# OLIVE GROWING IN A TIME OF CHANGE

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**Keywords:** *Olea europaea* L., olive growing, phenology, breeding, new cultivars, nursery industry, traditional orchards, mechanized orchards, Integrated Pest Management (IPM), olive oil, table olives, HACCP system.

## Contents





## Summary

The olive (*Olea europaea* L.) is indigenous to the Mediterranean Basin. It is a small to medium sized tree that is a major crop in the Mediterranean Basin countries and has been grown in other similar climates in the southern hemisphere, south west Asia, Africa and elsewhere. This tree crop has played a major role in the culture and diet of peoples in the Mediterranean regions of the world. This chapter focuses on the current olive growing practices in the world emphasizing the contrast between the empirical and traditional practices with the new emerging techniques based on both empirics and scientific knowledge and innovation. Initially, harvests were made from wild olives but over the past 5,500 years selection and cultivation have transformed olive growing and now olive production is entering a new phase. Currently, olive growing is progressively moving from traditional olive groves to new-style olive orchards.

Since War World II, olive growing is changing in Northern Mediterranean countries and in new olive growing regions elsewhere. Migration from rural to urban areas required productive and mechanized orchards. The accumulated changes since that time led to new olive plantations. These new olive orchards bear earlier and their life span is shorter than in the past. The management of traditional olive groves and the newer

orchard plantings has been modified to reflect changes in the availability of labor and the changing market demand.

## 1. Introduction

Traditional olive growing has several distinctive traits. The crop is very well adapted to the Mediterranean climate, which is characterized by long drought periods throughout the year. Olive groves are usually composed of widely spaced long-lived trees. Dry farming (rainfed) is the rule in most plantations. Olive growing often represents the main, even the only, agricultural commodity in many places. Most agricultural practices are primarily based on local empiric techniques. Consequently yield is generally poor. For this reason the increasing demand for olive oil and table olives has been historically attended by increasing the planted area. Thus new olive groves were progressively established in poorer and more fragile soils. Finally, the harvesting, which is still made by hand in many olive districts, requires most of the yearly labor. This demand provides work to many people during the 2-3 months that the harvesting period lasts.

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Since War World II olive growing is changing in Northern Mediterranean countries and in new olive growing regions elsewhere. Migration from rural to urban areas required productive and mechanized orchards. The accumulated changes since that time led to new olive plantations. These new olive orchards bear earlier and their life span is shorter than in the past. Good agricultural practices to avoid soil erosion and contamination of the environment are being gradually used. Annual cultural practices are being simplified, and pruning and harvesting become more mechanized. Yield has increased under irrigation and by high density orchards. Traditional and local practices of selection and propagation of cultivars are being replaced by few cultivars multiplied by nurseries in many countries. For the first time in history new improved cultivars are in development in several countries. Finally, olive oil is now considered an important agricultural product for health and its consumption is continuously growing in the World.

## 2. Origin and World Distribution

The origin of olive growing is associated with the discovery of vegetative propagation using cuttings in the Middle East about 5,500 years ago. Since that time the crop has expanded west along both shores of the Mediterranean Basin (Figure 1). This crop was well established by Roman times as witnessed by the agricultural treatises of Pliny and

Columela. Olive oil export from Andalusia to the rest of the Roman Empire is well documented by "Mount Testaccio", a rubbish dump in Rome where remains of olearia amphorae are accumulated. The subsequent changes in olive growing has been discontinuous with periods of expansion and contraction associated with events such as demographic changes, olive oil and table olive demand, and political factors. From the fifteenth century, transoceanic voyages of Columbus, Magellan and Juan Sebastián Elcano helped it reach and spread throughout the New World. Olives are currently grown also in South Africa, Argentina, Chile, Peru and USA in America, and China, Japan and Australia (Table 1).

