

Olive Oil Production in Greece

Report on the Olive Oil Production Tour (11-28 to 12-8, 1999)

By Paul Vossen



Background

The country of Greece lies in the southeast corner of Europe. It has a total area of 131,957 sq. km (50,949 sq. miles), of which about one-fifth is composed of islands in the Aegean and Ionian seas. Athens is the capital and largest city.

The mainland portion of Greece comprises the regions of Thrace and Macedonia in the north; Epirus, Thessaly, in the central section; and, in the south, the Pelopónnisos, a peninsula, which is connected to the rest of the mainland by the Isthmus of Corinth. The Corinth

Canal, completed in 1893, passes through the Isthmus of Corinth, making an artificial island of the Pelopónnisos. The remainder of Greece consists of islands, which include Euboea; Crete; the Northern Sporades; the Cyclades, Dodecanese, the Ionian Islands; Ikaría, Khíos, Límnos, Lésvos, Sámos, Samothráki, and Thásos.

The population of Greece is about 98 percent ethnic Greek and is estimated to be 10.5 million people, giving the country an overall population density of about 207 per sq. mile. The population of Greece is large in relation to the size and economic capacity of the country, and much poverty and unemployment exist. About 63 percent of the population is urban and concentrated around Athens, Thessaloniki, the western Pelopónnisos, and on the islands of Corfu, Zákynthos, and Khíos. Famous ancient cities such as Árgos, Corinth, and Sparta are only small towns today.

Archaeological evidence indicates that a primitive Mediterranean people, closely akin to the races of northern Africa, inhabited the southern Aegean area as far back as the Neolithic Age, before 4000 BC. The many natural harbors along the coast of Greece and the multiplicity of close-lying islands led to the development of a homogeneous, maritime civilization linking Europe and the West Coast of Asia Minor. The evidence shows a cultural progression from the Stone Age to the Bronze Age, which in the area of Greece commenced about 3000 BC.

Greece is famous for its natural beauty. The land is mountainous and rugged with a very diverse topography. The central mountain area, the Pindus Mountains, which extends in a north – south direction, is one of the most rugged, isolated, and sparsely populated parts of the country. Mount Olympus (9,570 ft), the highest peak of Greece, was considered in ancient times to be the home of the gods. The western slopes, which extend through Epirus down to the Ionian Sea, are somewhat lower and more hospitable.

The southeastern extremity of Central Greece, known as Attica, is broken into many isolated valleys and plains by mountain ridges. The most famous part of Greece, the Athenian plain, is in Attica. The largest plain of the eastern coastal area, however, is in Boeotia, to the north of Attica. Thessaly, a plain ringed by mountains, is one of the more fertile parts of the country. Macedonia has the largest plains in Greece. Thrace, to the east of Macedonia, has a varied topography consisting of mountains, valleys, and several coastal plains.

The Pelopónnisos is mountainous, but to a lesser degree than Central Greece, and is shaped somewhat like a giant hand with high mountain ridges extending like fingers into the sea. Between the mountain ridges are narrow isolated valleys, which open onto the sea. The western section of the Pelopónnisos is less mountainous than the eastern section. The islands of the Aegean Sea are generally high, rugged, stony, and dry. They are important because of their great beauty, historical importance, potential for tourism, and strategic military value.

The climate of Greece is similar to that of other Mediterranean countries. In the lowlands the summers are hot and dry, with clear, cloudless skies, and the winters are rainy. The mountain areas are much cooler, with considerable rain in the summer months. Frost and snow are rare in the lowlands, but the mountains are covered with snow in the winter. The rainfall varies greatly from region to region. In Thessaly less than 1.5 in. of rain falls in some years, whereas parts of the western coast receive about 50 in. The mean annual temperature in Athens is about 63° F; the extremes range from a normal low of 31° F in January to a normal high of 99° F in July.

Greece is poorly endowed with natural resources of economic value. Only 23 percent of the land is arable; the rest consists mostly of barren mountains. The forests, probably abundant in ancient times, have to a great extent been depleted. Subsequent soil erosion has made reforestation efforts difficult.

