

FR *ui* TROP

Focus



Lemon



WHY?

The need to ensure the highest level of quality as regards Spanish lemons

The need to offer a list of lemon exporters that offer maximum guarantees and confidence.

WHO?

AILIMPO: The Spanish Lemon and Grapefruit Inter-professional Association that is officially recognised by:

The Spanish Ministry of Agriculture

The European Commission

WHAT?

We certify the Supply, Reception, Washing, Classification, Preparation and Despatching of Spanish lemons.

FOR WHOM?

Clients: Importers, Wholesalers, Supermarkets...

HOW?

This is a voluntary Protocol that has been designed by the sector in order to achieve rigorous and demanding self-regulation in the sector.

QUALITY LABEL AND CERTIFICATION FOR SPANISH LEMON EXPORTERS



- Food Safety
- Environmental Management
- Occupational Health and Safety
- Social Responsibility
- Fulfilment of tax and social security obligations
- Commitment to generalise the use of the standard official packing house-farmer contract for the purchase of fruit from producers

A GUARANTEE FOR ALL

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Global production and markets are at the heart of this series. This economic overview also sheds light on cultivation and post-harvesting. The texts, produced by experts, are richly illustrated by graphs, tables, maps and photos. FruiTrop FOCUS is a collection managed by Eric Imbert and Denis Loeillet.

The purpose of this FOCUS series is to highlight the main challenges of industries in the midst of transformation, and to provide upstream and downstream professionals with the tools on which to base their strategic decision-making.

On the strength of twenty years' experience in the field of the tropical fruits and vegetables economy, and recognised for the professionalism of its analyses, the FruiTrop review is distributed in around forty countries, reaching a large readership among the public and private industry decision-makers.

This edition of FOCUS is distributed in three separate versions: French, English and Spanish.

Is the explosion in prices of the main lemon derivative products a short-term phenomenon? Could this movement have an impact on the world fresh lemon market, currently highly static? It is these questions that this new work by FruiTrop FOCUS sets out to answer, through a meticulous exploration of the production trends of the various countries playing a big role in this industry, and the trend in world demand for fresh lemons, essential oil and concentrated juice.

FruiTrop FOCUS makes its contribution to the discussions of industry professionals, by setting out the current situation and the prospects of the various players through "producer country files".

A host of professionals have contributed to making this document as comprehensive and accurate as possible, for which we would like to extend our warmest gratitude. Drawing up a review of such a rich and diverse industry is a challenge; readers should not hesitate to share with us any remarks they may have. We would be pleased to consider them for a forthcoming edition.

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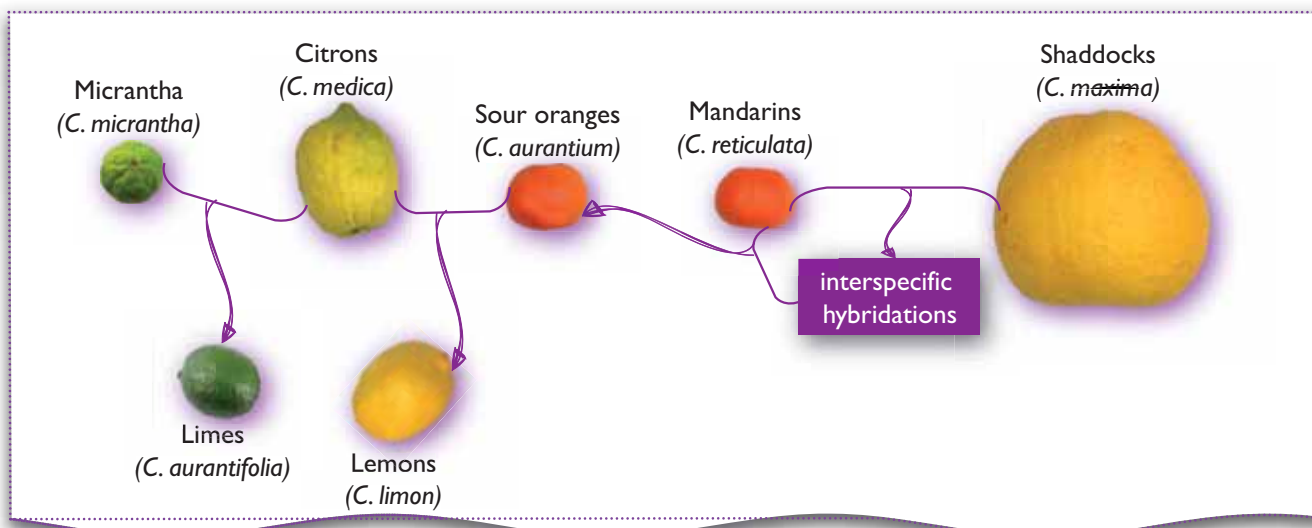


LEMON TREE CULTIVATION

Origin

For many decades, botanists have considered the lemon tree (*Citrus limon* L.) and lime tree (*Citrus aurantifolia* Swing.) as hybrids by nature. This hypothesis has been confirmed and specified by genetic studies based on use of molecular markers. These two species are derived from complex hybridations. In both cases, the citron tree (*Citrus medica* L.) was identified as a major contributor to the genome. The other genitor of the lemon tree appears to be the sour orange tree (*Citrus aurantium*), itself a hybrid of the grapefruit tree (*Citrus maxima*) and a mandarin tree (*Citrus reticulata* Blanco). For the lime tree, there is still some uncertainty as to its female genitor. It could be a citrus of the sub-genus *Papeda*. The name *Citrus micrantha* has been put forward, though this hypothesis has not yet been verified.

The ancestral lemon and lime trees have different zones of origin and diversification. Lemon trees, like citron trees, appear to have originated from the subtropical zones of north-east India: the Himalayan foothills and plains of Assam. Lime trees appear to have originated from tropical zones in south-east Asia,



Origin of the cultivated forms.

such as the Malay Peninsula. Before reaching, at the beginning of the Common Era, the Eastern part of the Mediterranean basin, via Persia and the Middle East, citron trees, lemon trees, and then lime trees followed a steady migration in close association with human activities (conquests, commercial trade, etc.). The Jewish Diaspora was behind the propagation of the citron and its cultivation around the Mediterranean coast. Lemon tree cultivation developed at a later stage. Initially restricted to the hot regions of the south-east Mediterranean, the lemon tree spread via the Arabian conquests to North Africa and the south of the Iberian Peninsula. Later, under the influence of the Crusades, its cultivation would reach the northern shore of the Mediterranean: Greece, Sicily, Italy, as far as the south-east of France.

General characteristics

Lemon trees (*Citrus limon* L. Burm. f.) occupy a special role within the citruses. Along with lime trees (*Citrus aurantifolia* Swing. and *Citrus latifolia*) and citron trees (*Citrus medica* L.), they form the acidic fruit citrus group, and share certain characteristics:

- **Multiple flowering waves within the same year.** They can appear after insignificant periods of non-growth. The new fruits from each flowering wave will reach maturity offset in time in relation to those from previous flowerings. For this reason, lemon trees are qualified as multiple-flowering, or sometimes called “four-season” trees;
- **a purple coloration** of the flower buds and the new vegetative shoots, associated with the presence of anthocyanic pigments in young tissues;
- **a very high sensitivity to negative temperatures compared to other citruses:** mandarin trees, orange trees, and pomelos. Lime trees and citron trees are slightly more sensitive to cold than lemon trees;
- **a high sensitivity to certain fungal parasitic attacks, especially those** caused by *Phytophthora*.



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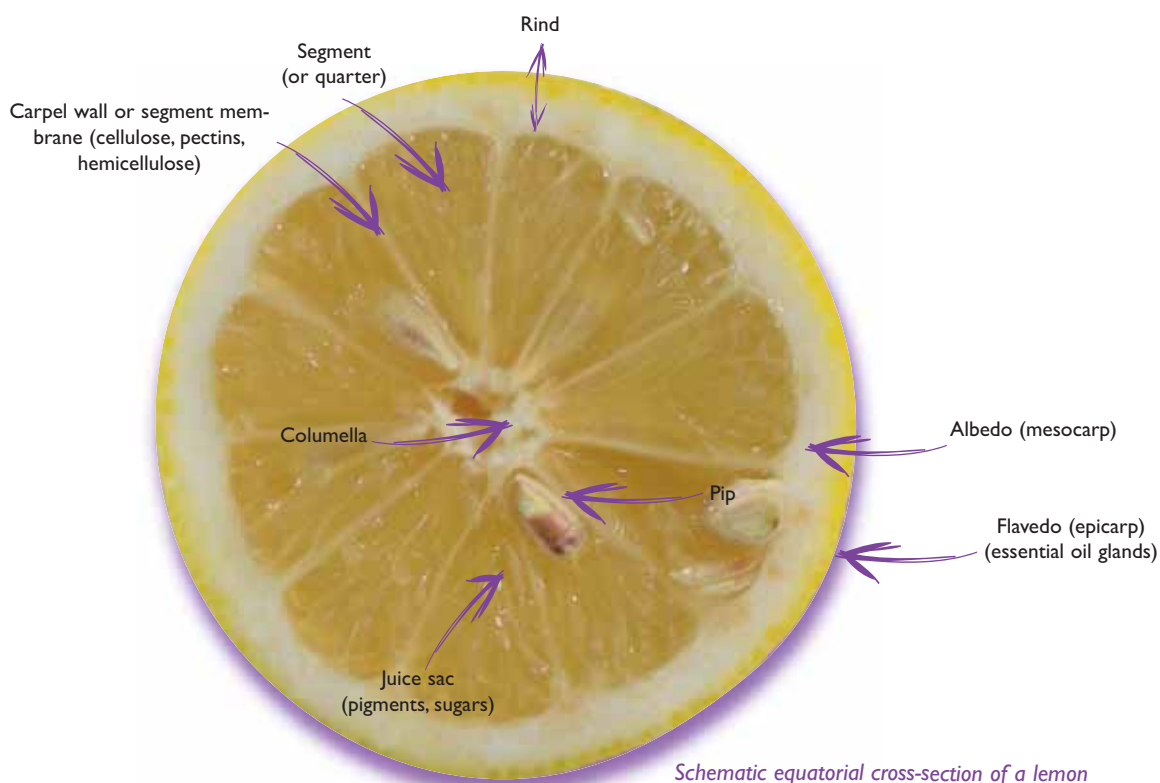
Plant description

The lemon tree is a vigorous citrus, with big lanceolate leaves light green in colour. Its leaf stalk is short, articulated, non-winged, with a plain margin. The young leafy shoots have a purple shade for a few days in the initial stages of their development. The leaf blade encloses glands containing essential oils with a characteristic aroma. The flowers are grouped in clumps. The flower buds are shaded purple. In certain cases, the flower can be male because of an aborted pistil. This phenomenon varies greatly between flowerings and seasons. The multiple-flowering character is more or less marked, according to the variety.





The oval-shaped fruit often ends in a highly characteristic nipple. Frequently, fruits on the same tree differ in shape and appearance, both during the same production cycle and between seasons. The lemon epidermis, or zest, comprises two layers. The flavedo (epicarp and outer mesocarp) is the outer layer of the fruit. Depending on the lemon's maturity, its colour varies from green to bright yellow. It contains numerous essential oil glands, with a highly characteristic aroma. These glands, rich in terpenes, represent a real chemical barrier against insects and micro-organisms, and help protect the fruit from external attacks. The albedo (or inner mesocarp), an inner white spongy layer, is the most important source of pectins and carbohydrates. Its thickness varies according to the fruit variety and maturity. The lemon epidermis is slightly rougher than that of limes, and it is possible to observe surface irregularities on the fruit, in the form of slight grooves or small ridges. The pulp is pale yellow in colour. This internal coloration is clearly distinct from that of the lime, where the pulp is always greenish. The lemon generally has 8 to 12 quarters, each surrounding elongated cells (endocarp hairs, comprising a large vacuole which builds up stores of water, carbohydrates and citric acid), enclosed in an inner epidermis (endocarp).



Effects of climate

The lemon tree and lime tree are particularly sensitive to cold, the lime tree more so than the lemon tree.

Lemon trees are well-suited to relatively dry subtropical climates, more specifically to the micro-climates of coastal areas where daily temperature variations exhibit small contrasts, and above all in coastal foothills where risks of winter frost are very low. This type of favoured situation is found for instance in the Franco-Italian "Riviera", although it is located in the northern-most area of citrus cultivation (see climate data tables and graphs).

Damage to the various lemon tree organs are observed from $-1^{\circ}/-2^{\circ}\text{C}$ if the tissues are very young (new leaves, flowers, tiny fruits, etc.). Temperatures of between -3 and -4°C cause damage to the fruits and the youngest adult leaves. Below -4°C , the damage affects leaves and twigs, and then branches or even trunks.

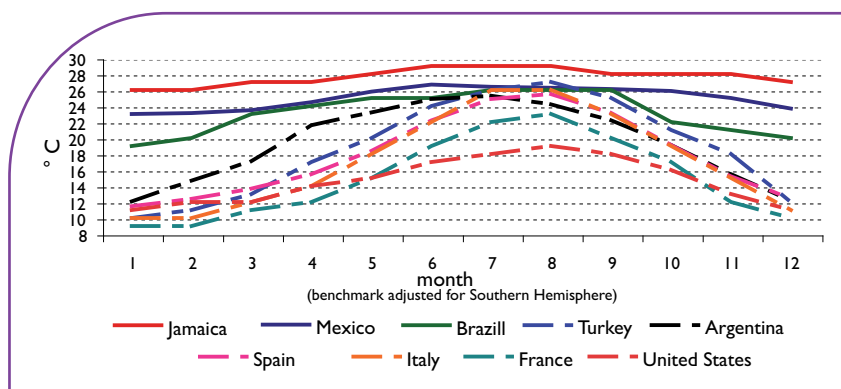
In a subtropical climate, the multiple-flowering character of lemon trees is most strongly expressed. This enables production to be spread over most of the year. Not every flowering wave has the same intensity, and each one produces a specific type of lemon. Italians have long taken advantage of this phenomenon to spread production through the year, by employing the forcing technique (see paragraph "Orchard and orchard management"). This technique has become more reliable nowadays.



© Henri Vannière



| | Production zone and altitude | | Cumulative total temperatures above the citrus vegetative threshold ($+13^{\circ}\text{C}$) | Mean number of days of frost/year | Absolute minimum temperature observed ($^{\circ}\text{C}$) |
|-------|------------------------------|---------------------|---|-----------------------------------|--|
| Lime | Jamaica | Kingston (9 m) | 5357 | 0 | 0 |
| | Mexico | Colima (83 m) | 4383 | 0 | 0 |
| | Brazil | Aracutaba (400 m) | 3686 | 0 | 0 |
| Lemon | Argentina | Tucuman (449 m) | 2322 | 0 | 0 |
| | Turkey | Silifke (14 m) | 2082 | 2 | -2 |
| | Spain | Alicante (31 m) | 1776 | 1 | -2 |
| | Italy | Syracuse (21 m) | 1537 | 8 | -5 |
| | France | Menton (143 m) | 714 | 1 | -3 |
| | USA | Santa Barbara (2 m) | 613 | 5 | -6 |



Mean monthly temperatures greater than 13°C .

For lime growing zones (solid line) or lemon growing zones (broken line).



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Each maturity period had a corresponding fruit type bearing a specific name

- **primofiori**, produced from September to November;
- **limoni**, produced from December to May;
- **bianchetti**, produced from April to June;
- **verdelli**, produced in summer, from June to September.

These various names illustrate the influence of the temperatures observed during the fruit development on its appearance, especially in the shape and coloration of the epidermis. In the tropics, but also in the summer period in a subtropical climate, the absence of a temperature drop limits or even inhibits the process of disappearance of chlorophyll pigments. The fruits remain green to greenish upon maturity. In subtropical zones, the winter temperature drops repress the chlorophyll pigments in lemons and limes, revealing the other pigments in the epidermis, which are yellow in colour. For this reason, the epidermis of “verdelli” summer lemons, or of tropical limes, remains green. In the Mediterranean region, the yellow coloration is particularly intense in lemons, and limes, because of the cool winters.

Hot and wet conditions are not favourable for lemon tree growing in the tropics, primarily because of:

- its excessive sensitivity to fungal diseases, which have a strong presence and severe impact in these environments;
- strong vegetative growth;
- excessive development of fruits, of a size not suited to market demand;
- a greenish outer coloration, similar to that of limes, because of the same phenomenon of the lack of a temperature drop, which can cause the chlorophyll pigments to disappear.

The distribution of the cultivation areas of these two fruit species worldwide perfectly reflects the influence of abiotic constraints (temperatures) and biotic constraints (diseases and pests) on their behaviour.



© L. Lorente

VARIETIES AND ROOTSTOCK

Introduction and selection criteria

Lemon tree orchards for the most part comprise grafted plants. Every tree comprises an association of two genetically distinct individuals. They are compatible, and have been grafted in a nursery before planting. The rootstock variety forms the lower part of the tree: root system and trunk base. The grafted variety forms most of the above-ground productive part. Grafted trees offer the advantage of being able to combine in the same individual capacities which it would be difficult to do so in a single-species individual.

The varietal selection comprises two components: the fruit bearing variety and the rootstock. In the case of the lemon tree, the very first stage of the decision-making process will relate to how well it is adapted to the environmental conditions (climate, soil, sanitary context), and to the existence of sustainable outlets, by means of market studies. In the second stage, the varietal selection and rootstock selection will be refined, taking into account the particularities and constraints relating to the production area, or even the plot.

The fruit-bearing grafted variety

The constraints of the various lemon tree varieties with respect to the cultivation conditions are relatively similar when compared to other citruses. They differ primarily in a few components such as:

- their productivity: level, multiple-flowering character, interannual regularity, harvest date, etc.;



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- their fruits: shape, juice and acid content, number of pips, etc.;
- sensitivities to qualified biotic and abiotic constraints.

The interaction of the climate on the fruit characteristics has been mentioned previously. The temperature conditions affect the shape of the fruit, and more markedly, the epidermis coloration, distinguishing in this respect subtropical and tropical climates.

Rootstocks

The first references to the use of rootstocks in citrus in Spain date from the 12th Century. Until the 20th Century, the major objective of use of rootstocks was to try to prevent *Phytophthora* attacks, which destroy the cortical tissues of the root system or trunk base in non-grafted highly sensitive varieties, such as lemon trees.

The benefit of various variety/rootstock associations to overcome biotic and abiotic constraints took on considerable importance in the second half of the 20th Century. It became possible, in part, to extend cultivation zones to new areas, agronomically less favourable (calcareous or slightly saline soils, heavy and poorly drained soils, etc.). These trials on rootstocks also led to the observation that certain associations could behave differently to transmissible degenerative diseases, ranging from mortality to resistance. These findings encouraged the search for solutions based on using a bigger range of rootstocks than previously.

Selecting a rootstock is complex, and results from an in-depth decision-making process to find the right compromise between the various biotic or abiotic constraints. It must also take into account the specific effect of each type of rootstock on the agronomic behaviour of the trees: plant vigour, how early the orchard can start production, level and regularity of production, and fruit quality (calibre, epidermal coloration, and juice, sugar and acid content, etc.).

Particularities of rootstock selection for lemon trees

Eureka variety lemon trees are completely incompatible with *Poncirus trifoliata* and many of their hybrids, such as citranges, citrumelos, etc. There are some very rare exceptions to this rule. This incompatibility phenomenon does not really concern other lemon tree varieties. Recently, tests showed that the rootstock *Citrus macrophylla*, compared to the sour orange tree, could increase the yield by around 50 % over a period of seven years. However, the very good productivity results achieved in the south of Spain



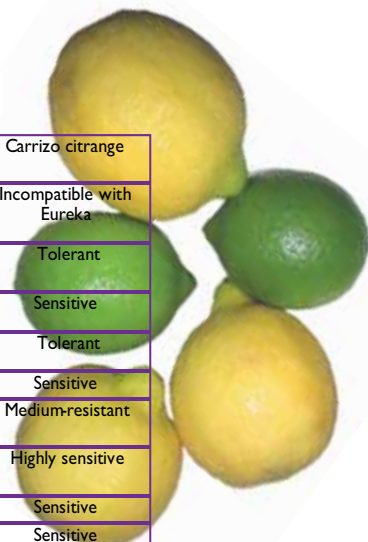
needed to be qualified because of the lower storage resistance of the fruits. For all “fruit quality” aspects, the sour orange tree generally has a favourable effect: fruits considerably more coloured upon harvesting (less greenish), and dry extract and acidity 10 to 12 % higher. In Argentina, crop tests demonstrated the possibility of using low-vigour rootstocks to design high-density orchards with trees of low vegetative development. *Poncirus trifoliata*, the “Flying dragon” offers this option, but there are two kinds of constraints limiting this practice:

- the Eureka lemon tree cannot be used because of its incompatibility with *Poncirus*;
- *Poncirus* are absolutely advised against if the soils are calcareous or slightly saline, which is relatively frequent in lemon tree cultivation zones.

The assessment grid, specifying the behaviour of the lemon tree/rootstock associations with respect to the various constraints, provides an overview of the number of parameters involved, so as to get to grips with the complexity of this approach for making a selection.

Assessment grid for the main lemon tree rootstocks

| | | Bitter orange | <i>Citrus macrophylla</i> | <i>Citrus volkameriana</i> | Cleopatra mandarin | Carrizo citrange |
|----------------------|-----------------------|-------------------------------|---------------------------|----------------------------|--------------------|--------------------------|
| Compatibility | for grafting | Good | Good | Good | Okay | Incompatible with Eureka |
| Viruses | Tristeza | Tolerant | Sensitive | Tolerant | Tolerant | Tolerant |
| | Exocortis | Tolerant | Tolerant | Tolerant | Tolerant | Sensitive |
| | Xyloporosis | Tolerant | Sensitive | Sensitive | Tolerant | Tolerant |
| | Woody Gall | Tolerant | Tolerant | Tolerant | Tolerant | Sensitive |
| Fungal diseases | <i>Phytophthora</i> | Highly resistant | Highly resistant | Medium-resistant | Slightly sensitive | Medium-resistant |
| | Mal secco | Medium-sensitive to sensitive | Highly sensitive | Tolerant | Medium-sensitive | Highly sensitive |
| | Honey fungi | Resistant | Sensitive | Resistant | Sensitive | Sensitive |
| Soil pests | Nematodes | Sensitive | Sensitive | Sensitive | Sensitive | Sensitive |
| Physical environment | Limestone | Resistant | Resistant | Resistant | Resistant | Medium-sensitive |
| | Salinity | Resistant | Resistant | Moderately resistant | Resistant | Sensitive |
| | Root asphyxia | Resistant | Resistant | Resistant | Sensitive | Sensitive |
| | Drought | Moderately resistant | Resistant | Resistant | Medium resistance | Sensitive |
| Effect on variety | Vigour | Good | Very good | Very good | Medium | Good |
| | Tree pruning | Normal | Normal | Increased | Normal | Increased |
| | Entry into production | Normal | Earlier | Earlier | Normal /variable | Normal |
| | Productivity | Good | High | High | Good | Good |
| | Fruit quality | Good | Unfavourable | Unfavourable | Very good | Good |
| | Fruit size | Good | Good | Good | Decreased | Good |
| | Maturity period | Normal | Earlier | Earlier | Delayed | Earlier |
| | Fruit coloration | Normal | Delayed | Delayed | Delayed | Earlier |
| | Skin thickness | Normal | Increased | Increased | Decreased | Increased |





ORCHARD AND ORCHARD MANAGEMENT

Selecting the planting site requires great attention, since it relates to the entire lifetime of the orchard. It determines the durability of the plantation, the fruit quality and productivity level, among other things. The rules generally adopted for citruses are valid for lemon orchards. We must be even more demanding in terms of at least two risks, relating to excess water and frost. The plot must not be subjected to temporary flooding, and the soil must be filtering. The main lemon production areas are generally limited to zones where the frost risk is very low. The exact location of the orchard, and certain cropping practices, must strictly adhere to this constraint, or even further minimise it.

Soil

Citruses are more abhorrent of the consequences of excess water than temporary water shortage. Poorly drained lowland zones, as well as heavy soils with a hydromorphic tendency, must be avoided. Sites with light and above all filtering soil, with neutral to slightly acidic pH (between 6 and 7.5), without excess limestone and sufficiently rich in organic matter are ideal for setting up orchards. Management of minor defects such as alkalinity, slight salinity, etc., can be partly resolved by selecting an appropriate rootstock, and possibly by appropriate cropping techniques such as inputting organo-mineral amendments before planting. The soil can be profiled before planting in order to raise the tree line, so as to remove excess surface water. Soil preparation and the selection of the plant material are important stages in ensuring orchard durability.

Because of the high sensitivity of lemon trees to *Phytophthora* and degenerative diseases, quality plant material must be used: healthy plants whose grafting point is at a height of at least 30 cm. The planting distances vary according to the climate zone and vigour of the rootstock. The density is around 6 x 4 m or 6 x 6 m in subtropical zones, or lower in the few tropical zones where lemon trees are present (8 x 8 m or more).

Windbreaks need to be planted around the plots in windy locations.

SOIL MAINTENANCE

In an orchard, the trees do not occupy all the available space. Apart from in semi-desert regions, soil not covered by perennial vegetation can remain constantly bare, and be subjected to attack from physical factors such as water. Besides some rare exceptions, soils must be protected during the rainy season. Permanent or temporary grassing, according to water availability, is the most frequent management method. The grass strip is generally limited to the central part of the inter-row space. It is mechanically maintained through rotary slashing. Development of weeds under citrus foliage is sometimes controlled by localised applications of herbicide once or twice a year. In zones subject to a prolonged dry period, it is preferable to select a plant covering which dries out and does not compete with the trees for the water supply.



Pruning

In the first years after planting, the object of pruning operations is to form the tree to obtain a balanced structure and prevent multiple primary branches at the same level. Starting in the first year, special attention is paid to the formation of a single trunk. From the second year, green pruning is employed to select the future primary branches, generally 3 to 4 branches properly distributed around the trunk, with insertion in stages.

Subsequently, the lemon trees will require annual pruning performed after the harvest, which will eliminate:

- dry, necrosis-bearing and blighted twigs;
- branch growth incorrectly placed or in excess numbers, so as to promote openings in the foliage. These “windows” lead to lighting of the foliage interior, promoting fruit coloration, internal renewal of branching, reduced containment of foliage, and thereby limit development of insect pests and fungal diseases;
- bowed and aged branch growth, which have given high yields over previous cycles, in order to promote renewal of fruit-bearing branches.

