The Strawberry Industry in South America

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The strawberry (*Fragaria ×ananassa* Duch.) was cultivated in South America long before the Spanish arrived on the continent. Native *Fragaria chiloensis* L. was domesticated over 1000 years ago by the Picunches in central Chile (Hancock et al., 1999). During the Spanish period of exploration and conquest in the mid- to late 1500s, *F. chiloensis* was spread throughout South America and major industries developed around Cuzco, Peru; Bogota, Colombia; and Ambato, Ecuador.

European cultivars of *F. ×ananassa* were probably introduced into South America in the late 1800s (Folquer, 1986), and California cultivars in the 1960s. These rapidly replaced most of the traditional *F. chiloensis* plantings, first through introgression, and finally through pure cultivar plantings. Today, cultivars of *F. ×ananassa* are found in almost all South American countries, flourishing in tropical, subtropical, and southeastern South America, where the climate is strongly conditioned by fresh South Atlantic winds, with average temperatures ranging from 11 °C in July to 24 °C in January.

The South American industry accounts for ≈4% of the total world strawberry production, but the strawberry plays important social and economic roles on the continent, since strawberry farms employ ≈50,000 full- or part-time workers. Strawberries are a popular item in local markets and are an exported commodity (Cicare, 1999). This paper describes the strawberry industry in Argentina, Brazil, Paraguay, Uruguay, Chile, Bolivia, and Ecuador. The first four countries are members of the Mercado Comun del Sur (MERCOSUR) or South American Free Trade Agreement, which is similar to the North American Free Trade Agreement. Brazil, Argentina and Chile are responsible for most of the South American strawberry production, while production in Paraguay, Uruguay, Bolivia, and Ecuador is less developed (Table 1).

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BRAZIL

Brazil is the largest strawberry (*morango*) producer in South America (Table 1). Strawberries in Brazil are a highly profitable crop, and are consumed fresh, frozen, or as pulp (frozen or dehydrated). The state of Minas Gerais leads the country in strawberry production with 29607 t and 1173 ha, followed by Rio Grande do Sul with 14511 t and 467 ha, and Sao Paulo with 10725 t and 444 ha (Santos, 1999b). Most of the strawberry growing area in Brazil is concentrated between latitudes 20° and 32°S (Santos, 1999b).

Each year, the Brazilian strawberry industry utilizes ≈180 million runner plants annually for fruit production. Most of the plantings are renewed annually. Runner plants are produced by certified local nurseries or the fruit growers themselves, or are imported from Argentina, Chile (fresh plants), and the United States (cold-stored plants). Two to four rows of plants are set on raised beds (0.20–0.50 m high) through black plastic mulch. Plant distances within and between rows are ≈0.30 m, resulting in densities of 65,000–80,000 plants/ha. Runners are planted from February (cool regions) to April (warm regions). Water requirements in strawberry plantings are met by sprinkler or furrow irrigation, although in southern states, such as Rio Grande do Sul and Santa Catarina, strawberry fields are watered through drip irrigation (Santos, 1999c; Vaz Ronque, 1998). The fertilizers most commonly used in Brazil are urea, calcium nitrate, normal superphosphate, potassium chloride, potassium sulfate, boric acid, zinc sulfate, and copper sulfate (Pires Ribeiro, 1999). Liming is a common practice to increase soil pH in Sao Paulo and Parana (Vaz Ronque, 1998).

Imported cultivars are important in Brazil, but there is also a major, local breeding center, the Instituto Agronomico de Campinas (IAC) at Sao Paulo. The most widely planted cultivars are: 'IAC Campinas', 'IAC Princesa Isabel', and 'IAC Guarani', developed in Brazil; 'Camarosa', 'Chandler', 'Oso Grande', 'Seascape', and 'Sequoia', developed in California; 'Dover', 'Rosa Linda', and 'Sweet Charlie', developed in Florida; 'Mioho', 'Reiko', and 'Toyonoka', developed in Japan; 'Tudla Milsei', developed in Spain; 'Korona', developed in Holland (Passos et al., 1995; Santos, 1999a; Silva et al., 1998).

