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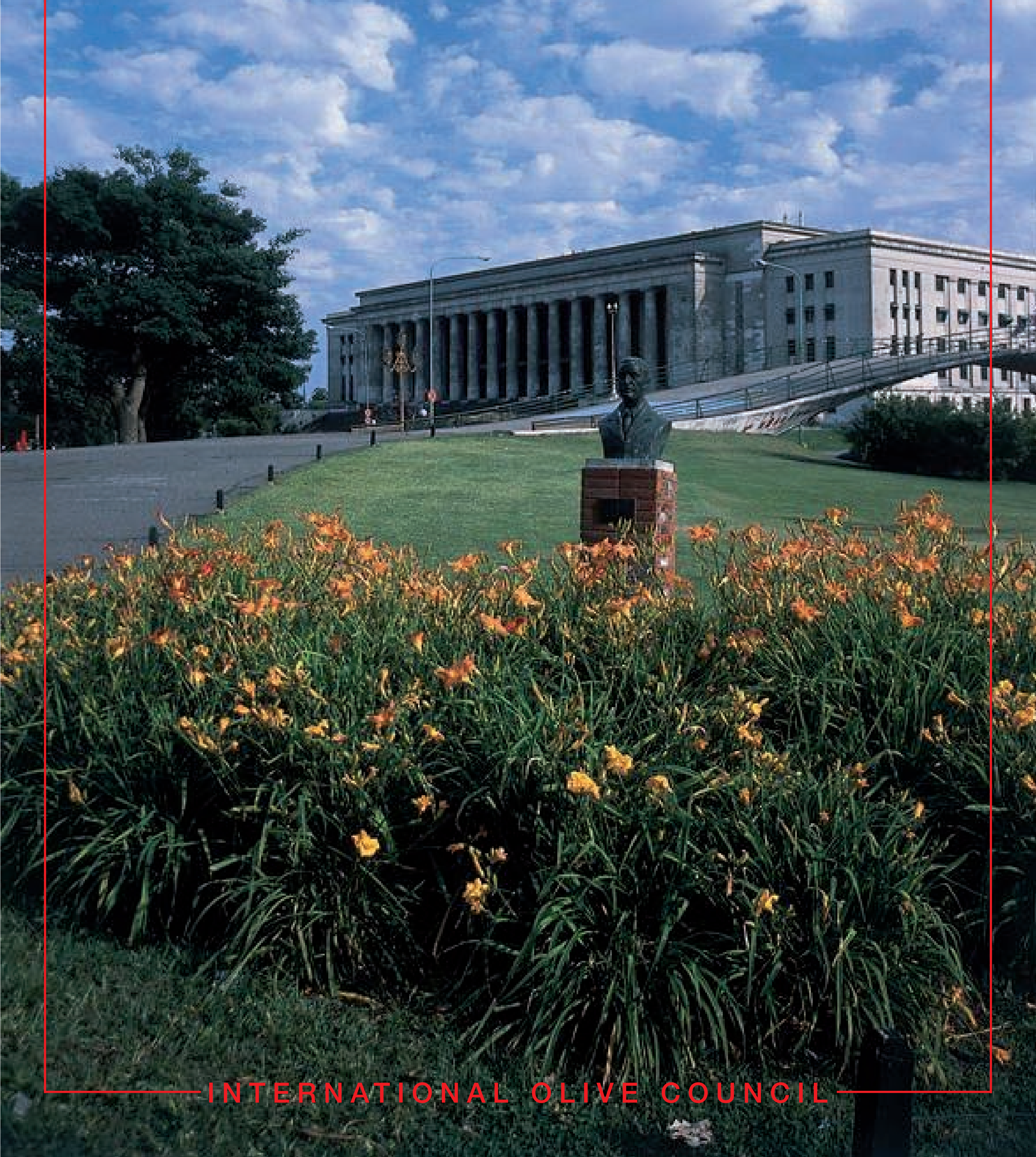

INTERNATIONAL OLIVE COUNCIL

CONSEIL OLEICOLE INTERNATIONAL • INTERNATIONAL OLIVE COUNCIL •
CONSIGLIO OLEICOLO INTERNAZIONALE
المجلس الدولي للزيتون
CONSEJO OLEICOLA INTERNACIONAL •

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EDITORIAL

The IOC membership expands

Over the last 18 months the International Olive Council has welcomed three new countries to the ranks of its membership, three producing nations – Albania, Argentina and Turkey – where olive growing is very different.

Numerous archaeological remains are testimony to the very ancient origins of olive cultivation in **Albania**. As yet, it accounts for a relatively small percentage of the country's agricultural area, but it is considered of key importance to the development of rural areas. This explains the interest of the country's leadership in olive cultivation and its keenness to join the IOC, the international benchmark organisation for olive products. Since Albania joined the International Agreement on Olive Oil and Table Olives in February 2009 several activities have already been carried out to assist its olive industry, in particular an evaluation of the national olive development plan devised by the Albanian authorities.

Switching to another continent and another hemisphere, after a membership stint between 1965 and 1974 **Argentina** announced in May 2009 that it would be returning to the Organisation. South America's leading producer, it has significantly expanded its production potential, driven by tax measures introduced some years ago by the Argentine government to encourage the establishment of new olive orchards which have recently started to bear crops, and by its consumption of olive oil and table olives after several promotion campaigns, including the IOC campaign in the 1990s. Carried across by Spanish missionaries in the 16th century, olive growing in Argentina is focused above all on table olive production.

After countries from Europe and America, it was the turn of a country at the gateway to Asia to rejoin the IOC and take an active part in the Organisation's work. After being a Member between 1963 and 1998, Turkey officially rejoined the International Agreement in February 2010. A major producer and consumer of olives and olive oil, it is a country where the olive has been grown since time immemorial, in fact it is believed to be one of the cradles of olive growing, and which plays a key role on the international olive oil and table olive market.

Readers can find out more about these new three additions in the country profiles featured in this issue of *Olivæ*.

The justification for the existence of the International Olive Council is precisely to bring together all the olive producing countries in order to work more effectively for their benefit. For this reason, the management of its Executive Secretariat and the representatives of its member countries are delighted to see these three new additions to the Agreement and encourage other producing nations to join the Organisation as soon as they can. In the meantime, it has just accepted the application for observer status presented by the authorities of Azerbaijan.

Mohammed Ouhmad Sbitri

Executive Director

IOC Executive Director travels to Brazil
(8-13 May 2010)

On the initiative of *ARGOS*, the *Rio Grande Olive Growers'* Association, the Executive Director of the IOC travelled to Porto Alegre in Brazil to speak at the International Olive Growing Conference. Held over 10 and 11 May in the auditorium of the Catholic University of Porto Alegre, the conference drew a large audience who were also able to listen to presentations given by four scientists from the Agricultural & Fisheries Research and Training Institute (IFAPA, Spain), the President of the Mendoza Olive Growers' Association (Argentina) and representatives of Uruguay.

In tandem with the conference, around a dozen stands displayed olive oils, table olives and olive plants outside the auditorium where olive oil tastings were also held.

Opening the event were:

- Gilmar Teitbohl, Brazilian Secretary of State for Agriculture;
- Guajara Oliveira, from the *Rio Grande do Sul* Olive Growers' Association;
- Darcisio Perondi, Federal Deputy;
- Mohammed Ouhmad Sbitri, IOC Executive Director.

The presentations ranged over the IOC regulations for olive oil and table olives and more generally olive cultivation in Latin America (Argentina, Uruguay, Chile and Brazil). The conference also featured a panel discussion on olive growing in Brazil now and in the future.

Brazil appears to afford major potential for olives and olive oil but has seen very little investment in the sector compared with Argentina and even Uruguay. This confirms the need for an awareness campaign straight away in Brazil to inform people about olive products.

In talks with industry representatives the Executive Director learned that Brazilian business circles were quite interested in future membership of the IOC and were determined to change the state of play with regard to the quality of olive oil sold on the Brazilian market, which is a key aspect for any country wishing to join the International Olive Council.

Accession to the IOC was also the subject matter of the Executive Director's meeting with the Secretary of State for Agriculture who enquired about the necessary arrangements and steps to join and reasserted the interest in developing olive growing in Brazil, particularly in the *Rio Grande do Sul* region.

During his stop-over in Argentina, the Executive Director met with the Head of the Argentinean Delegation to the IOC, the President of the Mendoza Olive Growers' Association and representatives of other regions from the north of the country. It emerged from discussions that contacts between business circles and the representative of Argentina to the IOC were not systematic and that the problems facing each region were specific and even sometimes conflicting. In reply to industry enquiries as to how to go about benefiting from IOC activities, the Executive Director explained the exact role of the

Head of the Delegation of Argentina to the IOC as well as the roles of the Advisory Committee and the signatory associations of the agreement for the quality control of olive oil products sold on import markets.

15th extraordinary session of the International Olive Council

The town of Essaouira in Morocco was the venue chosen by the International Olive Council to hold its 15th extraordinary session from 22 to 25 June 2010.

At the meeting of the IOC Advisory Committee on Olive Oil and Table Olives held the day before, guest experts from the worlds of olive oil and table olive addressed the issues of the value chain for olive oil and table olives and the profile of olive oil consumers in Italy and Spain.

The Economic Committee met on 22 June to discuss producer prices, imports and the as yet provisional data on market performance through the 2008/09 and 2009/10 crop years, pending confirmation at the 98th session of the IOC (Madrid, 22–26 November 2010). The committee also discussed the plans for the IOC seminar on geographical indications of olive oils and table olives, which are reported at greater length on page 20 of this issue.

A further three specialist committees – the Technical, Promotion and Financial Committees – met on Wednesday 23 June to report on the activities carried out since the preceding IOC session (November 2009, Madrid) and the activities scheduled up to the year end.

98th session of the IOC

The International Olive Council held its 98th session at the headquarters of the Organisation in Madrid, Spain, from 22 to 26 November 2010.

Through the week Members discussed business according to the timetable of meetings shown below:

- **Monday 22 November:**
  - Economic Committee: 9.00 – 11.00
  - Technical Committee: 11.30 – 13.30
  - Promotion Committee: 15.30 – 18.00

- **Tuesday 23 November:**
  - Financial Committee: 9.00 – 13. 30
  - Meeting of Heads of Delegation of IOC Members: 15. 30 – 18.00

- **Wednesday 24 November:**
  - Meeting of Heads of Delegation: 9.00 – 13. 30/ 15. 30 – 18.00

- **Thursday 25 November**
  - Plenary session: 9.00 – 13.30/ 15.30 – 18.00
  - World Olive Day reception: 20.00

- **Friday 26 November**
  - Closure of proceedings: 9.00 – 12.00

Programme for the development and dissemination of sustainable irrigation management in olive growing IRRIGAOLIVO

Launched in 2010, this project involves setting up irrigation management demonstration and research plots in two partner countries – Morocco and Syria – to show irrigation techniques to farmers and to collect core data on crop response to differing soil and climatic conditions.

The chief objectives are:

- To apply rational irrigation techniques to guarantee regular yields and to improve fruit quality
- To improve the livelihood of farmers and to help attenuate the phenomenon of rural depopulation and its consequences for the land
- To determine plant response to different irrigation regimes in quantitative and qualitative terms
- To determine water and timing requirements to optimise water use, including in conditions of scarce available water resources

The project kick-off meeting marking the official start of activities took place at the headquarters of the project executing agency – the International Center for Agricultural Research in the Dry Areas, ICARDA for short – in Aleppo, Syria, on 7 and 8 April 2010. The leaders of the collaborating centres from Syria and Morocco signed the corresponding Project Agreement and visited the demonstration plots where planned activities were to be carried out in Syria.

The PEA submitted its first six-monthly report to the Executive Secretariat in September 2010.

The activities scheduled for 2011 will entail:

- Irrigation and field management
- Field sampling and data analyses
- Training and technology dissemination
- Project monitoring and supervision

Further details will be given in future issues of *Olivæ*.

Promotional activities get off the ground in Russia

The IOC promotional campaign in Russia for 2010/11 got off the ground in the summer of 2010 after the contract for its implementation went to the Moscow-based agency, Market Group and Marketing Communication ZAO MarCom. In the preparatory phase, the Executive Secretariat contacted the Heads of Delegation of the IOC member countries and the Russian Embassy in Madrid to seek interaction to maximise the impact of the campaign in this market, which offers major potential for the consumption of olive products.

Above and below. The Deputy Director in charge of the IOC Promotion Division during two instances of his visit to Russia for the launch of the 2010–2011 promotion campaign.

September marked the launch of the campaign in Moscow. Over the following two months a series of food and scientific events or meetings took place, including a cardiology congress in Moscow in October and a meeting between the Executive Secretariat and local authorities in November. Plans for the months ahead include the launch of the IOC campaign website in Russian, TV sponsorship, and continuing relations with the media and advertising channels.

Brief country profiles of the new IOC members: Albania, Argentina and Turkey

ALBANIA

A. BRIEF GENERAL DESCRIPTION

Albania belongs to the humid subtropical belt zone of the northern hemisphere as well as to the Mediterranean climatic zone characterised by short, wet winters and dry summers.