Note: to prevent disease transmission, pruning tools must be disinfected using concentrated bleach, and big pruning wounds must be protected with a sealant.

Mineral nutrition and water supply

MINERAL NUTRITION

A distinction should be made between basal dressing and amendments on the one hand, and annual dressing on the other hand. Basal dressing and amendments are aimed at correcting, before planting, mineral or pH imbalances revealed by the soil analysis. So there is no standard advice on the subject. Most often, the corrections made involve inputs of organic matter, low-solubility elements such as phosphorus, or elements fixed on the absorptive complex such as potassium, magnesium and calcium.

The primary aim of annual dressing is to maintain the soil fertility level, compensating for losses of mineral elements calculated from harvest data. Soil and foliar analyses are frequently used complementary decision-making tools. On the one hand, they are used to verify that there is no big nutritional imbalance between the main elements, and that the level of trace elements is satisfactory. On the other hand, comparison of the results of foliar analyses with a reference grid, and monitoring of changes in contents from one year to the next, are used to verify whether the dressing plan adopted is satisfactory, or whether it needs to be adjusted.

Over the last few decades, localised irrigation has seen rapid development, and with it the practice of ferti-irrigation. Without undermining the basic reasoning underpinning the definition of the nutritional requirements of lemon trees, this practice has brought greater flexibility in the use of mineral fertiliser, with highly advanced fractionation and better positioning of inputs. This provides better efficiency, which should be manifested by a fall in the input quantities of fertiliser. This practice requires a higher technical level, use of equipment and specific high-quality inputs.

Nitrogen and potassium are the two major elements in annual dressing. They are inputted in one or more fractionated applications. For young non-productive trees, the potassium requirements are low. Upon entering production, they become equivalent to the nitrogen requirements. It is rare for highly productive adult orchards to require nitrogen or potassium fertilisation of more than 200 kg per hectare per year for each of these elements.

Since phosphorus is a much less mobile element, it is preferable to use the soil tilling operations before planting to dress it into the soil along the planting line, at the future root profile level. Thereafter, phosphoric fertiliser may be used every other year, inputting quantities adjusted to this frequency. Applications will be positioned at the foliage limit. Since phosphorous losses are low, P_2O_5 inputs will be smaller, generally between a quarter and a third of the quantities of nitrogen or potassium.



Trace elements, such as magnesium, iron, zinc, manganese, copper, boron, molybdenum, etc., are rarely inputted systematically. If the results of foliar analyses reveal an incipient deficit, they will be sprayed onto the new vegetative shoots (known as spring shoots) at the end of the flush. Application of iron in chelated form to the soil is the most effective method.

Lemon – The most frequent leaf symptoms of mineral deficiency

| Element | Symptoms | Remarks | Control |
|--------------------|---|--|--|
| 1 NITROGEN | A fairly frequent deficiency. It is shown by uniform discoloration of the leaf lamina, which is from pale green to yellow according to the severity of the deficiency. The veins are also discoloured and are always paler than the lamina. The leaves are not deformed. Trees suffering from nitrogen deficiency are less vigorous and the foliage may be sparse | This deficiency may have two different causes—a true deficiency or deficiency induced by a disease that hinders sap translocation | Treatment of the diseases causing deficiency. Application of nitrogenous fertiliser or spraying of urea in case of true deficiency |
| 2 MAGNESIUM | Signs of this deficiency are found only in adult leaves. Discoloration starts in the median part of the lamina and spreads gradually to the base and tip of the leaf in a V-shaped pattern. In the final stage, only a V-shaped part close to the petiole is not discoloured. | The young leaves of trees suffering from this deficiency are never affected. Nutritional balances are determinant for this deficiency | Spraying new leaves with 1.2% magnesium nitrate on completion of lamina elongation. |
| 3 IRON | The deficiency is shown by overall discoloration of the lamina, which turns pale green to yellow. In contrast with nitrogen deficiency, the vein pattern remains green. | True soil iron deficiency is rare. It is more frequently a blockage of assimilable forms of iron. | If possible, first correct the physical causes of the deficiency: hydromorphy, alkaline pH, etc. Apply chelated forms of iron to the soil. |
| 4 ZINC | A frequent deficiency in all citrus growing areas. It is seen in the young leaves which remain small and erect. The lamina is seriously discoloured— from pale green to yellow—in all the inter-vein parts. The veins and halo along each of them remain green. | These symptoms of deficiency are similar to those of certain degenerative diseases. Care should be taken that these are not the cause of the problem observed. | Spraying new leaves with zinc sulphate (2.5 g/l) on completion of lamina elongation. |
| 5 MANGANESE | This is another common deficiency. It is similar to zinc deficiency but differs in two respects: the leaves are not deformed and remain their normal size and lamina discoloration is less intense | | Spraying new leaves completing lamina elongation with manganese sulphate (1.5 g/l). |
| 6 BORON | This fairly rare deficiency is shown by the suberisation of the veins on the underside of the lamina. The young shoots may wither. | The distance between deficiency and toxicity is small and so boron applications must be carefully measured. | Spraying with 2.5 g/l Solubor. |



LEMON TREE FORCING TECHNIQUE

In a Mediterranean climate, the most multiple-flowering lemon trees can have up to four successive flowering periods in the same year:

- **in March**, with most often few flowers which will produce lemons from October, or even September for the early varieties;
- **from late March to early June**, often abundant flowering yielding the biggest harvest, from November to late May for a conventional variety;
- **late June**, a small flowering yielding lemons that will reach maturity one year later;
- **in August-September**, yielding fruits harvested the following summer, and which are known as “Verdelli” because of the slightly greenish coloration of their epidermis.

With no human intervention and no extraordinary external constraints, the second flowering period is generally the most intense, and therefore proportionally yields the majority of the harvested fruits. Sicilian producers were the first to use special lemon tree management techniques to increase the intensity of certain flowering waves, and thereby achieve a considerable offset of the harvest dates. This technique is known as forcing. It can only be successfully considered on multiple-flowering varieties. Technique relies in large part on correctly managing the water supply to the lemon trees, by controlling the gradual desiccation of the soil, followed by a scheduled resumption of water inputs. Light, sandy and shallow soils are the most favourable. The soil is tilled starting in spring to promote water evaporation. No other cropping operation is performed, and in particular irrigation is completely halted. Throughout the spring, and until the start of summer, the trees will undergo the effects of desiccation and exhibit clear incipient withering. In early August, they are pruned and mineral fertiliser applied, followed by partial resumption of irrigation: half-doses on every other row. Taken together, these practices result in moderate resumption of lemon tree growth, followed by abundant flowering in September. This late-summer flowering will yield next summer's lemons: the Verdelli. This technique is traumatic for the lemon trees, so the advice is to apply it only to trees in good vegetative condition, and to apply alternation within the same plantation, in order to obtain at least one rotation every four years. It is feasible to adjust the water stress level taking into account the intensity of the multiple-flowering character of a variety, as those which re-flower most easily require a lower stress.



© Eric Imbert

WATER SUPPLY

Just after planting, the young plant has a small root system and occupies a limited volume. The aim of the first spraying operation, carried out immediately after planting, is to ensure a good contact between the plant brick and the plot soil. The aim of the other spraying operations is to satisfy the water requirements.

Lemon trees have similar water requirements to those of other citruses. Irrigation management (calculating doses and input frequency) will take into account:

- climate demand: potential evapo-transpiration (PET) calculated by a weather station;
- precipitation balance: useful precipitation;
- the water reserves available in the soil: depth of horizons explored by the roots and soil composition;
- development of plant covering in the orchard: developed area of trees and grass;
- the nature of the irrigation system.

Management of the water inputs incorporates two objectives. During the production cycle, from the emergence of the first flower buds to the harvest, it is necessary to provide the water requirements of the lemon trees, without excess. After harvesting, according to the local climatology, a sufficiently marked period of non-growth must be ensured, applying water rationing if necessary. So it is not always desirable to irrigate in the absence of rain if the water stress is still reasonable and is not causing a physiological reaction, such as deformation or leaf fall.

The irrigation systems used differ greatly between production sites. Water savings are most often sought, which entails using localised irrigation systems: micro-spraying, drips, most often in association with ferti-irrigation.

FROST PROTECTION

Damage caused by sub-zero temperatures is observed in citruses when they reach -1.7°C for at least half an hour. The ice crystals which form cause the cells to burst and destroy the tissues. There are different frost sensitivities among citruses. Lime and citron trees are the most sensitive, followed very closely by lemon trees. The youngest tissues and organs are the most vulnerable. Besides the frost intensity, its duration must be taken into account to evaluate the risk, since it intensifies the damage. The table below states the critical sub-zero temperatures for different parts of the lemon tree.

Radiation frost and advective frost are the two forms of frost to which lemon plantations may be exposed.



Radiation frosts are associated with a temperature drop at the end of the night, in clear windless weather. They affect low-lying layers of the atmosphere near ground level. Temperatures may be locally a few degrees below zero for a few hours. Between 10 and 20 m in height, the temperatures are higher, frequently remaining positive. There are several management techniques for protecting against radiation frosts:

- mechanical mixing of low and medium air layers to heat up the atmosphere in contact with the trees;
- spray irrigation. As it changes state the water (frost) releases heat, heating up the surrounding atmosphere by a few degrees;

Lemon tree — Critical sub-zero temperature

| Lemon tree parts | Temperatures ($^{\circ}\text{C}$) |
|----------------------------|-------------------------------------|
| Buds and flowers | -2.8 |
| Small set fruits < 13 mm | -1.3 to -0.8 |
| Small fruits < 13 mm | -2.8 to -1.5 |
| Mature fruits | -3 to -2 |
| Mature leaves | -3 |
| Twigs and small branches | -4 |
| Trunk and primary branches | -8 |

- emission of smoke to create an opaque covering over the orchard, thereby limiting the earth's radiation which cooled the low-lying layers;
- radiant heaters, arranged regularly along the planting rows.

Advection frosts are associated with large-scale movements of cold air of polar origin. These frost periods are less common, but also more destructive. The frost intensity is generally much greater, for two reasons:

- temperatures are often significantly further below zero, including at heights of tens of metres;
- frost duration is longer, and can last several days.

It is very difficult to manage this type of frost. Prevention is primarily down to the choice of cultivation zone, a region naturally with low frost exposure. Within the zone, less exposed locations will be favoured to mitigate the frost intensity, and therefore the extent of damage. So lowland zones and corridors of cold air circulation should be avoided.



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VARIETIES

MEYER LEMON (ORIGINATING FROM CHINA)

This variety, long considered a hybrid of the lemon and orange tree, was identified by molecular biology tools as a hybrid of the citron and mandarin tree. Originating from China, it was imported for the first time to the United States by Frank Meyer in 1908.

The tree exhibits intermediate vigour and a cold resistance similar to orange trees, i.e. greater than other lemon trees. Because of this character, Meyer lemon trees have been planted in colder climate areas, where classical lemon tree cultivation was too risky.

The Meyer lemon tree has the particularity of being a healthy carrier of certain viroses, including citrus tristeza. In the absence of visual symptoms of damage, this variety could not be propagated without taking the risk of the spread of degenerative diseases. So it was not

recommended until the late 1970s, when sanitised lineages became available.

The lower organoleptic quality of the fruits and their inferior post-harvest behaviour compared to true lemons also impede the extension of Meyer lemon cultivation.

The medium-sized fruits are elliptical to oblong (elongated). They have a slight neck at the stalk base, and a wide, rounded apical nipple. The yellow-orange skin, characteristic of the variety, is smooth and very thin, which makes it especially fragile for the fresh market. The highly juicy pulp is less acidic than those of other lemon varieties. In its traditional production regions, the harvest is early. At this time of year (September), the supply shortage to the market favours the flow of fruits onto the local markets.



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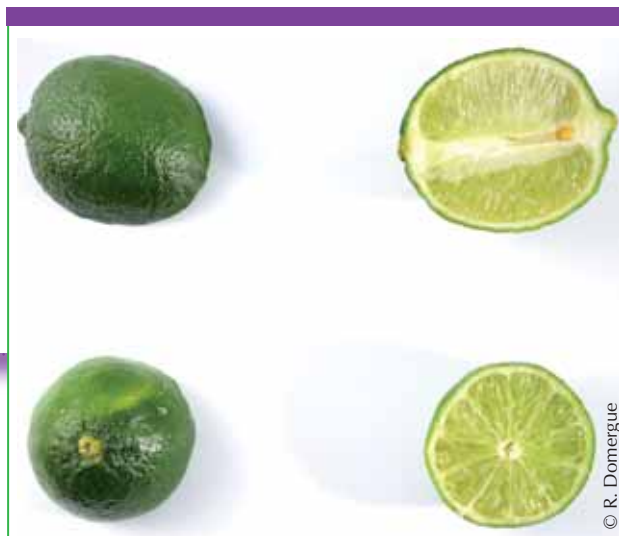
CITRUS AURANTIFOLIA (MEXICAN, WEST INDIAN OR KEY LIME)

Originating from the Indo-Malayan Peninsula, this variety represents the basic type of lime trees most commonly produced worldwide. The small-fruit lime trade is very important in all the production regions. The small size of the fruits, along with their numerous pips, have greatly limited their share in international fresh fruit trade, where the seedless large-fruit lime is preferred.

The Mexican lime is a vigorous and spiny tree, slightly more sensitive to the cold than the large-fruit lime tree (*C. latifolia*). It is multiple-flowering, which enables harvests spread over the

year. The small-size fruits are rounded or oval in shape. They have a slight neck at the stalk base, and a small nipple at the apex. The skin, smooth and particularly thin, is highly adhesive. It turns toward yellow upon maturity, but the fruit is often harvested when still green. The essential oils contained in the epidermis are highly aromatic and prized for cooking or making drinks. The pulp, highly juicy and strongly acidic, is yellow-green in

colour. The high number of pips (around fifteen on average) represents an agricultural advantage in rural production systems (direct sowing). In subtropical zones, the harvest takes place from late summer to mid-winter.



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EUREKA (ORIGINATING FROM AMERICA)

This variety was selected in 1858 in Los Angeles, California, from a population of lemon trees grown from seedlings. The seeds came from lemons imported from Italy, probably of the Lunario variety. The tree is vigorous with few spines.

The medium-sized fruits vary in shape, between elliptical and oblong (elongated). They generally have a small neck at the stalk base, and a short apical nipple surrounded by an areolar groove. This nipple is sometimes

more developed. The pulp, yellow in colour upon maturity, is thin, juicy, acidic and aromatic. The fruit contains few pips.

The tree is multiple-flowering, at three to four times staggered throughout the year. The local climate conditions greatly influence flowering intensity, and therefore

the size of the various harvests. Although they produce fruits all year round, Eureka lemon trees do so especially in late winter and early spring.



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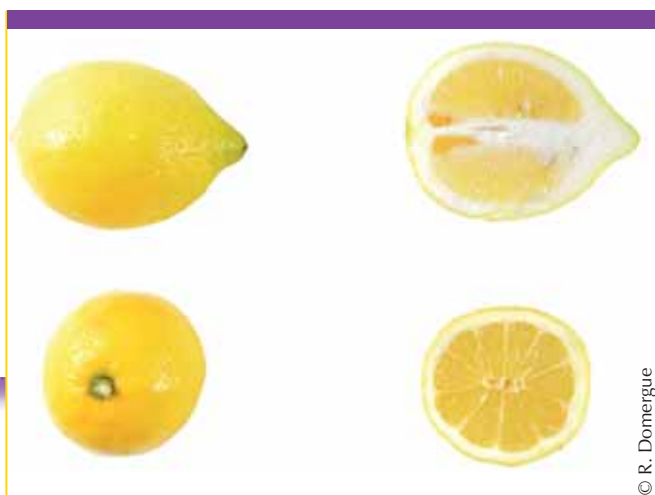
LISBON (ORIGINATING FROM AMERICA)

This variety appears to have been selected from plants grown from Gallego variety seedlings, of Portuguese origin. It was present in California from the mid-19th Century. Its highly vigorous and spiny tree is more resistant to adverse conditions (heat, cold, wind, lack of care) than other lemon trees. Buried in the vegetation, the fruits are well protected from adverse conditions (wind, sun, etc.).

The medium-sized lemons vary in shape, between elliptical and oblong (elongated). They generally have a slight neck at the stalk base, and an apical nipple surrounded by an irre-

gular areolar groove, more marled on one face. The pulp, highly juicy and strongly acidic, is yellow in colour upon maturity. The fruit has an intermediate number of seeds. The epidermis is medium thick, and adhesive. Its surface is finely pitted, slightly rough and very slightly ribbed. Compared to the Eureka lemon, its groove and nipple are often more developed, and its epidermis is less ribbed and smoother.

Lisbon lemon trees have an upright habit, are highly productive and little repeat flowering, with one main dominant flowering. Harvest generally takes place from mid-autumn to mid-winter.



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CITRUS LATIFOLIA TAHITI OR PERSIAN LIME, BEARSS LIME)

The triploid character of large-fruit lime trees results in seedless fruits, of larger size than those of regular limes. The origin of these lime trees is unknown. Limes of this type were introduced into the United States from Tahiti, between 1850 and 1880, hence the name. The Persian lime is very similar. Its name leads us to assume a Mediterranean origin, after being introduced there via Persia. Bearss lime, which is also very close, was observed in 1895 among the stock of a Californian nursery grower, T.J. Bearss. These types of lime tree are now very widely cultivated in Mexico and Brazil.

It is a vigorous tree with few spines, which is slightly more sensitive to cold than the lemon tree. The fruits, bigger than those of the Mexican lime, vary in shape: elliptical to oblong (elongated). The stalk base is generally rounded, though sometimes there is a slight neck surrounded by an areolar groove. The apical nipple is not prominent. The skin, smooth and thin, is highly adhesive. The pulp, juicy and strongly acidic, is yellow-

green in colour and nearly free from pips (triploid variety). This lime currently holds the biggest share of the international market.



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FEMMINELLO (ORIGINATING FROM ITALY)

Femminello lemons represent the majority of Italian production. The medium-sized fruits are elliptical to oblong, with a neck and nipple of varying size. The skin is medium thick and highly adhesive. The epidermis, finely pitted and moderately smooth, has depressed oil glands. It is yellow upon maturity. The yellowish pulp is highly juicy and strongly acidic.

The trees are of intermediate vigour, with very few

spines, and are highly productive, with harvests staggered throughout the year. This lemon tree has a marked multiple-flowering character, flowering several times in a season. The lemons from natural flowering are harvested in autumn ("Primofiori") and in winter ("Limoni"). This lemon tree lends itself well to the forcing technique, with a significant production season offset to the summer (summer lemons known as "Verdelli").



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INTERDONATO (ORIGINATING FROM ITALY)

This selection originating from Italy is a natural hybrid of the lemon and citron tree, identified in 1875 in Nizza, Sicily. It has advantageous characteristics in terms of resistance to mal secco and of earliness. The tree is of intermediate vigour, productive, and nearly free from spines. The variety does not lend itself to forcing.

Although close to other lemon varieties, the Interdonato differs in its bigger size, its smoo-

ther and thinner skin, and a smaller number of segments and pips. Its internal qualities also differ, since the fruit is less juicy and less acidic. This lemon tree is little cultivated in its original region, Italy. However, it has a particular share in Turkey where its earliness and resistance to mal secco

are prized. After harvesting, the fruit is very quickly marketed, because of the supply shortages on the market at this time of year (September-October).

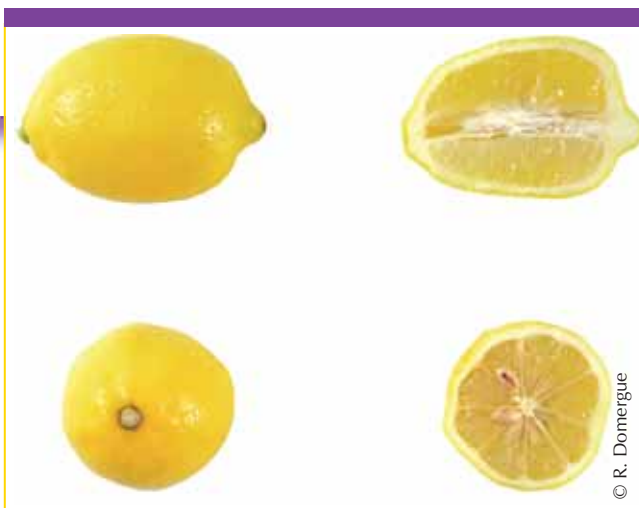


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KÜTDIKEN (ORIGINATING FROM TURKEY))

This Turkish lemon very probably originated from Italy. It is similar to the Femminello and Eureka multiple-flowering lemon trees, with similar fruit characteristics. It is the main variety cultivated in Turkey. A half-season

variety, it is harvested from November, after the Interdonato. The Kutdiken is well suited for keeping in storage, for up to nine months. Sensitivity to mal secco represents its main handicap.



VERNA (ORIGINATING FROM SPAIN)

This Spanish variety, of unknown origin, represents the majority of the lemon tree orchards in Spain, but is little grown in other countries. The tree is vigorous, with few or no spines. It is multiple-flowering. There are two distinct harvest periods, each with fruits of different characteristics: "Cosecha" corresponds to the harvest period from late February to early July, and "Rodrejos" or "Verdelli" correspond to the second period covering the whole summer. Fruits from the second flowering are

of slightly inferior quality. This second potential harvest, however, offers the options of supplying the market at a time of supply shortage.

On their stalk part, the fruits have a more or less prominent neck, and at the apex, a prominent nipple. The epidermis is slightly rough, with tiny deformations. The juice content is good, and the number of seeds low to zero. The fruit is preserved well on the tree. Fruit bearing poses some alternation problems.

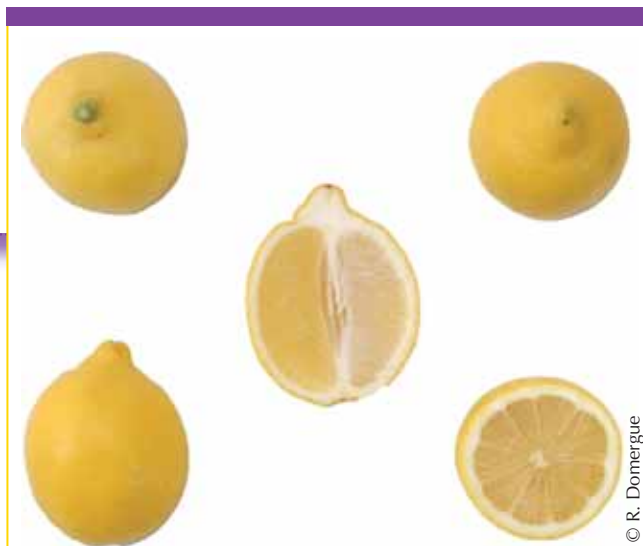


FINO (ORIGINATING FROM SPAIN)

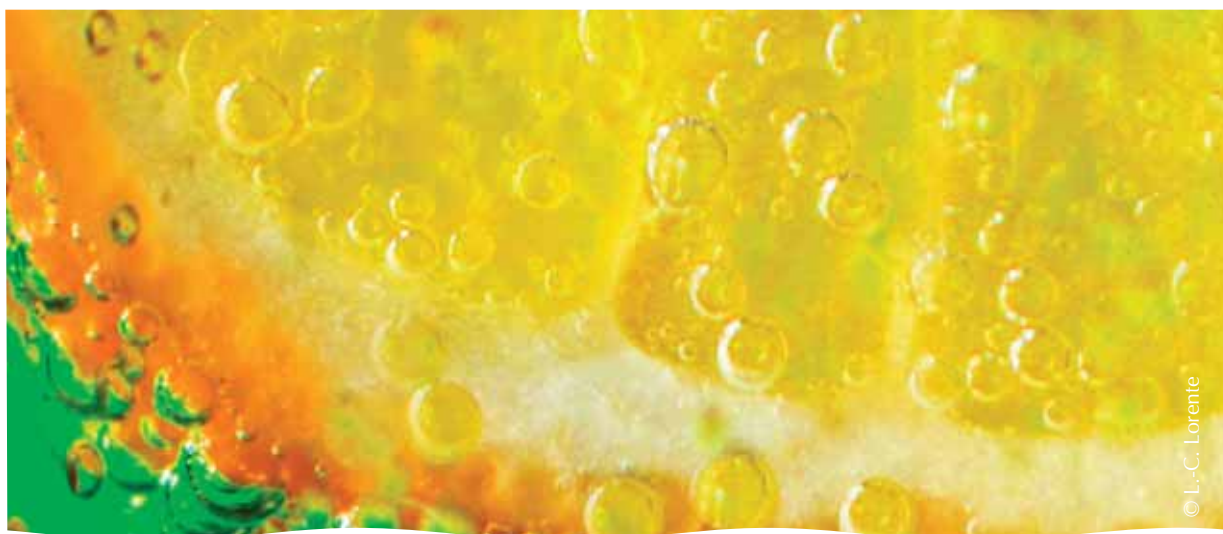
This variety appears to have originated from a common lemon tree seedling from Vega del río Segura. The tree is vigorous, and tends to produce spiny shoots.

Compared to the Verna variety, its fruits are slightly smaller, with no neck on the stalk

part, and with a small nipple. Their epidermis is smoother and thinner. The pulp, highly juicy and acidic, contains a small number of pips. This variety is highly productive, but with little or no multiple-flowering. The main harvest starts in early October, and ends in late February.



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NAME

Fruit fly

• Diptera: Tephritidae
Various species of the genera *Ceratitis*, *Anastrepha*, *Dacus*, *Bactrocera*, etc.

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Leaf miners

• Lepidoptera:
Gracillariidae
Phyllocnistis citrella

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Citrus blossom moth

• Lepidoptera:
Yponomeutidae
Prays citri

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Mealybugs

• Mealybugs
Hemiptera: Diaspididae, Coccidae, Pseudococcidae, Monophlebidae
Genera: *Aonidiella*, *Unaspis*, *Chrysomphalus*, *Cornuaspis*, *Coccus*, *Ceroplastes*, *Planococcus*, *Icerya*, etc.