Greece has a great diversity of vegetation. From sea level to an elevation of about 1,500 ft, oranges, olives, dates, pomegranates, figs, cotton, and tobacco are grown. From about 400 to 1,500 ft deciduous and evergreen forests are found, where oak, black pine, chestnut, beech, and sumac grow. Tulips, hyacinths, and laurel are also characteristic of the area. Firs and such wild flowers as anemone and cyclamen are found above about 4,000 ft, and mosses and lichens predominate above about 5,000 ft. elevation. Wildlife includes boar, European black bear, lynx, jackal, chamois, deer, fox, badger, and weasel. Among the birds are the hawk, pelican, egret, pheasant, partridge, nightingale, turtledove, and stork.

The soil of Greece is mostly very rocky and very dry, but the country is interspersed with small valleys where the soils are of the rich Mediterranean *terra rosa*, or red earth. Agriculture plays an important role in the Greek economy. In 1970 the contribution of manufacturing to the annual national output surpassed that of agriculture for the first time. Two other major sources of income for Greece are shipping and tourism. The production of petroleum from fields in the northern Aegean Sea began to aid the economy in the early 1980s. Since the 1950s the public sector of the economy has grown considerably; the government now controls about 60 percent of the economy, particularly in energy, shipbuilding, communications, transportation, insurance, and banking. The estimated national budget in the 1990s was approximately \$50 billion annually.

About 21 percent of the Greek labor force is engaged in farming, and agriculture constitutes about 15 percent of gross domestic product (GDP). Since the 1970s the number of people engaged in agriculture has declined significantly as people have moved to urban areas seeking employment in the manufacturing and service industries. Farms are small, subdivision through inheritance has reduced the average size to approximately 8 acres, and consequently it is difficult to use

mechanized equipment efficiently. In addition, yields are low because of the dryness and eroded soil.

The approximate yearly output of major crops (in metric tons) in the early 1990s was: sugar beets, 3.2 million; wheat, 2.9 million; corn, 2 million; olives & olive oil, 1.7 million; tomatoes, 1.7 million; grapes, 1.3 million; peaches and nectarines, 1.1 million; potatoes, 965,000; oranges, 872,000; and tobacco, 182,000. Livestock included approximately 27 million poultry, 9.7 million sheep, 5.8 million goats, 1.2 million pigs, and 616,000 head of cattle.

Olive oil is one of the most precious products of Greece. Over 350,000 families earn their living from olive oil production, producing 200,000 to 300,000 tons annually which averages to about 18% of the world's production. Greece has almost 3,000 mills and 220 bottling companies: 30% of the Greek oil is produced in Crete, 26% in the Pelopónnisos, 10% in Lesbos, 10% in the Ionian Islands, and the remaining 24% is scattered around the rest of the country. One reference indicates that 80% of all fats and oils consumed in Greece is olive oil and lists the Greeks as the largest per capita consumers of olive oil at 20 liters per person per year, which is twice what the Italians and Spanish consume.

Itinerary for the Educational Tour – November 27 to December 8, 1999

November 27 & 28: Travel

November 29: Pelopónnisos near Kalamata – olive oil production

November 30: Pelopónnisos near Sparta - olive oil production

December 1: Pelopónnisos near Kalamata – table olive production

December 2: Thessaloníki – table olive production & tree nursery

December 3: Thessaloníki – olive oil production & visit to an archeological site

December 4: Athens – archeological & cultural studies

December 5: Crete near Heraklion – archeological studies

December 6: Crete near Hania – olive oil production

December 7: Crete near Hania – olive oil production

December 8: Travel – return to California

Tour Attendees

Robert and Dorothy Adamson

Richard and Lillian Dickson

Robert and Gayle Dunlap

John Hadley

Alfred and Kathy Herberman

Marino Garbis

Bill and Lila Jaeger

Lia Lund

Elizabeth Martini

Jean Michels

Carl and Charlotte Muia

James and Helen Nassikas

Peter Panagotacos

Petros Panagiotakakos

Julie and Carloyn Poe

Garland and Catherine Stoup

Darrell Corti

Mary Jane Drinkwater

Apostolos Kiritsakis

Paul Vossen

Pelopónnisos near Kalamata {Palace of Nestor - Gargaliani Cooperative – Olive Harvest}

Upon our arrival in the Pelopónnisos near Kalamata, we were welcomed by the Governor of the Messinia region and our host for the day, Fotis Tsarpopulus, the local farm advisor. We were told that the region of Messinia has approximately 15 million olive trees producing 60,000 tons annually. Within the region there are 300 oil mills and over 40,000 people are employed in the olive oil business. Olive cultivation is a part of the culture of the local people, and many annual events and festivals surround the oil crop, including a landscape covered with olive trees. The health of the people is fundamentally based on olive oil. They consume 35 liters of olive oil per person per year in the region, almost twice the national average. The oil of the region is mostly from the Koroneiki variety, which does very well in the hot dry summer climate, somewhat equivalent to the climate of California. Good quality oil is produced because the small-scale farmers can pay close attention to detail in their production techniques. The *Dacus olea* (olive fruit fly) is a major problem in the area. Many of the farmers use no pesticides, but farm their trees organically.