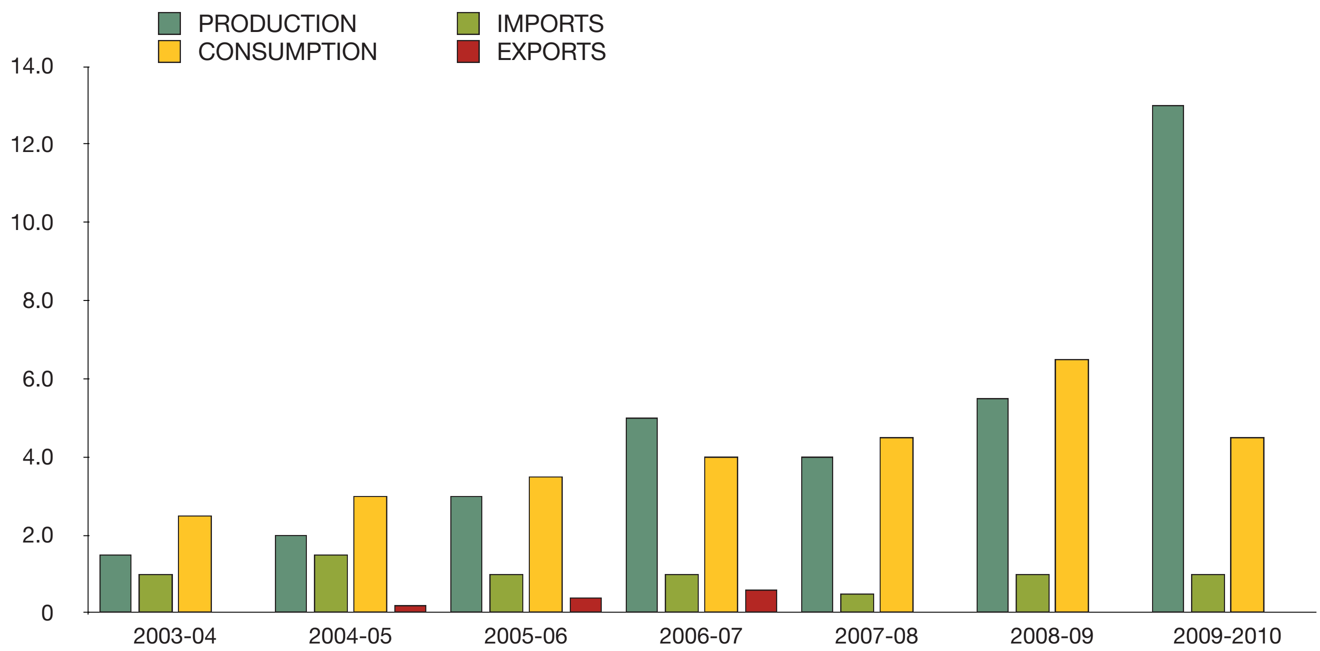
Its terrain is largely mountainous, excluding a small flat strip along the coast. The Albanian Alps, an extension of the Dinaric Alps, cover the north of the country. The highest peak in Albania is Mount Korab (2,764 metres). The country's rivers flow through deep canyons between the mountains into the Adriatic Sea.

B. KEY FIGURES

- **Population:** 3.1 million (2008 UN).
- **Population growth rate:** 0.4%.
- **Capital:** Tirana.
- **Area:** 28,748 sq km.
- **Major language:** Albanian.
- **Life expectancy:** 74 years (men), 80 years (women) (UN).
- **Monetary unit:** Leke (ALL).
- **Main exports:** Textiles and footwear; asphalt, metals and metallic ores, crude oil; vegetables, fruits, tobacco.
- **GNI per capita:** US $3,840 (World Bank, 2008).
- **GDP composition agriculture:** 20.8% (2008).
- **Labour force by occupation agriculture:** 58%.

Background data on Albanian olive sector

OLIVE OIL								
								1,000 t
	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
AREA (1000 ha)	28.1	29.2	30.4	32.1	33.6	35.7	39.8	32.7
PRODUCTION	1.5	2.0	3.0	5.0	4.0	5.5	13.0	4.9
IMPORTS	1.0	1.5	1.0	1.0	0.5	1.0	1.0	1.0
CONSUMPTION	2.5	3.0	3.5	4.0	4.5	6.5	4.5	4.1
EXPORTS	0.0	0.2	0.4	0.6	0.0	0.0	0.0	0.2

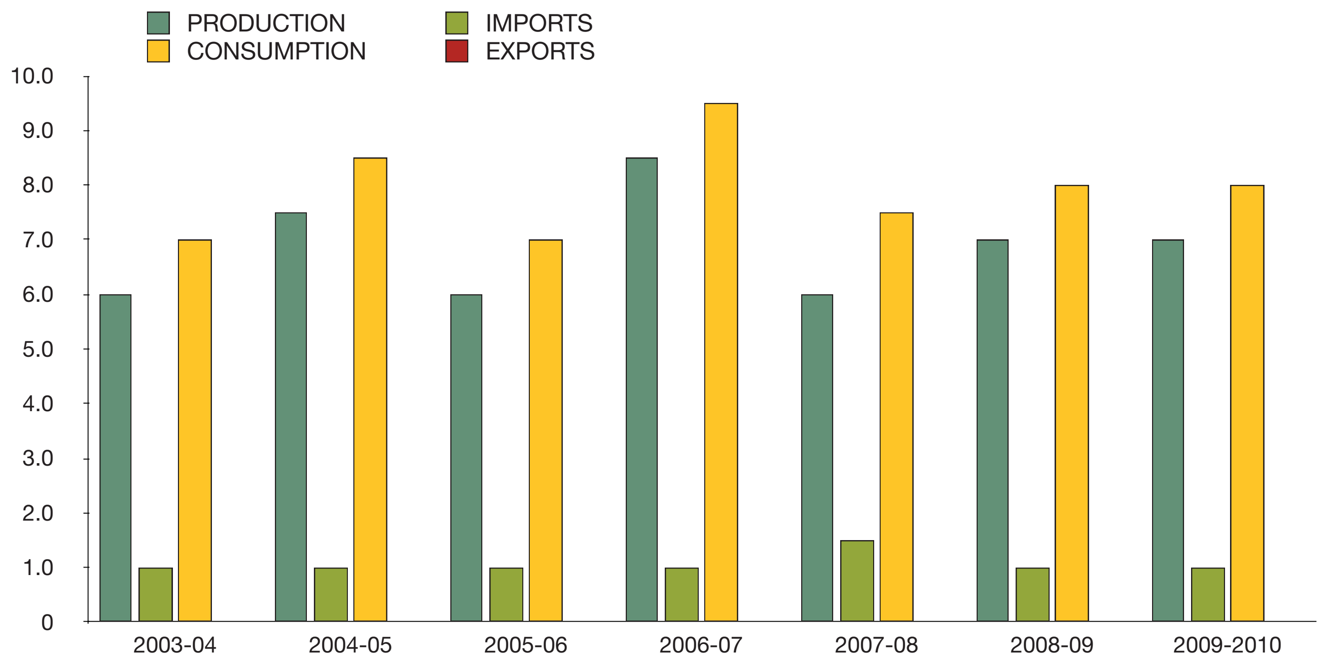


Background data on Albanian olive sector

TABLE OLIVES

1,000 t

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
PRODUCTION	6.0	7.5	6.0	8.5	6.0	7.0	7.0	6.9
IMPORTS	1.0	1.0	1.0	1.0	1.5	1.0	1.0	1.1
CONSUMPTION	7.0	8.5	7.0	9.5	7.5	8.0	8.0	7.9
EXPORTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



ARGENTINA

A. BRIEF GENERAL DESCRIPTION

Argentina stretches 4,000 km from its sub-tropical north to the sub-Antarctic south.

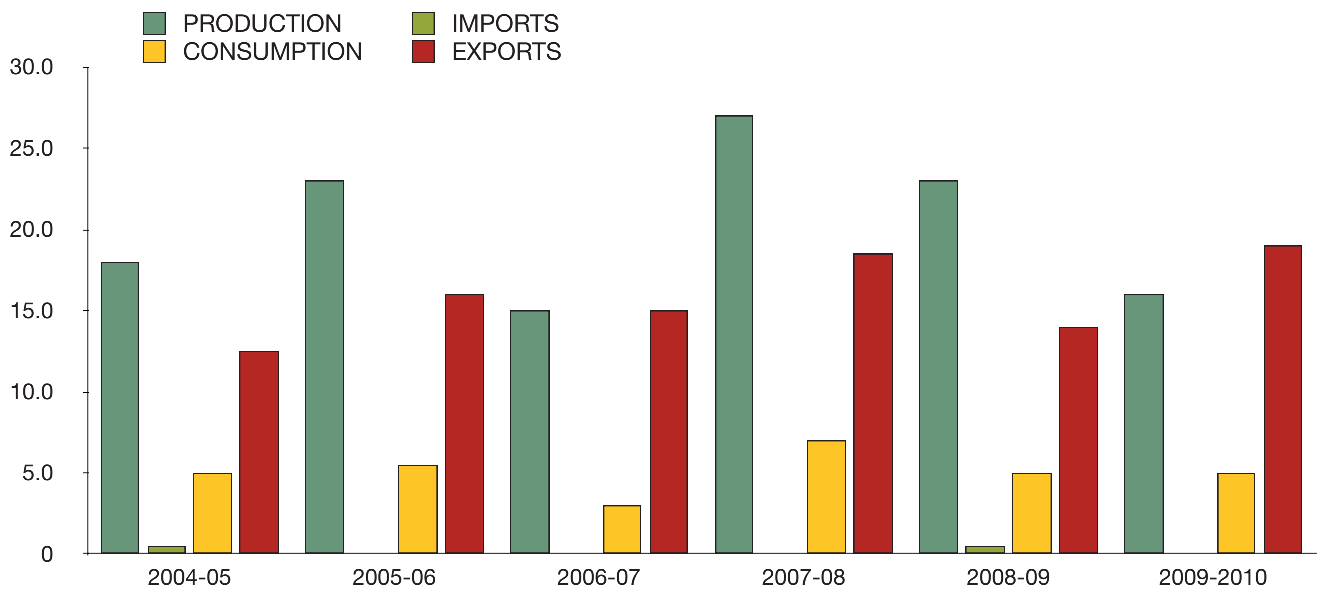
Its terrain includes part of the Andes mountain range, swamps, the plains of the Pampas and a long coastline.

B. KEY FIGURES

- **Population:** 40.9 million (2009).
- **Population growth rate:** 1.053%.
- **Capital:** Buenos Aires.
- **Area:** 2.8 million sq km.
- **Major language:** Spanish.
- **Life expectancy:** 73 years (men), 79 years (women) (UN).
- **Monetary unit:** 1 peso = 100 centavos.
- **Main exports:** Food and live animals, mineral fuels, cereals, machinery.
- **GNI per capita:** US $4,470 (World Bank, 2006).
- **GDP composition agriculture:** 9.5%.

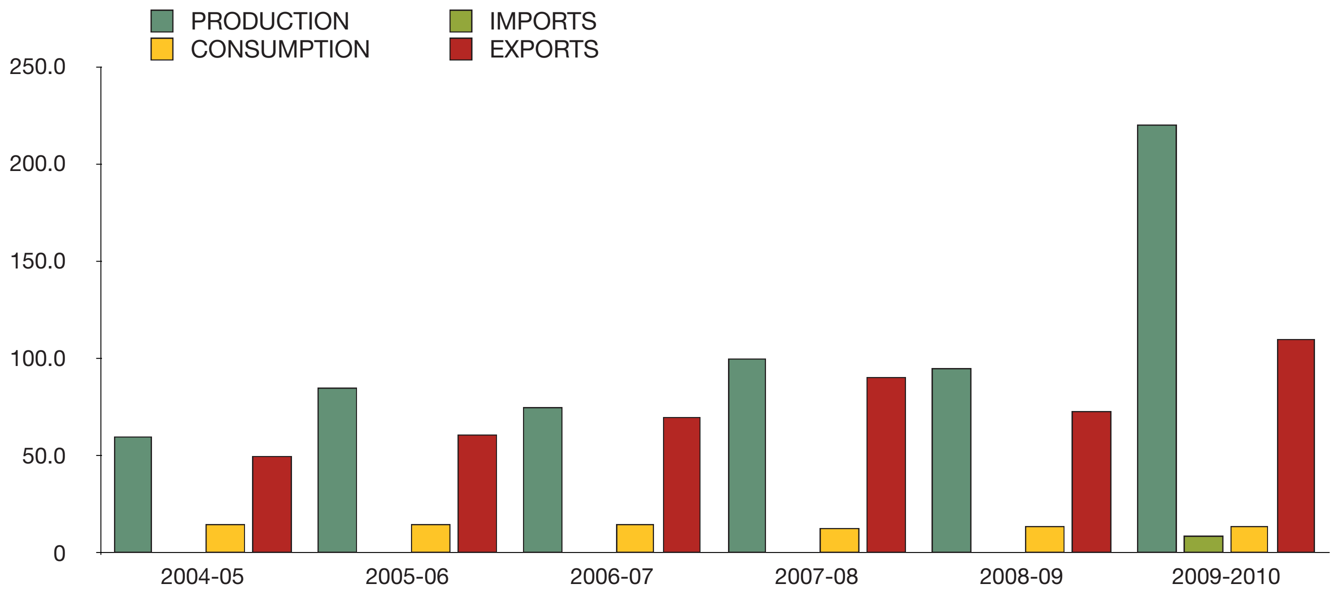
Background data on Argentine olive sector

OLIVE OIL							
							1,000 t
	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
AREA (1000 ha)	87.1	89.0	90.0	90.1	90.1	90.1	89.4
PRODUCTION	18.0	23.0	15.0	27.0	23.0	16.0	20.3
IMPORTS	0.5	0.0	0.0	0.0	0.5	0.0	0.2
CONSUMPTION	5.0	5.5	3.0	7.0	5.0	5.0	5.1
EXPORTS	12.5	16.0	15.0	18.5	14.0	19.0	15.8