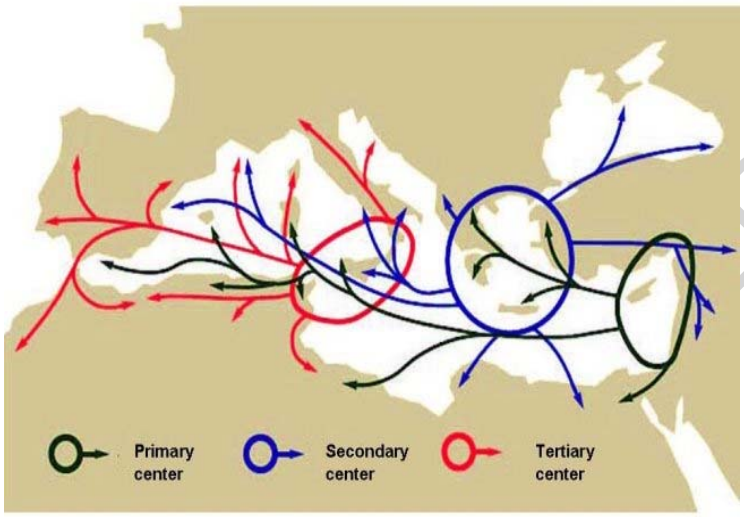


Figure 1. Olive diffusion in the Mediterranean Basin. (Adapted from Morettini. 1950. Olivicoltura. REDA.Roma.Italia, by Rallo, L. 2005 In Rallo, L., Barranco, D., Caballero, J. M., Del Río, C., Martín, A., Tous, J. Trujillo, I. (Eds.). (2005). *Las variedades de Olivo en España*. Junta de Andalucia. Ministerio de Agricultura Pesca y Alimentación. Ediciones Mundi- Prensa, Madrid, España. We acknowledge the permission by authors, scientific editors and publishers)

Current olive groves are estimated at approximately 960 million olive trees, of which some 945 million (98% of the total), are found in the Mediterranean Basin countries where they cover approximately 9.3 million hectares (Table 1). Approximately 50 million olive trees are under irrigation, but most groves are rainfed. Olive plantations have shown a continuous increase since 1987 (Table 1) with a spectacular increase of the irrigated area in many countries. The average annual production is 14 million tonnes of olives, of which 90% are used for oil production and 10%, are used for the table olives.

| | **Area Harvested Olive Crops (ha)** | | | | |
|---|---|---|---|---|---|
| **Countries** | **1967** | **1977** | **1987** | **1997** | **2007** |
| Algeria | | 167020 | 161680 | 162840 | 330000 |
| Argentina | | | 24000 | 27700 | 34000 |
| Australia | 862 | 1500 | 500 | 450 | 8000 |

| | | | | | |
|---|---|---|---|---|---|
| Brazil | | | 40 | 45 | 10 |
| Chile | | | 3400 | 4507 | 6600 |
| Egypt | 3700 | 1680 | 9660 | 24000 | 50000 |
| France | 29405 | 29710 | 17388 | 12879 | 18700 |
| Greece | | | 726000 | 728735 | 800000 |
| Iran | 5000 | 4800 | 5162 | 6130 | 23000 |
| Israel | 11000 | 10430 | 12480 | 15730 | 16000 |
| Italy | 1266100 | 1386300 | 1149676 | 1124320 | 1164211 |
| Jordan | 62157 | 18382 | 38145 | 61602 | 60140 |
| Libya | | | 60000 | 105000 | 148000 |
| Morocco | 170000 | 200000 | 274200 | 426600 | 530900 |
| Peru | 2664 | 3709 | 5688 | 5848 | 9456 |
| Portugal | | | 339835 | 338414 | 379400 |
| Spain | | | 2057000 | 2207556 | 2600000 |
| Syria | 141718 | 228263 | 323233 | 445180 | 600498 |
| Tunisia | 680000 | 1324300 | 1325000 | 1200000 | 1600000 |
| Turkey | 449667 | 493333 | 526667 | 571867 | 620000 |
| USA | 10926 | 13390 | 12780 | 14285 | 12141 |
| Total M. W. | 2917469 | 3975253 | 7204803 | 7709066 | 9238319 |

Source: International Olive Council

Table 1. Area of cultivated olive trees in the World (ha) in the last 50 years.