We traveled west from Kalamata through the city of Missini to the village of Gargaliani. Along the way we visited two farms that were harvesting Koroneiki olives for oil. The farms of the area were small with an average size of about 5 acres. Albanian farm laborers were hired to help harvest the fruit at a wage rate of \$19-22/day. The farmers and their workers were beating the fruit off the trees with long wooden poles onto nets placed on the ground. They were also pruning out fruit-laden branches that would normally be removed in the pruning process and pulling these branches through a stationary combing machine to remove the fruit. These machines were visible in almost every orchard. They operated on a gasoline engine that rotated a horizontal cylinder with rubber fingers to comb the fruit off into a small pile on the net below. The fruit was then placed into nylon or burlap sacks of about 80 lbs. capacity and transported on flat bed wagons and trucks to the mill.

The four primary varieties that we saw in the area were Koroneiki, Mavroyá, Kalamata, and Mastoides. The following is a description of these varieties:

- ***Koroneiki***: Also known as Myrtoyá, a very hardy drought resistant variety that sets a very heavy crop almost every year. The fruit are very small and attachment to the tree is very strong, making the fruit difficult to harvest.
- ***Mavroyá***: Early maturing variety that needs better soil (more water holding capacity) than Koroneiki.
- ***Kalamon***: The classic Greek table variety from the area of Kalamata. This variety tends to alternate bear and is less productive than the other varieties.
- ***Mastoides***: A local oil variety that has medium sized fruit with a characteristic pointed shape.

On the way to the cooperative we visited the Palace of Nestor which was built in the beginning of the 13th Century BC. It was destroyed by fire about 1200 BC. The palace was the seat of the ruler Neleus, the father of Nestor, and the administrative center for the agricultural region. The palace contains interesting clay olive oil magazines and clay tablets with texts relating to the allocation of taxes, debts, distribution of goods, and expenditure on armaments. It is surrounded by olive orchards and sits on the top of a small rise that affords a beautiful view of the area.

The Gargaliani Cooperative is a large facility that serves many farmers in the area. Their brand is called Pithari and is sold locally and in Europe, primarily to Italy and Germany, bottled in tins and in bulk. The facility has two large capacity 2-phase Peralisi continuous flow decanters and a large capacity hammermill. The fruit is brought into the holding yard in burlap bags and unloaded into a

hopper by hand. Most of the fruit we saw, the day we were there, had olive fly damage and had been sitting in the bags long enough to start to ferment. The oil tasted of both “grubby” and “fusty” defects. Other oil that we tasted from previous workings and made primarily from Koroneiki was quite good, however, and had a typical fruity varietal character.

The wet pomace waste-product left from the 2-phase operation was dumped into open topped dump trucks and sold to a pomace refinery in the area. The same trucks returned with spent dry pomace which was used to heat the mill and warm the water jackets in the malaxation tanks.

Pelopónnisos near Sparta {Sparta - Mistras – Cooperative in Dafnio - Agrofarm Nursery}

The second day, we headed up and over the mountain ridge east of Kalamata to the town of Sparta, once a huge center for the famous warrior civilization. We saw rugged mountainsides covered with terraced olive orchards, barren areas with little soil to support growth of any kind, and forested areas covered with pine trees. Sparta is still a regional government administrative center for the Laconia region but is now quite small with very few remains of the once thriving metropolis. The region’s mountain topography and climate is very enjoyable. One of the most beautiful sites was the Fortress City of Mistras, which we walked through. It is still being used by a small group of local nuns. It is a wonderful archeological site built by the Byzantine culture between 1249 and 1460 and located in the high country surrounded by a rich valley containing olives, citrus, and grapes.

We visited the home of Peter Panacotacos near the village of Dafnio. His orchards were recently planted, within the last 10 years, and typical of dry-farmed olive production agriculture of the area. Peter and his Greek cousin, Petros, have their olives milled at a nearby mill in the next village, but we had an opportunity to see the local Dafnio cooperative oil-processing mill because of its convenient location. It was a good example of what not to do.