Background data on Argentine olive sector

TABLE OLIVES							
							1,000 t
	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
PRODUCTION	60.0	85.0	75.0	100.0	95.0	220.0	105.8
IMPORTS	0.0	0.0	0.0	0.0	0.0	9.0	1.5
CONSUMPTION	15.0	15.0	15.0	13.0	14.0	14.0	14.3
EXPORTS	50.0	61.0	70.0	90.5	73.0	110.0	75.8



TURKEY

A. BRIEF GENERAL DESCRIPTION

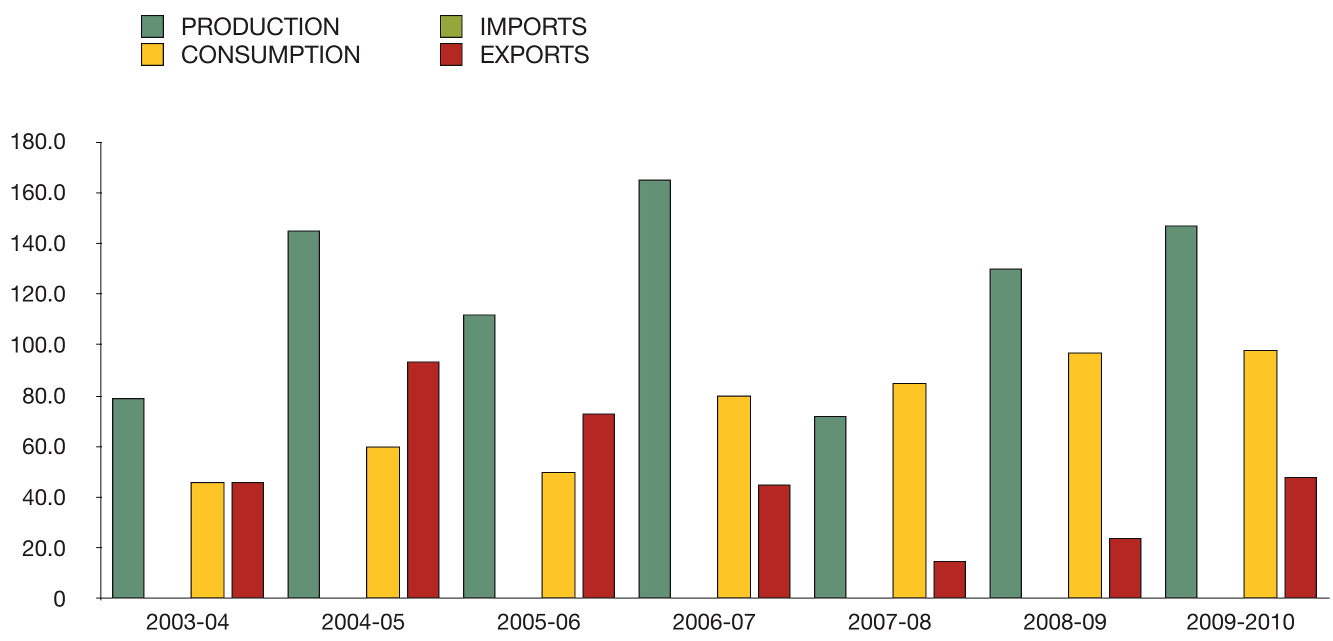
Straddling the continents of Europe and Asia, Turkey's strategic location has given it major influence in the region - and control over the entrance to the Black Sea.

B. KEY FIGURES

- **Population:** 74.0 million (UN, 2008).
- **Population growth rate:** 1.2%.
- **Capital:** Ankara.
- **Largest city:** Istanbul.
- **Area:** 783,562 sq km.
- **Major language:** Turkish.
- **Life expectancy:** 70 years (men), 74 years (women) (UN).
- **Monetary unit:** New Turkish lira.
- **Main exports:** Clothing and textiles, fruit and vegetables, iron and steel, motor vehicles and machinery, fuels and oils.
- **GNI per capita:** US $9,020 (World Bank, 2008).
- **GDP composition agriculture:** 9.3%.
- **Labour force:** 24.74 million.
- **Labour force by occupation agriculture:** 29.50%.

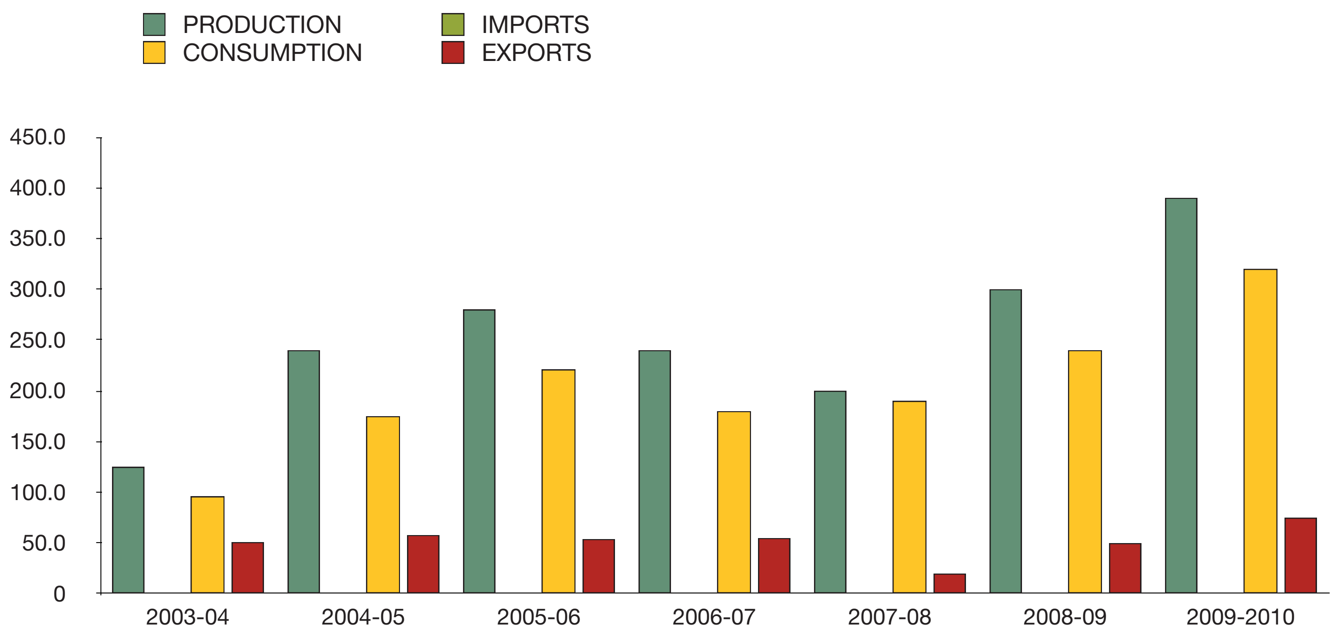
Background data on Turkish olive sector

OLIVE OIL								
								1,000 t
	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
AREA (1000 ha)	808.0	810.0	812.5	815.0	753.0	775.0	778.0	793.1
PRODUCTION	79.0	145.0	112.0	165.0	72.0	130.0	147.0	121.4
IMPORTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSUMPTION	46.0	60.0	50.0	80.0	85.0	97.0	98.0	73.7
EXPORTS	46.0	93.5	73.0	45.0	15.0	24.0	48.0	49.2



Background data on Turkish olive sector

TABLE OLIVES								
								1,000 t
	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10 (prov.)	Average 03/04 - 09/10
PRODUCTION	125.0	240.0	280.0	240.0	200.0	300.0	390.0	253.6
IMPORTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSUMPTION	96.0	175.0	221.0	180.0	190.0	240.0	320.0	203.1
EXPORTS	51.0	58.0	54.0	55.0	20.0	50.0	75.0	51.9



Geographical indications reviewed in technical/legal study

When holding its 95th session the IOC Council of Members decided to entrust the Executive Secretariat with conducting a technical and legal review of geographical indications or GIs. At the following 96th session in November 2008 the member countries suggested that the Executive Secretariat begin this task on a solid footing by outsourcing a study on the subject and that it later hold an international seminar to release the study findings and recommendations.

And so, on 9 October 2009, the Executive Secretariat met for the first time with a group of experts from the IOC member countries to discuss the physico–chemical and organoleptic properties and varieties of the olive oils and table olives covered by protected designations of origin and protected geographical indications. Besides suggesting the creation of a steering committee, the experts drew up a list of the technical conditions for inclusion in the specifications for a call for tenders, which they proposed issuing before the end of 2009.

After winning the contract, the firm Insight Consulting attended the second meeting of the steering committee on 3 February 2010 at which its general objectives were fixed. In a nutshell, these were:

- To describe the legal framework of GIs in the IOC member countries and other producing countries;
- To identify the legal instruments available in each country to protect GIs;
- To provide an overview of the state of play of bilateral and multilateral negotiations on intellectual property issues (cross-country recognition);
- To provide a comparative analysis of GI specifications;
- To identify potential GIs in the producing countries;
- To provide the IOC with backup for the organisation of an international seminar by preparing a draft programme and list of possible speakers and presenting the results of the study.

At this second meeting it was decided that the study would span 28 countries in all:

- **IOC Members:** Albania, Algeria, Argentina, Croatia, Egypt, European Union, Iran, Iraq, Israel, Jordan, Lebanon, Libya, Morocco, Montenegro, Serbia, Syria, Tunisia and Turkey
- **Other producing countries:** Australia, Chile, Mexico, Palestine, Peru, Saudi Arabia and the United States
- **Consumer countries:** Brazil, China and Switzerland

Through the first semester Insight Consulting adhered scrupulously to the time line drawn up for the phases of the study under the supervision of the steering committee, which met for the third and last time on 20 July 2010 to analyse and approve the completed phases of the study and target fulfilment:

- Phase I: description of the legal frameworks of geographical indications
- Phase II: compilation of a comprehensive list of the olive oils and table olives covered by GIs in the 28 countries reviewed in the study, specifically the 18 member countries of the IOC plus Australia, Brazil, Chile, China, Mexico, Palestine, Peru, Saudi Arabia, Switzerland and the United States. This phase provided a detailed analysis

of each set of GI specifications as well as of the differences between the products covered in EU and non-EU countries and the cultural practices employed. Morocco and Turkey are the only two non-EU countries to have GIs (one in Morocco and three in Turkey for extra virgin olive oils).

- Phase III: identification of potential GIs. The study identified approximately 100 potential GIs. More olive oils than table olives are potential candidates for GI status although the situation does vary significantly from country to country. While the legal frameworks for GI protection may not yet be in place in some countries, most have started to give thought to this matter. Among the IOC's Members, Tunisia has the most potential GI areas for olive oil (21), followed by Morocco (11). In the case of table olives, Argentina is the country where the most potential GIs have been identified.
- Phase IV of the study: presentation of the results at an international seminar hosted by the Italian authorities in Reggio–Calabria, Italy on 21 October 2010

Given the clearly extensive and varied range of technical requirements for GIs the steering committee suggesting framing a proposal to the Council of Members to form an expert group to amplify the GI study and to use it as a basis for drafting a guide to good technical–legal practice to help countries wishing to create GIs.

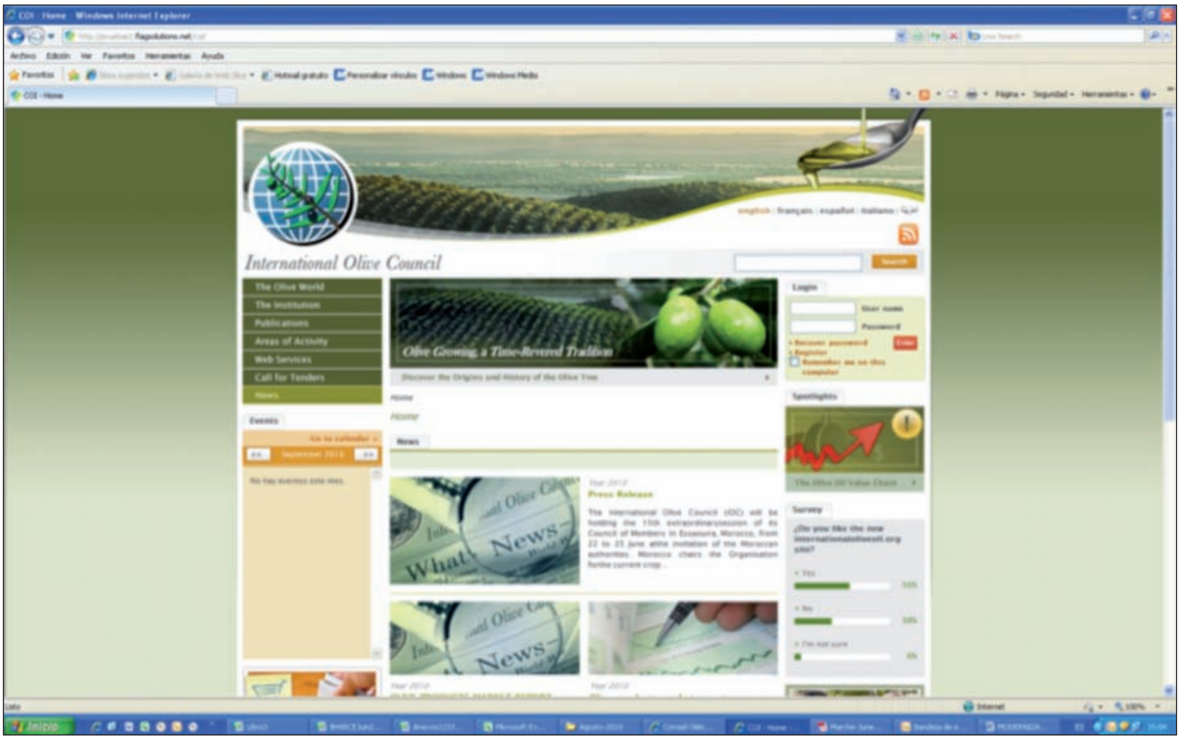
IOC launches its new-look website

The Executive Secretariat has finished renovating the IOC website to give it a more user-friendly and dynamic image based on a content management system making for simplified editing and maintenance.