World olive oil production and consumption have increased steadily since 1993 (Table 2) due to its beneficial influence on human heath. Consumption has grown at a rate of 45,500 tonnes/year. Production and consumption are balanced: each important increase in mean production has been related to a similar increase in consumption. Currently production and consumption stands around 2.8 millions tonnes. The European Union is the main producer (76%) and consumer (70%). Spain (37%) is the main producing country and Italy (28,5%) the first consumer country.

The international olive oil trade, approximately 570,000 tonnes, is dominated by the European Union which is the largest exporter (58%) as it also re-exports most of the oil imported from Tunisia, the second exporter (24%).United States is the first importer (35%) followed by the EU (25%). Italy and Spain lead bottled oil olive exports and Spain mass olive oil exports, mainly imported by Italy.

| | **Production Olive Oil (1000 t)** | | | **Consumption Olive Oil (1000 t)** | | |
|---|---|---|---|---|---|---|
| **Countries** | **1993/97** | **1998/02** | **2003/07** | **1993/97** | **1998/02** | **2003/07** |
| Algeria | 33,3 | 31,0 | 34,3 | 31,7 | 33,7 | 35,4 |
| Argentina | 9,4 | 7,9 | 16,1 | 5,1 | 6,9 | 4,9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Australia | | 0,8 | 5,5 | 17,9 | 25,1 | 36,1 |
| Brazil | | | | 17,9 | 25,1 | 36,1 |
| Canada | | | | 14,6 | 21,5 | 29,1 |
| Egypt | 1,2 | 1,2 | 4,5 | 1,8 | 1,2 | 3,6 |
| EU | 1456,0 | 2021,2 | 2141,4 | 1448,3 | 1774,4 | 1963,6 |
| France | 2,1 | 3,4 | 4,3 | 47,3 | 84,6 | 97,9 |
| Germany | | | | 14,66 | 32,26 | 43,68 |
| Greece | 340,8 | 411,3 | 390,2 | 214,6 | 258 | 271,5 |
| Italy | 478,6 | 584,8 | 664,9 | 667,2 | 716,2 | 794,6 |
| Portugal | 35,0 | 37,1 | 35,6 | 57,5 | 64,8 | 71,0 |
| Spain | 599,5 | 984,6 | 1040,2 | 416,94 | 558,7 | 567,5 |
| U.K. | | | | 17,2 | 31,0 | 55,0 |
| Tunisia | 157,0 | 136,6 | 172,4 | 53,3 | 49,4 | 42,6 |
| Turkey | 100,8 | 104,0 | 128,2 | 59,4 | 71,6 | 57,2 |
| USA | 1,7 | 0,8 | 1,1 | 113,3 | 169,2 | 217,4 |
| Total | 1962,5 | 2526,7 | 2804,4 | 2002,6 | 2486,7 | 2794,5 |

Table 2. Average Year Production and Consumption of Olive Oil (t x 1000) in the World from 1993/97 to 2003/07.

World table olives production and consumption have almost doubled in the last 15 years, reaching around 1,828 tonnes per year for the 2003/07 period (Table 3).The EU is the main producer and consumer, being Spain (26%) and Greece (6%) the main producer within the EU. Currently others important producers are Egypt and Turkey followed by Syria (138,000 tonnes), Morocco (94,000 tonnes) and USA. This latter country is the first consumer followed by Spain, Egypt, Turkey, Italy and Syria (125,000 tonnes).