This small mill has 350 members, all from the local village, each with 200 to 5,000 trees. Their fruit was mostly of the Koroneiki variety, but with some Mastoides. The quality of the fruit was poor with olive fly damage, harvest bruising, and storage fermentation. Much of it is held for 3-10 days before milling. The mill was not kept clean. It had old rancid pomace on the floor and dirty plastic containers piled up waiting to receive the new oil. The facility had a large older model 3-phase horizontal decanter (brand named *DDS Separation*) and four horizontal centrifuges. The olives were milled with a hammermill. The wastewater was mixed with lime and discharged directly into the dry creek bed behind the mill. Most of the oil was consumed locally as they indicated that each family of 3-4 people used about 200 liters of oil per year. Excess oil was sold in bulk to the Italians.

On our way back to Kalamata we stopped at *Agrofarm Nursery*, a large olive and citrus plant propagation facility. Thousands of plants stood in pots in rows all neatly tied to bamboo stakes. Most of the olive trees were started by digging up feral olive trees to be used as rootstocks. These trees grow from seeds deposited by birds in the wild mountainous areas. The wild trees are placed into one or five-gallon pots with native soil and patch or bark grafted with the chosen scion variety. The trees are grown to a height of 4-5 ft. with no side branching below 3 ft. Multiple shoots are allowed to develop above 3 ft. over a six-month period. The trees are sold within Greece for \$3.00 for the 1 gal. size, \$5.00 for the 5 gal. size, and up to \$10 for larger sized trees. These trees can not be shipped into the US because they are grown in native soil and have an unknown rootstock.

Kalamata Table Olive Production

The next day we had a chance to see the original Kalamon variety tree that was the source of grafting wood for the famous Kalamata style table olives. The tree is about 800 years old. It is maintained by the local government in very humble surroundings behind a locked fence.

Early the next morning, after viewing an orchard being harvested, we were guests at The Lagiakos table olive processing plant, which was located just outside Kalamata next to their family home. The entire facility was meticulously clean and beautifully landscaped. It was a stucco style set of buildings with a tile roof. Kalamata style olives were being processed from the Kalamon variety brought into the plant in plastic hand-held lug boxes. Most of the fruit was graded for size and then passed through a slicing machine that aligns the fruit and cuts the flesh down to the pit on one side. This speeds the processing time by allowing the bitter compounds within the fruit to exit rapidly. Several different styles of olives were being produced to sell in the world market including Europe, Australia, and the US. Most of the fruit was treated with a salt solution in 50-gallon plastic drums. The following are some of the different styles produced.

- Sliced ripe fruit placed in 6-7% salt brine for about 20 days without changing the water.
- Sliced ripe fruit placed in 3% salt brine and changing the water daily; ready in 8-10 days.
- Unsliced ripe fruit placed in 8-9% brine solution changing the solution every 7-10 days; fruit ready in about 20 days.
- Ripe black fruit placed in 3% salt brine solution for two months without changing the water.
- Green fruit cracked in a roller and placed in a brine + lemon juice + herbs solution for 20 days.
- Green fruit placed in a 3% brine solution for 2 weeks then fermented in mother brine for 5 months.

Once the olives were finished in the original processing phase they were packed in fresh salt brine into various sized containers for bulk or retail sale. Some were sold in 2-gallon tins topped off with 1" of olive oil; others were sold in shrink-wrap plastic. Bulk olives were sold in larger 5-10 gallon plastic barrels. The ripe olives that are harvested black or as they are turning black are somewhat bleached in color due to their time in the salt brine solution. As they are exposed to air, however, they slowly oxidize and turn black. Dry olives are produced by placing black ripe fruit into rock salt and tumbled once/week for 45 days. Cull fruit was processed into "Kalamata" olive oil. We did not see that process, but tasted some of the oil, which was quite good.

Thessaloniki Area {Table Olive Cooperative – Tree Nursery – City Market}

In Thessaloníki, Greece's second largest city, we received a tour of the ancient city's 12 meter thick walls that are mostly in ruins, but in some places are still part of old homes. The walls were built to defend the city and port from invaders. Philip II and Alexander the Great founded it in 319; it now has 1.1 million inhabitants. The Turks destroyed much of the original walls in 1430. The city was also captured by the Romans and Byzantine in its past.