New features include the menu on the left-hand side of the home page, permitting swift access to the site contents. There will also be a calendar of IOC activities listing the dates of past and future meetings and events organised by the IOC and visitors will be able to buy IOC publications online.

The central section will run the latest major news items while the right-hand side will be the gateway to the private area for the member countries and the members of the Advisory Committee and working groups featuring an automatic e-mail alert system whenever anything new comes in.

Other novelties include a *Spotlight* section where important IOC publications will be posted, an online user satisfaction survey and the possibility of signing up for automatic delivery of the monthly IOC newsletter. The new-look site will also incorporate a system to count the number of visitors to the site and to identify their source by url.



Home page.

Olive growing in the arid valleys of Northwest Argentina (provinces of Catamarca, La Rioja and San Juan)

M. Gómez del Campo, A. Morales-Sillero, F. Vita Serman, M.C. Rousseaux & P.S. Searles

HISTORY OF OLIVE GROWING IN ARGENTINA

The origins of olive growing in Argentina can be traced to the Spanish colonisation when the first orchards were planted in Arauco (La Rioja). A 400-year-old specimen survives to this day as testimony to that period (Photo 1). However, it was not until the late 19th century that olive cultivation started to develop to cope with demand from the influx of Italian and Spanish immigrants which supplies from the existing Argentinean market were unable to meet. In 1953 there were estimated to be 7.5 million olive trees in the country, some of which were planted near urban areas (Photo 2). Olive growing started to decline in 1960 as it came up against competition from sunflower and corn oil (theoretically healthier and cheaper). Farm profitability decreased and olive orchards were abandoned or grafted to convert them to table olive or dual-purpose varieties. By 1984, only 3.72 million olive trees were cultivated, many in inadequate conditions.

The early 1990s signalled a radical about-turn in this state of affairs as olive acreage started to expand without interruption from the existing level of just under 30,000 ha. This expansion was due not only to enhanced profitability driven by olive oil prices and information campaigns about the health benefits of olive oil consumption, but also to support measures passed by the Argentinean government, notably the Tax Deferral Acts for industrial, agricultural, livestock and touristic undertakings (Act 22.021 in La Rioja, Act 22702 in Catamarca and Act 22973 in San Juan). This legislation was applied in agriculture from the start of the 1990s until 2008 and stimulated the development of new olive orchards in the Northwest provinces of San Juan, La Rioja and Catamarca (Fig. 1). Many of the new investors came from outside the agricultural/livestock in-

Photo 1. This 400-year-old olive tree (variety 'Arauco') is a National Historical Monument. A symbol of the identity of the Arauco people, it continues to stand erect after being saved in the 17th century from being felled as ordered by King Carlos III of Spain, who feared that the prosperity of olive growing in the area might eventually exceed olive production in Spain. Legend has it that this one plant is the source of the resurgence of olive growing not only in Argentina but also in Chile and Peru, where offshoots were taken.

dustry because the legislation allowed Argentinean companies to defer tax payments for 17 years in the case of olive cultivation. The deferred payments were later settled in equal annual instalments over a period of five consecutive years, at no interest.

TABLE 1
Expected olive growing area (ha) in Argentina after the application of the Tax Deferral Acts

Province	Prior area	Tax deferral area	Total area
Mendoza	13700	300	14000
Córdoba	5000	470	5470
San Juan	4800	13800	18600
La Rioja	2900	27000	29900
Buenos Aires	1800	0	1800
Catamarca	1400	30000	31400
Total	29600	71570	101170

Source: Argentine Secretariat of Agriculture, Livestock, Fishing and Food (SAGPyA)

The figures speak for themselves. At the outset of the 1990s Mendoza, San Juan and Córdoba (Table 1) were the main olive producing provinces, accounting for 80% of the country's 29,600 ha of olive trees, concentrated primarily in the departments of Pocito, Rawson, Rivadavia and Zonda in San Juan, Junín, Maipú, Lavalle and Lujan de Cuyo in Mendoza and Cruz del Eje in Córdoba. The orchards were traditional, 5–15 ha in size on average and planted on a 10 x 10 m layout. The trees were pruned to several scaffold branches and flood irrigated. 'Arauco' was the chief variety grown owing to its high crop yield, large fruit size and dual-purpose characteristics (Photo 2). Domestic production was estimated to be 30,000 t of table olives and 8,000 t of olive oil (Fig. 2), which went primarily to a market led by product price as opposed to quality. In some cases the oils had defects (fusty and muddy sediment defects) because of the shortage of modern processing facilities and the lack of suitable storage. In 1998, Argentina grew 71,000 ha of olive trees, 70% of which were varieties for oil pro-

Figure 1. Map of Argentina highlighting the provinces of Catamarca, La Rioja and San Juan.

Photo 2. A traditional, 70-year-old orchard of 'Arauco' olive trees in the town of Anillaco (La Rioja), planted on a 10 x 10 m layout and flood irrigated.

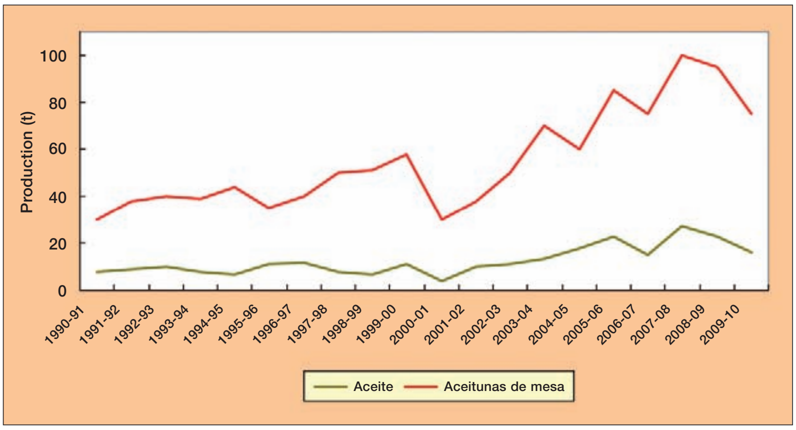


Figure 2. Changes in olive oil and table olive production in Argentina between 1990/91 and 2009/10 The numbers for the last two crop years are provisional. Data are from the IOC (Source: IOC, 2009).

duction and 30% for table production. By 2008, this area had expanded to 90,100 ha (more than 90% under irrigation), split roughly 60%/40% between oil-olives and table olives. This crop area has positioned Argentina in 13th place in the world olive acreage ranking, but many of the new orchards were planted in areas where little was known about the agricultural or processing performance of the olive varieties imported from Europe. As a result, some of the area planted with olives to qualify for the tax deferral measures did not bear crops due to frost damage or soil and plant health problems, and some varieties were switched to increase production.

The orchards planted since the enactment of the tax laws are between a minimum of 100 and 150 ha, although some are over 1,000 ha. Planting densities are higher, ranging from 250 to 330 olive trees/ha. The orchards were planted with stock from other producing countries and were often monovarietal, with one or two polliniser varieties. They also apply more advanced soil management practices such as localised irrigation and fertigation. This combination of factors has stimulated higher yields of 10–12 t/ha compared with 5–6 t/ha in traditional groves, which has resulted in higher domestic production. In 2007/08, Argentina produced 100,000 t of table olives and 27,000 t of olive oil (Fig. 2) and its commercial strategy placed growing priority on quality. Nowadays, Argentina is South America's leading producer of table olives and olive oil. According to the average figures released by the International Olive Council (IOC) for the period 2002–07, it ranks ninth in the world table olive production league (4%) while remaining a minor player in world olive oil production (<1%).

Currently, the olive growing map of Argentina mainly covers the provinces of Catamarca, La Rioja, San Juan and Mendoza (Fig. 3) where the most important olive growing areas are Valle Central, Pomán and Tinogasta in Catamarca; Chilecito, Aimogasta and La Rioja Capital in La Rioja; and Valle del Tulum, Jáchal and Ullum-Zonda in San Juan. Olives are also grown in the provinces of Córdoba and Buenos Aires, and new crop expansion projects have recently arisen in Río Negro, San Luis and Neuquén.

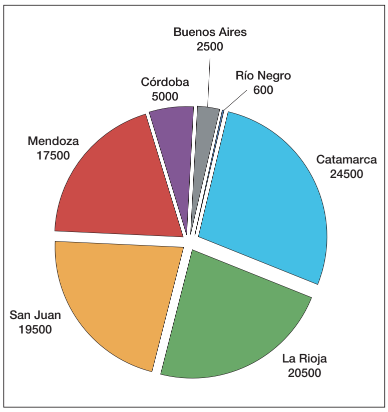


Figure 3. Distribution of the olive growing area (ha) in Argentina (SAGPyA, Argentine Secretariat for Agriculture, Livestock, Fisheries & Food, 2009)

DESCRIPTION OF VALLEYS

The topography of this region is characterised by a series of depressions or valleys running lengthwise parallel to the Andes, separated by a chain of mountains misleadingly called the Sierras Pampeanas or Pampean Ranges because they are not geographically related to the humid pampas region (Fig. 4). Moving from East to West, the first valley is the Valle Central de Catamarca, demarcated by the Sierra de Ancasti del Alto to the East (elevation of 1,573 m) and the Sierra del Ambato to the West (4,405 m) (Photo 3); the next valleys are the Bolsón del Pipanaco (where the Aimogasta and Pomán olive growing areas are located), with the Sierra del Ambato to the East and the Sierra de Velasco to the West (4,029 m), the valley of La Rioja Capital, lying at the foot of the Sierra de Velasco (Photo 4), the valley of Chilecito, lying between Sierra Velasco to the East and Sierra de Famatina to the West (6,097 m), and lastly the valley of Tulum in San Juan lying at the foot of the Sierra del Tontal in the Andean foothills. This includes the piedmont area of Cañada Onda–El Acequión where new orchard development is currently at its height.

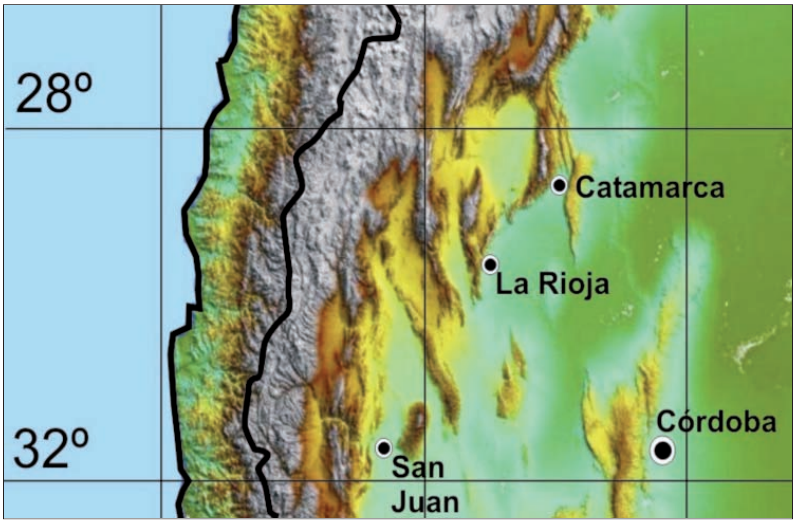


Figure 4. Topographical map of the provinces of Catamarca, La Rioja and San Juan showing the Pampean Ranges running parallel to the Andes and the intervening valleys.

Not all the valleys lie at the same altitude. The Valle Central de Catamarca and the valley of La Rioja Capital lie between 400 and 450 m whereas the valley of Tulúm is at 650 m, the olive farms in Pomán and Aimogasta in Bolsón de Pipanaco lie at 800 m, the valley of Chilecito is at 950 m, and the Tinogasta area in Catamarca at 1,100 m. These differences in altitude cause major climatic differences despite the fact that the valleys are at the same latitude.

These valleys are depressions which gradually filled

Photo 3. Olive orchards in the Valle Central de Catamarca with the Sierra de Ambato in the background (4,405 m). The farms are big (average size 300 ha) and windbreaks face EW.

Photo 4. Olive orchard in the valley of La Rioja Capital with the Sierra de Velasco (4 029 m) in the background.

up with sediment through weathering of the rocks from the surrounding mountains; consequently, most of the soils are alluvial. Plots in the central parts of the valleys are almost on the level while those on the mountain sides are on constant, moderate slopes. A characteristic feature of these mountain ranges is that their eastern slopes are gentler and their western slopes are more abrupt. The slope of the foothills permits masses of cold air to move towards the bottom of the valleys. This is particularly important in colder areas, specifically San Juan and Mendoza.

The native vegetation is made up of species of xerophytes such as Cactaceae and thorn scrub. The region has long been used for goat grazing although some of the valleys were too arid for large-scale grazing and even now still have large tracts of virgin mountains. The construction of the railway led to deforestation in some areas.