The major pests and diseases found on Brazilian strawberries are spider mites (*Tetranychus urticae* Koch), aphids [*Chaetosiphon fragaefolii* (Cockerell), *C. thomasi* (H.R.L.), and *Aphis forbesi* Weed], thrips (*Frankliniella occidentalis* Pergande), gray mold (*Botrytis cinerea* Pers. ex Fr.), anthracnose (*Colletotrichum fragariae* A. N. Brooks, and *C. acutatum* Simmonds), black root rot (*Rhizoctonia solani* Kühn), common leaf spot [*Mycosphaerella fragariae* (Tul.) Lindau], angular leaf spot (*Xanthomonas fragariae* Kennedy & King), leaf scorch [*Diplocarpon earliana* (Ellis & Everh.) F.A. Wolf], leaf blight [*Phomopsis obscurans* (Ellis & Everh.) Sutton], Verticillium wilt (*Verticillium albo-atrum* Reinke & Berthold), and leather rot [*Phytophthora cactorum* (Levert & Cohn) J. Schröt.] (Betti, 1994; Passos et al., 1995; Tanaka et al., 1994a, 1994b, 1995, 1996; Vaz Ronque, 1999).

The Brazilian harvest begins in April and ends as late as December. The production peak occurs in August, while the highest prices are obtained in April (Fig. 1A). About 70% of the total fruit production is consumed fresh, while the rest is processed. Usually, growers send

Table 1. Strawberry hectareage, production, and yield in some South American countries.

Country	Production area (ha)	Production (t/year)	Avg yield (t·ha ⁻¹)
Brazil ²	2643	62,766	24.3
Argentina ³	1080	25,000	26.0
Chile ⁴	700–900	18,000	22.5
Paraguay ⁵	197	2,215	11.2
Uruguay ⁶	180	2,160	12.0
Bolivia ⁷	180	600	3.4
Ecuador ⁸	50	500	10.0

²Source: Santos (1999b).

³Source: Kirschbaum (1999a).

⁴Source: Gambardella et al. (1999).

⁵Source: FAO (1999).

⁶Source: C.E. Vicente – INIA–Salto (Uruguay) (1998, personal communication).

⁷Source: G. Lopez–Arce. Departamento Difusion del Instituto Nacional de Estadísticas (Bolivia) (1995, personal communication).

⁸Sources: Consejo de Comercio Exterior e Inversiones del Ecuador (1999); FAO (1999).

Fig. 1. Volume of strawberries sold and prices registered in wholesale produce markets of (A) Sao Paulo, Brazil, during 1995 (Centrais de Abastecimento S.A. Campinas, 1995), (B) Buenos Aires, Argentina, during 1997 (Mercado Central de Buenos Aires, 1997), and (C) Montevideo, Uruguay, during 1996 (Junta Nacional de la Granja, 1996).

the fruit to shippers located in a regional produce market, to supermarkets, and to processing facilities (Passos et al., 1995).

Fruit with 50% to 75% red color are harvested for the fresh market, while 100% red fruit are picked for processing. Strawberries for processing are bulk-packed in 5-kg wooden boxes. Fruit destined for the fresh market are harvested into baskets and then taken to packing facilities, where they are graded and packaged in individual styrofoam, wooden, plastic, or cardboard containers that hold 250–800 g of fruit (Silva et al., 1998). Four to eight individual containers are packed in larger wooden boxes. Strawberries are graded according to weight (or size) for the fresh market: >14 g = “extra” and 6–14 g = “first” grade (Passos et al., 1995).

ARGENTINA

Argentina is the second largest strawberry (*frutilla*) producer in South America (Table 1). Strawberries are produced in this country year-round (Fig. 2), as they are

planted across a broad range of latitudes (24°S to 42°S), with climates ranging from cold-temperate in the province of Rio Negro to tropical in Jujuy. Three major production regions—northern, central, and southern—can be distinguished, based on their particular climates and harvest seasons (Rodriguez and Hompanera, 1988). Tucuman and Santa Fe provinces produce 70% of Argentina’s strawberries.

Typically, the Argentine strawberry industry uses leafless, bare-root transplants, either fresh, or cold-stored (Voth, 1980) transplants, which are set in two rows through black plastic mulch on raised beds (0.5–0.6 m wide × 0.4 m high), usually after fumigation with 98 methyl bromide : 2 chloropicrin. Plants are spaced 0.2–0.3 m apart in the row, with 0.3–0.4 m between rows, requiring 50,000 to 80,000 plants/ha. One-bed plastic tunnels are used in both winter and spring production systems (northern and central regions, respectively) to accelerate fruit growth and ripening (Instituto Nacional de Tecnología Agropecuaria, 1995). Most of the Argentine strawberry

growers utilize drip irrigation. The most common fertilizers are ammonium phosphate, 15N–15P–15K, calcium nitrate, potassium nitrate, ammonium nitrate, magnesium sulfate, and phosphoric acid.