East of the city we visited a large cooperative table olive packing plant in the region of Halkidiki called the Union of Agri-Coop Societies of Nea Moudania. Their brand name was Halkidiki. Just outside the gates of the processing plant we observed hired laborers from Albania harvesting the large round Halkidiki table fruits. They spread tarps on the ground and knocked the fruit off with long wooden poles then dumped them into plastic lug boxes for transport to the processing plant.

For stuffed green olives the fruit is harvested green and firm. We observed the harvest of black ripe fruit that was to be used for dried olives in the salt cured process.

At the plant the fruit was moved by elevator into large lye (sodium hydroxide) vats for 12 – 14 hours during which time about 2/3 of the bitterness was removed. The fruit was then soaked for 15 hours in clean water that was changed three times to remove any residual lye and bitterness. Then the fruit was deposited into underground storage vats kept at 55-60° F in a mild brine solution for 3-4 months and allowed to go through lactic acid fermentation. The fruit is then vacuum pumped into the plant where it is sized by machine and sorted by hand for defects.

Some of the fruit is pitted and stuffed by hand. We observed four women in a small room off to the side where one was cutting up pickled pimento peppers into strips and the other three were stuffing them into the pitted olives. It looked like tedious work, but the attention to detail and quality was excellent.

Later that afternoon we visited an olive nursery near Olinthos that produces 200,000 plants per year. This nursery produces plants using modern plant propagation techniques including bottom heated perlite beds and hormone dipped cuttings. Most of their cuttings are taken in the spring, dipped in IBA (Indole Butyric Acid), placed in perlite that is bottom heated to about 70°F while the air temperature is kept near 55° – 60° F. Depending on the variety, they usually receive between 50% and 85% rooting within 45 days. The rooted cuttings are planted into 4” pots for three months, then transplanted into one gallon pots and grown for a whole year before they are sold. The process takes about 1½ years. The trees are sold for about \$3.00 each. Their varieties include the Halkidiki, Megaron, and Amfesis. Back at the hotel that evening, we tasted 16 different Greek olive oils from around the entire country.

The next day we visited a private oil mill that was working locally grown overripe Halkidiki olives and Amfesis fruit shipped in from further south in a salvage operation. It was the Ieremias mill owned by two brothers. They used a hammermill to produce a paste and then Alfa-Laval malaxators, horizontal decanters, and vertical centrifuges to extract the maximum quantity of oil possible. The paste and oil were hot to the touch. Quantity rather than quality was obviously their goal for that fruit and that time of year. The fruit they were working was large table fruit that was overripe or had been culled from the table fruit processing facilities.

We also toured the Museum of Thessaloníki to see the many exhibitions of Byzantine culture that presented aspects of their society, with an emphasis on the transition from the ancient world to the Christian era. At the royal tombs at Vergina, which was once the ancient capital of the kingdom of Lower Macedonia, we saw the graves “rich in gold” of Philip II’s mother and Philip II himself. The museum and tumuli (chamber tombs) were brilliantly decorated with carved marble and enriched with brilliant works and inscriptions. In the evening we visited the city market filled with open butcher shops, table olive & olive oil shops, fish markets, cheese shops, fruits & vegetables, and various local arts, crafts, and low cost household items.

Athens {Acropolis – Placa – Wine & Olive Oil Tasting}

On Saturday we relaxed in Athens with a stroll through the Acropolis and Old City (Placa) - the cradle of western civilization. The city itself now has over 4 million people, when in 1950 there were just 400,000. The air pollution and automobile traffic is terrible. Fortunately it was a beautiful and clear sunny day. We also saw the Athenian Olympic stadium, government buildings,

botanical garden, and ancient warrior ship. That evening we tasted several unique Greek wines and olive oils in a formal tasting.

Crete {Palace of Knossos – Research Institute – Organic Mill – Pomace Oil – Kolumvari Coop}

On Sunday morning we flew to Crete and visited the Palace of Knossos just outside Heraklion. This is the main site of the ancient Minoan people that was inhabited from the Neolithic period until the 5th Century AD. The Minoan people came from North Africa and settled on the Greek islands, predominantly in Crete. They were invaded many times by several different cultures (Byzantines, Romans, Arabs, Turks, and Venetians) which left various influences. Many of the buildings have impressive painted plaster walls and some of the pottery vessels used to store wine and olive oil are still present (amphora). This seems to indicate that the civilization had the means to produce olive oil 5,000 years ago. There are live trees believed to be over 1,000 years old on the island. Olive oil is documented to have been traded since 1,700 BC.