Before the appearance of the large olive plantations prompted by the tax deferral laws, crops such as grape, olive, date (brought by Lebanese and Syrian immigrants in the early 20th century), pomegranate, aloe, other fruit trees such as peach, almond and quince and all kinds of vegetables were grown in oases in these valleys. Nowadays, the main agricultural activities are irrigated in the provinces of La Rioja and Catamarca where olive, grape, walnut and jojoba are cultivated, and to a lesser extent other fruit trees, vegetables and herbs. Dry farming is confined to the areas where rainfall is above 300 mm a year (La Rioja Capital and Valle Central de Catamarca) and is mainly associated with pastureland and cereal growing for livestock. Agriculture in the provinces of San Juan and Mendoza is centred on grapes for wine production. Although stone fruit, seed fruit and vegetable growing underwent heavy expansion in these two provinces, olive growing has now become the second agricultural activity in San Juan.

DETERMINANTS OF OLIVE CULTIVATION

Soil characteristics

Alluvial sediments including conglomerates, coarse, medium and fine sands and loess loams were the material from which the soils of the mountain valleys developed. Owing to this origin, olive orchard soils can vary in grain size depending on the distance from the mountains and water courses: the further away they are from both, the finer they are (Lucas Moretti, personal communication). The soils belong to the Entisol and Aridisol orders and show little evidence of development. Generally, the plots are on flat land; the soils are deep (> 2m), often with a loam, sandy loam, silty clay loam or silty clay texture, low organic matter content (< 1%) and a neutral or slightly basic pH (between 7.2 and 8.5). Coarse textured soils have a low cation exchange capacity owing to their low clay content. In some lower parts of San Juan olive growing encounters problems because of shallow groundwater levels and salt accumulation. Due to their coarse grain size and the absence of calcareous horizons, piedmont soils do not have problems of water logging.

Temperature and olive phenology

As can be seen from the map in Fig. 4, the region of Argentina where olive growing has basically developed lies between latitudes 28 and 32ºS; hence, it is closer to the equator than the traditional olive growing regions of the Mediterranean Basin (30–45ºN). However, the topography of Argentina's mountain valleys is the clear determinant of their climate, which is of the arid basin-and-range type (http://www.ambiente.gov.ar/aplicaciones/mapoteca) as opposed to being subtropical, which is what might be expected. The Pampean Ranges and the Andes (3,000–6,900 m above sea level) are natural barriers that isolate the region from the influence of the humid winds from the Atlantic and Pacific, which release their moisture on the mountain crests and are dry by the time they reach the valleys. Moreover, the NS orientation of the ranges allows the entry of masses of cold air from the South. Nevertheless, it is the snowfalls in the upper reaches of the Andes that lead to warm, dry winds like the Zonda, which affects all the valleys in the foothills to a varying extent. As already explained, climatic characteristics differ according to the altitude of the valleys.

Table 2 provides data on the chief climatic variables from four meteorological stations in Argentina, located in Catamarca, La Rioja Capital, Chilecito and San Juan, as well as three stations in major olive growing regions of Spain: Seville, the epicentre of table olive production (60,000 ha) where 'Manzanilla de Sevilla' variety is grown primarily; Úbeda, at the heart of the 'Picual' area (800,000 ha); and Toledo, the coldest region where the variety cultivated is 'Cornicabra' (200,000 ha). Figure 5 plots the changes through the year in mean temperature, ETo and precipitation at the Catamarca, San Juan, Seville and Toledo meteorological stations.

In general, the mean annual temperatures are milder in the mountain valleys of Argentina than in the olive growing regions of Spain. The combination of these temperature conditions and the low ambient humidity leads to high atmospheric demand, which reaches values above 1,500 mm at all the meteorological stations. The Valle Central de Catamarca is the warmest, followed by La Rioja Capital where absolute maximum temperatures in the vicinity of 45 ºC are recorded in summer.

The mild year-long temperatures modify the rate of vegetative growth of the trees relative to that of the Mediterranean Basin. In the valleys of La Rioja Capital and Central Catamarca where winters are shorter, the growth season runs from early spring to late autumn. This permits active vegetative growth to the extent where some shoots may reach 1 m in length when the olive trees receive abundant irrigation and fertilisation, which causes problems of excessive vigour (Photo 5).

In springtime, the mild temperatures cause earlier flowering in olive and also move forward the other phenological stages (Fig. 6). As a result, fatty acid synthesis is concentrated in summer and early autumn, particularly in the Valle Central de Catamarca and La Rioja Capital where temperatures are high during this period (Table 2). In contrast, oil synthesis occurs in the autumn in Spain, when temperatures are lower. In all probability the high

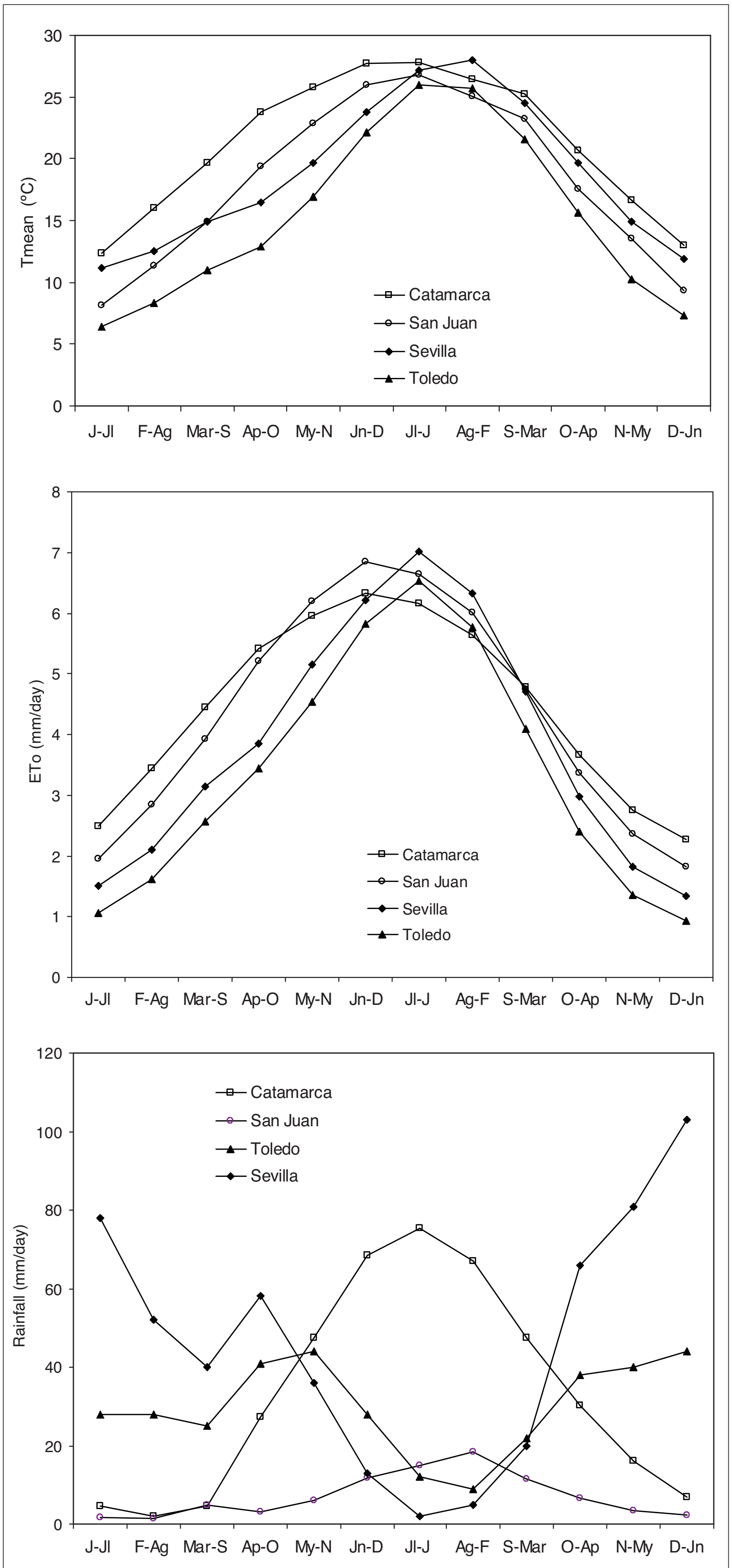


Figure 5. Monthly values of mean temperatures, ETo and rainfall at meteorological stations in Argentina (Catamarca and San Juan) and Spain (Seville and Toledo).

temperatures are the reason for the reduction in oil synthesis that occurs in the majority of the varieties grown in Northwest Argentina because more moderate temperatures are typically needed to promote oil synthesis in olive (Salas *et al.*, 2000; Bongi, 2004). For example, the 'Arbequina' variety in NW Argentina often does not give an oil yield of more than 12%. Furthermore, in some varieties the high temperatures also appear to be the cause of the low oleic acid content of the oils and conversely of their high linoleic acid content. In the specific case of the 'Arbequina' variety, and to a lesser extent of 'Arauco', the oil may not comply with IOC limits owing to its low oleic acid content (below 55%). Commercially, this is corrected by blending 'Arbequina' oil with oils from other high-oleic varieties (e.g. 'Coratina' and 'Picual'). Preliminary trial results suggest that the temperatures reached during the months when oil synthesis is at a height (February– March) have the greatest impact on oil content while the temperatures reached near the stone hardening stage may best explain the variations in fatty acid composition (García-Inza, Castro and Rousseaux, unpublished data).

The temperature at harvest can also affect oil quali-

TABLE 2
Mean climatic data from meteorogical stations located in olive growing regions of Argentina and Spain

Station	Variables	Spring	Summer	Autumn	Winter	Annual
Catamarca	Tmean (ºC)	23.1	27.3	20.8	13.8	21.3
28.36 S	Tmax (ºC)	30.2	33.7	27.2	21.4	28.1
65.46 W	Tmin (ºC)	16.0	20.9	14.5	6.1	14.4
454 m	Rainfall (mm)	79	211	94	13	397
	ETo (mm)	480	544	343	252	1,619
	Chilling hours					287
La Rioja Capital	Tmean (ºC)	22.8	27.5	20.5	13.4	21.0
29.23 S	Tmax (ºC)	30.2	34.3	26.6	20.7	28.0
66.49 W	Tmin (ºC)	15.3	20.7	14.4	6.1	14.1
429 m	Rainfall (mm)	64	222	117	12	415
	ETo (mm)	491	565	335	244	1,634
	Chilling hours					330
Chilecito (La Rioja)	Tmean (ºC)	19.8	25.3	18.4	10.5	18.5
29.14 S	Tmax (ºC)	27.9	32.6	25.4	18.7	26.2
67.26 W	Tmin (ºC)	11.6	18.0	11.5	2.2	10.8
945 m	Rainfall (mm)	18	110	29	7	164
	ETo (mm)	474	556	337	234	1,602
	Chilling hours					641
San Juan	Tmean (ºC)	19.0	26.0	18.1	9.6	18.2
31.33 S	Tmax (ºC)	27.5	33.8	25.3	17.7	26.1
68.25 W	Tmin (ºC)	10.6	18.1	10.9	1.5	10.3
598 m	Rainfall (mm)	14	45	22	6	87
	ETo (mm)	465	586	321	203	1,576
	Chilling hours					733
Seville	Tmean (ºC)	17.0	26.3	19.7	11.9	18.7
37.22 N	Tmax (ºC)	23.2	34.0	26.0	17.1	25.1
6.00 W	Tmin (ºC)	10.6	18.3	13.5	6.6	12.2
8 m	Rainfall (mm)	134	20	167	233	554
	ETo (mm)	372	600	288	147	1,408
	Chilling hours					501
Úbeda (Jaén)	Tmean (ºC)	15.1	24.7	16.2	8.2	16.0
37.56 N	Tmax (ºC)	20.8	31.1	20.8	12.3	21.3
3.18 W	Tmin (ºC)	8.8	18.3	11.9	4.1	10.8
358 m	Rainfall (mm)	153	32	123	187	495
	ETo (mm)	341	524	220	110	1,195
	Chilling hours					929
Toledo	Tmean (ºC)	13.6	24.6	15.8	7.3	15.3
39.53 N	Tmax (ºC)	19.7	31.9	21.7	12.1	21.3
4.03 W	Tmin (ºC)	7.5	17.3	10.0	2.5	9.3
516 m	Rainfall (mm)	110	49	100	100	359
	ETo (mm)	324	556	238	107	1,225
	Chilling hours					1,022

ty. Mean temperatures of 25ºC and mean maximum temperatures of 31 ºC are reached in March (late summer, early autumn) when the first varieties are harvested in Catamarca. This means that the olives may start to ferment if they are not processed as soon as they are picked.

