The world of Horticulture

› Globe artichoke cultivation in Argentina

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Horticulture in Argentina

Horticulture in Argentina is an intensive activity that covers a smaller area than other agricultural activities, but involves a greater return per hectare. Agriculture occupies around 30% of Argentina's total area of approximately 270 million hectares. Whilst only 2% of this area involves horticultural practices, it represents up to 11% of the value of Argentinian agricultural products.

The horticulture area has expanded to approximately 500,000 hectares, but varies from year to year since most crops are annuals. Garlic, sweet potato, onion, lettuce, potato, pepper, beans, tomato, carrot, and squash comprise 85% of the total horticultural production value (Table 1). Annually, around 10 million people are employed in horticulture, making it an activity of important social value.

The fresh market absorbs 90% of the country's production, in wholesale and retail markets. The remaining 10% goes to industry, and is mainly processed as canned, frozen or dehydrated products and, to a lesser extent, as pickled or ground products. In recent years, an increase in the consumption of vegetables has been evident globally because consumers have become more aware of the benefits to human health. However, the mean vegetable daily intake in Argentina is approximately 140 g/person, far short of the 400 g/person recommended by the World Health Organization (WHO, 2012).

■ Table 1. Cultivated area of horticultural crops in Argentina (mean of the last decade). Source: INTA, 2009.

Crop	Area (ha)
Common bean	220,000
Potato	120,000
Lettuce	30,000
Onion	27,000
Tomato	24,000
Pea	23,000
Lentil	20,000
Squash	20,000
Sweet potato	20,000
Sweet corn	14,000
Pepper	10,000
Water melon	10,000
Carrot	9,000
Melon	7,500
Chickpea	4,000
Globe artichoke	**3,700**
Asparagus	1,300
Strawberry	1,000

Globe artichoke in Argentina

The term "alcaucil" instead of "alcachofa" is used to refer to globe artichoke (*Cynara cardunculus* var. *scolymus*) in Argentina. *Alcaucil* is derived from the Arabic *harscioh* or *al-karshuf*, which mean earth spines or pricking plant.

Soon after World War I, a significant number of Italians emigrated to Argentina and along with their culinary customs they introduced the first globe artichoke varieties and cultivation techniques to Argentina.

During the decade from 2003 to 2013, the production of globe artichoke increased, both in total production and in productivity per hectare (Table 2). The average annual percentage increase in harvested area (ha), total production (t) and productivity (t/ha) over this 10-year period were -2.8, 1.43 and 3.9%, respectively (Figure 1).

The shift towards new cultivars and the implementation of improved agronomic practices have allowed harvest to begin as early as May, resulting in better prices than in spring, and increased total yield.

■ Table 2. Argentinian production (t) and yield (t/ha) during the period 2003 to 2013 (FAO).

Year	Production (t)	Yield (t/ha)
2003	88,000	18.72
2004	89,930	19.55
2005	94,094	20.02
2006	88,951	18.73
2007	90,000	19.14
2008	91,154	18.96
2009	76,948	20.20
2010	84,694	23.73
2011	100,891	26.22
2012	106,000	26.50
2013	106,325	24.93

■ Figure 1. Average annual percentage increase in harvested area (ha), total production (t) and yield (t/ha) from 2003 to 2013.

■ Figure 2. Main globe artichoke production regions in Argentina.

Productive zones

The La Plata's horticultural belt (Buenos Aires province) is the major production zone, and 64% of the country's globe artichoke fields are located there. Rosario (Santa Fe province) and Cuyo area (Mendoza and San Juan provinces) each have around 14% of the production fields (Figure 2). Generally artichokes

Figure 3. 'Romanesco'.

Figure 4. 'Ñato'.

Figure 5. 'Precoz Italiano'.

Figure 6. 'Blanco de San Juan'.

Figure 7. 'Oro Verde FCA'.

Figure 8. 'Gauchito FCA'.

are destined for the fresh market, with the exception of those from Cuyo, where the processing industry has absorbed up to 65% of the production for some years.

The rest of the globe artichoke fields are sparsely distributed amongst the horticultural belts of important cities like Mar del Plata, Córdoba and Tucuman.

The climatic and soil conditions vary in the different production areas. La Plata and Rosario have a temperate climate, frost-free between October and April, 1000 mm mean annual rainfall and a medium-heavy clay soil with up to 5% organic matter. Cuyo is characterized by its dry climate, sandy soils and very low annual rainfall, which is usually less than 100 mm.

Vegetatively-propagated cultivars

'Romanesco'

'Romanesco', also known as 'Francés', 'Francés precoz' or 'Ñato Francés', is a violet material derived from the Lazio region in Italy. In order to maintain the secret of its origin, Italian horticulturists claimed that it was a French cultivar, which explains the term 'Francés', which means French (Figure 3).

Figure 9. 'Gurí FCA'.