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PESTS

SYMPTOMS

Holing due to egg-laying by females in the fruits. The larvae develop in the pulp and cause the fruit to rot and fall

Characteristic winding tunnels, bored by the caterpillars under the leaf epidermis

Flowers devoured by moth caterpillars

Whitish patches or clumps on leaves, twigs and fruits

PARTS ATTACKED

Fruit

Leaves, very rarely fruits

Flowers

Leaves, twigs, fruits, trunk

MEASURES TO TAKE

Population monitoring. Spot treatments, Male Annihilation Technique (MAT), mass trapping

Monitoring of populations and parasitism rates. Biological management using parasitoids

Monitoring by pheromonal trapping or visual inspection. Treatment using *Bacillus thuringiensis* (moderately effective)

Monitoring of populations and parasitism-predation rates. Biological management using parasitoids or predators

ECONOMIC IMPACT

Harvest loss. Damage more limited than on other Citrus spp.

Limitation of photosynthesis by the presence of tunnels. Facilitates attacks by citrus canker

Sometimes very heavy (partial destruction of flowering)

Weakening of the tree in case of large populations. Deterioration of outward appearance of fruits. Development of sooty mould, restricting photosynthesis

DISTRIBUTION

American continent: *Anastrepha*. Africa: *Ceratitis*, *Dacus*, *Bactrocera*. Asia-Pacific: *Bactrocera*

Cosmopolitan

Mediterranean region

Variable according to species



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Thrips

- Thysanoptera: Thripidae
Scirtothrips spp.
(*S. aurantii*, *S. citri*, *S. dorsalis*)



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Aphids

- Hemiptera: Aphididae
Toxoptera spp.,
Aphis gossypii,
Aphis spiraecola, etc



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Whiteflies

- Hemiptera: Aleyrodidae
Aleurothrixus floccosus,
Dialeurodes citri,
Aleurocanthus spp



© Digitizl CSJC

Jumping plant lice

- Hemiptera: Psyllidae
Diaphorina citri,
Trioza erytreae



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Mites

- Acarina: Tetranychidae, Tarsonemidae, Eriophyidae
Genera: *Tetranychus*, *Panonychus*, *Polyphagotarsonemus*, *Phyllocoptruta*

.....LEMON.....

Greyish ring-shaped spots around the stalk (feeding thrips on young fruits)

Colonies on young shoots. Larvae and adults suck out sap. Excretion of honeydew and development of sooty mould. Blight due to transmitted viruses (tristeza)

Larvae and adults suck out leaf sap. Sooty mould develops on the honeydew secreted by larvae and adults.

Larvae and adults suck out leaf and stem sap. Secretion of honeydew and development of sooty mould. Blight due to transmitted pathogens (HLB)

Flecks on leaves, desiccation, leaden or bronzed appearance of fruits

Young foliage, fruits

Young shoots

Leaves

Leaves, young shoots

Leaves, fruits

Population monitoring (trapping or threshing or visual inspection). Treatments according to thresholds

Population monitoring (visual inspection). Preservation of auxiliaries. Treatments according to thresholds

Effective larvae parasitoids generally limit the populations, if they are not destroyed by chemical treatments or disrupted by ants

Monitoring of populations and parasitism rates. Biological management using parasitoids (*Tamarixia* spp.)

Population monitoring (visual inspection). Treatments according to thresholds

Deterioration of outward appearance of fruits

Limitation of shoots. Deformation of leaves. Weakening or blight due to viroses

Limitation of photosynthesis following development of sooty mould. Weakening of the tree

Limitation of photosynthesis following development of sooty mould. Weakening of the tree. General blight due to HLB

Weakening of the tree in case of large numbers (spider mites). Spots on the fruits (soft mite, gall mite)

East and Southern Africa: *S. aurantii*. USA-Mexico: *S. citri*. Asia-Pacific: *S. dorsalis*

Variable according to species. *T. aurantii* in Mediterranean zone

Variable according to species. *A. floccosus* in tropical and Mediterranean zones, *D. citri* in the Mediterranean basin and *Aleurocanthus* spp. in Africa

D. citri in Asia, American continent, Caribbean. *T. erytreae* in Africa

Cosmopolitan

THE MAIN SANITARY CONSTRAINTS

Four main infectious diseases, which have very severe effects on citruses in general, and lemon trees in particular, are described in detail below. Among these four, the agents responsible for bacterial citrus canker, huanglongbing and black spot are classified as quarantine organisms by the European Union, and are subjected to strict regulations, especially the ban on exporting citruses to the EU from contaminated zones. The other main afflictions are presented in the table below, as well as the most widespread pests.



BACTERIAL CITRUS CANKER, *Xanthomonas citri* pv. *citri*, is a bacterial disease which affects all commercial citrus species, with some such as the lemon being sensitive to it. The disease is present in many tropical citrus growing zones, primarily in Asia with the Arabian peninsula, but also in South America (Argentina is one of the biggest producers), in Florida and, more recently, in sub-sahelian African countries.

Rain and wind help disseminate the bacteria and the infection, with cyclone periods highly favourable for its extension and long-distance contamination. Young tissues and injuries present on the plant tissues are both means of entry for bacteria. The disease symptoms are visible mainly on the leaves and fruits, as well as on the twigs. On leaves, in the first stages of evolution of the disease, we can observe on the leaf blade slightly convex small oily spots, visible in particular on the lower face. With ageing, these symptoms take over both faces and take on the appearance of rough, cracked pustules, beige-bronze in colour. A lighter, yellow-coloured halo develops around the darker central part. The size of these pustules is between 3 and 5 mm. On fruits, the symptoms are similar. They stand out in relief from the epidermis, and take on a crater-like appearance without ever developing in the fruit pulp. In a sensitive species like the lemon tree, canker development can be observed on the twigs. The pathogen agent survives in the symptoms, and for several years in twig lesions. Rain or irrigation enable the bacteria to spread from these symptoms, and perform a new infection cycle.





© H. Vannière

PHYTOPHTHORA GUMMOSIS is definitely the most widespread fungal disease on citrus worldwide. Three *Phytophthora* species are most particularly affected: *P. parasitica*, *P. Citrophthora* and *P. palmivora*. The pathogenic fungus is endemic in the soils of all citrus growing zones. It is particularly active when the climate conditions are hot and humid. *Phytophthora* can survive there in a form of conservation during dry periods unfavourable for its development. In citrus, attacks may occur at any stage of cropping, on young seedlings or adult trees in the orchard, and affect roots, trunks, branches and fruits. In the parts of the plant which are attacked, the fungus is present in living tissues, in the immediate vicinity of necrosed areas. On the trunks and lower branches, these attacks destroy the wood and vascular system, manifested by canker with gum seepage (termed gummosis). This greatly disrupts circulation of the sap manufactured, and causes

blight on the branches concerned, with yellowing of the foliage upstream of the destroyed part of the bark. There are other less visible symptoms, such as root rot or fruit rot, which can be expressed pre- or post-harvest. Attacks on the trunk or roots, if not controlled early, cause partial or complete blight of the tree. Not all citrus exhibit the same sensitivity to *Phytophthora* attacks. This particularity has long been used by grafting sensitive varieties onto tolerant or resistant species, which are termed the rootstock.



© Citrus Diseases, USDA-APHIS-PPQ, Center for Plant Health Science and Technology



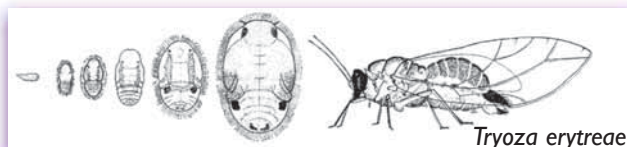
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HUANGLONGBING DISEASE (HLB), also known as greening, is described as the most important and destructive citrus disease in the world. This disease is caused by three bacteria: *Liberibacter asiaticus* (Las), *L. africanus* (Laf) and *L. americanus* (Lam), described most recently. These bacteria have different thermal tolerances and distribution areas, with Laf present in Africa and the Arabian Peninsula, Las in Asia but also America, and Lam in America, but also in China since recently. The disease is present in the main citrus producing countries except for the Mediterranean basin. These bacteria are transmitted by two vector insects: the African citrus psyllid *Trysoza erytrae* preferentially transmits Laf, and the Asian citrus psyllid *Diaphorina citri* preferentially transmits Las and Lam. These vectors have thermal tolerances similar to those of the bacteria species preferentially associated with them. Lemon trees have been described as insensitive to sensitive, according to the regions and, perhaps, consequently according to the species responsible for HLB. Lemon trees appear to be more tolerant to HLB in Africa, whereas the Asian and American forms severely affect most commercial species. Psyllids feed on young leaves, injecting bacteria into the phloem and making HLB a systemic bacterium, i.e. its pathogen is distributed throughout the plant. The

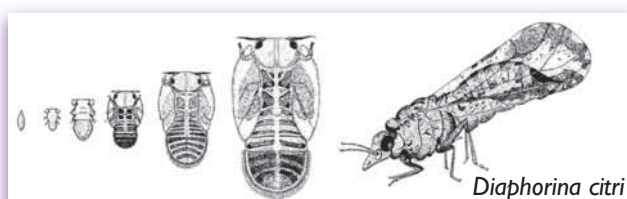
first symptoms are yellowing of the shoots with mottling of the leaves, and later on, symptoms similar to those of zinc deficiency may appear. The leaves then fall and the branches are blighted. The fruits are deformed, poorly coloured (which has also led to this disease being named greening) and remain small. There is no known resistance in citrus, but the arrival of HLB in the main producing countries has triggered a major international research effort.



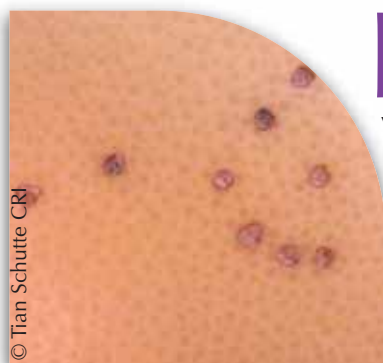
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Trysoza erytrae



Diaphorina citri



© Tian Schutte CRI

BLACK SPOT DISEASE is a citrus disease caused by a fungus, *Guignardia citricarpa*, with lemon trees among the most sensitive hosts. Black spot is primarily a fruit disease. Present in Australia, South Africa and South America, it was recently declared in Florida. Several types of symptom, denoted A to D, have been described. Type A lesions are the most typical: hard, circular, brown and slightly yielding spots, formed of a grey crater in their centre, with a black border ringed with green tissue. The other types of symptom come in the form of reddish spots (orange to brick red), virulent spots deeper in the epidermis and black flecks. The fungus sexual spores borne on plant debris are the main source of inoculum initiating an epidemic. The critical infection period is in fruit setting, but lasts for the first 4 to 5 months.

The infection occurs preferentially during hot and wet periods. Severely attacked fruits fall and spotted fruits are unfit for sale. Use of fungicides is fairly effective, but must coincide with the critical periods. The quarantine organism status of this fungus imposes strict rules for exporting fruits from contaminated regions.



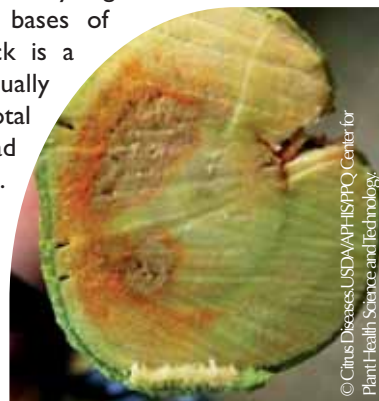
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MAL SECCO is a fungal disease caused by *Phoma tracheiphila*. This vascular disease, which primarily destroys lemon trees, but has also been reported on the citron, bergamot, sour orange or lime trees, is confined to the Mediterranean basin. The fungus primarily penetrates via injuries (natural entries such as stomata are suspected) to leaves and branches, but also roots. The first symptoms are often chlorosis of shoots, followed by blighted branches and twigs. The development of buds at the bases of contaminated branches and of sprouts on the rootstock is a commonly observed reaction. The fungus, which gradually contaminates the vascular system, can cause more or less total

tree blight. Infection via the roots causes more rapid blight. Chronic infection can lead to brown staining of the wood, giving a salmon-pink or orange-reddish coloration. Cropping practices, wind, frost and hail cause injuries to various organs, which promote infection. The fungus survives in the form of mycelium or spores on plant debris, or even for a few weeks in the soil. The size of the infected parts and application of fungicides help reduce the inoculum, but the best method of managing it appears to be using resistant varieties grafted onto resistant rootstocks. However, the quality of the varieties on offer has not been persuasive, both for their low yields and their inferior taste properties (e.g. test replacement of the sensitive Femminello cultivar by the resistant Monachello in Sicily).

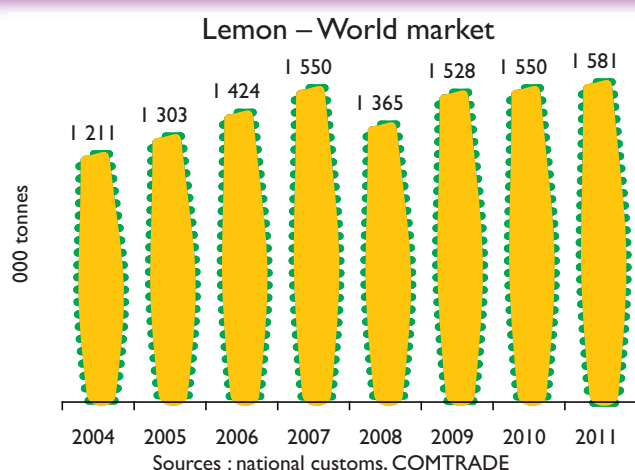


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FRESH LEMON CONSUMPTION TRENDS ON THE WORLD'S BIG MARKETS

A medium-sized market lacking juice

The fresh lemon is not one of the heavyweights of the international fruit trade. While the volumes involved, around 1.6 million tonnes over the past few years, are far from anecdotal, the lemon is down in 11th place in the world ranking, behind peaches and nectarines, though ahead of the kiwi - a position which unfortunately does not seem set to change. After a fine trend in the first half of the 2000s, growth has stalled since 2007. How has this status quo come about?



World – Main trade fruits (million t).

| | |
|----------------|-------|
| 1 Bananas | 17.7° |
| 2 Apples | 8.2 |
| 3 Oranges | 5.7* |
| 4 Easy peelers | 3.8* |
| 5 Table grapes | 3.7 |
| | |
| 11 Lemons | 1.6* |

Source: FAO 2010 °CIRAD 2012 *CIRAD2011

A fruit in a class of its own, a victim of its own flaws and growing competition

To better understand this sluggishness, we should review a few obvious points. The lemon is a fruit in a class of its own, due to its acidity: between 4.6 and 5.5 % of the juice comprises citric and malic acid, as opposed to 0.4 to 1.2 % for most varieties of small citruses and orange. This particular taste profile banishes it from the direct consumption market, the primary outlet for citruses and fruits in general. So it is employed only in making drinks, as an ingredient (zest or juice) or decoration (slice or

quarter). This tells us why, although this product is among the most commonly used by consumers, as a penetration rate of 67 % attests, the quantities purchased rapidly hit a plateau.

As an additional difficulty in high-income countries, it has direct competition on one of its major markets, i.e. juice, from a rich and fairly high-quality range of processed products, which are more expensive but 100 % practical and seedless! To cap it

all, the lemon is also faced with a fearsome competitor very much in fashion: the lime. World trade in this product has boomed over the past few years, to in excess of 500,000 t, while the lemon trade remained hopelessly stable (see inset). The combination of all these factors probably explains why, after a long period of growth, consumption has hit a plateau on most markets, and primarily in rich countries where the effects of substitution by processed products have hit hardest.

The heart of the world market is beating less strongly with growth stalling in Western Europe

This is the case of the EU, which is no longer playing its driving role; a real problem in the knowledge that this market absorbs more than 50 % of the world trade. Volumes have stagnated at between 780,000 and 830,000 t since 2006, with growth stalling both during the winter season and in summer, and average consumption hitting a plateau of 1.5 kg/inhabitant/year in Western Europe. This level corresponds to approximately one lemon per person

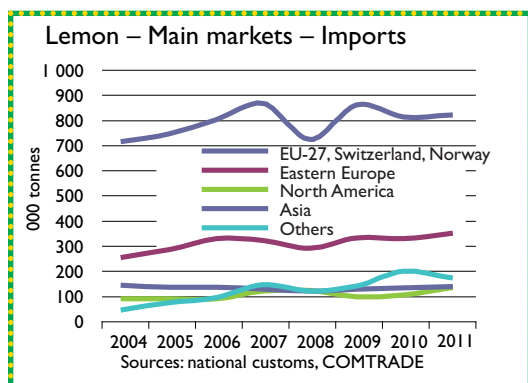
per month, similar to the level found in most temperate-climate rich countries worldwide. Furthermore, the country-by-country analysis does not reveal any movement, whether negative or positive. Volumes consumed are stable and considerably higher than this average in the more northern countries: between 1.8 and 2.0 kg/inhabitant/year in Scandinavia. Yet another example which seems to demonstrate the relationship that exists

between a cold climate and over-consumption of citruses, probably because of the preventive effects of these fruits, renowned for their richness in vitamin C, on the appearance of pathologies such as the flu. The volumes absorbed are also above-average in France and Benelux. However, consumption is less than 1.5 kg in the United Kingdom and Ireland, the only country where slight growth has been seen.

Lemon – World imports by market (000 tonnes).

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| EU-27, Switzerland, Norway | 707 | 738 | 795 | 858 | 716 | 851 | 805 | 813 |
| Eastern Europe | 247 | 278 | 321 | 314 | 283 | 324 | 321 | 340 |
| North America | 81 | 82 | 82 | 111 | 115 | 90 | 97 | 126 |
| Asia | 136 | 126 | 128 | 119 | 112 | 119 | 124 | 131 |
| Others | 38 | 66 | 87 | 138 | 113 | 132 | 190 | 166 |
| Total | 1 209 | 1 290 | 1 412 | 1 540 | 1 339 | 1 516 | 1 537 | 1 575 |

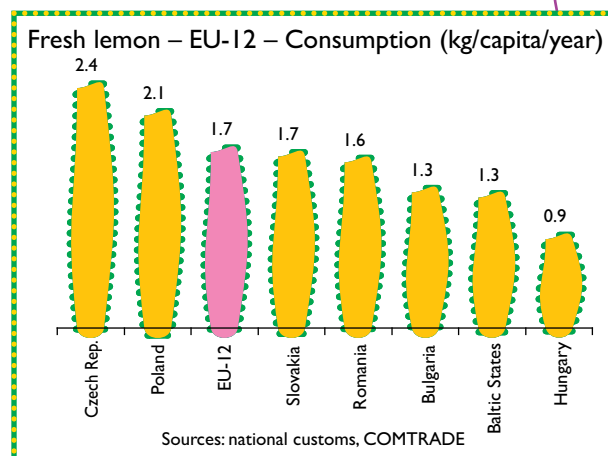
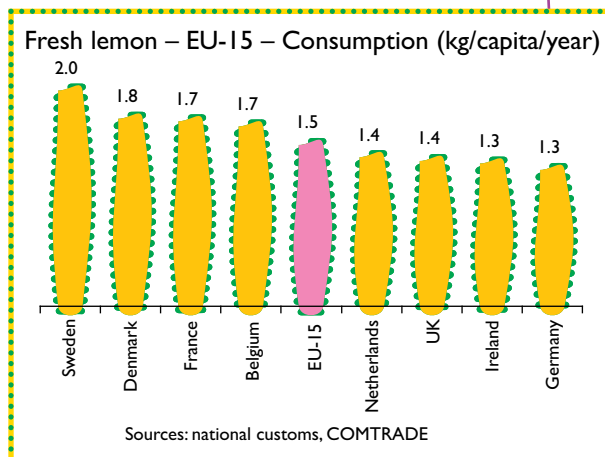
Sources: national customs, COMTRADE



A higher consumption level in the Eastern EU, but just as stable

The average consumption in the Eastern EU exhibits a slightly higher level than that observed in the West, but there is the same prevailing status quo. After a considerable fall until the mid-2000s, annual consumption volumes have stabilised at between 1.7 and 1.9 kg/inhabitant over the past few years. This over-consumption can probably be explained not just by the greater affinity of cold-climate countries for citruses. The breakthrough of substitution processed products has advanced less, because of the purchasing power corresponding on average to half that in the western part of the continent; a diagnostic which in the long term points to a drop in volumes absorbed by the highest-consuming countries in this region, as purchasing power rises. While this substitution phenomenon does not seem to have taken hold among Czech consumers, who continue to absorb approximately 2.4

kg/year, it seems well underway in Poland, where volumes have fallen by 600 g since the mid-2000s, though they are still more than 2 kg. A slight growth still seems intact in the other countries in the zone. However, consumption has reached practically the regional average in Romania and Slovakia. A small margin for development still seems possible in Bulgaria, and especially in the Baltic States, where volumes absorbed are approximately 1.3 to 1.4 kg. Though this is nothing to get overly enthusiastic about if we consider the population of these countries, and the decrease in Poland, which involves more than 40 million consumers.



North America, a minor market for imports

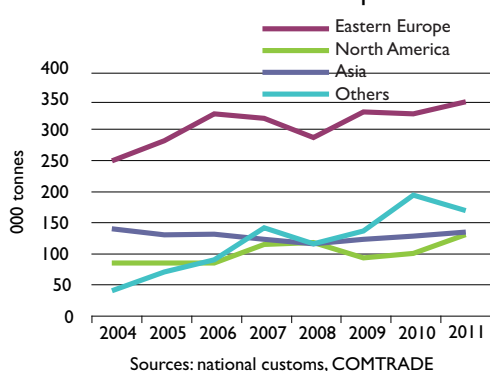
The big North American markets also seem to be suffering from the problem stated above. Consumption is stagnating at between 1.4 and 1.8 kg/inhabitant/year in the United States - a somewhat high level for the country that is king of "convenience foods", where prepared juices generally have a greater reserved share than on other markets worldwide. However, despite this fine average and more than 310 million inhabitants, this country remains a very minor importer, receiving only 40,000 to

60,000 t per year, i.e. approximately 3 % of world trade. This makes sense when we see that the United States has the world's 4th highest production, thanks to the 800,000 t harvested in Arizona and above all California. The well spread production calendar of the orchards of the Californian coast means that imports are limited even during the summer period, besides the sanitary protection measures in force on the country's borders. The Eureka from Argentina, which had been able to squeeze through the door, once more became a "fructus non grata" in 2001. Chile and, from this season 2013, Uruguay, can export to this destination, but only by adhering to a protocol of insect control fumigation, which is not without consequences on the competitiveness of the fruits (appearance, high rejects in the incoming sorting). The Mexican lemon, often heterogeneous in shape and colour, is also less prized than Californian produce.



Could the lifting of the restrictions impeding Argentina, or even of the protocols in force for lemons from other sources, turn the tide and change the United States into a leading import market, at least during the summer season? The question has been asked. Market studies point to a possible consumption growth of approximately 25 %, with marketing support and a "fancy" fruit supply, from Argentina for example. Neighbouring Canada is also a minor import market, absorbing approximately 40,000 to 45,000 t per year. Development prospects appear to be zero, with consumption, on average 1.2 kg/inhabitant/year over the past few years, on rather a downward trend.

Lemon – Other markets – Imports



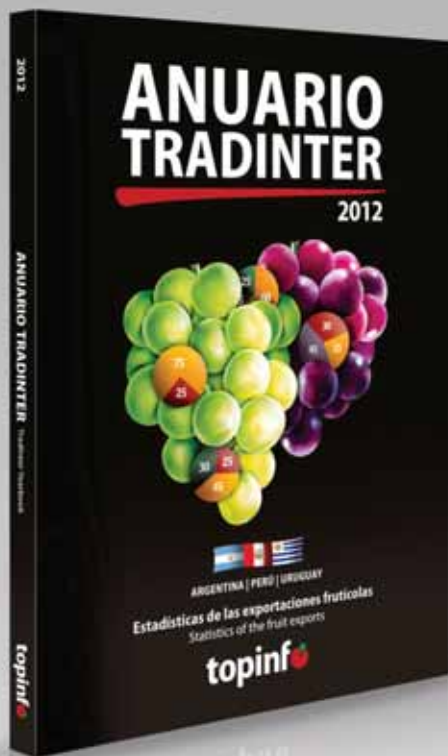
Citrus consumption in Asia being corroded

The findings are scarcely more optimistic in Asia. Although counting for more than half the world's population, this continent absorbs only 8 % of world trade, i.e. approximately 120,000 to 130,000 t per year, and it cannot be said that volumes are rising. Japan, the region's main market, has seen its imports fall by 40 % during the 2000s, before stabilising at between 50,000 and 55,000 t over the past few years; a very meagre level for a country without its own production and amounting to no fewer than 126 million inhabitants. The

400 g consumed per inhabitant per year in this country illustrates the lack of interest from the Asian population in acidic products. The lime, grown locally in some countries in the region, is sufficient to cover requirements. In this context, it is hard to imagine great prospects in this part of the world. The imports of other markets on the continent also show this clearly. Volumes are stagnating at between 30,000 and 35,000 t in China, the region's 2nd biggest market, where production is developing in Sichuan. The next four



markets in the ranking, i.e. Singapore, South Korea, Malaysia and Azerbaijan, import less than 10,000 t and are not rising.



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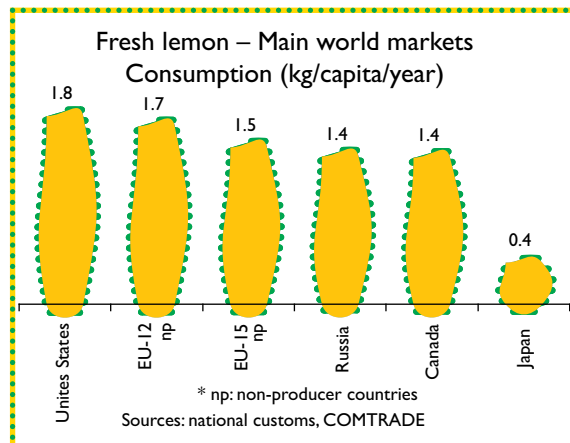
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Russia, the only market still growing, but for how much longer?

The markets of the Eastern part of the old continent, situated outside the EU, saw strong growth during the 2000s, and have imported approximately 340,000 t over the past few years, i.e. more than 20 % of world trade. It represents the only speck of hope in this gloomy world panorama, though a minimal one. Growth is ongoing in Russia, the main market in the zone with approximately 230,000 t imported over the past few years. However, its rapid slowdown probably illustrates the weakness of the margin for development still available. The consumption of the 140 million inhabitants of the country was already exhibiting a fairly high

level of approximately 1.6 kg/inhabitant/year in 2011.