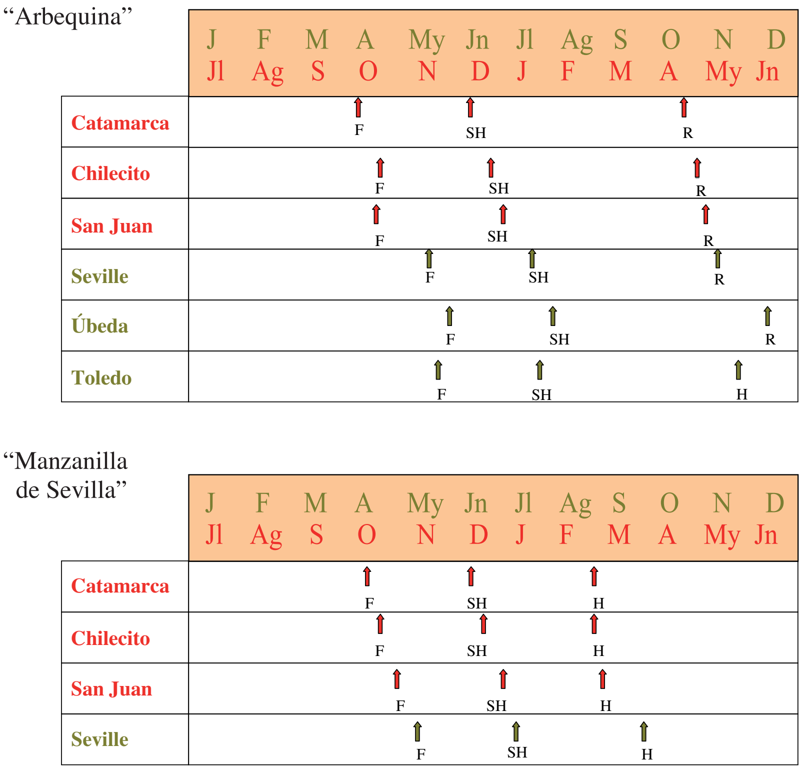


Figure 6. Mean date of flowering (F), stone hardening (SH) and harvesting (H) of the 'Arbequina' and 'Manzanilla de Sevilla' varieties at locations in Argentina (Chilecito, Catamarca and San Juan), shown in red, and Spain (Toledo, Úbeda and Seville), shown in green.

Mean winter temperatures are also higher than in Spain. For instance, while 501 chilling hours are recorded in Seville using the method of Mota, the warmest valleys of Argentina such as the Valle Central de Catamarca and La Rioja Capital record only 287 and 330 chilling hours, respectively. Given that the olive tree needs low winter temperatures to stimulate flower buds to emerge from winter rest, the lack of chilling in these valleys appears to be the reason why some high chill requirement varieties such as 'Empeltre', 'Frantoio' and 'Leccino' do not flower. However, flowering is not affected in varieties with lower chill requirements such as 'Manzanilla', 'Coratina', 'Arauco' and 'Arbequina' (De Melo-Abreu *et al.*, 2004; Aybar, 2010). Mean minimum winter temperatures can be lower in the mountain valleys than in Spain, due to incoming cold fronts from the South which cause severe frost (Photo 6). Because it lies geographically furthest to the south Tulum valley is affected the most by the arrival of polar air masses. According to the agroclimatic

Photo 5. Mild temperatures coupled with high irrigation rates (>1,200 mm) and fertilisation lead to greater tree growth than in the Mediterranean Basin. The olives shown are 11-year old 'Arbequina' trees in the Valle Central de Catamarca, planted on an 8 x 4 m layout (left) and 10-year-old 'Barnea' trees in Chilecito (La Rioja) planted on a 6 x 4 m layout (right). Shoots grew to a length of more than 1 m per year.

data for the locality of Media Agua over the last 25 years, mean absolute temperatures below -7ºC were recorded in 45% of the winters. This has a heavy impact on olive orchard yields, as is borne out by the low crop production of 2007/08 and 2009/10 when temperatures reached -10 ºC and -10.5 ºC, respectively.

Figure 6 shows the average dates for flowering, stone hardening and harvesting of ‘Arbequina’ and ‘Manzanilla de Sevilla’, the two most widespread varieties in the mountain valleys. The corresponding dates for locations in Spain are also given. The phenological stages of ‘Manzanilla de Sevilla’ are only specified for Seville, because neither Úbeda nor Toledo is a major growing area of this variety.

Although there is normally a difference of six months between the northern and southern hemispheres, flowering is a month earlier in the mountain valleys owing to the high spring temperatures. Stone hardening takes around two months, as in Spain; a further two–three months are needed before harvesting ‘Manzanilla de Sevilla’, or four months in the case of ‘Arbequina’. The fact that ‘Arbequina’ is harvested so early in Toledo (before 15 November) is not due to earlier ripening but to the risk of autumn frosts detrimental to oil quality. Harvesting of ‘Arbequina’ begins in late March in the Valle Central de Catamarca, followed by La Rioja and ends in May in San Juan and Chilecito. In Spain harvest does not start until November. Harvesting of ‘Manzanilla de Sevilla’ begins in mid-February in Argentina, and seven months later (September) in Spain.

Rainfall and irrigation water

Two aspects of rainfall in the mountain valleys should be highlighted: the low level of rainfall and the difference in distribution compared with the Mediterranean Basin (Table 2 and Fig. 5). Mean annual rainfall is below 500 mm; the valleys receiving the least rainfall are the Bolsón de Pipanaco (where Aimogasta and Pomán are located) and the Tulúm valley, with less than 100 mm. More than half of the rainfall occurs in summer and in many cases is torrential. This rainfall does not usually heighten the risk of disease owing to the low relative ambient humidity and the rapid percolation into the soil profile. This contrasts with the Mediterranean Basin where summer is the driest season.

The low rainfall and high atmospheric demand in these valleys therefore make it necessary to irrigate intensive olive orchards. The irrigation water used in commercial orchards in the

Photo 6. ‘Picual’ olive trees in the valley of Chilecito (La Rioja) damaged by frosts in May 2008 (-6ºC for 8 h).

provinces of Catamarca and La Rioja comes mainly from the aquifers. The water is pumped from a depth of 80–300 m and recharge comes from the Pampean Ranges where rainfall is higher. However, there are signs that annual recharge is often less than orchard water consumption (>1,000 mm/ha). Well water has an electrical conductivity (EC) ranging between approximately 0.5 and 2.0 dS/m and a high carbonate content as well in some cases. However, the level of salinity does not tend to lower crop yields provided that the soil humidity of the wet-bulb is maintained. In the province of San Juan, surface water is more important and both the foothills and Andes feed the waters of the rivers San Juan in the South and Jáchal in the North, which are of high quality with a low EC.

Frost and wind

Another characteristic feature of the mountain valleys is the damage they suffer from two types of wind: the cold South wind, and the warm Northwest wind known as the Zonda wind. The south wind blows from the SE; in some valleys in autumn and winter it moves masses of cold Antarctic air which can reach temperatures between -8 and -14ºC, with the lowest temperatures being recorded in the highest valleys like Jáchal or Chilecito. When this wind occurs in autumn, it not only damages the vegetative structures of the trees but may also jeopardise the quality of the oil owing to severe oxidation of frost-damaged fruit cells if the olives have not yet been harvested. Lowering irrigation and fertilisation rates in the autumn can reduce vegetative damage by promoting lignification. Additionally, windbreaks (Photo 7) of the evergreen species *Casuarina equisetifolia* from Australia (Photo 8) are used to protect crops from these winds. Other species such as the deciduous *Populus nigra* lose their leaves and do not provide protection for the orchards in winter. *Casuarina* is quite a hardy species and poses few health risks (i.e. diseases or insects) to olive trees. Windbreaks are usually oriented EW to stop the passage of the South wind, but this is never done when the orchards lie on slopes, because this prevents air drainage. Despite the incoming polar air, many frosts are radiation frosts and a slope of more than 1% permits air drainage to the lowest lying areas. Furthermore, late frosts are quite common at the beginning of spring and cause significant damage to flowering, leading to lower crop production.

Photo 7. Olive orchards with two rows of windbreaks in the Valle Central de Catamarca facing EW almost perpendicular to the rows of trees.

The Zonda wind occurs mainly in winter and spring and affects the valleys closest to the Andes; consequently, the Tulúm valley in San Juan is the most heavily affected. It occurs when a mass of damp air from the Pacific ascends the Andes, losing its moisture and growing colder along the way. On its descent it grows warmer, eventually reaching the valleys in hot, dry gusts, generally from the north-west. When it occurs in the spring, it can jeopardise flowering because it is usually accompanied by a rise in temperatures and very low ambient humidity which can cause the flowers to dehydrate. In short, it is a dry, warm wind that reaches temperatures of about 35 ºC and which is characterised by strong gusts (40–100 km/hour).

ORCHARD DESIGN

Plant material

The plant stock for the traditional orchards in the mountain valleys was often obtained from seed or from vegetative propagation of specific specimens, mainly ‘Arauco’ for table olive production, while ‘Arbequina’, ‘Frantoio’ and ‘Picual’ were planted on a smaller scale for oil production. The olive fruits of the ‘Arauco’ variety are characterised by their high resistance to detachment from the tree, large size (similar to ‘Gordal de Sevilla’), high flesh-to-stone ratio and a flesh firmness suited to several methods of table

Photo 8. *Casuarina equisetifolia* windbreak in Chilecito (La Rioja), planted at a distance of 15 m from a ‘Picual’ olive orchard. Windbreaks are planted every 200 m.

olive preparations. However, owing to its asymmetric shape, the stone of this variety is difficult to remove (Barranco *et al.,* 2000). This description coincides with that of the ‘Azapa’ variety of Chile and the ‘Sevillana’ variety of Peru. Some genetic differences are also found between ‘Arauco’ of different regions; for instance, the ‘Arauco riojano’ differs from the variety found elsewhere in the country.

The varietal makeup changed when it became necessary to import large amounts of plant material to plant the orchards covered by the tax deferral legislation. In 1997 alone, 12 million olive trees belonging to over 30 varieties were imported. Later, a preference developed for varieties internationally renowned for the quality of their olives or oils, specifically ‘Manzanilla de Sevilla’ for table production and ‘Arbequina’, ‘Frantoio’, ‘Leccino’ and ‘Picual’ for oil production. In some cases, there was little control of the plants imported from Mediterranean nurseries; the upshot was that some orchards were planted with mixed varieties. Moreover, some of the varieties planted had not been evaluated beforehand in the region and over the years it has been been found that they do not adapt well to specific climatic conditions. The most striking examples are the orchards planted with ‘Frantoio’, ‘Empeltre’ and ‘Leccino’ in the valleys of Catamarca, La Rioja Capital and San Juan where these varieties do not flower, or do so occasionally but without setting any fruit. Orchards planted with the 'Picual' variety also have some flowering problems owing to the lack of winter chilling. As already mentioned, there is evidence that these varieties do not receive sufficient hours of chilling to emerge from winter rest and continue with the process of flower structure differentiation. These varieties are currently grafted or replaced outright by 'Arbequina', 'Arauco' or 'Hojiblanca' (Photo 9).

The design of the new olive orchards incorporated polliniser varieties, chiefly in the Valle Central de Catamarca and La Rioja Capital. Some olive varieties are partially self-incompatible, i.e. they have difficulty in fertilising the flower ovules with their own pollen and need the help of other varieties to do so. Given this physiological aspect of the olive, in some olive growing countries such as Italy it is frequent for more than one variety to be grown in the same plot. However, this is not taken into account in the design of olive orchards in Spain because in traditional orchards it was common for a mix of varieties to be planted. Nevertheless, there is no consensus on the optimum design to ensure adequate pollination in Argentina's olive orchards. To give some examples, table olive orchards usually include rows of trees belonging to the 'Arbequina', which is used as a polliniser variety, while 'Arbequina' orchards are usually also planted with 'Hojiblanca' or 'Picual' as polliniser varieties, which are grown on a small portion of the orchard, often located solely along the edges of the plots.

Photo 9. Graft union of a 'Frantoio' olive tree in the Valle Central de Catamarca onto which 'Hojiblanca' had to be grafted (*left*) and close-up of the graft (*right*). The chilling requirements of 'Frantoio' are not met in the warmer valleys and so the trees do not flower.

The varieties that are cultivated vary from province to province. Taking the province of Catamarca as an example, the bulk of production is from oil varieties, mainly 'Arbequina' because it starts to bear crops early and its oil is highly rated on international markets. In both the Valle Central de Catamarca and La Rioja Capital, a high percentage of production is from oil varieties but these give low oil processing yields (10–14%) due to the high temperatures during oil synthesis. For reasons of profitability, 'Picual' is considered nowadays to be a dual–purpose variety, with a large part of production going for table olives. In the province of La Rioja as a whole, 60% of the olive orchards grow olives for table production and the main varieties are 'Manzanilla' and 'Arauco'; 'Aloreña' is also grown on a small area. The 'Manzanilla' variety passed 'Arauco' in terms of crop area due to the expansion triggered by the orchards which took advantage of the tax deferral legislation. 'Manzanilla' has gained prominence in these new orchards because of its international reputation. Nevertheless, 'Arauco' continues to be important because of the strong demand from the Argentine and Brazilian markets. Within the 'Manzanilla' designation there are several types which are probably different varieties, such as 'Manzanilla de Sevilla', 'Manzanilla Criolla', 'Manzanilla Fina', 'Manzanilla Reina', 'Manzanilla Común', 'Manzanilla Aceitera', 'Manzanilla Denté', 'Manzanilla Californiana', and 'Manzanilla israelí'. 'Arbequina' is the main oil variety in La Rioja although 'Picual', 'Coratina' and 'Barnea' are also grown. To the south in San Juan where the climate is not as warm, 70% of the olive growing area is for the production of oil-olives. 'Arbequina' is the chief variety (60% of the area), followed by 'Manzanilla de Sevilla' (10%). 'Changlot Real' (table olives), 'Picual', 'Hojiblanca' and 'Arauco' are minor varieties, while 'Coratina', 'Arbequina' and 'Hojiblanca' are clearly expanding.