Crete is mountainous with considerable snowfall on the peaks in most years that supply the many rivers and creeks with fresh water. The average rainfall is 12-15 inches and there is a 5-6 month dry season very much like California. The warm dry climate near the sea level valleys provides an excellent agricultural area for winter vegetables that are shipped to Europe. The various elevation differences also moderate the temperatures and create various micro climates for the different olive varieties grown on the island. Crete has a population of 500,000 people, but 4 million tourists visit each year. The Cretan people consume 25 liters of olive oil per person annually. Olive oil production has been increasing at a rate of 2-3% per year for the last few years due to new plantings, improved irrigation technologies, and good prices. Most (90%) of the oil produced on Crete is classified as extra virgin oil.

The primary varieties are Koroneiki (75% - 30 million trees) which is a small tree with small fruit that is mostly self fertile (it does better with some cross pollination). It grows best in the lowland valleys because it does not need any chilling and will not tolerate any moisture during bloom or a hard frost. Mastoides (15%) is a larger table and oil olive that is primarily grown around 3,000 ft. elevation which tolerates and needs colder temperatures. Trubolea (5%) and Manaiki (5%) are also table and oil varieties used as a pollenizers for Koroneiki and Mastoides. The bloom period is usually the first part of May, lasts about 7-10 days, and all of the varieties bloom at the same time.

At the Institute of Olive Growing (Ministry of Agriculture – National Agricultural Research Foundation) we saw their experimental mill where they were comparing different milling processes with modern systems. They have been able to almost triple production in the area due to promotion of modern processing methods. Achievements have also been made in the quality of oil produced on Crete due to the development of small scale harvesting equipment, crushing within 1-2 days of harvest, and the use of modern centrifugal decanters. The-institute has played a key role in reducing alternate bearing in olives through the use of irrigation (40% of groves are now irrigated) fertilization, and pest control.

We visited Professor John Metzidakis, one of the primary researchers working with olive improvement. He has harvesting trials, pruning trials, and has conducted variety evaluation on several European olive cultivars for 12 years. We also tasted two olive oils in a formal sensory evaluation to compare the fruitiness of oils from the same variety harvested at the same maturity, but grown at different elevations. The higher elevation Koroneiki oil was more fruity and flavorful than the fruit grown at a lower elevation.

Outside Chania and up into the mountains near the village of Zimbragos we visited the farm and mill of Monolis Psillakis, where they produce an organically grown estate bottled olive oil. The farm is also certified under a Greek system called P.D.O (Protected Designation of Origin) to verify its origin. The olive fly is controlled with a special olive fly trap, which is a McPhail trap with a protein bait attractant. Along the border of the orchard a pheromone attractant is used in combination with a synthetic pesticide impregnated paper to kill the flies. Compost made from manure and olive processing waste is used for fertilization, and care is taken to reduce erosion on the steep lands. They recently installed a wastewater evaporative holding pond to store the wastewater from the olive oil processing plant. It was full when we saw it.

The mill is a cooperative with 40 members, all with small farms producing both Mastoides and Koroneiki fruit. The olives are beaten off the trees onto nets and milled within 2 days. Harvest workers cost \$32.00 per day plus lodging for 8 hours of work. Their yield this last year was about 125 gallons of oil per acre from 50 acres of trees. They use a combination of sinolea separation and horizontal decantation after hammer milling the fruit. While touring the plant we saw that the wastewater was flowing directly out of the plant into the dry creek bed behind the building. The fruit being processed was recently harvested and in good condition. The oil was excellent.

We had a unique opportunity to visit a working pomace oil extraction facility near Chania. The wet and oil laden pomace is delivered and dumped by high capacity dump trucks onto an earthen holding area just outside the plant. This pomace contains about 8% oil and 70 – 75% moisture. It is deposited into a large hopper with a front-end loader where it passes through elevators and heated tumbling drums. It is dried down to about 5 - 6% moisture at 500° – 600° C. The dry pomace is then elevated and dumped into six large vertical tanks. The tanks are then sealed and hexane (solvent) is added to the first tank. The solvent moves through each tank until ~~it~~ all six are saturated. Steam is then added to each tank in succession to force the solvent out. The hot dry and spent pomace is then expelled through a port that opens to the outside. In this process, the port is opened with a long cable that is pulled from a safe distance of about 100 ft., whereby the pressurized steam and pomace blast out of the tank and shoot about 100 ft to the side.