The other markets in the zone, which each amount to more than 10 million inhabitants, also seem to be approaching maturity and are seeing their import level hit a ceiling. Volumes have stabilised at just over 60,000 t in Ukraine, the second biggest importer in the region, where the consumption of the 45 million inhabitants fluctuates between 1.3 and 1.4 kg. The Serbian market is just as stagnant (15,000 to 16,000 t imported for 10 million inhabitants, i.e. 1.5 to 1.6 kg). Only Belarus, also populated by



approximately 10 million inhabitants, probably has a margin for development, with a consumption of between 700 and 800 g.

Differentiating for increased added value, in the face of rising production costs



With such limited growth prospects in terms of volume, it is rather growth in terms of value that must be targeted, through approaches of product differentiation and innovation. These directions to work on appear all the more important since market prices have risen only very slightly, at least during the winter season (with the exception of the one ending), while production costs have risen steeply, especially since the surge in oil prices

that has occurred over the past few years. According to the data from our monitoring, the average Spanish Primofiori rates have increased by approximately 12 % in ten years, i.e. barely more than 1 % per year, while annual inflation alone has been between 1.5 and 2 %. Numerous pathways have been explored, with varying degrees of success.



IGP, no more suited to international promotion for the lemon than for other products

The concept of local segmentation (IGP) does not seem to have proven effective in international sales in the case of the lemon, or for the other products in the world of fruits and vegetables. The current level of communication budgets for these

approaches does not generally make it possible to effectively distinguish the labelled product from the rest of the range, which of course is easier to do in the country of production. The example of Italy, where there are no fewer than seven IGPs, says it all:

exports are still small, and continue to represent less than 10 % of production, with the small rise since the early 2000s probably more due to the boom in the organic sector than the Amalfi, Syracuse or Sorrento lemons, etc.



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Combined source-quality approaches, at least enabling communication



Other differentiating approaches, combining source and quality, have been implemented. The label "All lemon: tested and certified", developed since 2009 by Argentinean pro-

fessionals, imposes on exporters a set of somewhat reinforced specifications, while above all unifying the budgets to enable large-scale communication about the lemons from this source. Hence 80 % of fruits exported by Argentina bear this label, to which around fifteen

exporters have signed up. It now remains to continue to develop the concept, by reinforcing the quality criteria or by taking into account the social and environmental dimensions to which the big Argentinean groups are already committed.

Towards a second stage of the certification approach in Spain, before communication

Spanish professionals, under the leadership of AILIMPO, have also started to develop a combined quality-source promotion label. A packing station quality certification system has been in place since 2010, and around thirty companies have signed up to it. It has

strengthened traceability and made the relationship between producer and shipper more transparent, thanks to the mandatory use of a sale contract. Another stage is about to start, with the implementation of production system certification, going beyond the

classic benchmarks such as GLOBALGAP, and opening up a social and environmental responsibility aspect. As with any well-composed approach, communication will form the third stage.



While the actions presented above are important, and reinforce the profile and competitiveness of the source, their effects on increasing added value are difficult to measure. The effects of segmentation are more direct. The idea of building a range based on the various production methods has already very naturally been a necessity for the lemon, whose skin is widely used. Fruits not processed after harvesting now represent a very significant proportion of the supply to

Segmentation by production method is developing

markets such as France and Germany (respectively 25 % and 10 % according to professional sources). Generally packed in four-piece flow packs, their sale price is between 10 and 15 % higher than conventional fruits.

Yet the segment which has seemed to have grown most over the past few years is organic fruit, with a price differential from conventional of approximately 25 %. This trend is due to the development of retail space dedicated to this range in most European supermar-

kets, the growth in the network of specialised brands and the regulatory obligations in catering in some countries such as France (obligation to have at least 20% organic products in school canteens). The organic lemon apparently now represents 30 % of sales in Germany, 15 % in France and 5 to 10 % in the United Kingdom. This interesting market segment might see further growth, while ensuring that the certification criteria are adhered to.



| Lemon - Europe - Segmentation on the main markets. | | | |
|--|--------|----------------|---------|
| | France | United Kingdom | Germany |
| Organic | 15% | 5-10% | 30% |
| No post-harvest treatment | 25% | 0% | 10% |
| Conventional | 60% | 90-95% | 60% |
| Professional sources | | | |

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Seedless lemons, a must!

One of the most serious pathways for differentiation is definitely the absence of seeds. However, the technical limitations in obtaining this highly differentiating and sought-after characteristic are great. The first option for achieving this is complete isolation of the crops from risks of cross-pollination by other citrus species. But this is particularly complex to implement unless on an island or in a desert, as Moroccan producers have been able to do for their Nadorcott, produced in

five isolated zones of the country, or the Californian producers in the State's desert zone.

The other technical solution consists in using specific cultivars. However, tests conducted to date do not seem to have been conclusive. The Lisbon Seedless did not develop in California, because of its excessively small fruit size, nor did the Betera in Spain, which became seeded after a few production cycles. Similarly the Eureka! TM Seedless does not seem to have been satisfactory in South Africa.

Surface areas, which had reached 1000 ha (i.e. nearly 20 % of the cultivation area), were down to slightly under 300 ha in 2012, in particular because of a low yield and high production costs. Will the Limoneira Seedless, probably derived from a cross between Femminello and Interdonato identified in Turkey, be satisfactory? The plantations are expanding in South Africa and California. Other varieties should appear in the medium term. Riverside University has decided to include this line of research among its priorities.

Obtaining a top-end lemon thanks to Californian "curing"

It is possible to make new from old! The curing technique used in California can also increase added value. Developed primarily to improve fruit resistance to alterations during transport, it also improves its appearance (smoother and less thick skin, brighter yellow colouring), while

increasing the juice and acidity contents. It is a simple process, consisting simply in storage at a temperature of 55 to 60°F at a relative humidity of 75 to 85 %. However, its main limitation is the relatively long and therefore fairly expensive treatment time.



Investments required to safeguard the future, but hard to accept in a context of crisis



Inflexibility of consumption, the current main markets having reached maturity or close to doing so, lack of means of large-scale growth, etc., the margins for development of the fresh lemon market seem very much limited in terms of volume. More than ever, market growth must be achieved through working on the added value of the product, and so through major investments, often over the long term, in research and communication. It is hard for European sources, facing an extremely tough context of economic crisis, to maintain this effort. It is also hard

to ensure that these innovations provide a financial plus, in the face of the super-market sector still being very much in a position of strength in commercial negotiations, and even more attentive to the price dimension than before – so much so that the struggle is approached with a degree of prior fatalism. Hence many professionals are now concentrating on increasing yields and reducing costs; an unavoidable response, but with long-term consequences that must not be underestimated.

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A market with a future, still focused on its basics

Who said that the citrus market was mature and sluggish? Certainly not the professionals of the lime market. Trade volumes in what some still call the “green lemon” have risen considerably since the 1980s, and this is still the case. World trade, growing on average 5 % per year over the past ten years, was in excess of 500,000 t in 2012; a figure that represents approximately 30 % of lemon trade volumes! However, it is not innovation which has driven world trade in this product, still highly monolithic, both in terms of varieties and supplier countries, as well as the markets.

Lime – Brazil – Exports

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|----------------------|--------|--------|--------|--------|--------|
| Total | 60 335 | 66 374 | 63 061 | 66 457 | 72 810 |
| EU | 54 985 | 58 083 | 58 921 | 62 251 | 65 962 |
| Canada | 1 856 | 944 | 1 470 | 1 033 | 331 |
| United Arab Emirates | 1 676 | 4 541 | 2 292 | 2 710 | 5 646 |
| Others | 1 818 | 2 806 | 378 | 463 | 871 |

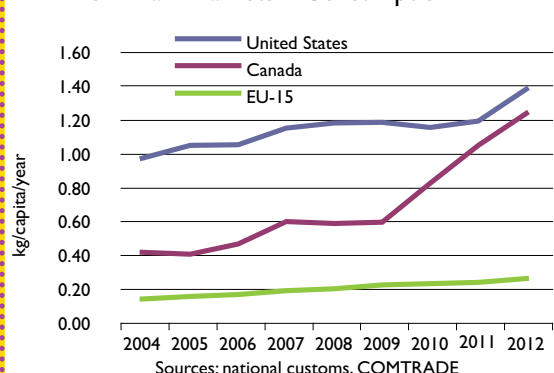
Source: national customs

Lime – Mexico – Exports

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|-----------------|---------|---------|---------|---------|---------|
| Total | 419 172 | 395 198 | 367 786 | 399 997 | 445 797 |
| USA | 394 519 | 365 127 | 334 669 | 365 109 | 407 701 |
| EU, Switzerland | 18 536 | 23 489 | 26 352 | 29 291 | 32 201 |
| Canada | 3 766 | 4 276 | 4 645 | 3 560 | 3 670 |
| Japan | 2 104 | 2 017 | 1 907 | 1 967 | 2 055 |
| Other | 246 | 289 | 213 | 69 | 170 |

Source: national customs

Lime – Main markets – Consumption



Tahiti, Mexican or Brazilian!

World trade volumes continue to rely nearly exclusively on just one of the two varieties of acidic lime. *Citrus latifolia*, better known as Tahiti lime, Persian lime or Bearss lime, is preferred to *Citrus aurantifolia* (Mexican lime, Key lime or West Indian lime). The triploid fruits are practically seedless (as opposed to around fifteen for *Citrus aurantifolia*) and significantly bigger. The highly insipid limes (*Indian lime*, *Palestinian lime* and other *Citrus limettioides*), which contain ten times less citric acid than an orange, are only sold locally in their production areas in the Middle East and India.

Nor is there any prevailing diversity in terms of the supplier countries. However, there are many producers in Asia (China, Thailand, etc.) and in South America (Mexico, Brazil, Peru, etc.). Furthermore, the world harvest is one of the biggest: it could be estimated at 4.5 million tonnes in 2010, not counting Iranian production (approximately 700,000 t) and Indian production (approximately 2.5 million tonnes), comprising lemon and lime in indeterminate proportions. Nonetheless,

Mexico and Brazil practically have the international scene to themselves.



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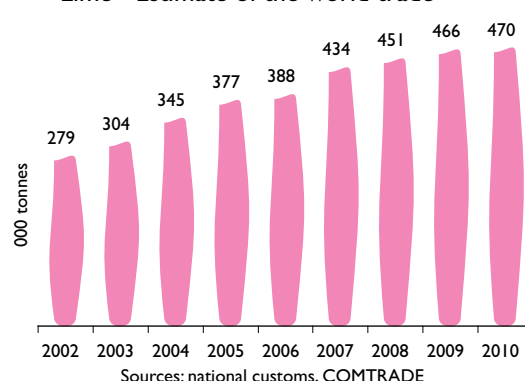
Martinez de la Torre against Itajobi

Mexico is by far the leading exporter, with growing volumes approaching 450,000 t in 2012, i.e. more than 85 % of world trade. Production appears to have been in excess of 860,000 t in 2011, and volumes in future should be sufficient to continue to fuel the trend! If we can believe the official statistics, plantations expanded by 30,000 ha between 2005 and 2011 to reach 76,000 ha in the Gulf of Mexico region, where most of the cultivation area is concentrated. The surface areas developed particularly intensely in Oaxaca State, and above all in the already leading State of Veracruz, where the country's main production centre is situated in the Martinez de la Torre region. Hence the extent of the Persian lime cultivation area is similar to that of the Mexican line, which with 86,000 ha

packed into the States along the Pacific Coast, still continues to dominate.

Brazil has a bigger harvest, in excess of a million tonnes, thanks to a cultivation area of more than 47,000 ha. The Tahiti lime, the main variety cultivated, is present throughout the country. However, the big citrus growing region of Sao Paulo houses nearly three-quarters of surface areas, especially around Itajobi. This city, situated north-west of Sao Paulo near Sao José do Rio Preto, is the genuine lime capital of Brazil, packing in approximately 80 % of the State's surface areas (along with the neighbouring cities). Most of the production is sold

Lime - Estimate of the world trade



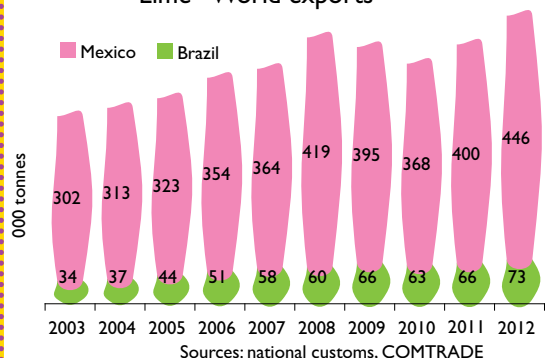
locally. However, exports, which were in excess of 70,000 t in 2012, are seeing slight growth, like the cultivation area. The trend has clearly dipped since 2005, though growing areas are still increasingly slightly.



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A whole world of growth...

Lime - World exports

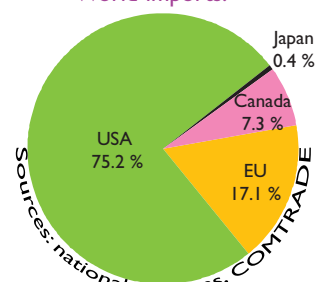


Nor should we look for originality on the markets side, where two destinations absorb more than 90 % of volumes. The United States has consolidated its place as the world's number one market over the past few years, importing three-quarters of world

volumes, and has played a driving role. Volumes, coming nearly exclusively from Mexico, rose by 200,000 t in ten years, approaching 430,000 t in 2012. Consumption, of approximately 1.4 kg/inhabitant in 2012, is close to that of the lemon, which is 1.7 to 1.8 kg. Western Europe comes in second place, with imports of approximately 100,000 t. Volumes have tripled since 2002, and growth should not stop, given that consumption is still down at approximately 250 g/inhabitant. Outside these two primary destinations, Canada is the only other country to absorb volumes greater than 10,000 t. Just as in the United States, consumption, with 1.2 kg/inhabitant, is one of the

highest among non-producer countries. Japan and the United Arab Emirates import some limited volumes. The other big citrus importing markets such as Eastern Europe are still ignoring this product almost completely; which means that margins for development are still available.

World imports.

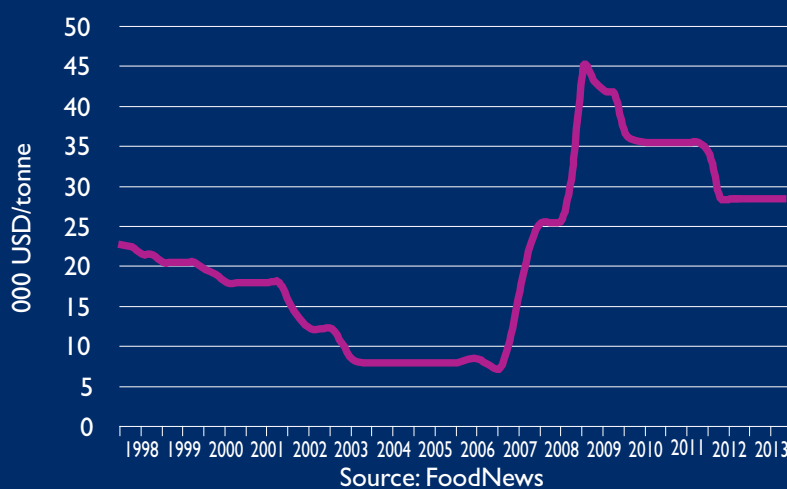


TRENDS IN WORLD CONSUMPTION OF LEMON DERIVATIVES

A dash of madness!

It was an explosion! It is no exaggeration to use this term to describe the spectacular rise in prices that occurred in 2007 on the lemon derivative products market. Essential oil rates, which had constantly fallen since the late 1990s, quintupled to reach a high point of nearly 45,000 USD/tonne in mid-2008 according to FoodNews. Concentrated juice was not to be outdone, with the average price per tonne tripling to in excess of 3000 USD in 2009. A trend which contrasts, to say the least, with the nearly-universal sluggishness of fresh lemon rates during this same period, described in the previous article. This sudden explosion was no flash in the pan. While prices have eased back over the past few years, they have nonetheless maintained an extremely high level. How has this trend come about? FruiTrop provides a review.

Lemon essential oil – Argentina
Delivered price in Europe



A hyper-concentrated market, with Argentina playing a cardinal role

The particular structure of this extremely concentrated market is a key element in understanding this abrupt movement in rates. Processed volumes, of approximately 1.6 to 2.2 million tonnes over the past few years, are important since they represent no less than one quarter of world production. However, more than

85 % comes from just three sources, which are on a far from equal footing. Despite a market share of approximately 15 % each, Spain and California are dwarfed by Argentina, which alone reigns supreme and processes practically 60 % of the world total. This is one of the constants of the world of

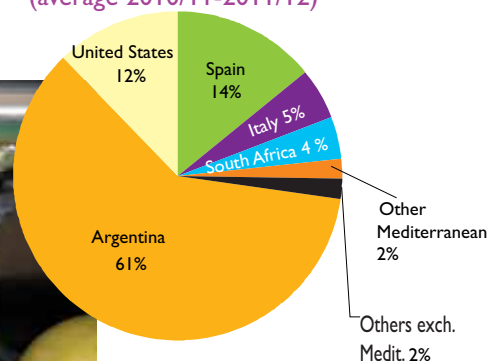
processed citruses, where an American source occupies a cardinal position, like Brazil for the orange and Florida for the grapefruit. Any large-scale movement affecting one of the countries which are part of the narrow foundation on which this sector is based therefore has major repercussions, particularly if that country is Argentina!

Lemon – Processed volumes (000 tonnes)

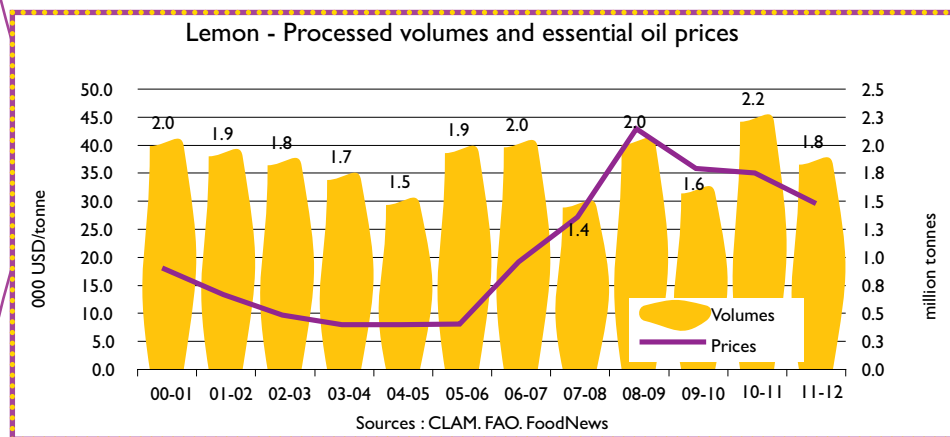
| | Average 2010/11-2011/12 | Average 2000/01-2001/02 | Evolution (%) |
|---------------|-------------------------|-------------------------|---------------|
| Argentina | 1 221 | 922 | +32 |
| Spain | 287 | 193 | +48 |
| United States | 248 | 339 | -27 |
| Italy | 98 | 359 | -73 |
| South Africa | 84 | 75 | +12 |
| Turkey | 31 | 22 | +41 |
| China | 20 | - | |
| Uruguay | 18 | 13 | +42 |
| Australia | 3 | 15 | -81 |
| Cyprus | 4 | 4 | -2 |
| Israel | 4 | 3 | +40 |
| Greece | 0.2 | 13 | -99 |

Sources: CLAM, USDA, FAO, professionals

Lemon - Processing by country
(average 2010/11-2011/12)



A short-term fall in production in 2007-08, which became a period of instability over the following seasons



Mother Nature was not at her most clement at the end of the last decade. Season 2007-08 was a black year for all

three countries, afflicted by various weather problems - even frost, to which this citrus is particularly sensitive.

Processed volumes, which had stabilised during the first part of the 2000s based on between 1.7 and 2.0 million tonnes, according to the effects of production alternation, have plummeted to a level of barely more than 1.4 million tonnes. This short-term shock became a period of long-term instability, when the Tucuman region in Argentina and the Murcia region in Spain were once again affected by serious weather problems in 2009-10. The fall in volumes used for processing was slightly less severe (1.6 million tonnes industrialised), but it came when the sector had already dried up.

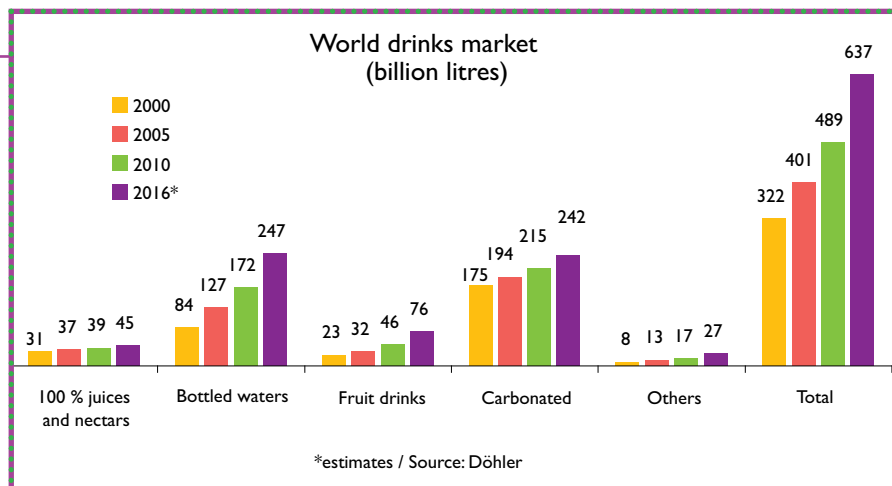
Lemon derivatives omnipresent on the drinks market

However, these falls in production, despite their repetitive nature, cannot on their own explain such a big trend. The extreme responsiveness of prices has also revealed a very high market tension, due to significant growth in demand for lemon derivatives. The main essential oil outlet, and practically the only outlet for concentrated juice, is the drinks market. Unlike the orange and pomelo, it is not juices (pure juice and concentrate-based juice, nectars) which drive the consumption of highly acidic lemon derivatives. It is rather other soft drinks with low fruit juice content in which the lemon is often just an ingredient. According to a 2008 study by Canadean, 98 % of concentrated lemon juice was used to make drinks containing less than 5 % juice (87 % of volumes), or between 5 and 15 % juice

(11 % of volumes). This product family, in which we can find fruit drinks such as "Sunny Delight" or "Limonada", flavoured waters, squashes, drinks for athletes and above all sodas (colas, lemonades, tonics, etc.) represents considerable volumes.

By way of illustration, 4000 litres of the best known cola is apparently sold every second worldwide! Even if we can exclude the bottled water market given the low percentage represented by flavoured waters (less than 2 % of total volumes in France), the volumes of drinks likely to contain lemon represented nearly 290 billion litres in 2011, on a world market estimated at 511 billion litres for all products, according to statistics from Döhler.





World drinks market – Annual growth rate by product type.

| | 2000-2005 | 2005-2010 | 2010-2011 | 2011-2016* |
|-------------------------|-----------|-----------|-----------|------------|
| 100% juices and nectars | 3% | 1% | 1% | 3% |
| Bottled waters | 9% | 6% | 7% | 6% |
| Fruit drinks | 6% | 8% | 8% | 9% |
| Carbonated | 2% | 2% | 2% | 2% |
| Others | 9% | 6% | 10% | 7% |
| Total | 5% | 4% | 5% | 4% |

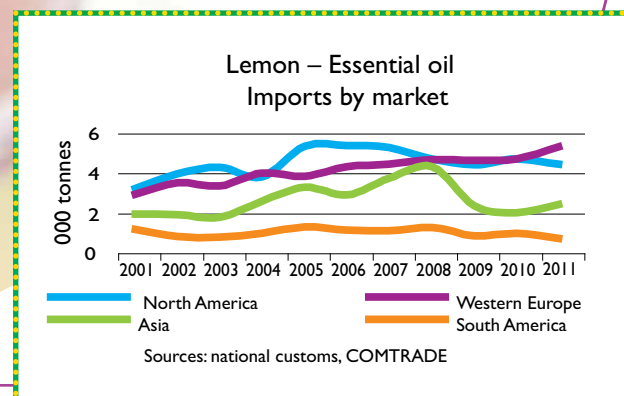
*estimates / Source: Döhler

A rapidly expanding market, but not thanks to the core markets situated in rich countries!

The world drinks market is rapidly expanding. The 2000s were auspicious, despite a slowdown at the end of the period, and growth has returned to a high level since 2010. It is not the main markets on the planet, i.e. the United States and the EU, that are behind this trend. It is rather due to qualitative substitution in these regions, where consumption seems to have reached maturity. Programmes to combat obesity, by means of iconic measures such as the ban on “jumbo sodas” in New York or taxation on sugary drinks

in France, have eaten into certain heavyweight segments such as carbonated drinks. Nonetheless, the diversification strategy implemented by manufacturers has moderated the fall, thanks to lower-sugar products (“diet” with sweeteners or “mid cal” with sugar level reduced by approximately 60 %), and made it possible to launch innovative segments driving growth, such as energy drinks, “Ready to Drink” teas, etc. Hence by virtue of their near-universal use, lemon derivatives have not waned on these markets,

as is attested by trade volumes of essential oil, which are easier to measure than flows of concentrated juice, for which the multiple customs codes raise uncertainty. While imported volumes are on a stable to slightly downward trend in the United States, they appear to still be growing in Western Europe (approximately + 4 % per year over the past five years).



Emerging countries, driving trade vitality

It is more the emerging countries which are dragging the market upward. On the one hand, the highly accessible prices of soft drinks due to their low juice content make them entry-level products well-suited to the intermediate living standard of these countries. On the other hand, these markets are also taking advantage of an active demographic. According to

Euromonitor, the average annual growth of the soft drinks market appears to have been between 5 and 10 % between 1999 and 2008 in the big consumer countries in Latin America, led by Mexico and Brazil. But it is above all Asia which has shown the strongest trend, with an annual rate of increase of between 10 and 20 % during the same period, according to the same

source. The Asia-Pacific region is now exhibiting a soft drinks consumption level greater than North America and Western Europe. The rise in lemon essential oil imports into China is a perfect illustration of this trend. Volumes increased by 20 % per year between 2003 and 2008, until the price explosion caused a significant backward step.