Orchard layout and training systems

Planting densities in the olive farms set up under the tax deferral legislation are generally between 250 and 330 trees/ha. The usual layout is 7–8 m between rows and 4–5 m between trees in the same row. In recent years, especially in San Juan, the tendency has been to increase planting density by using layouts of up to 6 x 2 m (approximately 800 trees/ha), and even 4–3.5 x 1.5 m (between 1,600 and 1,900 trees/ha). This increase in planting density has been prompted in part by the mounting cost of hand harvesting and the financial necessity of mechanising harvesting by using shakers, over-the-row harvesters or other machinery like the Colossus harvester or the Jacto coffee harvester.

The orchards were designed without foreseeing that vegetative growth would be greater than in the Mediterranean Basin. The trees were trained to a vase shape (Photo 10), but in some cases the excessive vigour of the trees caused the canopies to touch and form hedgerows 5.5 m high and 4.0 m wide (Photo 5). The large size of the trees adds considerably to the cost of cultural practices such as harvesting and pruning. Moreover, it does not generally result in higher crop production because of the lack of light penetration to the leaves and fruit and the competition between fruit development and vegetative growth. Consequently, the hedgerows are topped to lower them to around 3.5 m so that light can penetrate through to the side walls and harvesting is made cheaper (Photo 11). Even so, in some cases the upper parts of the canopy close over and it is necessary to pull out whole rows (Photo 12).

Photo 10. 'Aloreña'olive trees grafted onto 'Frantoio', pruned to a vase shape and established on an 8 x 4 m layout in the Valle Central de Catamarca. The lack of light penetration has caused leaf and fruit loss in the lower part of the hedgerow.

Photo 11. 'Arbequina' olive trees in the Valle Central de Catamarca which have been machine pruned to permit the entrance of vehicles and farm machinery and to facilitate harvesting. Prior to pruning, the trees had reached a height of over 5 m.

CULTURAL PRACTICES

Soil management

Because the olive farms are generally very large and the orchards are irrigated, farmers tend to pay little attention to soil management and weed control. Nevertheless, the most widespread technique is a combined system of herbicide application along the orchard rows and natural or sown plant cover within the row interspace all year round (Photo 13). Mowing or the application of contact herbicides is used to keep the cover crops to a specific height to stop them from flowering and seeding. In areas where rainfall is minimal (<100 mm/year), the plant cover barely develops within the row interspace (Photo 14).

Photo 12. 'Arbequina' olive orchard on a 6 x 4 m layout in Chilecito (La Rioja), designed for trunk shaker harvesting. The excessive vegetative growth of the trees will make it necessary to pull out alternate rows to permit light penetration to the lower parts of the tree canopy and to harvest mechanically.

Irrigation

So far there is enough water – chiefly belowground water of medium quality – in the mountain valleys for irrigation purposes. The biggest constraint on water use for irrigation is the cost of pumping. In some cases, farms and urban areas compete for electricity in summertime, which limits electricity consumption and hence farm irrigation at this time of year.

The majority of the farms calculate irrigation rates according to FAO recommendations for the crop coefficient method (0.70-0.75), which means applying 1,000–1,200 mm of water throughout the year. The irrigation strategy for which these coefficients were calculated aims to satisfy the water requirements of the olive; hence, the crop has access to water which can be readily used throughout the

Photo 13. Soil management with plant cover along the lanes (i.e. row inter-spaces) of 'Arbequina' olive orchards in the Valle Central de Catamarca.

cycle. Because the temperatures are so mild (Table 2), this year-long water availability leads to excessive vegetative growth and makes it difficult for the olive trees to enter winter dormancy. Several experiments with olive have shown that the application of deficit irrigation at specific times causes moderate water stress. This reduces vegetative growth without affecting crop production and may even increase it. Vegetative growth can be controlled by decreasing water applications at times when this does not interfere with fruit growth and oil synthesis, such as from the end of fruit set until peak oil synthesis. In addition, post-harvest water stress forces the tree into winter dormancy and permits subsequent flower differentiation, which would not be achieved otherwise due to the mild autumn and winter temperatures.

Fertilisation

Fertilisation tends to be applied empirically as is still the case in many orchards of traditional producing countries, and often it depends on the financial resources available. Nitrogen, phosphorus and potassium are applied frequently. Overfertilisation, particular-

Photo 14. 'Manzanilla de Sevilla' olive orchard in Aimogasta (La Rioja) with bare soil along the orchard lanes owing to the low level of rainfall (<100 mm/year). The orchard lanes were not ploughed or treated with herbicides. The rows of olive trees where the irrigation lines are located are kept weed free by using herbicides.

ly with nitrogen, is practised on some farms to 'secure' high yields. Coupled with the effect of the climate and high irrigation rates, this contributes to the excessive vigour of the trees. Fertilisers are applied via fertigation or leaf fertilisation. Leaf analysis is not always used as a tool for diagnosing the nutritional status of the orchard and, if it is used, the sampling period is not always optimal. For instance, it is frequent for leaf sampling to be performed in winter on the grounds that this is when the nutrients are stable, but this is not necessarily the case in the warm valleys of Argentina. The analyses should be performed on one-year-old shoots in summer, coinciding with stone hardening (July in the northern hemisphere), the period for which reference critical nutrient levels are available for olive. One important issue yet to be determined is the optimal time for sampling in the valleys of Argentina where the olive generally has a longer cycle than in the traditional olive growing countries (Fig. 6). Magnesium deficiencies frequently occur in some orchards, especially in the 'Arbequina' variety, which tend to be related to high calcium carbonate levels in the soils. In San Juan, some soils are high in potassium but phosphorus-deficient, which often causes deficiencies.

Main pests and diseases

So far, olive orchards do not have any major health problems that cannot be controlled by chemical means. The main pests are the ash whitefly (*Siphoninus phillyreae*), mites (*Aceria oleae* and *Oxycenus maxwelli*) and black scale (*Saissetia oleae*). A few orchards are affected by nematodes or fungi such as *Verticillium dahliae* and *Phytophthora* spp. The appearance of the latter two problems is usually connected with poor health control in the source nurseries from which the plant material is obtained.

Harvesting

Harvesting occurs over five months in the mountain valleys, beginning in February in table olive orchards and running through to June or July in oil orchards. The first table olive variety to be harvested is the 'Aloreña' in early February, followed by 'Manzanilla de Sevilla' and one month later by 'Arauco' and 'Picual' when they are intended for Spanish-style green olives, and two months later when they are for black olives in brine. Harvesting of oil-olives begins with 'Arbequina' in April and May (depending on the area and mill capacity). The varieties 'Changlot Real', 'Frantoio', 'Leccino' and 'Farga' are all harvested at the same time. One month later, it is the turn of the 'Barnea', 'Coratina' and 'Arbosana' varieties to be harvested, while 'Picual' harvesting for oil production gets underway in June.

Although the orchard layouts chosen for many oil-olive orchards (7–8 x 4–5 m) permit harvest mechanisation, the olives are picked by hand with the aid of large stepladders because of the large size of the trees (Photo 15); poles are not used. Olive farmers are starting to view harvest mechanisation as a must due to the amount of labour required for harvest – more and more manpower comes from other northern provinces such as Salta, Jujuy and Tucumán, as well as from Bolivia – and the mounting costs of hiring harvest workers (at present, harvest labour can account for 60% of total production costs). Some farms are equipped with trunk shakers (Photo 16) or Jacto coffee harvesters, which can harvest less vigorous trees although harvesting is sometimes difficult because the trees are not properly trained. Currently, large 'Colossus' harvesters are

Photo 15. Hand picking of 'Arbequina' olives in an orchard in the Valle Central de Catamarca.

being developed (Photo 17). In the case of table olives, mechanised harvesting detracts from their quality. As a result, harvesting will be a big problem in a few years' time if costs continue to climb. The province of La Rioja in particular will be heavily dependent on labour owing to the large expanse of orchards dedicated to table olive growing.

CROP PRODUCTION AND QUALITY

As a rule, well managed farms produce around 10,000 kg olives/ha on average, which can rise to 20,000 kg/ha in bumper years. When viewed in terms of oil production, 'Arbequina' stands out because although higher in San Juan (16%) than in La Rioja and Catamarca (12%), it gives quite poor oil yields compared

Photo 16. Trunk shaker for harvesting oil-olives. This is being used with success even in large trees (up to 5 m in height), provided they have been properly pruned to allow transmission of the vibrations.

Photo 17. Over-the-row harvester (Colossus) for harvesting oil-varieties, which can harvest trees up to 4 m high and 4m wide.

with rates in several olive growing areas of Spain where it can easily reach 18% and even 22%. The high temperatures, which hinder oil synthesis, appear to be the most likely cause although other factors such as high irrigation rates also have to be taken into account. This last factor is due to the fact that generally growers sell their olives by weight and do not stop irrigating prior to harvest; as a result the olives arrive at the mill with a high moisture content, which lowers oil extraction efficiency. As far as the effect of temperature is concerned, a zoning study carried out in several agro-ecological areas of the Tulúm valley (San Juan) revealed that oil synthesis levels were higher in the 'Arbequina' variety in the southern part of the valley where the temperatures are lower.

The oil made from some varieties does not always meet the parameters required by the IOC for extra virgin olive oil. For instance, 'Arbequina' tends to give oils with low concentrations of oleic acid (<55%) in La Rioja Capital and the Valle Central de Catamarca whereas in colder areas such as San Juan the concentrations are generally above the limit. This low oleic acid content is related to compositional changes during oil accumulation. The oil obtained from 'Arbequina' and 'Arauco' olives picked from the tree contains 70% oleic acid one month after stone hardening, but this level gradually decreases through fruit ripening until it reaches values of close to 55% when oil synthesis is completed. Other varieties like 'Coratina' and 'Picual' have a high oleic acid content (around 70%) which remains constant throughout fruit ripening (Deborah Rondanini, personal communication). Campesterol and waxes are two other sets of compounds whose levels are frequently not accepted under IOC standards because they are above the permitted limits. Total polyphenols content is lower than in olive growing areas of Spain owing to the high temperatures and abundant irrigation during fruit ripening. Experimental trials applying deficit irrigation during fruit ripening have managed to achieve an increase of up to 30% in total polyphenol content.

In some cases, the long distance (100–500 km) the olives have to travel from the farm to the mill where they are eventually processed also affects the quality of the oils, which sometimes have free fatty acid values above the limit set for extra virgin olive oil (0.8%). However, these levels are not related to the date of harvest or maturity index (Rondanini *et al.,* 2007). Other quality parameters such as the K_{232} and K_{270} specific extinction coefficients, the peroxide value and oxidative stability generally lie inside the parameters proposed by the IOC (Ceci *et al.,* 2004; Ceci and Carelli, 2007).

Where table olives are concerned, the traditional local variety ('Arauco') stands out in terms of quality. This variety is in great demand because of its large fruit, which is prepared as Spanish-style green olives or natural black olives, although the market is limited due to the difficulty in removing the stone. The introduction of 'Manzanilla de Sevilla' in newly established farms has recently facilitated exports to new markets such as the United States and Canada where until now there had been no tradition of importing olives from Argentina.

PROCESSING AND MARKETING

In the 2007/08 crop year Argentina produced 27,000 t of oil (Fig. 2). Rising production in recent years has gone hand in hand with rising processing capacity. The majority of oil mills are modern and use the two-phase system. Most of the oil (69% in 2007/08) is exported to other countries because of its high cost compared with seed oils since it is five to six times more expensive than domestically produced soybean and sunflower oil. As a result, per capita consumption in Argentina is no more than 0.1 kg compared with 24.2 kg in Greece and 12.3 kg in Italy and Spain. Most of the oil exported is sold in bulk, chiefly to the United States (40%), followed by Brazil (25%).

In the early 1990s Argentina produced some 30,000 t of table olives, mainly belonging to the 'Arauco' variety. These were chiefly processed as green olives and to a lesser extent as natural black olives. By 2007/08 production had reached 100,000 t, principally of the 'Manzanilla de Sevilla' variety. This has forced the industry to change its processing techniques because the skin of this fruit variety needs more delicate handling and lye treatment. Modern processing facilities (Photo 18) enable the industry to turn out a top-quality, internationally renowned product. Processing is very highly concentrated in that although there are more than 90 registered processing companies, only four process 70% of production. Ninety per cent of the table olives produced go for export, chiefly to Brazil (80%), and then the United States.

STRENGTHS AND WEAKNESSES OF THE SECTOR

The mountain valleys contain a large land area that is practically flat or only moderately sloping. This land has not been cultivated previously and is therefore pathogen-free. The coarse textured soils are highly suited to olive growing, provided irrigation water is available. The fact that the information gleaned from existing orchards is available to establish new orchards means that the right varieties can now be selected. In addition, the nursery industry has developed in recent years and produces quality plants to meet the needs of new orchards.

The climatic conditions in the highest valleys of the provinces of Catamarca, La Rioja and San Juan are ideal for olive production and are therefore well suited for growing top quality oil vari-

Photo 18. Modern table olive processing plant in Aimogasta (La Rioja).

eties. The warmest valleys should probably concentrate on table olive production and apply deficit irrigation strategies, especially in autumn and winter, to force the winter rest period required to achieve high flowering rates. Only oil varieties with a high content of polyphenols and oleic acid (e.g., 'Picual', 'Coratina') can be cultivated in these warmer valleys.