The annual demand for strawberry transplants in Argentina is estimated to be 50 million plants annually (Rodriguez, 1997). Specialized Argentine nurseries supply 80% of this amount, while most of the remaining 20% is imported from the United States and Europe (mostly cold-stored plants). Transplants with different chilling hours are produced at high latitude (34°S at <500 m elevation), low latitude (27°S at <500 m elevation), and high altitude (2000 m at 27°S) by several nurseries (Kirschbaum et al., 1998); however, most Argentine transplants are produced by two high-latitude nurseries located in Mendoza (Kirschbaum, 1999b). Every 2 or more years, ≈30% of the strawberry hectareage is renewed.

The Argentine industry relies primarily on cultivars released by the Univ. of California, although the demand for Univ. of Florida and Spanish cultivars has increased remarkably over the last 3 years (Kirschbaum, 1999b). The most widely planted cultivars in the northern and central regions are ‘Camarosa’, ‘Chandler’, ‘Sweet Charlie’, and ‘Tudla Milsei’, while ‘Selva’ and ‘Seascape’ lead the strawberry hectareage in the southern region. Other cultivars of importance in Argentina are ‘Oso Grande’, ‘Pájaro’, ‘Heidi’, and ‘Rosa Linda’ (Fernandez, 1997b; Kirschbaum, 1999b; Scaglia, 1997).

Diseases affecting strawberries in Argentina are anthracnose [*Colletotrichum gloeosporioides* (Penz.) Penz & Sacc., *C. fragariae*, and *C. acutatum*], leather rot, gray mold, black root rot, and several leaf diseases caused by *Xanthomonas fragariae*, *Gnomonia comari* Karsten, *Mycosphaerella fragariae*, *Diplocarpon earliana*, and *Phomopsis obscurans* (Baino et al., 1999; Instituto Nacional de Tecnología Agropecuaria, 1997; Mena et al., 1974; Mitidieri, 1997; Ramirez, personal communication). Pests causing economic damage in Argentina are two-spotted spider mites, aphids (e.g., *Myzus persicae* Schultz and *Chaetosiphon fragaefolii*), thrips (*Frankliniella occidentalis*), ants (*Agromyrmex* sp.), and lepidopterous larvae (e.g., *Agrotis ipsilon* Rott and *Heliothis zea* Boddie) (Costilla and Martinez, 1991; del Toro et al., personal communication; Fernandez, 1997a; Lemme et al., 1996).

According to the Instituto Nacional de Estadística y Censo (INDEC), Argentina in 1997 imported 1000 t and exported 300 t of frozen strawberries. About 60% of Argentina’s locally produced strawberries are consumed fresh, while most of the remaining 40% are frozen. The exported fruit is usually shipped to Brazil and Europe. Little fresh fruit is imported, but in 1997, the Mercado Central de Buenos Aires (MCBA), the largest national wholesale produce market, reported that small quantities of fresh strawberries were imported from Brazil, Chile, and Uruguay.

Fresh-market fruit in Argentina is packed

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern												
Tucuman												
Salta – Jujuy												
Corrientes – Misiones												
Central												
Santa Fe (Coronda)												
North. Buenos Aires												
Southern												
South. Buenos Aires												
Rio Negro – Neuquen												

Fig. 2. Argentina strawberry harvest calendar, including harvests from subtropical Tucuman (May–December) and from Tucuman high-altitude (700–2000 m) valleys (January–April).

in plastic containers, which hold ≈ 250 g of fruit, and wrapped with plastic film. Eight of these containers are packed together in cardboard boxes (flats) for shipping. Flats are arranged in pallets (200 flats) and then cold-stored and shipped at 1 °C. Argentina has four grades of marketable fresh strawberries: superior, selected, common, and economic. Individually quick frozen (IQF) fruits follow international quality standards. In 1997, the production peak occurred in September, while the price peak occurred in June (Fig. 1B).

CHILE

Strawberries (*frutillas*) in Chile are grown from Regions IV to XII (27°S to 41°S lat., respectively), although most of the production is concentrated between Santiago and Region VIII (33°S to 36°S lat., respectively). Although all fruit is produced on only 700–900 ha (Table 1), the strawberry industry is important for both social and economic reasons, as it is a highly profitable activity, and has a high requirement for human labor. Strawberries are grown by both large corporate growers and small family-owned farms. (Gambardella, 1996).