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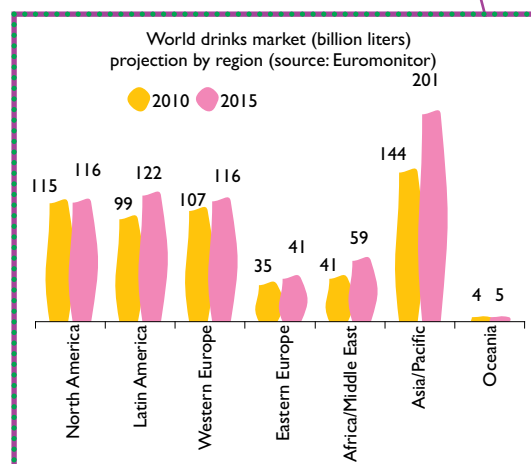
A trend which is not close to fading away



And this trend does not seem about to stop! Certainly, a rigorous study is required, but there are clear trends. Although the Asian markets already represent more than a quarter of volumes sold worldwide, consumption per inhabitant remains very low. It was estimated at 35

litres in 2011, leaving a big margin for development in relation to a world average of 80 litres and 180 litres in the United States! Hence Euromonitor predicted an annual growth rate of around 7 % in Asia between 2010 and 2015, a trend shared by the Chinese authorities which predicted a rise of 10 % in their five-year plan during the same period. The annual 3 to 4 % increase in the East European and Latin American markets should also be highlighted. Certainly, the range is also evolving in these countries, and the phenomenon of substitution of excessively sweet sodas by other drinks, such as iced teas and local specialities in Asia for example, seems

to have started. But just as in Western Europe and the United States, this trend is not necessarily unfavourable for the omnipresent lemon derivatives.



World drinks market (billion liters).



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| | 2010 | 2015 | Growth 10-15 | Annual |
|--------------------|------|------|--------------|--------|
| North America | 115 | 116 | 0% | 0% |
| Latin America | 99 | 122 | 23% | 4% |
| Western Europe | 107 | 116 | 8% | 2% |
| Eastern Europe | 35 | 41 | 18% | 3% |
| Africa/Middle East | 41 | 59 | 42% | 7% |
| Asia/Pacific | 144 | 201 | 39% | 7% |
| Oceania | 4 | 5 | 4% | 1% |
| Total | 547 | 660 | 21% | 4% |

New industrial uses?

Synthetic vitamin C obtained by fermentation of sorbose is widely used in the food industry (acidifying agent in the canning industry, antioxidant, etc.). Its substitution by lemon juice could be a new market with high potential. The nutritional assets of the natural product could compensate for its higher price. Although scientific knowledge on the subject is still partial, it appears that many factors are involved in bioavailability of vitamin C, i.e. the proportion of the absorbed quantity of this constituent that will be actually active in the body. The effect of the matrix in which vitamin C is incorporated is an essential factor which

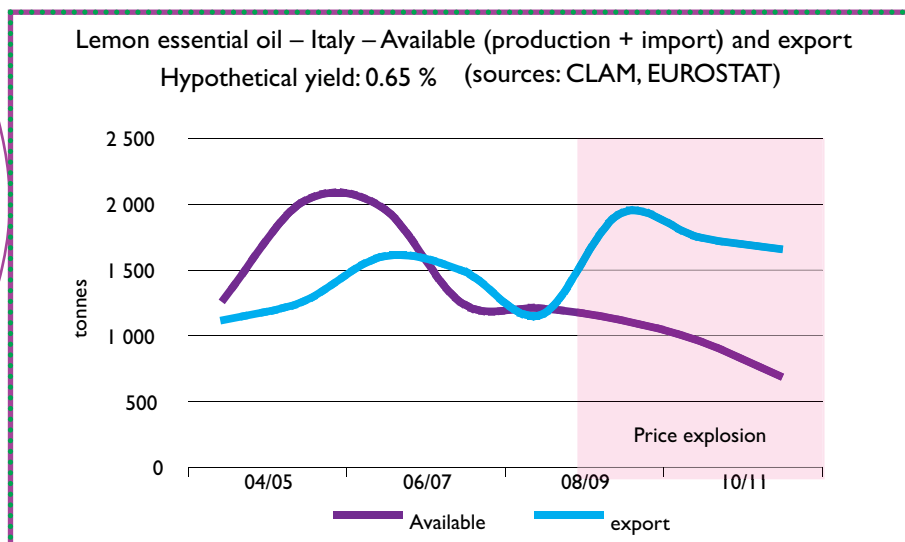
comes into play in the absorption mechanisms. Furthermore, possible synergies between vitamin C and other micro-constituents (e.g.: flavonoids such as hesperidin in the case of the lemon) are other factors that could affect absorption of vitamin C. To illustrate this hypothesis, in a comparative study to improve the vitamin C status of students, whose average plasma level was 57 μ mol/L, orange juice or vitamin C supplements were given to volunteers. Consumption of 200 ml of fresh orange juice (50 mg of vitamin C) increased the plasma level (75 μ mol/L) in 14 days. However, taking 250 mg of supplements did not improve their plasma contents. Supplements cannot reproduce the complexity of a fruit, and so diet is still the

preferable route of vitamin intake (fruits, and especially citruses). The size of the potential market justifies lemon-specific complementary studies.



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When the laws of economics overtake the laws of nature



Nothing is lost, and nothing is created, everything is transformed.” This well-known principle of the chemist Lavoisier seems to reach its limits in a context of price explosion, as the essential oils market has experienced. Many professionals lament the rise in fraud, such as deception about the source, or even more serious cases of counterfeiting. It is actually not very difficult to replace a less highly rated source with a higher rated

one on a label, or even for specialists to recreate the main constituent molecules of a natural essential oil with synthetic products. The balances of some countries raise questions, and seem to clearly illustrate the high proportions involved in the phenomenon. How can Italy export quantities of essential oil greater than the combined total of its production and its imports, which has been the case over a period going back fairly pre-

cisely to the start of the rates explosion? The extent of the differential does not seem to leave room for any error of interpretation (see graph).

Besides the dishonesty of a small minority of professionals, this problem also reveals the deficiencies of European regulations in this area, not to mention those of inspections. Classification of products, as stipulated in Regulation 1334-2008, does not enable products of natural origin to be clearly identified. The naming systems employed by professionals are also hard to read. A genuine need for clarification must be overcome to prevent a minority of unscrupulous professionals from continuing to take advantage of this loophole. The problem goes well beyond mere fraud: it discredits an industry which for the vast majority comprises honest professionals, and may even endanger the health of the end consumers, as the composition of synthetic products may be unsafe. But Italy is apparently not alone, as the practice seems to affect many producer countries.



Rising quality requirements

While demand is growing in terms of volume, it is also more demanding in terms of quality. The pesticide residue content is an increasingly crucial point, with food or cosmetics industry professionals particularly vigilant due to the numerous health scandals which regularly punctuate the news. This explains price differences ranging from 20 to 30 % between the various

products. Mediterranean professionals, whose priority outlet is the fresh industry, are confronted with the dilemma of having to provide a lemon of perfect appearance for the fresh market, and a raw material free from treatment products for processing. Some of the solutions found to this difficult equation are being implemented, in particular specific picking for each outlet, to

prevent fruits intended for industry from going through the packing lines and being subjected to post-harvest treatments. Use of natural treatment products is also an option. Professionals must also incorporate the social and environmental aspects, which are set to play a growing part in the specifications of manufacturers over the coming years.

Their positive **attitude** is their **success**



Training & Development

Casilda Calsina joined Camposol in 2001 as a shop floor worker on the piquillo pepper production line. Today she is Head of Production.

Ever Risco joined Camposol as a field worker in 1997. Today he is our Superintendent of our Blueberry farm.

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Phone: +31 174 521 016 / Fax: +31 174 523 334



A future based on high rates and strategic sourcing?



Will the annual growth rate of the drinks market be approximately 4 % per year, as the forecasts of some specialised offices predict? The future, tainted by the economic crisis still present in some big consumer countries in 2013, will tell. What we should remember most of all is that the prospects for demand growth are still solid, while big potential markets such as the Middle East and Africa have not yet really started

up, and that low growth rates are resulting in considerable rises in volume because of the size of the market. Hence with an annual growth of less than 2 % in 2012-13, the carbonated drinks market was up by 3.8 billion litres!

On the upstream side, the growth prospects appear very limited (see next article). The balance of the current market, based on high prices, should remain in place, unless there is a phytosanitary catastrophe due to greening, which would further intensify the trend. Rabobank recently highlighted the

advantage of implementing strategic sourcing for some agricultural products. By way of example, the issue is increasingly crucial for tea, with growth in demand exceeding that of production limited by the difficulty of finding suitable zones in terms of climate. The time has probably come to think about it also for some fruit derivatives, including lemon essential oil and concentrated lemon juice. However, such investments will not come without an accompanying rise in the level of requirements in terms of food safety, and social and environmental responsibility.



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PROCESSED VOLUMES

Professional sources / CLAM / FAO

| Tonnes | 03-04 | 04-05 | 05-06 | 06-07 | 07-08 | 08-09 | 09-10 | 10-11 | 11-12 |
|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Argentina | 923 000 | 800 000 | 1 045 954 | 1 061 880 | 889 574 | 1 100 270 | 812 741 | 1 360 741 | 1 082 076 |
| United States | 234 141 | 227 694 | 267 028 | 279 404 | 235 037 | 344 248 | 361 346 | 289 827 | 205 879 |
| Spain | 184 800 | 146 800 | 215 765 | 237 966 | 64 817 | 304 623 | 142 089 | 299 014 | 275 000 |
| Italy | 224 200 | 170 500 | 275 000 | 280 000 | 146 000 | 160 000 | 130 000 | 110 000 | 85 000 |
| South Africa | 76 836 | 56 006 | 79 010 | 62 582 | 61 833 | 53 561 | 64 190 | 79 204 | 89 000 |
| Other Medit. | 32 200 | 50 500 | 33 800 | 48 400 | 31 400 | 17 700 | 18 300 | 30 000 | 47 900 |
| Turkey | 25 000 | 40 000 | 25 000 | 40 000 | 25 000 | 15 000 | 15 000 | 20 000 | 42 000 |
| Cyprus | 2 500 | 4 400 | 4 300 | 4 000 | 1 000 | 700 | 1 300 | 6 000 | 2 600 |
| Greece | 3 700 | 100 | 500 | 400 | 1 400 | - | - | - | 300 |
| Israel | 1 000 | 6 000 | 4 000 | 4 000 | 4 000 | 2 000 | 2 000 | 4 000 | 3 000 |
| Others excl. Medit | 24 200 | 26 000 | 30 300 | 27 407 | 16 847 | 23 960 | 40 851 | 41 000 | 41 524 |
| Uruguay | 13 000 | 13 000 | 13 200 | 13 007 | 13 847 | 20 960 | 17 851 | 18 000 | 18 924 |
| China | | | | | | | 20 000 | 20 000 | 20 000 |
| Australia | 11 200 | 13 000 | 17 100 | 14 400 | 3 000 | 3 000 | 3 000 | 3 000 | 2 600 |
| Total | 1 699 377 | 1 477 500 | 1 946 857 | 1 997 639 | 1 445 508 | 2 004 362 | 1 569 517 | 2 209 786 | 1 826 378 |

ESSENTIAL OIL

Supplier countries exports — customs code 330113 — Source COMTRADE or national customs

| Tonnes | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|--------------|--------------|--------------|---------------|
| Argentina | 3 556 | 4 466 | 4 148 | 4 064 | 5 421 | 5 084 | 5 105 | 3 518 | 4 818 | 4 287 | 6 052 |
| USA* | 1 037 | 1 064 | 872 | 1 101 | 1 580 | 1 808 | 2 451 | 2 221 | 1 441 | 1 481 | 1 483 |
| Italy* | 1 114 | 1 173 | 1 023 | 1 063 | 1 090 | 1 229 | 1 569 | 1 466 | 1 126 | 1 898 | 1 715 |
| South Africa | 249 | 507 | 198 | 324 | 788 | 287 | 298 | 442 | 274 | 465 | 374 |
| Spain* | 135 | 226 | 365 | 359 | 358 | 390 | 401 | 208 | 176 | 425 | 321 |
| China | 34 | 76 | 65 | 255 | 116 | 153 | 181 | 171 | 136 | 144 | 136 |
| Uruguay | 52 | 36 | 75 | 95 | 81 | 72 | 55 | 21 | 62 | 50 | 49 |
| Swaziland | - | - | 112 | 0 | 175 | 0 | - | - | - | - | - |
| Total | 6 177 | 7 548 | 6 857 | 7 260 | 9 607 | 9 023 | 10 060 | 8 046 | 8 033 | 8 749 | 10 130 |

Main markets imports — customs code 330113 — Source COMTRADE or national customs*
Total greater than exports from producer countries because of double counts with re-exports.

| Tonnes | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| North America | 3 092 | 3 802 | 4 144 | 3 656 | 5 208 | 5 244 | 5 144 | 4 544 | 4 266 | 4 552 | 4 287 |
| Western Europe | 2 785 | 3 384 | 3 198 | 3 858 | 3 678 | 4 185 | 4 312 | 4 514 | 4 479 | 4 570 | 5 162 |
| Asia | 1 785 | 1 777 | 1 645 | 2 447 | 3 142 | 2 766 | 3 594 | 4 166 | 2 213 | 1 875 | 2 274 |
| South America | 1 038 | 684 | 652 | 820 | 1 158 | 994 | 951 | 1 123 | 693 | 836 | 592 |

CONCENTRATED JUICE

Supplier countries exports — customs code 200939 — Source COMTRADE or national customs*

| Tonnes | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Argentina | 50 703 | 47 005 | 44 272 | 39 571 | 49 629 | 37 277 | 54 978 |
| Spain* | 13 031 | 13 334 | 19 980 | 10 622 | 13 536 | 8 444 | 13 165 |
| Italy* | 9 631 | 11 106 | 12 474 | 12 141 | 9 941 | 11 434 | 12 662 |
| South Africa | 1 331 | 1 882 | 4 584 | 5 996 | 6 768 | 8 617 | 8 732 |
| USA* | 1 823 | 2 692 | 3 776 | 3 157 | 3 543 | 4 258 | 4 101 |
| Turkey | 539 | 688 | 1 474 | 666 | 627 | 1 125 | 1 662 |
| China | 207 | 725 | 336 | 1 222 | 571 | 441 | 1 271 |
| Chile | 88 | 79 | 108 | 14 | 4 | 10 | 174 |
| Cyprus | 117 | 329 | 46 | 4 | 55 | 92 | 130 |
| Egypt | | | 8 628 | 1 079 | 526 | 26 | |
| Uruguay | 2 629 | 2 020 | 2 938 | 2 006 | 2 091 | 775 | 368 |
| Total | 80 098 | 79 859 | 89 988 | 84 029 | 87 844 | 72 999 | 97 270 |

Main markets imports — customs code 200939 — Source COMTRADE or national customs*
Total greater than exports from producer countries because of double counts with re-exports.

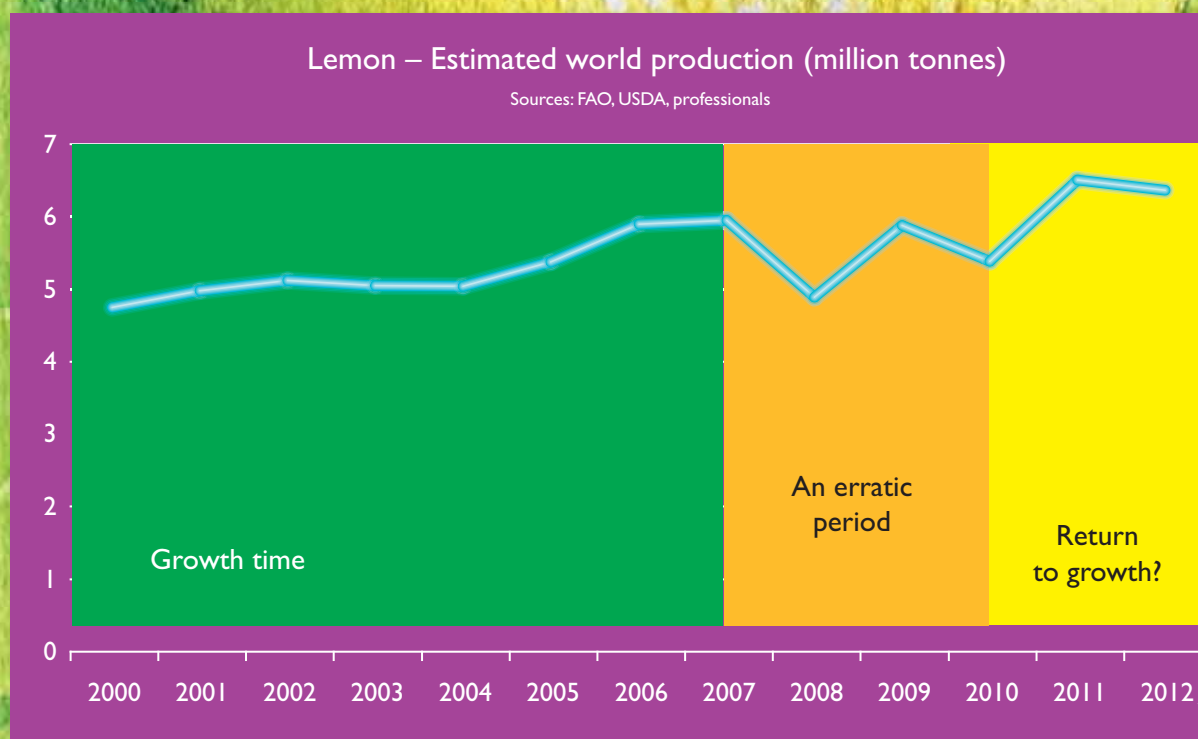
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|--|--------|--------|--------|--------|--------|--------|
| North America | | | | | | |
| Asia | 12 797 | 12 830 | 15 955 | 14 465 | 20 914 | 16 131 |
| Middle East | 854 | 1 000 | 10 351 | 2 142 | 6 431 | 10 222 |
| EU-27* | 65 431 | 65 953 | 66 305 | 78 056 | 65 091 | 64 533 |
| South America | 254 | 314 | 702 | 834 | 1 634 | 3 141 |
| EU: EUROSTAT extra + Spain, Italy, Cyprus intra, code 200939 | | | | | | |

TRENDS IN WORLD LEMON PRODUCTION

Return to a period of moderate growth in production?

In which direction is world lemon production heading? It is hard to say, even after unravelling the chaotic tangle of lemon and lime harvest statistics (see inset).

The growth trend was both clear and strong until the mid-2000s, with worldwide production increasing by more than one million tonnes between 2000 and 2006, to in excess of 6 million tonnes. But the situation became much more confused during the second half of the same decade, with the many weather problems affecting major market players blurring the picture. Are we to see in the minor recovery back up to 6.5-6.8 million tonnes registered since 2010 the sign of resumption in growth? FruiTrop offers you this review, analysing the trends of the main producer countries.



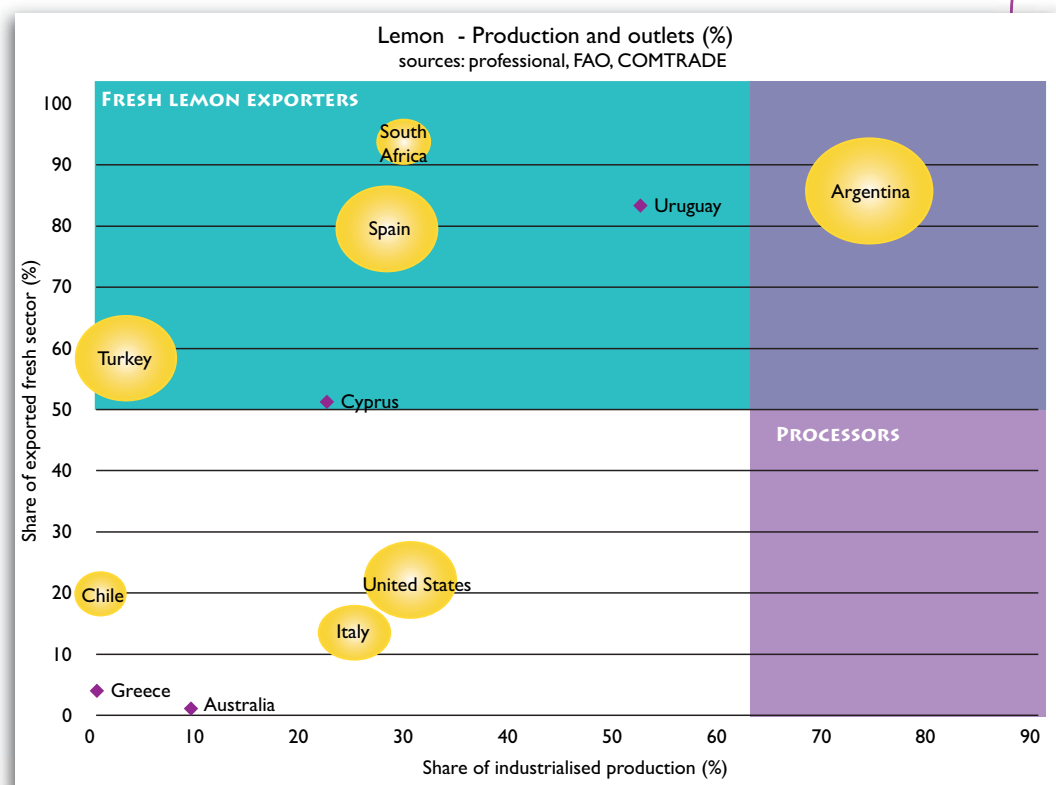
An economy concentrated on a limited number of sources

Very fortunately for the analyst, the sector is concentrated; there is no host of countries playing a tangible role. Nearly 80 % of world fresh lemon citron trade is based on four players which all export more than 100,000 t. The degree of concentration is even higher for derivative products: 90 % of volumes for industrial use are in the hands of four producer countries which each process more than 100,000 t. Hence there are only six sources which have nearly complete control of the 1.5 to 1.6 million tonnes of fresh lemon exported, and the 1.8 to 2.2 million tonnes industrially processed per year.

Argentina occupies a place of its own in this exclusive club, with a harvest amounting to a million tonnes and which represents nearly a quarter of world production. The only source that is historically industry-oriented, it nonetheless also plays the leading role on the counter-seasonal fresh market. Three countries are trailing it, with a

production of between 800,000 t and 1 million tonnes. Spain, whose industry was built on the fresh market, is nonetheless a leading player on the derivatives market. The outlet duality is less marked for Turkey, which is nearly exclusively focused on the fresh sector. The same applies to California, which plays a major role on the international derivatives market, but which favours the local market for its fresh lemons. Italy, now more industry-oriented, and South Africa, a major player on the counter-seasonal fresh market, are fifth and sixth in this ranking, with production levels of between 250,000 and 500,000 t.

We will note in passing that the lemon industry is peculiar: the classic system of a geographic specialisation for each outlet, namely the Americas processing and the Mediterranean supplying the world fresh market, appears to be less pronounced than for the orange or grapefruit.

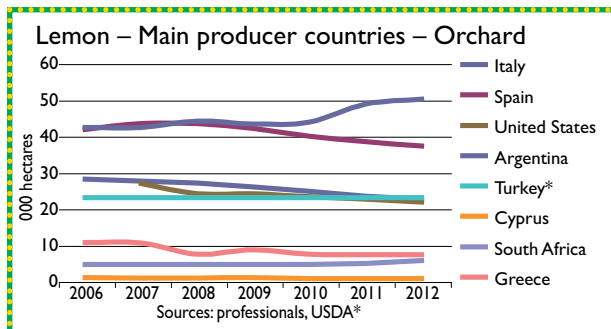


The golden age followed by recession for European Union producers

The possible movement of resumption of production growth mentioned above does not seem likely to originate from the EU producer countries, neither now or in the future. While Italy and Spain are still clearly essential players, the period of growth seems well and truly over. This has long been the case for Italy. It now has only 25,000 ha of orchards left of the 39,000 ha in the early 1980s, when Sicily controlled most of the world fresh lemon trade. National exports are now less than 40,000 t, and Italian lemons are even losing ground on the local market

against imported fruits. The 2000s hit Spain very hard, marked as they were by the abandonment of more than 6000 ha of orchards, i.e. 15 % of the cultivation area.

The decline has been even more drastic for the “minor” EU producers. The Greek industry, which used to supply many of the neighbouring East European markets with its 15,000 ha, has purely and simply disappeared from the world market. The 5000 ha of orchards remaining after the frosts of 2004 are able only to



supply the local market during the winter season. Cyprus, which now has just 600 ha of orchards, has practically left the international scene for this product.

Better balance as the ambition

Rationalisation and consolidation rather than growth: this is clearly the credo of the European industries. Although production costs have risen for all sources, the competitiveness differential bet-

ween the EU and other big producer countries of the Mediterranean or Southern Hemisphere has remained great. It represents a weighty handicap that has made a big contribution to the decline described above. Of course, it is mainly the high price of European labour which is involved. It represents nearly 50 % of the total direct production cost (including the harvest) in countries such as Spain. Its level is such a burden that payment for raw materials provided by the industry does not even cover the harvest costs alone in some seasons.

In this context of high production costs, the European industrial sectors are cap-

tive to the fresh lemon market, which offers better returns than the derivatives market for non-integrated producers. However, it too lacks great prospects in Western Europe, and is extremely competitive in Eastern Europe. Furthermore, some basic problems, such as small farm size, persist, especially in Sicily. Finally, we need to remember other limiting factors such as competition with urbanisation in often highly sought-after coastal areas, the lack of water availability and a burdensome sanitary situation, especially in Italy where the resurgence of virulent strains of Tristeza has added to mal secco.



Abandoned orchards, Murcia, Spain

An objective achieved in Spain?

Is this balance being achieved in Spain? This is hinted at by the economic results, which have been up for the past few years, especially the significantly positive results of the 2012-13 season.

Certainly, the context has been favourable with the early end of the Southern Hemisphere season and Turkish competition temporarily weaker. However, the fall from a production level

of approximately 1 million tonnes in the mid-2000s to an average of between 850,000 and 950,000 t thanks to the cuts in surface areas seems to have played a major role.

