	mg/L	243-342
eriocitrine (HPLC)	mg/L	201-244
limonene	mg/L	4-17
lead		n/d
arsenic		n/d
copper	mg/L	0.2-0.44
zinc	mg/L	0.2-0.4
iron	mg/L	< 1
tin	mg/L	< 0.05
cadmium	mg/L	< 0.01

Source: Historical data files Citromax S.A.C.I.

Percentage of constituents in a single-fold lemon oil recovered by cold-pressed extraction

T-6

Components	Average percentage for individual components by year					
	2000	2001	2002	2003	2004	2005
α-thujene	0.4055	0.4050	0.3863	0.3929	0.3857	0.3776
α-pinene	1.9716	1.9574	1.8804	1.9149	1.8228	1.8211
camphene	0.0691	0.0710	0.0654	0.0644	0.0589	0.0582
sabinene	2.2303	2.2777	2.0472	2.2255	1.9952	2.0991
β-pinene	14.5188	14.1819	12.8842	13.7845	12.2404	13.0576
β-myrcene	1.4772	1.4851	1.5320	1.4918	1.5434	1.4122
octanal + phellandrene	0.0489	0.0523	0.0527	0.0612	0.0473	0.0674
δ-3-carene	0.0041	0.0045	0.0180	0.0083	0.0037	0.0023
α-terpinene + p-cymene	0.3859	0.3089	0.2961	0.2850	0.2816	0.2636
D-limonene	64.7750	65.1967	66.8696	66.4213	68.1594	67.2646
ocimene	0.1456	0.1219	0.1139	0.0858	0.1186	0.0979
γ-terpinene	8.9094	8.8142	8.4971	8.6313	8.5515	8.5422
terpinolene	0.3444	0.3660	0.3569	0.3437	0.3423	0.3353
linalool + nonanal + <i>trans</i> -sabinene	0.2181	0.2158	0.2015	0.1785	0.1686	0.1789
citronellal	0.0532	0.0519	0.0466	0.0436	0.0560	0.0599
α-terpineol	0.1299	0.1311	0.1257	0.1050	0.0970	0.0720
decanal	0.0532	0.0409	0.0383	0.0406	0.0344	0.0435
neral	0.7948	0.8319	0.8723	0.7493	0.7727	0.7593
geranial	1.2104	1.2565	1.3283	1.1500	1.2021	1.1969
undecanal	0.0285	0.0269	0.0258	0.0236	0.0184	0.0289
citronellyl acetate	0.0197	0.0183	0.0150	0.0150	0.0187	0.0192
neryl acetate	0.4477	0.4200	0.4575	0.4688	0.4463	0.4632
geranyl acetate	0.2824	0.2697	0.2226	0.2352	0.2660	0.2644
caryophyllene	0.2406	0.2397	0.2264	0.2068	0.2252	0.1760
bergamotene	0.3310	0.3377	0.3245	0.3357	0.3428	0.3048
β-farnesene	0.0528	0.0411	0.0420	0.0434	0.0426	0.0561
bisabolene	0.4859	0.4993	0.4917	0.5059	0.5150	0.4858
Optical Rotation	+57.06°-+62.48°	+57.18°-+61.27°	+59.12°-+67.00°	+57.33°-+66.15°	+59.48°-+67.00°	+60.18°-+67.54°
Refractive Index	1.4744-1.4750	1.4747-1.4753	1.4741-1.4753	1.4745-1.4755	1.4722-1.4755	1.4741-1.4744
Specific Gravity	0.844-0.8586	0.8514-0.8535	0.8471-0.8533	0.8463-0.8513	0.8467-0.8513	0.8485-0.8510

Source: Historical data files Citromax SACI and Fritzsche SAICA

The lemon oil is recovered via cold-pressed extraction and sold as single-fold to a variety of industries. Some lemon oil also is sold as concentrated lemon oil into various folds, the most common being fivefold and tenfold. T-6 shows the properties of a single-fold lemon oil recovered by means of cold-pressed extraction.

The wet lemon peel is dried to a humidity of between 8-10 percent and is sold to the pectin industry for further processing. The pectin is used as a gelatin in jams, jellies and yogurts, and also as a binder in the pharmaceutical industry.

The Argentine province of Tucumán has led the world since the 1990s as the No. 1 producer of lemons, and it continues to grow at a rate of 5 percent per year. Argentina is fast becoming the gold standard for lemon juice and lemon oil.

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