The fact that the table olive varieties grown in the region ('Arauco' and 'Manzanilla') are well suited to processing and that the industry has modern facilities has meant that table olives from Argentina have earned a great reputation on the international market. However, in the case of olive oil, several critical points need to be reviewed. Although mills are equipped with modern facilities, the high temperatures reached during oil synthesis and harvesting lead to low oleic acid levels and instability in the oils made from some varieties. If quality oil is to be achieved, harvesting needs to be earlier and the distance between orchard and mill must be as short as possible to avoid fermentation prior to processing. Decreasing irrigation prior to harvest would mean that the olive paste does not contain so much moisture and would therefore raise oil extraction yields and polyphenols content.

Membership in international organisations and the associative structure of the sector are positive aspects of the expansion of olive growing. Argentina became a Member of the International Olive Council in May 2009 and will thus be able to participate in decision-making on olive oil policies, benefit from international technical cooperation, and take part in promotional activities. Furthermore, several national scientific research and technical teams are working in Northwest Argentina in partnership with the private sector (e.g. Provincial Chambers of Commerce and other producer groups such as the Regional Consortium of Experimental Agriculture and Livestock, CREA) to improve crop management.

Generally speaking, olive management in the climatic conditions of the arid valleys in Northwest Argentina faces two challenges: control of vegetative vigour and resistance to the cold South winds. Excessive vigour means that the trees grow to a huge size and makes harvesting very costly. A combination of irrigation and nitrogen fertilisation control and adequate pruning will help to obtain canopies suited to mechanical harvesting or at least to lower harvesting costs if done by hand. The winds from the South Pole in winter cause severe damage to plants which are not hardened off or to trees whose crop has not yet been harvested. Moving forward the winter rest period by lowering irrigation and fertilisation will help to trigger the process of lignification. Earlier harvesting will also be necessary. New orchards established in the coldest valleys should not be located in the valley floor but on the hill sides.

The last aspect that should be highlighted is the availability of irrigation water. The water level is becoming lower in the aquifers of many mountain valleys where groundwater is the primary water source. Hence, the sustainability of the crop may be threatened in the coming decades unless water use is better controlled.

ACKNOWLEDGEMENTS

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The importance of observing and harmonising international standards

The International Olive Council carries out a long string of activities. Two of its top objectives are to improve product quality and to draw up standards for international trade in olive products.

It is tasked to examine any business relating to the physico–chemical and sensory standards applicable to olive oils and table olives. Its brief is to work in partnership with specialist organisations to obtain a better insight into the compositional and quality characteristics of these products.

Other key priorities are to track international regulations and to harmonise them with the IOC trade standards for olive oils and olive-pomace oils, and table olives.

The IOC is a non-profit intergovernmental organisation. As the benchmark institution for olive oil and olives, it believes that the harmonisation and observance of official standards is of key importance in making trade clearer and more equitable, in preventing fraud and in protecting consumers. To achieve this harmonisation, it means to carry on with its efforts to improve product quality on a rigorous scientific and objective basis in partnership with all countries.

The IOC also sponsors a voluntary, self-regulatory scheme currently in place on a number of markets where exporters, importers and distributors of olive oil and olive-pomace oil are required to adhere to IOC standards in order to secure the orderly and fair development of the market. This quality control scheme has been operating since 1991 under an agreement signed by the IOC with associations to undertake product quality control at recognised laboratories using updated methods of analysis and taking into account the designations and quality criteria specified in the IOC standards, which are not compulsory in non-IOC member countries. The existence of an organisation like the IOC to coordinate this kind of quality control work is fundamental for ensuring compliance with regulations and product authenticity.

Since its inception, the IOC has been working on identifying analytical criteria to detect fraud and guarantee the quality of olive oils and olive-pomace oils. The standards drawn up by the IOC are trade standards. The limits they set for each analytical criterion and grade and the accompanying methods of analysis are adopted by consensus of the Members, which pledge to incorporate them into their legislation for application. These standards are revised in the light of scientific advances that lead to more accurate testing methods, as well as of technological and commercial developments, the object being to ensure product authenticity and quality while taking into account the realities of production.

The alignment of standards is essential to facilitate international trade and to encourage and guarantee fair trading practices; it is likewise essential to protect consumer health and to make sure that product content is true to label.

Ever since it first started to be involved in the standardisation of olive products, the IOC has cultivated a solid cooperative relationship with the Codex Alimentarius Commission and the two institutions have worked together on bringing their food and trade standards into line with each other.

The Codex Alimentarius Commission is responsible for a joint programme of the Food and Agriculture Organisation and the World Health Organisation for the development of food standards fixing minimum quality, hygiene, health and safety criteria aimed at the protection of consumer health and fair trading. The World Trade Organisation takes into account Codex Alimentarius standards and recommendations in the application of its agreements on sanitary and phytosanitary measures (SPS Agreement) and technical barriers to trade (TBT Agreement).

The IOC trade standard for olive oils and olive-pomace oils fixes the definitions and purity and quality criteria of the nine grades of products that can currently be traded on the international market. It also lays down rules on hygiene, packing, container fill and labelling, primarily in line with the international requirements set by the Codex Alimentarius Commission, and it recommends testing and sampling methods. The Members of the IOC undertake to apply the standard in their international trade in accordance with their respective laws while non-Member States are invited to apply it.

The IOC holds meetings of groups of expert chemists and sensory analysts to study and develop testing methods to determine the quality and control the purity of olive oils and olive-pomace oils; constant updating is needed to allow for detection requirements and advances in analytical science and technology. Representatives of standards agencies and institutions from non-member countries (AOCS, Codex Alimentarius, COOC, CFA, ISO, USDA, AOOA, NAOOA, etc) are also invited to attend meetings.

When a method has been finalised, its margins of error have been checked and its applicability to olive oil has been confirmed, it is adopted by the IOC, which fixes the permissible limits for each parameter and grade and includes them in its trade standard.

The testing methods recommended by the IOC are included in the current trade standard. Both the standards and the methods, referenced COI/T.20, are posted on the IOC website (www.internationaloliveoil.org) as they are reviewed and adopted.

Following in the wake of similar information released by the same team in other countries, the UC Davis Olive Centre has recently released a study which has caused a ripple in the media. The study applies non-official methods proven in the past to be of quite limited reliability, which is why they were not validated or adopted by the IOC. In doing so, an attempt has been made to distort reality by giving data which, taken out of context and without knowledge of the technical background, might mislead consumers and seriously damage the image of olive oil.

The IOC is the forum where Members draw up and consensually adopt rules for the quality improvement and quality control of olive products in order to achieve a transparent international market for olive oils, olive-pomace oils and table olives and so stimulate consumption of these products. Speaking as the intergovernmental point of reference for olive products standardisation, the IOC urges the competent authorities of producing and importing countries to harmonise their rules and regulations and offers its cooperation on any issues that might arise.

In view of all these considerations, the IOC group of experts on olive oil chemistry and standardisation officially designated by the IOC Member States signed the consensus document given on the next page in which they express their unanimous technical opinion on the UC Davis study.

Statement issued by the chemistry expert group of the International Olive Council on the report produced by the UC Davis Olive Centre

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A report issued by the UC Davis laboratory questioning the trueness-to-grade of extra virgin olive oil imported into the United States has been published recently in various news media. The IOC Chemistry Expert Group have discussed this subject at their latest meeting.

The Group is made up of expert chemists from almost all the IOC member and non-member countries (Australia, Canada and the United States) and international organisations (AOCS, CODEX and ISO). The main aim of the group is to study testing methods and revise them when necessary to determine the quality and control the purity of olive oils and olive-pomace oils. Methods are constantly being improved to adapt them to industry needs and technological developments.

IOC standards are revised in the light of scientific advances that help to make testing methods more accurate, or of technological and commercial developments. Their aims are to enhance and control quality, as well as to ensure transparency on the international market for olive oils, olive-pomace oils and table olives, and to promote their consumption.

Considering the report published by UC Davis, there are several points this Expert Group wishes to clarify.

The results reported are for only 52 samples of 19 brands. This is not statistically significant of the olive oil imported into the USA, because samples traded in three cities of California are not representative of the whole olive oil market in the USA; therefore, the claim questioning the trueness-to-grade of the extra virgin olive oil imported into the USA is not realistic.

There are no details of storage conditions during shipping or time of testing. Without this information it is impossible to consider the results to be reliable. In addition, the recommendations stated on the product labels indicate that the oils must be kept in a cool dry place and must not be exposed to direct light in order to comply with their assigned grade classification during their shelf life. We do not know if the non-compliance with the standards was due to the original characteristics of the oils or to the storage conditions during trading.

The IOC trade standard is under constant supervision by the IOC Chemistry Expert

Group and contains all the necessary methods to assess the quality and purity of olive oil. Hence, it was not necessary to apply the non-official methods cited in the report.

Most of the samples were misclassified by the sensory analysis. The official method of the IOC was used, but was not applied according to the standardised procedure described in the method. When the grade assigned by the sensory analysis does not match the grade stated on the label classification, the procedure requires a second analysis to be performed by another IOC recognised panel. This was not done in the UC Davis study.

The UC Davis study places particular emphasis on the application of non-official methods and gives the impression that the IOC methods are not sufficient to assess the quality and purity of olive oil. We would like to stress that some of the methods used in this study are not IOC methods, even though IOC methods are available (polyphenols and TAG) to assess the same parameters.

It is also important to point out that the IOC does have an official method to detect low quality oils or the addition of soft refined oils obtained from low quality oils (alkyl esters of fatty acids). Instead, the study used non-official methods, – DAGs -and pyropheophytine – that had already been studied by the IOC Chemistry Expert Group, which concluded that the scope of these methods could not include the assessment of the quality and purity of olive oil because these compounds change dynamically during the shelf life of the oil.

In this context, the UC Davis report claims that cheap refined oil was added to the oils; however, all the parameters (stigmastadienes and sterol composition) that detect the addition of this type of oil were within the limits. Consequently, they cannot conclude that refined oils were added.

As the IOC Chemistry Expert Group, we are very concerned about the final recommendations of the study advocating the implementation of methods that have not been proven to have any relationship with the quality or purity of olive oils.

The Group wishes to end by saying it is ready and willing to discuss any new input to ensure the quality and authenticity of olive oil.

Madrid (Spain), 8 October 2010

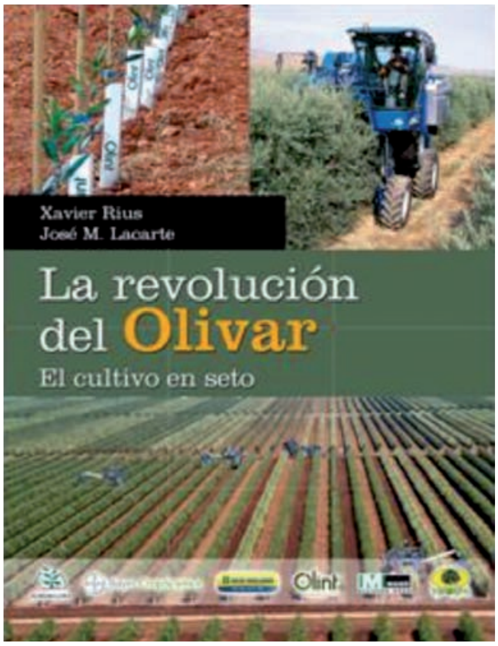
La revolución del olivar: el cultivo en seto

Authors: **Xavier Reus and José M. Lacarte**
Ed. Agromillora Iberia, S.L.

As the authors explain in the introduction, this book attempts to condense the many years of experience in hedgerow olive cultivation acquired by the company AGROMILLORA, a pioneer of this system. Opening with a description of current and expected production and consumption in the olive growing countries, readers will go on to learn about the developments in super-intensive olive growing since its beginnings and the whys and wherefores of the specific techniques currently used (orchard layouts, varieties, fertilisation, pruning machinery,…). Highly practical in approach, the book widely explores aspects and technologies not usually discussed in other books on olive growing. Soil mapping, irrigation or fertilisation are just some of the key areas in which novel concepts are put forward for olive cultivation to lead to cost savings, better quality and better production control.

By providing answers to the needs of farmers in super-intensive olive growing across the globe, this book is meant to be a very useful tool for the day-to-day management of olive farms.

For information about buying this book visit the publishers' website at: www.elolivarsuperintensivo.com



Tecnologie di lavorazione delle olive in frantoio: rese di estrazione e qualità dell'olio

Author: **Luciano di Giovacchino**
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It gives us pleasure to present this book authored by Professor Luciano Di Giovacchino on the subject of olive oil processing technology, oil extraction yields and quality and intended for people in the olive and olive oil industry, university students, researchers – who will find a helpful source of information in the references – and anyone else interested in adding to what they know about virgin olive oil.

In the introduction, the author explains that the book is meant to contribute to research into olive oil processing at the mill, a subject on which, in Italy at least, the scientific literature dates back to the 1960s to 1970s.

After running through the systems used at that time, basically pressing, percolation and centrifugation (three and two-phase), the book highlights the gradual consolidation of two-phase centrifugation in the top producing countries – Italy, Spain and Greece – over the subsequent two decades. It goes on to describe the developments in the olive oil industry in Italy and Spain in step with the progress in research findings and technological innovation.

A large section deals with the analytical determination of phenolics content owing to the nutritional importance of antioxidants in foods and more specifically in oil. There is evidence that antioxidant content varies not only according to olive variety, degree of ripeness, fruit health and storage conditions but also to the handling, processing and storage techniques applied at the mill.

A description is also given of the techniques used to enhance mechanical efficiency during centrifugation or oil extraction yield with the aim of maximising mill processing ca-

pacity while using less labour, and optimising the reuse of processing by-products as part of making olive growing sustainable.

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