*Grand Lemon
Palace* ****
Tucuman, ARGENTINA



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is lemons

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Soly Import has been in the citrus fruit and particularly lemons trade for many years. From May to October, we exclusively distribute **SAN AGUSTIN** and **FAMAILLA** brands, both grown in Tucuman, Argentina. This area has optimal, regular, climatic conditions, and the crops certified Global Gap have a very high juice content, characteristic of the top quality yellow lemons we market.

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A comparable issue in California, on a more protected market

Lemon - Direct production costs (USD)

The American industry seems to have better withstood these past few years than the European ones. Production appears to have stabilised at approximately 750,000-850,000 t, excluding weather vagaries, and crop profitability remains at a decent level, considerably higher than for the orange. Although just as in the EU, production costs are particularly high, the presence of a powerful local market of more than 300 million inhabitants and the near-total absence of competition during the winter season, thanks to the drastic sanitary protection measures on the borders, are major assets.

Nonetheless this balance does not seem to promise any growth. The relative stability of production conceals a rationalisation trend of production structures, which is manifested by a continuous fall in surface areas in cultivation in Arizona and California. According to the 2012 survey, there remained less than 22,000 ha in cultivation, as opposed to more than 30,000 ha in the early 2000s. On the one hand,

| | California 2010 / UC Davies | Argentina 2010-11 / EEAOC | Spain 2010-11 / MARM |
|------------------------------|--------------------------------|------------------------------|-------------------------|
| Frost protection | 801 | # | * |
| Irrigation + miscellaneous | 1 339 | * | 2 082 |
| Treatments/fertilisers | 1 245 | 1530 | 1 128 |
| Pruning | 964 | 232 | 1 069 |
| Labour | 1 087 | 603 | 1 319 |
| Total excl. harvest | 5 436 | 2 365 | 5 597 |
| Harvest | 8 950 | | 2 359 |
| Total direct costs | 14 386 | | 7 957 |
| *non-existent for most farms | | | |
| # | n/a | | |
| ~ | 1 EUR 2010/2011 = 1.3879 USD | | |

just as for Spain and Italy, the development prospects in the fresh niche, the economic engine of the industry, are limited: the local market is strong but stabilised, and exports are shrinking. On the other hand, the availability of certain production factors is increasingly problematic. The price of land can be deemed prohibitive in some areas. The lack of agricultural water is increasingly severe, with prices constantly rising and quotas increasingly meagre in certain areas such as the inland valley. Finally,

while the probable adoption by Congress in the near future of laws on immigration seems to ward off the spectre of a fatal labour shortage, labour costs remain high. Hence there is a big risk of the shrinkage of the cultivation area being confirmed, especially as the appearance of greening in 2012 is not likely to encourage investment in citrus growing. The annual rate of planting has collapsed, even for production that is still lucrative, such as small citrus.



Argentina in development, though in moderate proportions

The trend should rather be sought in Argentina. If we can believe the latest satellite survey, the surface areas, falling since 2006 in Tucuman province where most lemon production is concentrated, increased by just over 10 % between 2010 and 2012, i.e. by approximately 3500 ha. Furthermore, according to professional sources, the cultivation area expanded by similar quantities in other north-western zones, such as Jujuy and above all Salta. Finally, productivity is rising with the frequent use of high-density replanting.

But will this be a large-scale movement? There are some doubts. On the one hand, there are geographic limitations in the Tucuman area. On the other hand, the high current economic instability is not favourable for investments. Finally, the profitability levels are no longer as excellent as over the past few years. Land prices have boomed, and this country is also affected by increasing production costs. According to an EAAOC study, the increase was 600 USD/ha between 2010-11 and 2011-

12. While all the production factors are more expensive, it is labour above all that is weighing increasingly heavy. The official daily agricultural wage (Jornal OATRE) doubled between 2006 and 2011. Hence while Argentina remains competitive against the sources presented above, lemon growing is increasingly less so compared to other flagship products of the region, such as sugar cane. The surface areas dedicated to this crop registered a leap of nearly 50,000 ha between 2008 and 2012.

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Strong growth of the Turkish industry becoming a thing of the past

Lemon – Main players – Production and trend.

| | Average production 2010-11 / 2011-12 1 000 t | Evolution to 5 years | Trend |
|---------------|--|-------------------------|-------|
| Argentina | 1 614 | 7% | ↗ |
| Spain | 961 | -12% | = ↘ |
| Turkey | 910 | 25% | = ↗ |
| United States | 803 | 2% | = |
| Italy | 473 | -21% | ↘ |
| South Africa | 249 | 22% | ↗ |

Sources: professionals, CLAM

Turkey is the other source that has made big advances over the past few years. Surface areas really took off during the 2000s in the Mersin region, driven by growth in demand for fresh lemon from the nearby East European markets. Production practically doubled in ten years, to approach the one million tonne mark.

Will the trend be as strong in the years to come? There are no orchard survey figures to say for certain, but the feeling of professionals is that surface areas have been on standby for the past few years. On the one hand, urban pressure and natural limitations mean that the crop cannot gain any more land in the historic area of western Mersin. The orchards

have withdrawn from the immediate vicinity of the sea to the inland boundaries of the narrow coastal strip. On the other hand, while extensions are still possible inland between Mersin and Adana, the low winter temperatures are rather incompatible with seasonal lemon production.

Why take the risk, when consumption growth prospects are no longer what they were in Russia, Ukraine or even on a local market already well supplied? The question is even more pointed if we consider that profitability and market potentials are much better for small citruses, the only varietal group that appears to still be growing significantly in Turkey. Hence the small growth in volumes for industrial use, up from insignificant to approximately 40,000 t, must not be overestimated. It seems more like an additional alternative for making use of sorting rejects that have no other place on the local market than a strategy of developing a new high-potential outlet.



Orchards entangled in the urban fabric, Mersin, Turkey.

South Africa banking on its assets to develop its presence on the fresh market

South Africa is also one of the growth countries, though since only recently. The cultivation area, static until 2009, seems to have recovered some momentum. Planting exceeded 600,000 feet in 2010 and 2011, while the average planting level was less than 200,000 feet throughout the previous decade. This boom affects both the histo-

rical zone of Sundays River, with its Mediterranean climate, and the more northern area of Limpopo/Mpumalanga, with an earlier production calendar. It is true that the economic returns from the fresh market have been particularly encouraging since 2010, well in excess of those for the orange and grapefruit, and even approa-

ching those of small citruses. This success is due to exploiting the small margins for development still available on the counter-seasonal market, and to a qualitative differentiation approach from its main competitor. This growth trend should last, but remain within contained proportions.



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Could other countries enter the lists or radically upscale? What about Mexico, the world no. 5 citrus producer, and number one for the lime? According to official sources, the country currently produces approximately 80,000 to

90,000 t, of which 25,000 to 35,000 t are exported to the United States. However, according to the professionals consulted, the fruits do not have the sufficient degree of competitiveness to access the top-end market (imperfect shape, green marks, etc.). Hence the surface areas seem to be stagnating because of indifferent economic returns. On the other hand, greening is impeding the citrus growing business in the country in general. Furthermore, the development projects mentioned in Brazil, especially in the large irrigated areas in the San Fernando river valley, seem to be stuck in limbo.

And so we come to China: is the lemon following the trend of the orange and

Outsiders on the horizon?

small citruses, cumulative production of which has gone from just under two million tonnes in the early 2000s to nearly 20 million tonnes over the past few seasons? Cross-checking different professional sources leads us to believe that Chinese production, very much concentrated in Sichuan near the city of Anyue, is around 300,000 to 350,000 t, and has tripled since the mid-2000s. Some experts reckon that it could reach 600,000 t by 2020-2025. Practically absent from the international market at present both for fresh and derived products, will China remain so with this level of production? The question has been asked.

A catastrophic scenario that is not so impossible...

DON'T GO GREEN!
Greening Disease (HLB) Kills
Citrus Trees [\(click to learn more\)](#)



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What could be the impact of greening on the lemon industry? The rapid growth of this disease and its danger level make the question an important one. This bacteriosis, against which there is currently no defence, was detected in California in 2012. It also threatens Argentina very directly from neighbouring Brazil, where it has been present since 2004. Would it cause damage as considerable as that

suffered by the Florida orange industry, where production has slumped by approximately 4 million tonnes since the contamination arose less than ten years ago in 2005? Probably not, since the symptoms of this disease are less drastic for the lemon than sweet citrus. Furthermore, the propagation would surely be less explosive than in Florida, thanks to the preventive measures

implemented in both California and Argentina, and the absence of a vector as efficient as hurricanes or tropical storms which regularly afflict the Sunshine State.

Nonetheless, the consequences appear not to be neutral, if only in economic terms. A study by the University of

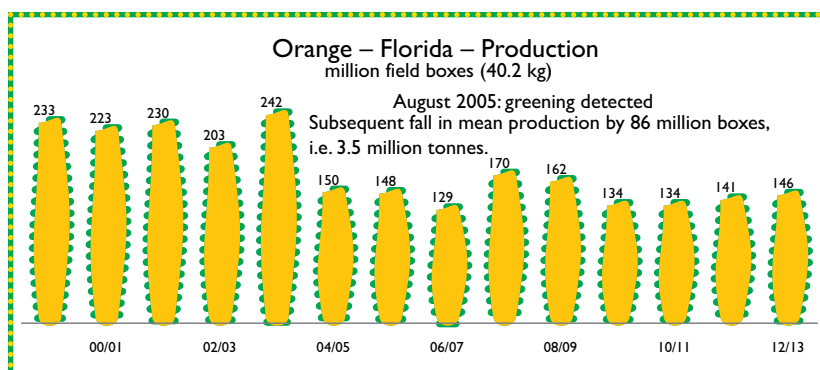
Florida showed that monitoring of orchards, chemical management of the vector and re-planting was increasing production costs by approximately 40 %. There is an evidently major impact on the financial balance of producers, especially those primarily dependant on the industrial sector.



Orange for industrial use - Florida - Production costs

USD/ha - Sources: IFAS, MURARO

| | 2002-03 without HLB/black spot | 2009-10 with HLB/black spot |
|--------------------|-----------------------------------|--------------------------------|
| Weed control | 452 | 460 |
| Pesticides | 339 | 1 194 |
| Fertilisation | 378 | 749 |
| Pruning | 69 | 79 |
| Lifting/replanting | 252 | 682 |
| Irrigation | 455 | 600 |
| Disease monitoring | - | 339 |
| Total | 1 945 | 4 102 |



*Safe from one crisis,
which could be concealing another!*

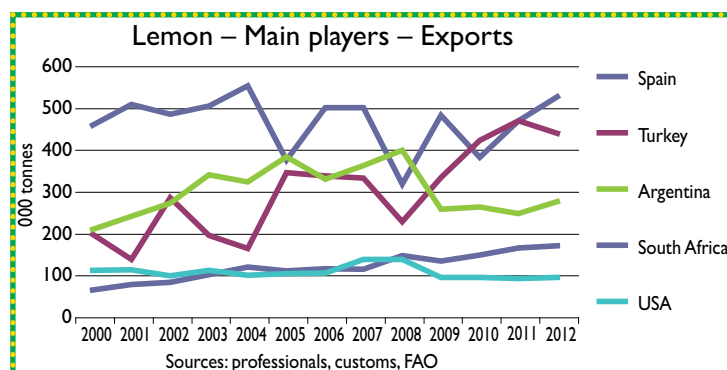
The supplier countries in the fresh segment, which make up most of the major players in the lemon industry, seem to have taken on board the lack of prospects for this segment. Apart from in South Africa, which still has a certain counter-seasonal market opening, and which is playing the card of qualitative differentiation, the orchard growth dynamic seems to have become very weak or even non-existent, even in countries where production costs are the most competitive, such as Turkey.

For their part, Argentinean producers, who are alone in having developed a highly integrated industry, focused on processing, appear to have fallen into step with the return of some momentum to the derivatives market, having reinitiated a wave of planting since 2010. History likes to repeat itself, and it must be ensured that the scale of this movement remains in proportion, or the sector could slip back into a crisis of overproduction as in the early 2000s. The danger is all the more real since

some multinationals consuming derivative products are aiming to participate in projects to secure their own supply, and could therefore encourage producers to go too far. The pedoclimatic limitations of this fragile crop and the uncertain financial context of the country are nonetheless serious safeguards.

Do some countries currently present on the fresh market have claims to come to the party, riding on the wave of growth of the derivatives market? This change, which would entail a change of economic model, seems incompatible with the production costs of the EU and California. It would probably be more within reach for Turkey. But without even talking about the “cultural revolution” that it would involve, and the investments to implement to achieve the necessary economies of scale, there are also pedo-

climatic limitations. If China retains as low a profile on the international market as at present, the market seems to be safe from a major overproduction crisis in the medium term. But should we not rather fear a drastic fall in production, with the direct threat posed by greening to California and that hovering over Argentina? Such a catastrophe would completely reshuffle the deck both on the fresh market and derivatives market, where the Mediterranean and South Africa appear to be the fall-backs.



IMPORT

The highest quality lemons from Tucuman

Lemons

Oranges

Grapefruits

Mandarines

Clementines

Grapes

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LIME OR LEMON, A SIZEABLE FIRST QUESTION

FAMILY histories are always complicated, and distinguishing the lemon from its cousin the lime in world production statistics is no easy matter! This is an important challenge for accurate analysis, since no fewer than four countries among the world's ten leading producers are situated in latitudes enabling the harvest of both these citruses. In countries with a tropical climate, the lime tree is preferred to the lemon tree, since its sensitivity to the fungal diseases widely present in these environments is high. In addition, its growth and vegetative development become exuberant, and its fruits too exhibit excessive growth unsuited to market demand.

Obtaining an accurate response for India and Iran does not seem of prime importance. Both these countries, which as a rule of thumb produce lemon in the north and lime in the south, do not currently play any role in the international lemon economy, and do not seem capable of doing so in the medium term.

The same cannot be said of Mexico and China. The situation is relatively clear for Mexico, thanks to the existing official figures. Introduced in the mid-1970s in the north-east of the country, lemon growing appears to represent approximately 4500 ha with an estimated production of 85,000 t, a drop in the ocean compared to the 2 million tonnes of Mexican or Persian limes harvested every year. The situation is more confused for China, for lack of literature... other than in Chinese! According to professional sources, production is approximately 300,000 t. The remaining 700,000 t declared in the FAO statistics would therefore be lime. The case of Egypt also raises questions. Although Mediterranean, this source produces only limited volumes of lemon. In accordance with the information collected from professionals, it was considered in this study that the whole of the 300,000 t harvested comprised varieties other than lemon (limettas, etc.).

WORLD PRODUCTION



| | |
|--------------|-------------|
| Lemon | 6 350 000 t |
| Lime | 5 000 000 t |
| Lemon + Lime | 3 325 000 t |



• International trade
1 550 000 / 1 600 000 t

• Industry
1 800 000 / 2 000 000 t

| LEMON + LIME (tonnes) | |
|--------------------------|-----------|
| India | 2 400 000 |
| Iran | 625 000 |
| Egypt | 300 000 |

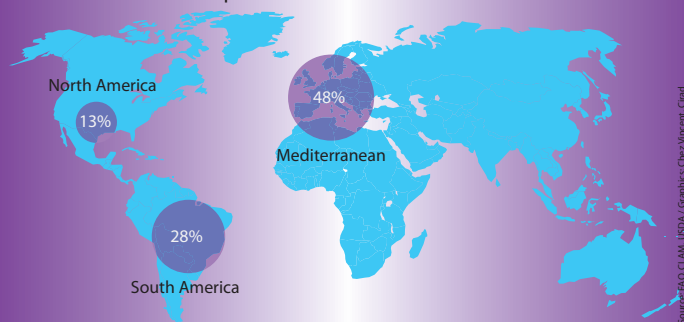
| LEMON (tonnes) | |
|----------------|-----------|
| Argentina | 1 600 000 |
| Spain | 960 000 |
| Turkey | 910 000 |
| United States | 800 000 |
| Italy | 473 000 |
| China | 350 000 |
| South Africa | 250 000 |
| Chile | 230 000 |
| Syria | 150 000 |
| Mexico | 82 000 |
| Lebanon | 80 000 |
| Israel | 55 000 |
| Algeria | 52 000 |
| Tunisia | 50 000 |
| Greece | 46 000 |



| LIME (tonnes) | |
|---------------|-----------|
| Mexico | 1 930 000 |
| Brazil | 1 075 000 |
| China | 880 000 |

LEMON — PRODUCTION

World production 6 350 000 tonnes



Lemon — The 8 leading producer countries

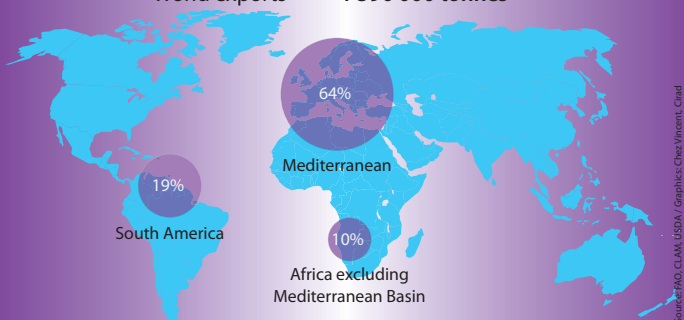
| tonnes | 2012 |
|---------------|-----------|
| Argentina | 1 472 119 |
| Spain | 990 000 |
| Turkey | 959 000 |
| United States | 771 107 |
| Italy | 458 000 |
| China | 400 000 |
| South Africa | 239 909 |
| Chile | 232 000 |

Source: FAO



LEMON — EXPORTS

World exports 1 590 000 tonnes



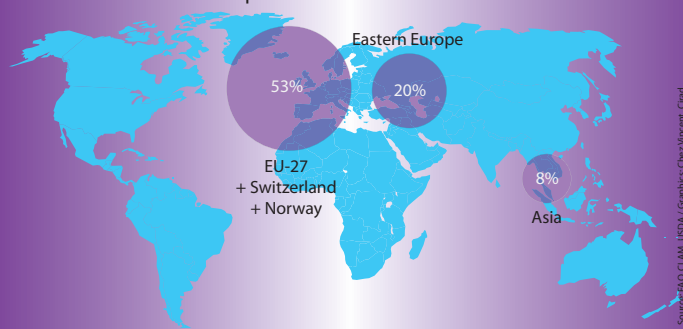
Lemon — The 7 leading exporting countries

| tonnes | 2011-2012 |
|---------------|-----------|
| Mexico | 523 000 |
| Turkey | 436 000 |
| Argentina | 272 000 |
| South Africa | 166 000 |
| United States | 91 240 |
| Chile | 39 460 |
| Italy | 30 900 |

Source: national customs

LEMON — IMPORTS

World imports 1 590 000 tonnes



Lemon — The 8 leading importing countries

| tonnes | 2012 |
|-------------|---------|
| Russia | 198 585 |
| Germany | 121 960 |
| France | 123 008 |
| Netherlands | 108 510 |
| Italy | 103 361 |
| UK | 87 667 |
| Ukraine | 61 647 |
| Japan | 53 834 |

Source: national customs

USA — Imports — Main supplier countries

| tonnes | 2007-08 | 2008-09 | 2009-10 | 2010-2011 | 2011-12 |
|------------------------|---------------|---------------|---------------|---------------|---------------|
| Southern Hemis. | 22 089 | 16 885 | 16 605 | 23 674 | 23 674 |
| Chile | 21 598 | 16 821 | 16 333 | 23 413 | 17 020 |
| Others H.S. | 491 | 64 | 272 | 621 | 608 |
| Northern Hemis. | 40 177 | 20 402 | 23 184 | 33 603 | 33 603 |
| Mexico | 39 277 | 16 954 | 22 286 | 23 413 | 32 374 |
| Spain | 139 | 3 159 | 609 | 835 | 1 581 |
| Dominican Rep. | 560 | 285 | 248 | 387 | 197 |
| Others H.N. | 201 | 4 | 41 | 8 | 96 |
| Total | 62 266 | 37 287 | 39 789 | 52 577 | 51 937 |

Source: national customs

Canada — Imports — Main supplier countries

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------|---------------|---------------|---------------|---------------|---------------|
| Northern H. | 29 004 | 30 365 | 31 310 | 32 470 | 35 471 |
| United States | 28 849 | 30 250 | 31 109 | 31 555 | 30 481 |
| Spain | 156 | 115 | 201 | 915 | 3 940 |
| Turkey | - | 20 | 88 | 306 | 1 050 |
| Southern H. | 10 522 | 7 724 | 6 787 | 11 013 | 12 216 |
| Argentina | 7 509 | 6 213 | 4 606 | 7 381 | 9 299 |
| South Africa | 2 020 | 443 | 1 612 | 2 789 | 2 560 |
| Uruguay | 407 | 211 | 90 | 227 | 71 |
| Chile | 552 | 653 | 311 | 435 | 112 |
| Australia | 34 | 203 | 169 | 181 | 174 |
| Others | 237 | 361 | 579 | 497 | 958 |
| Total | 39 764 | 38 450 | 38 677 | 43 980 | 48 645 |

Source: COMTRADE

South America — Imports — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------|---------------|---------------|---------------|---------------|---------------|
| Argentina | 238 | 4 837 | 6 524 | 1 177 | 331 |
| Ecuador | 4 889 | 819 | 4 088 | 2 356 | 3 200 |
| Chile | 1 441 | 1 319 | 3 966 | 17 574 | 10 000 |
| Brazil | 346 | 918 | 1 248 | 1 954 | 2 381 |
| Colombia | 4 480 | 4 639 | 956 | 2 993 | 3 500 |
| Mexico | 364 | 453 | 602 | 2 398 | 1 420 |
| Costa Rica | 348 | 511 | 536 | 802 | 800 |
| Bolivia | 500 | 415 | 471 | 301 | 160 |
| Total | 12 605 | 13 911 | 18 931 | 29 556 | 21 792 |

Source: COMTRADE

LEMON — IMPORTS

EU — Imports — Main supplier countries

| tonnes | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 |
|------------------------|----------------|----------------|----------------|----------------|----------------|
| Northern Hemis. | 476 268 | 578 027 | 565 295 | 569 644 | 587 071 |
| Spain | 305 116 | 439 194 | 372 445 | 412 568 | 442 573 |
| Turkey | 75 812 | 85 519 | 132 610 | 110 261 | 103 455 |
| Italy | 62 971 | 40 889 | 47 306 | 37 226 | 30 731 |
| Greece | 8 224 | 3 481 | 4 493 | 3 790 | 3 804 |
| Cyprus | 2 524 | 2 947 | 1 658 | 2 031 | 2 041 |
| Egypt | 3 928 | 1 001 | 2 191 | 554 | 567 |
| Portugal | 2 281 | 1 007 | 1 154 | 942 | 2 571 |
| Israel | 1 596 | 730 | 1 099 | 373 | 187 |
| United States | 190 | 1 346 | 1 | 428 | 2 |
| Morocco | 11 006 | 3 184 | 1 785 | 1 771 | 1 119 |
| Iran | 143 | 63 | 85 | 73 | 12 |
| Tunisia | 1 322 | 11 | 43 | 53 | 11 |

| | | | | | |
|------------------------|----------------|----------------|----------------|----------------|----------------|
| Southern Hemis. | 216 854 | 250 009 | 215 532 | 217 737 | 237 927 |
| Argentina | 163 969 | 182 387 | 158 391 | 159 063 | 180 712 |
| South Africa | 39 007 | 45 633 | 44 532 | 45 233 | 40 217 |
| Uruguay | 10 166 | 10 762 | 8 064 | 8 280 | 9 917 |
| Chile | 1 888 | 9 275 | 3 211 | 3 217 | 5 710 |
| Brazil | 652 | 5 | 136 | | 92 |
| Dominican Rep. | 1 172 | 1 947 | 1 198 | 1 943 | 1 279 |

Total **693 122** **828 036** **780 827** **787 381** **824 998**

Source: EUROSTAT

Other western European countries — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------|---------------|---------------|---------------|---------------|---------------|
| Switzerland | 17 138 | 17 483 | 17 861 | 18 358 | 18 998 |
| Norway | 5 477 | 5 431 | 5 888 | 4 858 | 5 077 |
| Iceland | 427 | 415 | 450 | 514 | 548 |
| Total | 23 042 | 23 329 | 24 199 | 23 730 | 24 623 |

Source: COMTRADE

Russia — Imports — Main supplier countries

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------------------|---------------|----------------|----------------|----------------|----------------|
| Northern Hemis. | 93 857 | 145 109 | 144 290 | 156 085 | 137 879 |
| Turkey | 68 747 | 106 890 | 117 255 | 131 314 | 101 648 |
| Spain | 17 610 | 29 664 | 16 989 | 17 801 | 28 964 |
| China | 3 487 | 2 478 | 4 995 | 2 866 | 3 837 |
| United States | 597 | 1 302 | 1 689 | 188 | |
| Egypt | 519 | 985 | 1 412 | 1 400 | 601 |
| Morocco | 1 495 | 2 925 | 1 230 | 2 511 | 2 172 |
| Israel | 1 401 | 866 | 719 | 5 | 657 |
| Southern Hemis. | 86 430 | 60 298 | 66 848 | 66 643 | 60 427 |
| Argentina | 78 053 | 47 192 | 43 948 | 40 250 | 41 853 |
| South Africa | 7 822 | 12 929 | 20 960 | 26 094 | 18 438 |
| Uruguay | 554 | 177 | 1 939 | 299 | 136 |
| Others | 2 078 | 318 | 748 | 536 | 279 |

Total **182 365** **205 726** **211 886** **223 264** **198 585**

Source: COMTRADE

Ukraine — Imports — Main supplier countries

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------------------|---------------|----------------|---------------|---------------|---------------|
| Northern Hemis. | 31 868 | 48 682 | 46 780 | 46 619 | 48 738 |
| Turkey | 27 462 | 41 263 | 41 992 | 43 102 | 37 464 |
| Spain | 3 431 | 6 709 | 3 732 | 3 516 | 10 478 |
| Egypt | 305 | 619 | 848 | 1 | 721 |
| Israel | 671 | 91 | 208 | - | 75 |
| Southern Hemis. | 19 534 | 13 399 | 12 147 | 15 021 | 12 624 |
| South Africa | | | | | |
| Argentina | 18 293 | 12 193 | 8 741 | 11 241 | 9 619 |
| Others | 2 119 | 706 | 1 175 | 548 | 285 |
| Total | 53 522 | 622 787 | 60 102 | 62 188 | 61 647 |