'Ñato'

'Ñato', also named 'Ñato criollo' or 'Violeta', was the cultivar most popular in the 1980s, but because of its late spring production it was progressively replaced by 'Romanesco', which fruits earlier (Figure 4).

Figure 10. Sucker of 'Blanco de San Juan'.

'Precoz Italiano'

'Precoz Italiano' is an old Italian cultivar, probably derived from 'Precoce di Jesi'. Due to its early fruiting and its origin, it was named 'Precoz Italiano', which means precocious Italian (Figure 5).

Figure 11. Plants grown using polyethylene mulching.

'Blanco' or 'Blanco de San Juan'

'Blanco' or 'Blanco de San Juan' is equivalent to the Spanish cultivar 'Blanco de Tudela', which was introduced by Spanish immigrants to the San Juan province (Figure 6).

'Oro Verde FCA'

'Oro Verde FCA' is a late spring, productive cultivar adapted to the fresh market. It was created by researchers at the Faculty of Agricultural Science, Rosario's National University (Figure 7).

'Gauchito FCA'

'Gauchito FCA' is a late spring, productive cultivar bred from French material, suitable for both the fresh market and processing. It was developed by researchers at the Faculty of Agricultural Science, Rosario's National University (Figure 8).

'Gurí FCA'

'Gurí FCA' is a late spring, productive cultivar that originated from a cross between a local and a French clone. It was selected for the fresh market. It was developed by researchers at the Faculty of Agricultural Science, Rosario's National University (Figure 9).

Seed-propagated material

Seed-propagated cultivars are from recent introductions to Argentina, including 'Madrigal', 'Opal' and 'Concerto'.

Propagation and cultivation techniques

In Argentina, globe artichoke multiplication is traditionally by vegetative means, using rooted offshoots in Rosario and La Plata (Region 1), and suckers or stumps in San Juan and Mendoza (Region 2) where the main cultivar is 'Blanco de San Juan' (Figure 10). More recently, hybrids and cultivars multiplied by seed have also been used.

The time when seeds and suckers are planted varies between cultivation regions. In Region 1, asexual propagation is performed in autumn, whereas propagation by seed takes place in spring. In contrast, planting of suckers takes place during summer (January-February) in Region 2.

Plants are maintained for three or four years in cultivation, therefore it is considered to be a perennial crop.

Growth regulators like gibberellic acid (GA) are used widely nowadays to obtain early production and are applied during March-April.

Plants are commonly grown on ridges and polyethylene mulching is sometimes used (Figure 11). Irrigation is often necessary and water is applied using the drip system.

Harvest

Artichokes are harvested by hand. Heads are cut with a knife leaving about 20 cm of stem and the two leaves closest to the inflorescence for primary heads and leaving only 10 cm of stem for secondary heads.

In the past, harvest was carried out using a cart with an elevated axle that passed directly over the plant and was pulled by horses (Figure 12).

Harvest time varies according to the production region and the crop cycle and there are early, intermediate and late cultivars. For 'Romanesco', harvest starts in August without GA application but can move forward to June if GA is applied. For later cultivars, such as 'Ñato', 'Oro Verde FCA', 'Gauchito FCA' and 'Gurí FCA', harvest starts in mid-September

Figure 12. Old way of harvesting, using a cart that has a high axle. Image by G. Villena.

and it is not possible to accelerate harvest using GA.

Harvest finishes in December when high temperatures reduce the development of high quality heads.

Marketing

Crop profitability varies depending on the time of harvest. Prices are higher at the beginning of harvest when supply is limited but they gradually decrease as production increases.

In general, higher prices are obtained during June and July, and then they stabilize. Finally, prices fall considerably in the period from October to December, when temperatures are higher and quality drops (Figures 13 and 14).

Breeding in Argentina

Globe artichoke is a cross-pollinated species, resulting in the need for vegetative multiplication to avoid heterozygosity and segregation in seed progenies, and plasticity in breeding programs. In this context, the phrase "if you plant artichokes, you will grow cardoons" (popular saying) was coined (cardoons are artichoke thistles, i.e. *Cynara cardunculus* var. *altilis* DC). During domestication of the globe artichoke, sexual reproduction was progressively abandoned. Asexual multiplication has long been used by horticulturists and breeders. However, nowadays, the search for seed varieties is important to avoid virus spread and to result in an annual crop.

The cultivar 'Francés', very popular in the Rosario's horticultural belt, has shown great variation in precocity and this has been shown to be associated with leaf type (Pecaut and Martin, 1993). This variability could be explained by a mixture of clones that were brought when the cultivar was introduced. Clonal selection could be conducted in order to result in uniform production.