There are two planting seasons in Chile: summer and fall, depending on the climate of the region. Near the Pacific shores, with mild winters, strawberries are usually planted in the late fall, while in areas with more severe winters, they are usually set in summer. In general, summer plantings are more productive; however, fruit size and early yields are smaller in comparison with those of fall plantings. The national average yield is 22.5 t·ha⁻¹ (Gambardella et al., 1999).

In the summer planting system, transplants

cold-stored for 6–7 months at –2 °C, are set in the field in December and January. Short-day (SD) cultivars are preferred. In the fall planting system, fresh, bare-rooted transplants, dug from the nursery 1–2 d prior to planting, are set in the field in April and May. This system is designed to hasten production (September) in coastal areas with mild winters. Day-neutral cultivars are preferred in this system, although ‘Chandler’ (SD) is also well adapted. About 25% of the strawberry growing area is in ‘Tudla Milsei’, followed by ‘Seascape’ (20%), ‘Camarosa’ (20%), ‘Chandler’ (10%), Cartuno (10%), ‘Selva’ (10%), ‘Pajaro’ (2%), and ‘Sweet Charlie’ (2%) (Gambardella et al., 1999).

The demand for strawberry transplants in Chile is estimated to be 50 million plants, which remain in the field for 2 years. Two rows of plants are set on raised beds, 0.45 m wide $\times$ 0.30 m high, through black or gray plastic mulch. Distance between plants both in and between rows is ≈ 0.30 m. Therefore, the average plant densities range from 60,000 to 72,000 plants/ha. In order to hasten fruit production, winter-planted strawberries are often covered with one-bed plastic tunnels (Sudzuki, 1992). Strawberries are most commonly watered by drip irrigation, although furrow irrigation remains a common practice on small farms. The main sources of nutrients are urea, triple superphosphate, and potassium sulfate.

The most frequent diseases affecting strawberries in Chile are red stele root rot (*Phytophthora fragariae* Hickman), leather rot, Verticillium wilt, black root rot, powdery mildew [*Sphaerotheca macularis* (Wallr.: Fr.) Jacz. F. sp. *Fragariae* Peries], common leaf spot, leaf blight, leaf scorch, and gray mold.

Pests causing economic damage to strawberries in Chile are *Tetranychus urticae*, *T. cinnabarinus* (Boisdural), *Chaetosiphon fragaefolii*, *Frankliniella occidentalis*, and *Heliothis zea* Boddie (Montealegre, 1996; Sudzuki, 1992).

Strawberries are harvested from September to May (Table 2), beginning with the most northern locations. The highest prices are received in September. Fresh fruit for export are harvested when the color of the berry is orange, and fruits for local markets are picked when 75% red. Fruit is packed into 5-kg wooden boxes when shipped to local markets. About 50% of the strawberries are sold locally as fresh fruit, 35% for processing, and 15% are exported frozen (e.g., to Argentina and Brazil).

PARAGUAY

Strawberries (*frutillas*) in Paraguay are grown in the states of Central, Alto Parana, La Cordillera, Itapua, and Caaguazu; the Central state contains $\approx 60\%$ of the total hectareage (Table 1), with national yields estimated at 10–12 t·ha⁻¹ (Merzario, 1999). An average of 80,000 plants/ha are planted annually between 10 Mar. and 10 Apr., and harvest lasts until October. The California cultivar Tufts, introduced to Paraguay in the 1980s, leads in importance because of its earliness, high productivity, large, firm, and shiny fruit, good tolerance to local diseases, and high rate of runner formation. Minor cultivars are the Brazilian ‘Monte Alegre’ and ‘Camanducaia’, and the Univ. of Florida’s ‘Florida 90’ (ABC Revista Rural, 1999).

Transplants are gathered from previously harvested fields. Once fruiting has ended, plants start to produce runners, and runner

Table 2. Average prices registered at a Santiago (Chile) wholesale market during 1997 (\$1.00 U.S. = 515.21 Chilean pesos).^z

Month	Chilean \$/kg
Jan	190.7
Feb	182.1
Mar	207.2
Apr	309.9
May	362.0
Jun	---
Jul	---
Aug	---
Sep	593.2
Oct	351.2
Nov	383.1
Dec	346.4

^zSource: Oficina de Estudios y Políticas Agrarias (ODEPA), 1997.

^yNo strawberries in the market.

plants will be dug the following March–April (Bareiro, 1997). Two-spotted spider mites and aphids are considered the most troublesome pests in Paraguay (Merzario, 1999).