| | **Production Table Olives (1000 tm)** | | | **Consumption Table Olives (1000 tm)** | | |
|---|---|---|---|---|---|---|
| **Countries** | **1993/97** | **1998/02** | **2003/07** | **1993/97** | **1998/02** | **2003/07** |
| Algeria | 12,7 | 31,5 | 71,5 | 13,1 | 29,7 | 73,3 |
| Argentina | 39,6 | 45,4 | 68,0 | 15,1 | 14,9 | 15,7 |
| Australia | 2,0 | 2,4 | 3,3 | 9,5 | 13,1 | 17,7 |
| Brazil | 1,0 | 0,7 | 0,4 | 43,36 | 48,7 | 54,1 |
| Canada | | | | 14,7 | 19,7 | 24,2 |
| Egypt | 45,6 | 76,2 | 253,1 | 41,9 | 57,0 | 199,6 |
| EU | 367,8 | 589,5 | 696,2 | 341,8 | 428,0 | 570,3 |
| France | 1,8 | 2,0 | 1,7 | 28,4 | 35,4 | 54,0 |
| Germany | | | | 19,1 | 28,8 | 41,4 |
| Greece | 62,0 | 94,0 | 111,5 | 25,2 | 24,6 | 32,0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Italy | 69,5 | 65,0 | 67,1 | 122,0 | 127,2 | 141,6 |
| Portugal | 12,1 | 10,2 | 12,2 | 14,8 | 13,1 | 12,4 |
| Spain | 222,3 | 418,4 | 497,0 | 115,8 | 163,9 | 204,6 |
| U.K. | | | | 5,4 | 12,7 | 31,0 |
| Tunisia | 12,0 | 11,7 | 17,4 | 11,6 | 11,1 | 16,7 |
| Turkey | 137,0 | 152,2 | 210,0 | 115,0 | 126,2 | 157,2 |
| USA | 106,3 | 95,4 | 80,4 | 166,7 | 185,8 | 212,0 |
| Total | 984,4 | 1292,5 | 1891,7 | 1024,06 | 1237,2 | 1827,5 |

Source: International Olive Council

Table 3. Average Year Production and Consumption of Table Olives (t x 1000) in the World from 1993/97 to 2003/07.

Total international trade of table olives reached approximately 450,000 tonnes per year. The USA (36%) is the main importer of table olives, followed by Brazil, France, Canada, Switzerland and Russia. Spain (39%) is the main exporter followed by Morocco, Turkey and Greece.

## 3. Soil and Climate Factors

The habitat of the olive tree is located around 30° and 45° latitude, both in the Northern and in the Southern hemispheres, this area has a Mediterranean climate which is characterized by dry and hot summers and mild winter temperatures. In the Southern hemisphere, olive groves are found in more tropical latitudes Altitude is the modifying factor that leads to lower winter temperatures and allows successful olive growing.

Olive is more sensitive to frost than temperate fruit crops. Like these species, olive is hardened by progressive cold temperatures in autumn which induce dormancy on the tree that become resistant to temperatures below 0°C. During dormancy, temperatures ranging between 0°C and -5°C cause small lesions on shoots and young limbs, which are the entry point for pests and diseases; temperatures ranging between -5°C and -10°C may cause greater damage to shoots and young limbs, which may lead to their death; and temperatures below -10°C kill large limbs and even the entire canopy of the tree. During the fruit growth and ripening period, temperatures below 0°C will damage fruit, decrease production and the quality of the oil produced. When olive trees are actively growing, temperatures slightly below 0°C may cause severe damage to shoots and kill buds and recently formed leaves; and low temperatures that are slightly above 0°C may cause incomplete flower development. The shorter the duration and the less sudden the cold spell, the lower the above described damage will be.

Olive growing can cover a great diversity of soils although it prefers deep loam textured soil with good drainage. In the Mediterranean basin, olive groves cover mainly slopes and limestone hills, although they also cover extensive areas on terraces and alluvial plains as well as foot slopes. In general, it may be said that dryland olive groves prefer coarser texture soils with lower rainfall because when the moisture soil retention is low, any water that reaches the soil is best used. With finer textures, more rainfall is needed

to avoid problems in the development of the crop.

Slope of the lands, rainfall, and eventually frost are the main ecological factors that determine the productivity of the olive orchards in dry conditions. The slope of the soil is the main factor determining erosion in the olive groves (Figure 2) . The extension of the risk of erosion is illustrated by a survey of the olive yards in Andalusia by the Consejería de Agricultura y Pesca (2003). The slope of the 38% of the Andalusian olive plantations is between 7% and 15%, and 36% of the groves are located in soils with more than 15% of slope. A clear relationship between slope and yield was found in this study. The yield of the orchards with more than 15% of slope was only 2.100 kg per ha while the yield of the orchards with less than 15% of slope was 2800 kg per ha. It is not easy to control erosion. In land with slopes below 6%, erosion may be minimized by soil management systems; for higher gradients, soil conservation requires contour and terrace plantings and even bench terraces.