In Argentina, systematic breeding programs were established in the 1990s with the introduction of European cultivars. This was the start of breeding using sib-crossing, self-crossing and open pollination. Along with these breeding methods, genetic parameters were estimated (López Anido et al., 1998; Asprelli et al., 2001; Cointry et al., 2005a; Crippa et al., 2011). The inheritance of colour and head compactness were studied, and the effect of selfing while obtaining inbred lines for hybrid production was assessed (Cravero et al., 2002, 2003, 2004). Heterosis in crosses between distant

Figure 13. Proportion of the globe artichoke crop supplied over the year in Argentina. Source: Mercado Central de Buenos Aires.

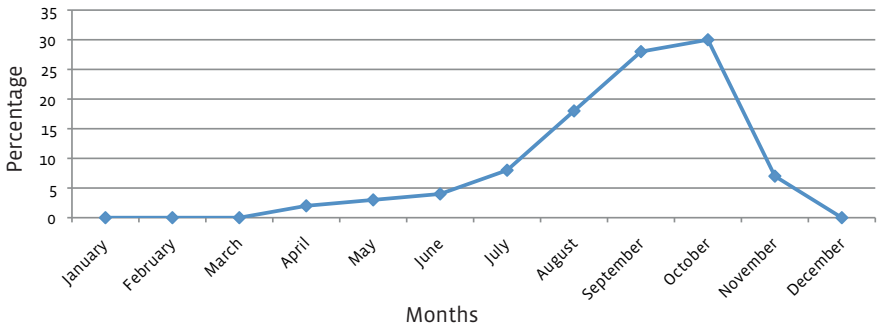

Figure 14. Price per dozen globe artichoke (US$) during the year in Argentina. Source: Mercado Central de Buenos Aires.

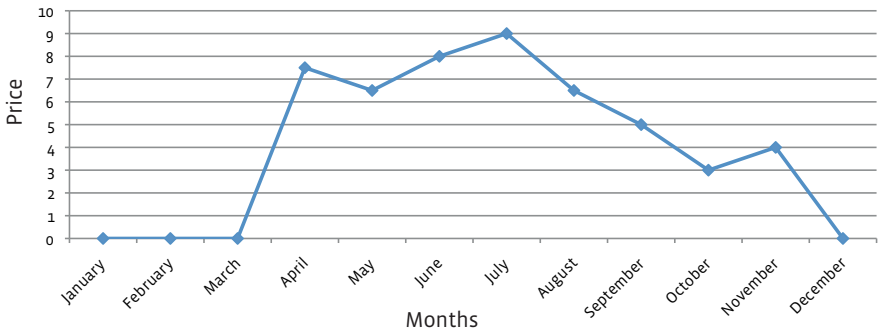

Figure 15. Typical dish: paella with artichoke, at the Artichoke Fest.

Figure 16. Stand of artichokes for sale at the Artichoke Fest.

parents was also evaluated and superior genotypes were selected within the progeny. Segregating populations were generated, out of which four new clones were selected ('Esmeralda FCA', 'Oro Verde FCA', 'Gauchito FCA' and 'Gurí FCA'), which broadened the spectrum of Argentinian cultivars (Cointry et al., 2005b). Also, from non-segregating material, a cultivar with a uniform violet head colour was derived and resulted in the first seed-propagated cultivar ('Estrella del Sur FCA') generated by the breeding program of the Faculty of Agrarian Science at Rosario's National University.

The genetic diversity in a collection of accessions of the species *Cynara cardunculus* was studied with the aid of *SRAP* (Sequence-Related Amplified Polymorphism) molecular markers, and these markers proved to be a useful tool (Cravero et al., 2007). Out of this collection, a core-collection was generated based on morphological and molecular attributes (Crippa, 2015). In the breeding program, the molecular approach, along with bulk segregant analysis, enabled the detection of amplicons associated with head colour and precocity (Martin et al., 2008), and the construction of a genetic linked map (Martin et al., 2013). Recently, the possibility of using this species as a biofuel in Argentina has been encouraged (Cravero et al., 2012).

Artichoke fest

Because it is the main production area in Argentina, La Plata was recognized as the "Artichoke capital" of the country. Ninety seven percent of the production area in this region is occupied by globe artichokes, so locals decided it should have its own festival. The first "Artichoke Fest" was celebrated in 2007. It has been conducted every year since. The next Fest will take place in late September this year, coincidentally at the same time as the IX International Symposium on Artichoke, Cardoon and their Wild Relatives (http://www.ishs.org/symposium/424).

Visitors can taste delicious dishes prepared by local farmers (Figure 15), enjoy folk concerts and participate in cooking workshops to learn how to cook artichokes. Moreover, they can learn about the culture surrounding artichokes by visiting the live show and going around several stands where they can find a wide range of gourmet foods.

The "Artichoke Fest" is how horticulturists choose to celebrate the harvest and share with the community their cultural traditions, their history and their ancestor's legacy. These are the ancestors who came from Italy in the 1950s and began the artichoke culture in the regional horticultural belt.

The "Artichoke Fest" is not only run so that people have a good time but also to provide information to increase artichoke consumption and to stimulate its production (Figure 16).

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