The solvent and oil mixture are then fractionally distilled to recover the oil and solvent separately. The solvent/oil mixture is greenish fine liquid, but when the solvent is distilled off, the remaining oil is black and thick, almost like molasses. The entire facility smells like a combination of solvent and fermenting pomace. Some of the spent (oil removed) pomace is burned to heat the drying tumblers, and the remainder is loaded onto trucks and used to generate heat at the olive oil mills. Several people commented that they would never consume olive pomace oil again.

We had a unique opportunity to visit the farm of Dr. Kiritsakis, our host and translator for the tour, on our way back to Chania. His mother, brother, and neighbors were all out harvesting their olive trees. They offered us some of their lunch, a drink of home made wine from a plastic ‘Orange Crush’ bottle, and a chance to take our hand at harvesting some fruit. They had spread fine mesh nets on the ground under the trees to catch the falling fruit and were using two different electric powered hand-held harvest aids. The power source was from a portable generator. Their hired laborers were using 6’ long wooden forks to beat the olives off the trees.

The first electric harvest aid device looked like a pointed bottle brush made of flexible rubber fingers, about 8 inches long and the diameter of a pencil, mounted on the end of a 10 ft. long pole. When the trigger was pushed, it rotated back and forth, flinging the small Koroneiki olives in all directions. The second device was also mounted on a long pole. Its head contained about 15 of the 8 inch long pencil diameter rubber fingers attached to a cylinder about the size of a paper towel roll.

It only spun in one direction and when placed in the tree it tended to rake and knock the fruit in a downward direction. The devices were a great improvement over direct hand harvest, but all of us found that the Koroneiki variety was very difficult to remove from the tree even when most of the fruit on the tree was turning black.

In Chania, we visited the port area, beautiful seaside, and some of the local shops at the morning market. We then visited the Kolumvari cooperative, which produces and stores 7,000 tons of oil, about 5% of Crete's production. They cooperate with 26 other small mills buying, storing, blending, and selling the oils. Each oil is tested in their laboratory using various technical methods to determine free acidity, fatty acid content, peroxide value, sterol content, pesticide contamination, etc. They also conduct sensory analysis according to IOOC guidelines. Most of the oils are sold to Italy in bulk.

Summary of the Status of Olive Oil Production in Greece

Greece ranks third in world production of olive oil (18%) behind Spain (30%), and Italy (24%) with an average production base of about 355,000 tons of olive oil annually (~ 85 million gallons). Almost half (160,000 tons) is exported and most of it to Italy (100,000 tons). The vast majority of the producers are small scale land owners with 8-12 acres or less. Most of the European Union subsidies are decreasing due to world trade agreements, but still amount to about \$1.00 per liter of oil. The largest cost is to harvest the fruit, which can be as much as 50% of the value of the oil.

Most of the orchards and mills have been in production for over 100 years and sell their oil at a fairly low cost in bulk to local consumers or for export. About 80% of the mills have modernized to continuous flow systems and many of the orchards have begun to irrigate and control pests more proficiently. Still, there are thousands of dry-farmed, low-production orchards with severe pest pressures from the olive fly. Some of the mills lack quality control in fruit delivered, time from harvest to milling is excessive in some cases, and the overall cleanliness of some mills is poor. Discharge of olive oil processing wastewater directly into the environment is also a problem.

Small groups of producers, however, have begun to pay close attention to the quality of the fruit, are milling the fruit within a few hours of harvest, and have cleaned up the mills to avoid oil contamination. They are beginning to set themselves apart from the bulk producers by bottling their own brand of extra virgin oil, growing the fruit organically, or marketing a gourmet specialty product. With the excellent flavor characteristics of the Greek varieties, especially Koroneiki, they have produced unique gourmet oils.

Bulk prices for extra virgin olive oil in 1999 were \$9.85 per gallon or \$2.60 per liter. Retail prices in a grocery store in Thessaloniki were: \$5.60 per liter for a glass container, \$3.32 per liter for a plastic container, and \$9.35 per liter for a specialty oil sold in glass 500 ml bottles. Soy and sunflower oils sold nearby were priced at \$1.87 per liter.

Greek mythology professes that the goddess Athena gave the gift of the olive tree to humans and it quickly became one of their most important natural products. It has become an integral part of the Greek culture. They used it to light their way, for heat, as an ointment for body health, as a lubricant, as a food, and in sacred rituals to anoint the holy.