Source: COMTRADE

Other eastern European countries — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------|--------|--------|--------|--------|--------|
| Serbia | 14 355 | 16 278 | 13 791 | 15 971 | 15 692 |
| Croatia | 10 968 | 12 218 | 11 025 | 12 399 | 12 037 |
| Belarus | 6 320 | 7 984 | 7 230 | 6 912 | 7 000 |
| Macedonia | 4 396 | 5 084 | 5 000 | 5 194 | 4 697 |
| Moldavia | 2 941 | 3 613 | 3 382 | 3 523 | 3 295 |
| Montenegro | 2 204 | 2 781 | 1 979 | 1 831 | 2 068 |
| Albania | 1 965 | 2 806 | 2 180 | 2 706 | 2 828 |
| Georgia | 1 190 | 1 441 | 1 265 | 2 871 | 3 141 |
| Bosnia | 8 177 | 9 159 | 7 839 | 8 921 | 8 220 |

Total **44 337** **52 205** **45 851** **51 406** **50 758**

Source: COMTRADE

Japan — Imports — Main supplier countries

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------------------|---------------|---------------|---------------|---------------|---------------|
| Northern Hemis. | 36 724 | 36 531 | 38 459 | 35 758 | 38 204 |
| United States | 36 724 | 36 462 | 36 741 | 32 099 | 36 917 |
| Mexico | - | 69 | 1 718 | 3 659 | 1 287 |
| Southern Hemis. | 20 545 | 14 475 | 14 159 | 18 022 | 15 562 |
| Chile | 17 299 | 12 187 | 12 949 | 16 767 | 14 331 |
| South Africa | 2 566 | 1 335 | 424 | 393 | 506 |
| New Zealand | 680 | 953 | 786 | 862 | 725 |
| Others | 136 | 416 | - | 1 | 68 |
| Total | 57 405 | 51 422 | 52 618 | 53 781 | 53 834 |

Source: Japanese customs

Other Asian countries — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|-------------|--------|--------|--------|--------|--------|
| China | 27 047 | 34 968 | 30 211 | 32 980 | 34 865 |
| Singapore | 8 015 | 8 423 | 8 988 | 9 932 | 10 191 |
| Azerbaijan | 1 127 | 2 261 | 8 745 | 6 963 | 6 303 |
| Malaysia | 5 252 | 6 556 | 6 646 | 7 559 | 9 377 |
| South Korea | 5 085 | 5 147 | 5 631 | 7 398 | 8 000 |
| Philippines | 572 | 854 | 1 277 | 1 430 | 1 390 |
| Kyrgyzstan | 422 | 1 100 | 872 | 1 059 | 1 000 |
| Kazakhstan | 6 360 | 7 503 | 8 000 | 4 568 | 4 712 |
| Armenia | 1 142 | 858 | 1 341 | 1 176 | 776 |
| Indonesia | | | | | 3 412 |

Total **55 021** **67 670** **71 710** **73 065** **76 614**

Source: COMTRADE

Persian Gulf — Imports — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|----------------------|--------|--------|--------|--------|------|
| United Arab Emirates | 51 838 | 50 000 | 50 000 | 50 000 | |
| Saudi Arabia | 22 534 | 42 770 | 93 613 | 55 745 | |
| Kuwait | 14 766 | 15 000 | 15 000 | 15 000 | |
| Qatar | 4 714 | 5 000 | 6 848 | 7 000 | |
| Bahrain | 3 822 | 3 577 | 3 700 | 5 930 | |
| Oman | 2 307 | 2 214 | 2 284 | 3 289 | |

Total **99 982** **118 561** **171 445** **136 964** **140 000**

Source: COMTRADE

Mediterranean — Imports — Main markets

| tonnes | 2008 | 2009 | 2010 | 2011 | 2012 |
|---------|--------|--------|--------|--------|--------|
| Jordan | 7 249 | 5 093 | 7 983 | 11 469 | 13 000 |
| Turkey | 3 137 | 1 808 | 1 722 | 670 | 3 093 |
| Lebanon | 759 | 451 | 891 | 615 | 820 |
| Tunisia | 50 | 906 | 777 | 800 | 800 |
| Algeria | 98 | 1 310 | 33 | 1 105 | 2 744 |
| Syria | 27 387 | 16 289 | 19 618 | 20 000 | 20 000 |

Total **38 679** **25 858** **31 023** **34 660** **40 457**

Source: COMTRADE



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Argentina

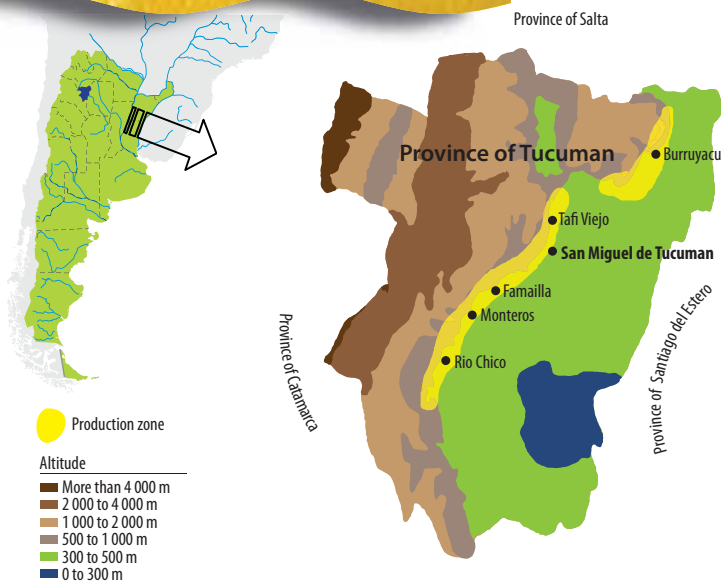


ARGENTINA is a major player in the lemon industry. It dominates world production of fresh lemon and derivatives, and is in third position among the top fresh exporter countries. After some difficult years, the industry has recovered a better financial balance thanks to the price rises in the derivative products market, in which it has historically specialised. Hence the cultivation area seems to be on the increase again, though in proportions moderated by physical limits (limited land availability in the predominant Tucumán region) and economic limits (competition from alternative crops and financial context).



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PRODUCTION



Production zones

The Tucumán region in the north-west of the country packs in nearly 80% of the Argentine cultivation area, which covered a total of 48,600 ha in 2011. The two main production centres in this zone are located in a narrow strip in the foothills of the Sierra de Burruyacú and Sierra del Aconquija (between Tafi Viejo and the recent more southern orchards extending as far as Río Chico). The microclimate makes it possible to avoid the severe frost risks on the plains situated further east, and a difficult topography further west. Furthermore, the rainfall level is fairly generous (800 to 1500 mm), through irrigation is required to obtain satisfactory yields. The rest of the cultivation area is divided between other north-western provinces (Jujuy, Salta) and the strip in the extreme north-east of the country (provinces of Corrientes and Entre Rios). However, yields are lower. The plantations are generally industrial.



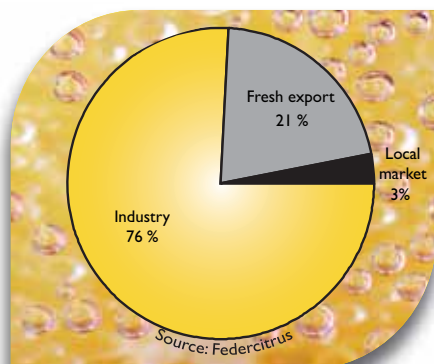
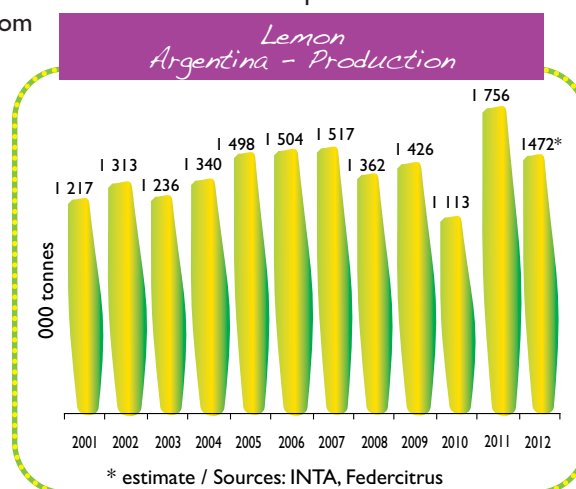
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Evolution of production

Introduced early in the 20th Century, lemon growing first started to boom in the late 1960s, following on from the sugar crisis. The growth trend, slow until the late 1980s, picked up significantly in the early 1990s, with the industry turning towards concentrated juice and essential oil production, after the signature of procurement contracts with foreign multinationals from the drinks sector. From the mid-1990s, the fall in profitability due to the explosive growth of production led producers to diversify, by developing a fresh lemon export activity to supply the international counter-seasonal market. However, the economic balance of the industry continued to weaken until 2008 with increasing production costs due in particular to the appearance of citrus canker in 2002 and to the stagnation of world demand for both fresh lemon and derivative products. Smaller harvests caused by weather problems, combined with good demand from traditional markets and emerging countries (Asia) have enabled rates for derivative products to rise, paving the way for better profitability. Hence the cultivation area, which had stabilised at approximately 43,000 ha at the end of the decade in 2010, seems to have taken an upturn, with some additional plantations and the renovation of orchards in the Tucumán region making for increased productivity, and investments by some companies in the Salta zone. However, the increasing production costs, amplified by inflation, the better profitability of alternative crops such as soya or sugar cane, the threat of greening present in neighbouring Brazil and the physical limits in the Tucumán region should restrict this trend.

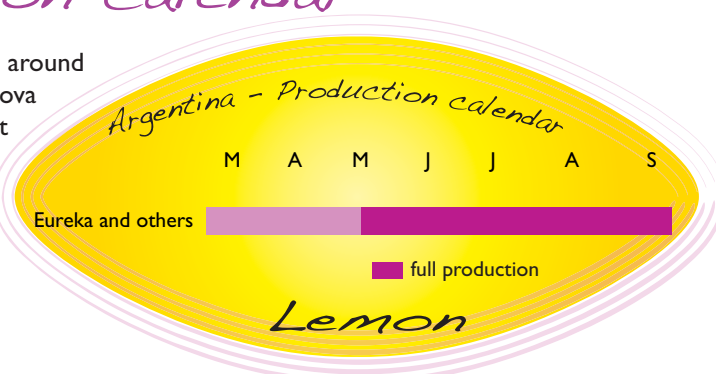


Breakdown of production by outlet

Argentina is the world's number one producer of lemons and derivatives. This is the primary outlet, and in recent years has absorbed on average 70 % of production. Approximately 1 million tonnes per year are processed by five very large companies. The volumes intended for fresh lemon export, a diversification outlet, have stabilised at an average level of approximately 250,000 t over the past few years, after falling steeply in the late 2000s. Local consumption has stabilised at 50,000 t for 42 million inhabitants.

Varieties and production calendar

Production is based on four main varieties. Eureka represents around 35 % of surface area, Limoneira and Lisbon 25 % and Genova 11 %. Four flowering periods of variable intensity mean that production can be staggered. The main harvest is between May and September (winter picking: approx. 70 % of production). However, the export season may start in March with the "crudo" (approx. 15 % of production). Production from other flowers is aimed at the local market.





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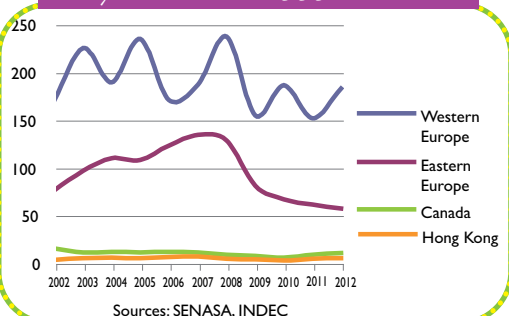
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FRESH EXPORT

Summary

- World number 3 exporter (252,000 t)
- Summer season
- Consumption markets:
Western Europe (70%),
Eastern Europe (25%)

Lemon - Argentina - Exports
by destination (000 tonnes)



400,000 t, but was slower because of the West European markets reaching maturity. The fall in demand from these two flagship destinations and the increasing weakness of the peso against the dollar caused a sharp fall in 2009. Since that time, total exports have fluctuated between 245,000 and 270,000 t. Volumes intended for the EU are primarily unloaded at the big Dutch ports. The Mediterranean producer countries such as Spain, Italy and Greece still play a significant role in imports in terms of category management, but are on a waning trend. The presence of citrus canker, a quarantine disease, has led to the implementation of strict orchard and fruit inspection procedures orchestrated by SENASA, and is restricting the opportunities for broadening the portfolio of customer countries. Hence the other world markets, primarily represented by Canada and Hong Kong, absorb no more than 5 % of volumes, and are practically stagnant. Japan is open, but its sanitary protocol is highly restrictive. Negotiations between SENASA and USDA on reopening the US borders, closed since 2002, have not yet ended. The sector is concentrated: the top five exporters alone, which ship more than 20,000 t/year, represent 60 % of volumes. Stricter qualitative criteria have been imposed with the "All lemon" programme, to which the twelve main export players have signed up.



Main shipping lines

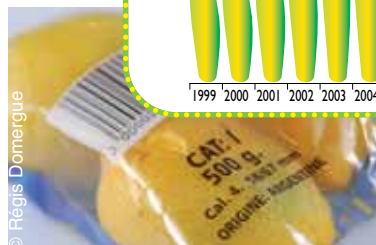
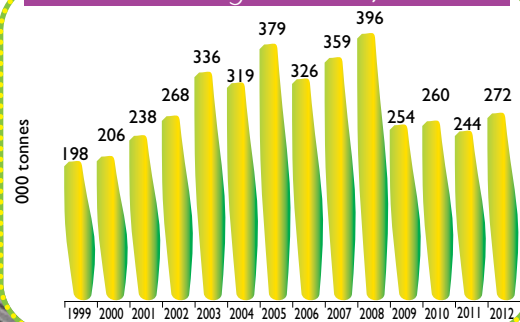
Transit time

Departure port

Arrival port

| | | |
|---------------------------|---------------|---------------|
| Buenos Aires, Campana,... | Rotterdam | 17 to 19 days |
| | St Petersburg | 20 to 22 days |
| | Black Sea | 19 to 20 days |

Lemon - Argentina - Exports



Argentine exports took off in the mid-1990s with the emergence of a counter-seasonal market in the European Union, and then in Eastern Europe. Growth, driven by the demand from these two markets, was extremely quick until 2005. The trend continued until 2008, when volumes reached a record level of nearly



Logistics

As a general rule, fruits aimed at the European market are shipped in refrigerated lorries to Campana on the River Parana, approximately 1200 km from Tucumán. They are then generally loaded onto conventional ships, reaching the northern EU ports (Rotterdam and Antwerp) after 15 to 20 days at sea. The pathway for Eastern Europe is similar. Volumes aimed at Far Eastern markets and Canada are containerised and generally exported from the port of Buenos Aires. Significant volumes are also shipped from the ports of San Pedro and Zarate.



San Miguel

Argentina • Uruguay • South Africa



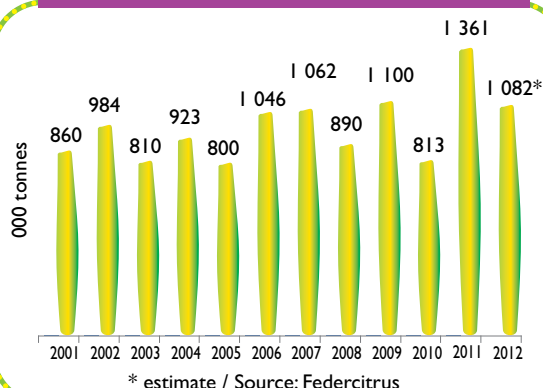
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INDUSTRY

Summary

- 1 million tonnes of lemon processed per year (57 % of world processing)
- World number 1 processor (53,700 t of concentrated juice, 4,500 t of essential oil, 53,000 t of dehydrated peel)
- World number 1 exporter (35,500 t of concentrated juice, 4,000 t of essential oil, 42,000 t of dehydrated peel)
- Consumption markets: Western Europe (41 %), United States (30 %)

Lemon – Argentina
Volumes for industrial use

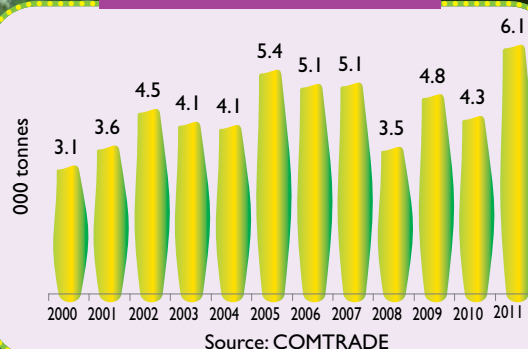


Absorbing on average 70 % of production, the industrial sector represents the driving force of the Argentine industry, after coming to the fore in the early 1990s following the association with multinationals from the drinks sector. The quantities processed reached the symbolic mark of 1 million tonnes in the early 2000s. Since then, Argentina has controlled more than 40 % of the world juice and essential oil market, thanks to massive exports, primarily to the United States and European

Union. However, the production boom hindered profitability, which became critical in the early 2000s. The planting trend came to a halt and manufacturers diversified into developing fresh exports. Despite rising production costs, the economic balance of the sector gradually recovered during the second half of the 2000s, first for essential oil and then for concentrated juice. Production saw successive cyclic falls, while world demand rose slightly, thanks to the traditional markets and the emergence of Asia. This trend was confirmed in the early 2010s, ensuring the health of the four main operators controlling nearly 90 % of the sector.



Lemon – Argentina Essential oil exports

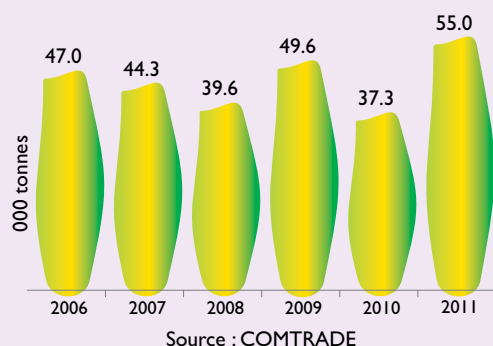


Lemon – Argentina – Essential oil exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---------------|-------|-------|-------|-------|-------|-------|
| United States | 2 894 | 2 736 | 1 757 | 2 282 | 2 041 | 2 555 |
| EU | 1 488 | 1 634 | 1 024 | 1 760 | 1 386 | 2 525 |
| China | 3 | 6 | 162 | 449 | 254 | 361 |
| Latin America | 423 | 576 | 419 | 155 | 261 | 194 |
| Others | 275 | 153 | 156 | 173 | 345 | 417 |

Source: COMTRADE

Lemon – Argentina Concentrated juice exports



Lemon – Argentina – Juice exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---------------|--------|--------|--------|--------|--------|--------|
| EU 15 | 26 031 | 26 895 | 19 682 | 32 993 | 20 870 | 27 143 |
| United States | 10 026 | 2 904 | 6 773 | 5 737 | 6 510 | 17 772 |
| Japan | 3 351 | 4 710 | 4 616 | 4 787 | 2 819 | 3 451 |
| Israel | 2 975 | 3 726 | 3 080 | 1 577 | 2 637 | 2 034 |
| Canada | 1 411 | 1 713 | 1 491 | 1 149 | 1 172 | 1 666 |
| Others | 3 212 | 4 324 | 3 930 | 3 386 | 3 269 | 2 912 |

Source: COMTRADE

Australia

ALTHOUGH Australia plays a significant role in the world citrus trade thanks to its oranges and small citruses, the lemon industry is underdeveloped and has little international reach. Production, stabilised at approximately 30,000 t, is consumed fresh on the local market. The industry should not see significant growth over the coming years

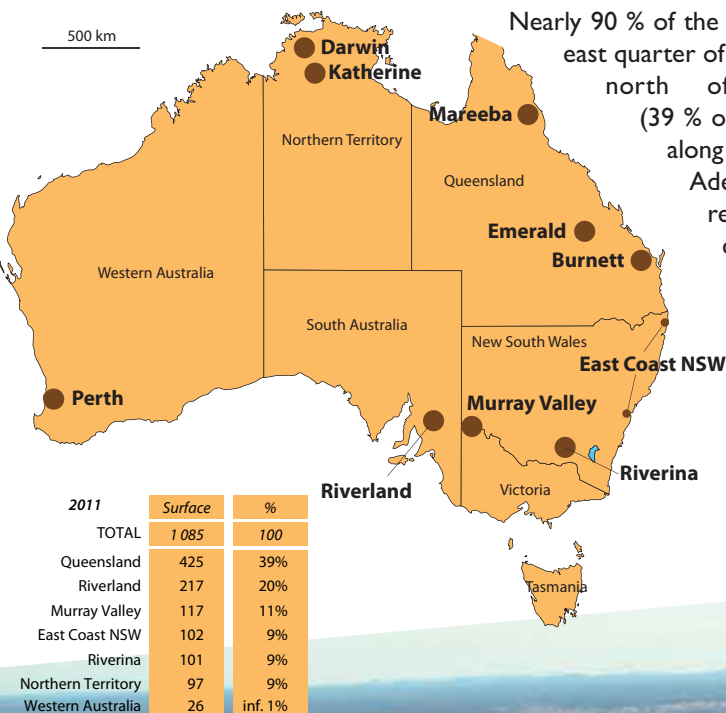


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PRODUCTION

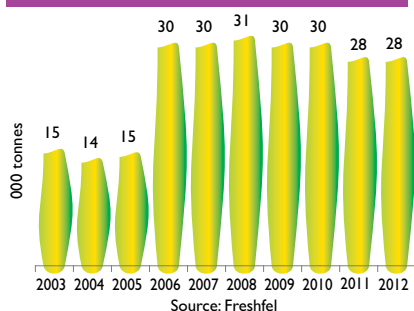
Production zones

Nearly 90 % of the 1 085 ha of the Australian cultivation area is packed into the south-east quarter of the country. The coastal region of Wide Bay-Burnett in Queensland, north of Brisbane, represents the main production centre (39 % of the total surface area). Further south, the cultivation zones inland along the River Murray (Riverland, approximately 150 km north-east of Adelaide, and Murray Valley, approximately 200 km further upstream) represent 20 % and 11 % of surface area respectively. Two production centres in New South Wales, one on a tributary of the River Murray in the Riverina zone, and the other on the north coast of Sydney around Lismore and Gosford, each pack in approximately 9 % of the surface area. The rest of the cultivation area, which represents just over one hundred hectares, is located in North Territory and in the south of Western Australia. The farms in Queensland are relatively large. On the other hand, there is still a large number of small facilities (less than 10 ha) in the other production zones, though this is on a waning trend.



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Lemon - Australia - Production

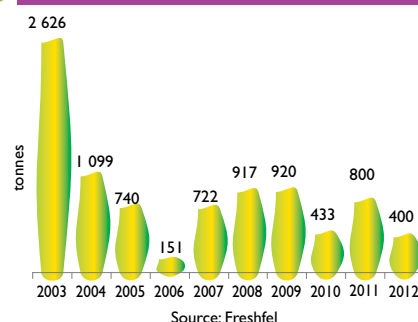


Evolution of production

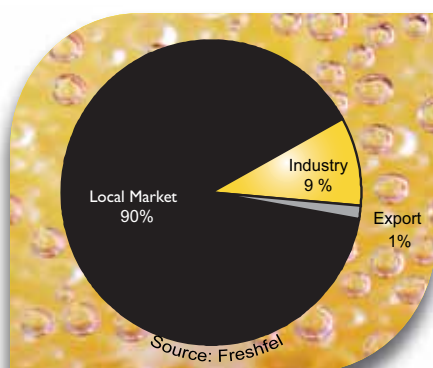
Production grew until the late 1970s, when it approached 50,000 t. The 1980s were a decade of decline, with production falling to 30,000-40,000 t, and stabilising at this level. The harvest is almost entirely aimed at the local market. The export sector, highly developed in small

citruses and oranges, is practically non-existent for lemons, with fewer than 1000 t exported in recent years. The same applies to industry, which processes fewer than 3000 t per year. No major changes are expected in the medium term.

Lemon - Australia - Exports



Breakdown of production by outlet



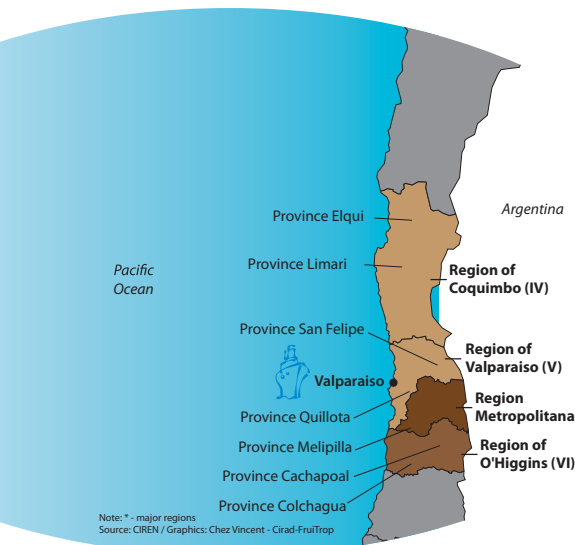
Chile

WITH an estimated production of approximately 200,000 t, nearly all sold fresh, Chile is a recent arrival as an international market player. Exports, primarily intended for the United States and Japan, comprise approximately 45,000 to 50,000 t, putting this source in sixth position on the world market. Production should not grow significantly over the coming years, in the face of tougher production constraints and the very limited growth prospects of the flagship markets for this source.



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PRODUCTION



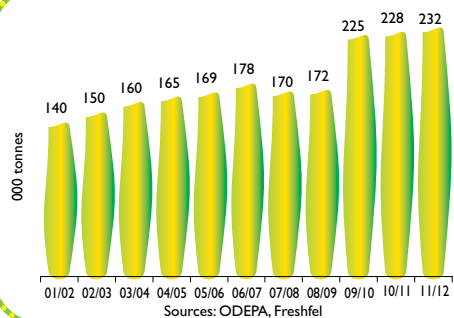
Production zones

The Chilean cultivation area, covering 7400 ha in total, is concentrated in the Mediterranean climate zone either side of the Metropolitan Region. Approximately half of the surface area is situated south-west of Santiago, around Melipilla in the Metropolitan Region, the country's main production centre, and in the north of the neighbouring O'Higgins province. Most of the remaining cultivation area is concentrated in the Valparaíso province, in the Aconcagua valley (particularly around Quillota) and Alicahue (Cabildo zone). Some plantations have also been set up further north, around Coquimbo in the province of the same name.