URUGUAY

About 75% of the strawberries (*frutillas*) in Uruguay are grown in Salto (NW) and the rest in San Jose and Canelones (south) states. The total production area is estimated to be 180 ha. Transplants are set in the field from March to May in the NW and from May to August in the southern region. According to Junta Nacional de la Granja (JUNAGRA), ‘Oso Grande’ occupies 60% to 80% of the strawberry hectareage, followed by ‘Tudla Milsei’, ‘Camarosa’, ‘Chandler’, ‘Sweet Charlie’, ‘Seascape’, and ‘Selva’. *Colletotrichum* spp. and *Gnomonia* sp. (Bernal, 1991) are currently the major pathogens.

In the NW region a winter production system is used, while in the southern region production is in spring–summer, with harvests from July to November, and from September to April, respectively. Seasonal fruit production is highest in September–October (Fig. 1C). Most of the fruit is shipped fresh to Montevideo City, where 50% of the country’s population lives. The Uruguay strawberry industry lacks good-quality transplants and cultivars adapted to local environmental conditions. Most of the transplants are produced by the strawberry growers themselves from plants that produced fruit the previous season.

BOLIVIA

The Bolivian strawberry (*frutilla*) industry is relatively undeveloped. According to the Instituto Nacional de Estadísticas, in 1995, the total production area was ≈180 ha, and was entirely of California cultivars. Strawberry fields in Bolivia are distributed in two geographical regions that are very different from one another. One, Santa Cruz (70 ha), is tropical (≈400 m altitude), and the other, which encompasses Cochabamba, Chuquisaca,

La Paz, and Tarija (110 ha), is located in the highlands (2000–3500 m altitude).

Average fruit yields in Bolivia are very low compared with those of neighboring countries (Table 1), because technologies such as drip irrigation, soil fumigation, plastic mulch, and good-quality transplants have not yet been available to most of the Bolivian growers. The small volume of fruit produced in Bolivia (≈600 t/year) is locally consumed. In the tropical areas, the crop calendar is similar to that of Brazil or northwestern Argentina (April to October), while in the highlands, strawberries are produced in summer.

ECUADOR

There are numerous, small strawberry (*frutilla*) farms in Ecuador that produce fresh fruit for local markets, but most of the production is dominated by a few large-scale operations that market their fruit in the United States as fresh and frozen products (Finn et al., 1998). Ecuadorian strawberries are also exported in syrup, jellies, and jams. On these large farms, the fruit is produced in a modified California system with California cultivars, where the field is kept in production for 2 years. ‘Chandler’, ‘Selva’, and ‘Oso Grande’ dominate production, although ‘Tufts’, ‘Fresno’, and ‘Tioga’ are still used (Consejo de Comercio Exterior e Inversiones del Ecuador, 1999). The greatest pest problems are Botrytis fruit rot, lygus bug (*Lygus* sp.), and anthracnose fruit rot (*Colletotrichum* sp.).

Fruit are produced year-round, with peaks in production every 3 months. When ready for shipping, strawberries are packed in 2-, 3-, or 5-kg plastic baskets and covered with a cellophane wrapper. Twelve of these baskets are then placed in a larger box for shipping (Latinexpo, 1999). Fruit is shipped to the United States, Argentina, France, Germany, Russia, Spain, the United Kingdom, and Holland (Banco del Pacifico, 1999).

CONCLUSIONS

Nearly 60% of South America’s strawberries are produced between June and November, and the remainder between November and May. About 50% to 70% of the fruit is shipped fresh, while 30% to 50% is shipped frozen. Most of the South American producers use raised beds, plastic mulch, and California cultivars, and crop management practices are similar across the region. However, two different planting systems are utilized in South America: 1) a winter production system, which produces the earliest fruit; and 2) a summer production system, which generates the latest fruit. The winter production system is utilized in areas with mild winters, such in tropical Bolivia, northern Argentina, central Chile, Brazil, Paraguay, and northern Uruguay, and the summer production system in areas with cold winters, as in Chile, central and southern Argentina, southern Uruguay, and the highlands of Bolivia and northern Argentina.

The two systems have different major disease problems, anthracnose being dominant in

the winter production system, and red stele root rot in the summer system; however, some pests and diseases, such as *Tetranychidae* mites and Botrytis fruit rot, are common to both systems. Argentina, Brazil, and Chile have developed certification programs for transplant production, a fundamental tool to improve plant productivity.

Strawberry production, especially for processing, is expected to increase in the region in the short term because of a decrease in production, totaling 60,000 t from 1996 to 1998, in Mexico, Poland, and Russia, which provide most of the strawberries for processing worldwide (Food and Agricultural Organization, 1999).

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