Figure 2. Plantations in high and moderate sloping locations (a and b) originate active erosion. Terrace and contour plantings (c and d) prevent erosion but they are not common in traditional groves. (From J. R. Guzman, 8a and c and from D. Barranco, 8b. From Pastor, M. 2005. 8d. In Barranco, D., Fernández-Escobar, R., Rallo, L. (Eds.).(2008). *El Cultivo del Olivo*. 6ª Edición. .Consejería de Agricultura y Pesca, Junta de Andalucía, Ediciones Mundi-Prensa, Madrid, España. We acknowledge the permission by authors, scientific editors and publishers).

The average rainfall in the main producing areas of the world ranges between 200 and 800 mm per year, although substantial annual variations occur. Rainfall is heaviest in fall and spring, and occasionally very intense, causing serious erosion damages. Summer is dry and hot, reaching temperatures of over 35ºC, which are not usually harmful, except in the event of hot weather during flowering, thus harming fruit set. Currently, rain fed farming account for more than 85% of the area devoted to olive growing. Yield integrates the response of the olive orchards to all limiting ecological and cultural factors. In Andalusia, the most important and one of the most productive olive region of the World, yield in rainfed orchards have been used to map marginality of the olive. In this study, 35% of olive orchards yielded less than 1,500 kg/ha and 65%

less than 3,000 kg/ha In Andalusia rainfall ranges between 300 and 600mm per year. A clear relationship has been found between yield and rainfall in the Andalusian olive orchards in dry lands.

## 4. Vegetative Growth and Reproductive Biology

The botany and morphology of the olive is not presented in this chapter but the key factors related to growth and reproduction is summarized. Olive trees produce fruit on the previous year's shoots (Figure. 2). Leaves last from two to three years. This means that the aerial part of the tree is made up of a support and storage structure (crown, trunk, main limbs and other limbs) and storage and photosynthetic structures (leaves on 2 year old, 1 year old and current year shoots) where the $CO_2$ uptake and shoot growth and reproduction processes take place. Two characteristics stand out in olive trees: a) the biennial habit of bearing, i.e. that good production years alternate with poor production years and b) the massive drop of flowers and fruit over the 6-8 weeks following flowering.

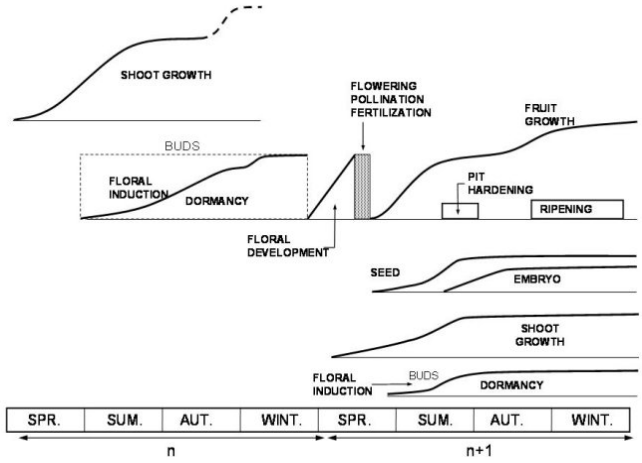


Figure 3. Olive fruiting shoots. Shoot growth in 1979 is smaller than in 1978 due to competition for assimilates between developing fruits and shoots in 1979.(From Rallo and Cuevas, 2008. In Barranco, D., Fernández-Escobar, R., Rallo, L. (Eds).(2008). *El Cultivo del Olivo*. 6ª Edición. .Consejería de Agricultura y Pesca, Junta de Andalucía, Ediciones Mundi-Prensa, Madrid, España. We acknowledge the permission by authors, scientific editors and publishers)

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and biotechnology with particular reference to the use of molecular markers for genotyping and Marker Assisted Selection (MAS)].

**Biographical Sketches**

**Luis Rallo** is Professor of Pomology at the University of Córdoba, Spain. His entire career has been spent on olive research, especially on genetic resources, breeding and reproductive biology.

**Concepción Muñoz-Díez** is postdoctoral researcher at the Agronomy Department of the University of Córdoba and she has focused on studies about the conservation of olive genetic resources and in their use in breeding programs.