© L. Lorente

Lemon - Chile Production



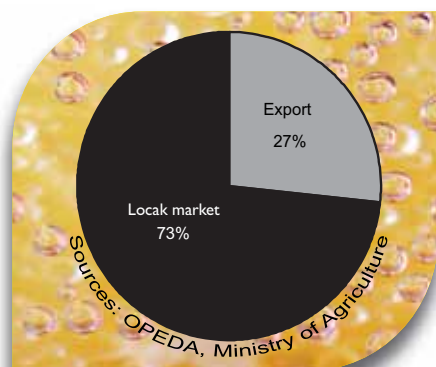
Evolution of production

A traditional crop aimed mainly at the local market, the lemon saw its production hit a ceiling of approximately 70,000 t before the early 1990s. Volumes have grown since then, with the start of exports to two markets which are lucrative but demanding in sanitary terms, i.e. Japan and the United States. The surface area expanded until the late 1990s, stabilising at just over 7000 ha, the level it has maintained since then. Furthermore, productivity has improved considerably,

especially thanks to the development of irrigation and use of more productive cultivars. According to professional sources, production has stabilised at a level of approximately 230,000 t over the past few seasons. It should not change significantly over the coming seasons. There are increasing production constraints (energy and labour costs, recurrent drought in the centre of the country), while demand from international markets is stagnating: fall in consumption in Japan, limited prospects in the United States with the rise of competition from Mexico and the possible entry of Uruguay and perhaps Argentina. The Chilean Citrus Fruit Management Committee [CGC] is responsible for R&D, lobbying and information/communication, both internally and internationally.



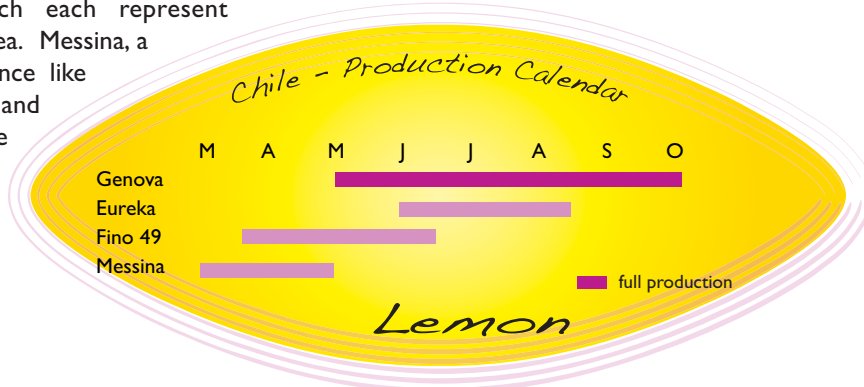
Breakdown of production by outlet



The industry remains primarily focused on the fresh product, though the export share was growing considerably until 2007. The local market, which amounts to nearly 17 million inhabitants, absorbs on average three quarters of the country's lemon production. The best fruits are earmarked for export to demanding and highly lucrative markets (primarily Japan and the United States). The industrial sector is practically non-existent.

Varieties and production calendar

Production is based on three main varieties. Genova, an iconic variety of Chilean cultivation, is on a downward trend, losing out to more productive cultivars. It represented just 25 % of the surface area in 2011. Production is now primarily based on Eureka and Fino, which each represent approximately 35 % of the surface area. Messina, a cultivar prized for its early appearance like Fino 49, is also on an upward trend, and represents approximately 5 % of the surface area.

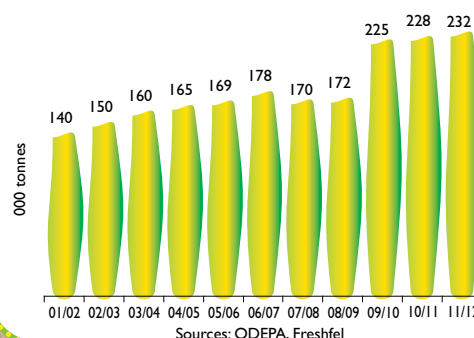


FRESH EXPORTS

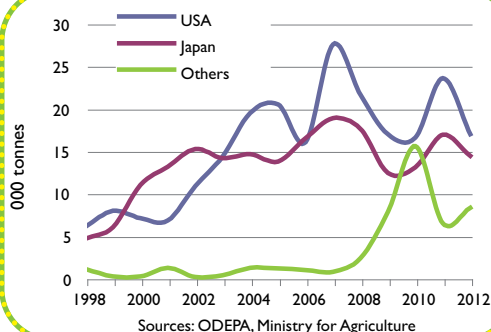
Summary

- World no. 6 exporter (44,000 t)
- Summer season
- Consumption markets:
United States (49 %), Japan (36 %)

Lemon - Chile - Exports



Lemon - Chile Exports by destination



The export activity is relatively recent, only really starting in the early 1990s, with the opening up of the US and Japanese markets. Volumes, aimed practically exclusively at these two markets until

Logistics

Most of the merchandise is transported by road to the port of Valparaíso, situated near the production zones.

2008, rose regularly, peaking at nearly 50,000 t in 2007. Shipments have levelled out since then. On the one hand, the sanitary protocol of insect control fumigation in force in both the United States and Japan is a major impediment to the development of trade. An alternative "System approach" based on orchard certification, is under investigation for the United States market, but has not yet been validated by the USDA. On the other hand, consumption is falling considerably in Japan, a market absorbing between 35 and 40 % of volumes. In this context, exporters have sought to expand their customer portfolio by opening up new markets. However, shipments to these diversification destinations represent less than 20 % of total volumes, excluding weather problems in a competing source. Shipments to the EU have stagnated at between 4000 and 10,000 t over the past few seasons. Shipments to South Korea, whose borders were opened in 2007, are growing but are still below 1500 t, as are shipments to the Persian Gulf. The leading four exporters alone represent more than half the volumes exported.



Main shipping lines

| Markets | Departure port | Arrival port | Shipping time |
|---------------|----------------|---|---------------|
| United States | Valparaíso | West Coast: Los Angeles, Long Beach, Lax, San Diego | 12 to 17 days |
| | | Miami | 10 to 12 days |
| | | East Coast: New Jersey, New York, Philadelphia | 15 to 22 days |
| Japan | | Tokyo | 25 days |
| EU | Valparaíso | Rotterdam | 20 days |
| | | Algeciras | 17 days |
| | | Felixstowe | 22 days |





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China

LESS prized locally than soft citruses, and faced with competition from the lime, widely cultivated in the south of the country, the lemon has not seen as intense a boom as small citruses and the orange in the past decade. Production, highly concentrated in East Sichuan, was evaluated at 400,000 t in 2012-13. Nonetheless, it is on an upward trend, to supply a growing local market.



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PRODUCTION



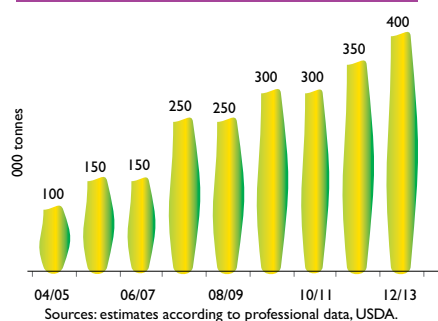
Production zones

Sichuan province packs in nearly 80% of the cultivation area. Most of the farms are in Anyue County, in the east of the province on Chengdu Plain. This part of Sichuan has the best climate compromise for lemon growing in China: not too tropical, or too cold in winter, thanks to the protection provided by the elevated relief in the western zone. Furthermore, this “red basin” is fertile. Alluvial deposits from the Minjiang, one of the biggest tributaries of the Yangtze (China’s longest river), make the soil rich and favourable for agriculture. The rest of production is primarily packed into Chongqing and Guangxi.



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Lemon - China Production



Evolution of production

The Chinese citrus growing industry saw a spectacular boom in the last decade. The high profitability of oranges and small citruses, as well as Government incentives set up as part of the development of large citrus growing areas (upstream of the three gorge dam, the hill belt in the south of Hunan and Jiangxi provinces, South Zhejiang/West Fujian/East Guangdong) enabled the country to seize the world number one producer spot, with a har-

vest exceeding 20 million tonnes over the past few years. The lemon, little prized locally because of its acidity and faced with competition from the large-scale lime production in the south of the country, did not see such a spectacular boom. However the harvest level appears to have quadrupled since 2005, reaching 400,000 t in 2012-13. According to the USDA, the current expansion of the cultivation area provides grounds to predict that production could be approximately 550,000 t by 2016. Local consumption of fresh lemon is still modest, though it is growing in the big cities. Furthermore, the industrial sector is growing. The small size of farms, the endemic presence of greening and the pedoclimatic limitations are still major impediments to the development of this crop. The local government of Anyue has set up a support plan for the industry, by means of technical aid aimed at standardising production, developing infrastructures such as a wholesale market and a processing research centre.

Distribution by outlets



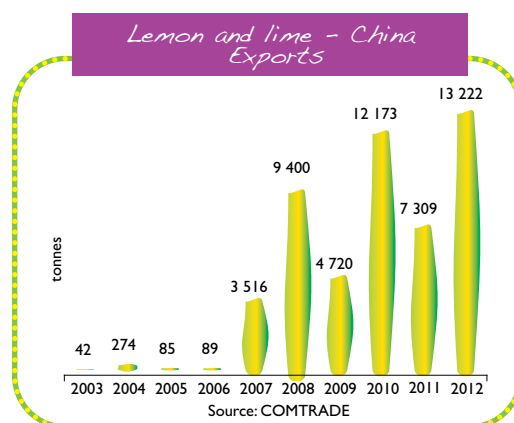
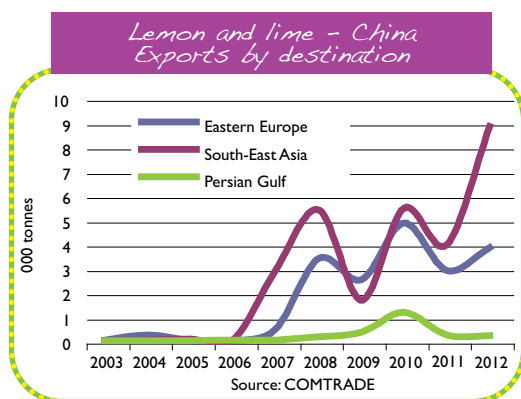
Chinese production is practically solely aimed at supplying the local fresh lemon market, which is growing, especially during the summer months (particularly June to August). The new generations are broadening their dietary habits, and starting to consume new types of product (Western gastronomic restaurants in fashion, strong interest in new drinks such as lemonade or lemon tea made from slices of dried lemon, etc.). Despite the development of local production, imports are on an upward trend, to supply the top-end segment and counter-seasonal market. They amounted to approximately 9000 t in 2012, 6500 t of which was from the United States. The industrial sector is still a secondary outlet at present. Until 2012, the only processing unit in operation in the country (Sichuan region) absorbed approximately 20,000 t per year. Setting up a second factory should double the quantities processed. Industrial production, limited to concentrated juice, is not exported for the moment, and is used to supply the local market. Fresh lemon exports are at a limited level (13,200 t in 2012, including limes). They are generally aimed at Russia, South-East Asia and the Persian Gulf.

Calendar and varieties

Eureka appears to be the main variety planted. The peak harvest period runs from October to January.



FRESH EXPORT



Cyprus

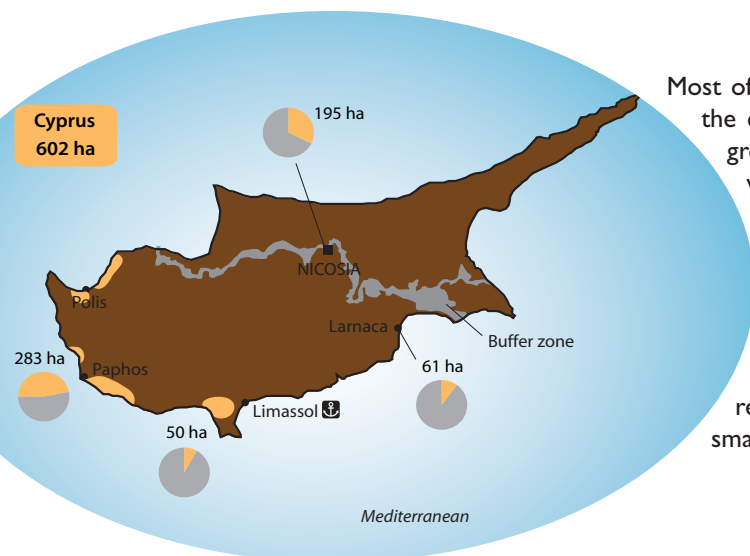
A major fresh lemon supplier to the European market in the 1970s and then the 1990s, Cyprus has not recovered from the recurrent drought affecting the country in the 1990s, or the increase in international competition. This source, which is still a reference in terms of product certification, now represents only limited volumes, and is still facing a serious competitiveness problem. While the surface area seems to be stabilising, it is not expected to grow over the coming years.

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PRODUCTION

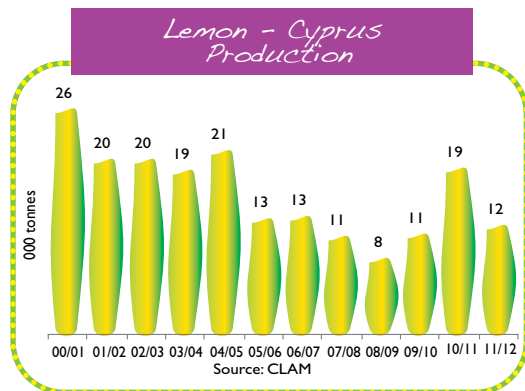
Production zones



Most of the cultivation area, covering approximately 600 ha, is located on the coastal strip. Since the rainfall level is highly restrictive, the citrus growing zones are concentrated within the irrigated areas fed by the waterworks built in the Troodos mountain range which occupies the central part of the island. The main production centres are situated in the west, in the province of Paphos, and in the south around Larnaka and Limassol. The sanitary pressure is relatively low because of the dry climate, but mal secco is present. The production facilities are highly disparate, ranging from industrial plantations to smallholdings of one or two hectares, which still represent a considerable proportion of the cultivation area. These smallholdings are grouped into one main cooperative, SEDIGEP.



© F. Cappellari



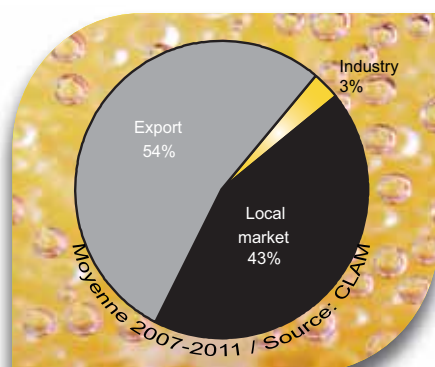
Evolution of production

Introduced in the 18th Century, lemon growing took off in the 1950s-

1960s, in particular to supply the United Kingdom, the former colonial power with which Cyprus maintain close relations. Production exceeded 40,000 t in the early 1970s, with Cyprus then positioned as one of the main suppliers to the European market. It would not be until the late 1980s that the Cypriot harvest would return to this level, after the loss of nearly three quarters of the cultivation area following the division of the country in 1974 (the historical Lapithiotiki centre in particular). After a period of stability where production varied between 40,000 and 45,000 t, the industry fell into a deep crisis in the 1990s. International competition was on the rise in Europe, while producers were confronted with nearly a decade of drought. The surface area, which had peaked at 2500 ha, collapsed to the current level of 600 ha. Production reached a low point in 2008-09, falling under the 10,000 t mark. More generous rainfall levels over the past few seasons enabled the harvest to pick up to between 10,000 and 20,000 t. However, the industry is still economically very fragile, especially because of the weakness of many of the production facilities, and the high labour and freight costs.



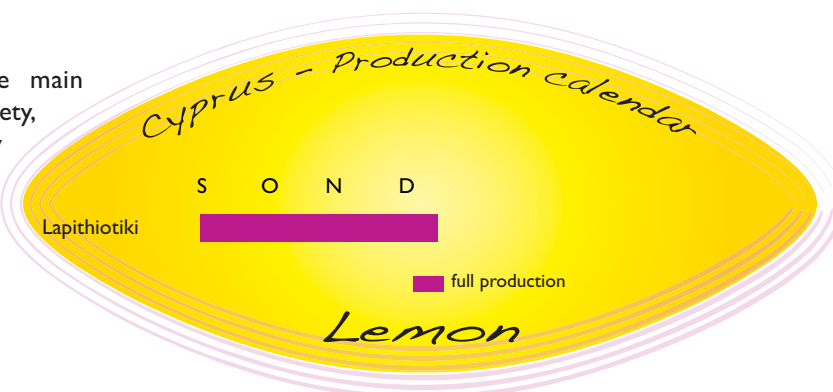
Breakdown of production by outlet



Although they have fallen steeply since the early 1990s, exports still absorb between 40 and 50 % of production. One third of volumes are intended to supply the local market, where increasing numbers of tourists swell a large local population of approximately 1.1 million inhabitants. The industrial sector remains a secondary outlet.

Varieties and production calendar

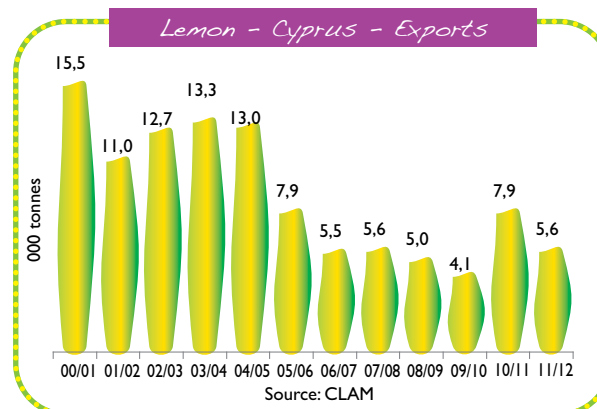
Cypriot production is based on three main varieties: Eureka, Lisbon and a local variety, Lapithiotiki. The latter is early, particularly productive and resistant to mal secco. The fruits are available from mid-September to mid-February.



FRESH EXPORTS

Summary

- World no.9 exporter (5,620 tonnes)
- Winter season



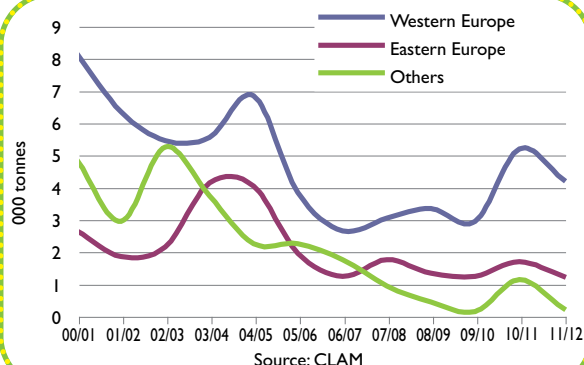
Main Shipping lines



| Markets | Departure port | Arrival port | Shipping time |
|---------|----------------|--------------|---------------|
| EU | Limassol | Piraeus | 4 to 5 days |
| EU | Limassol | Antwerp | 14 to days |
| EU | Limassol | Ravenna | 8 to 10 days |



Lemon - Cyprus Exports by destination



Exports, which peaked at nearly 28,000 t in the mid-1990s, have gradually declined to between 4000 and 8000 t these past few years. Besides its reduced production capacities, the Cypriot industry has also suffered from Spanish competition on the West European markets, and Turkish competition in Eastern Europe. Most of the volumes are still aimed at Western Europe: just over 1000 t to Austria and approximately 500 t to Greece, with all the other markets receiving fewer than 200 t. The remaining volumes are primarily aimed at Eastern Europe

(especially the Czech Republic). The Asian markets (particularly Hong Kong and Singapore), which enabled significant volumes of early fruits to be sold in the early 2000s, have been practically abandoned. Exports are concentrated within a very limited number of operators. The cooperative SEGIDEP dominates the sector, alongside some large private companies which generally have their own packing station. The production certification level is very high.



Logistics

The fruits are exported by the port of Limassol, situated in the south of the island. They are containerised and loaded onto ships sailing regular lines between Cyprus and the European Union. Fruits aimed at the south of the continent are generally shipped to the port of Ravenna.



Greece

GREECE was an essential player in Mediterranean production and world trade during the 1970s and 1980s. Hit by repeated frosts and the rise of Turkey on its natural markets in Eastern Europe, this country has now completely fallen behind, in both harvested and exported volumes. A return to the international stage seems unthinkable, though surface areas have been on a slightly upward trend over the past few years.



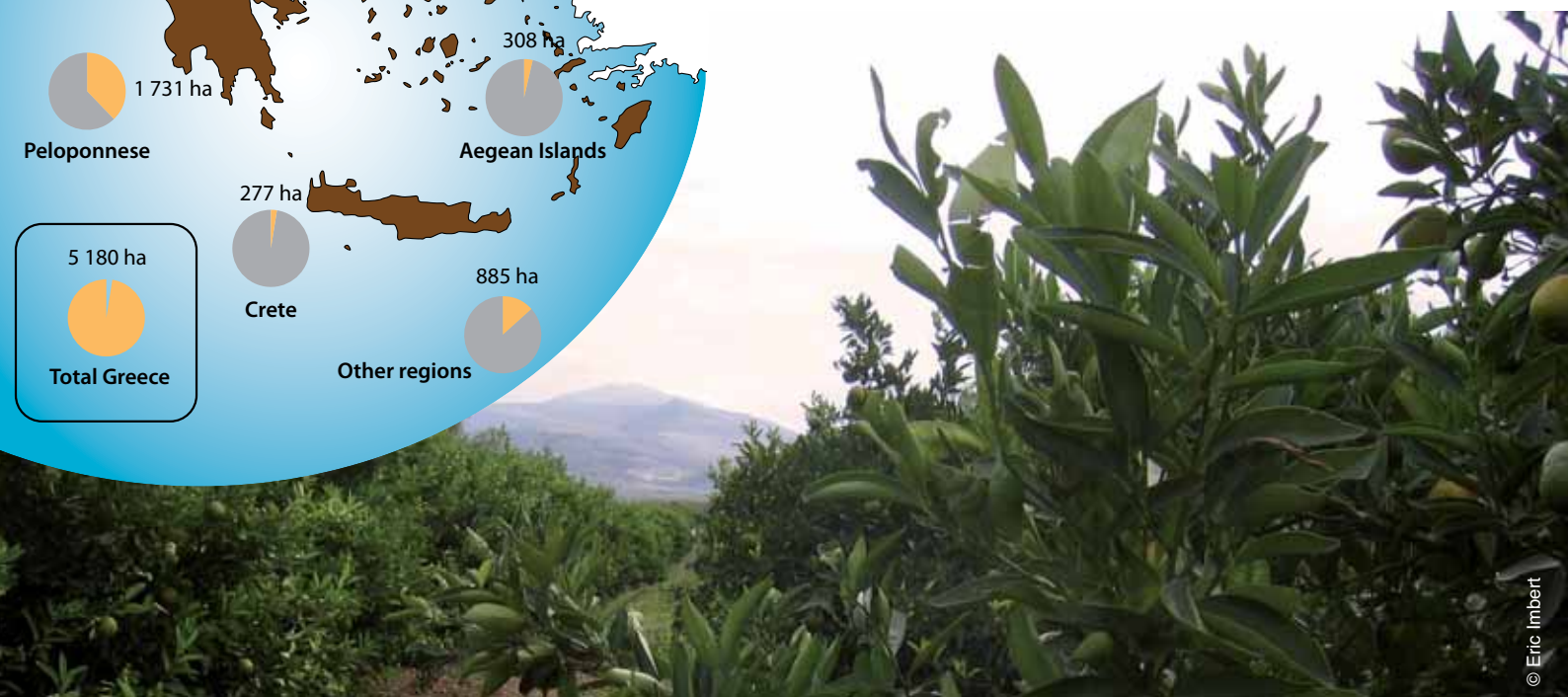
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PRODUCTION

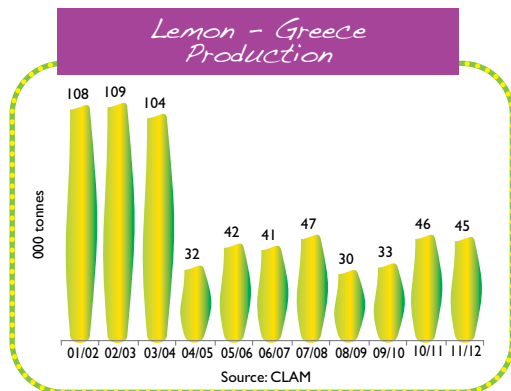


Production zones

The Greek cultivation area covers in total 5200 ha, and is primarily concentrated in two zones. Nearly 40 % of the plantations are located in the central district of Greece (Boeotia, Evrytania, Phocis, Phthiotis and Euboea). The other production centre, which covers one third of the surface area, is situated in the north of the Peloponnese Peninsula, primarily along the Bay of Corinth and in the districts of Achaia and Elis. The cultivation area is rounded off by Crete and the Aegean islands. Family smallholdings of less than 20 ha predominate.



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Evolution of production

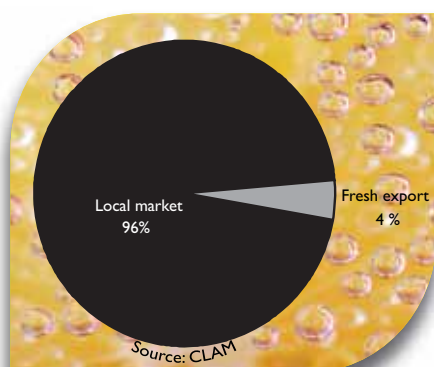
Lemon growing reached its apogee in the 1970s-1990s. The quantities produced, approaching 180,000 t, enabled Greece to be among the biggest lemon suppliers, after Spain and Italy. In the late 1990s, the Greek

industry started weakening with the rise of extremely strong Turkish competition on the East European markets, and damage caused by mal secco. Production slowly but surely decreased, reaching approximately 100,000 t in 2003-04. The 2004 frosts dealt a fatal blow to the already weakened industry. Most of the cultivated 12,000 ha was not replaced, with farmers abandoning the lemon in favour of other produce (wine, apricots). Since then, production has varied between 30,000 and 45,000 t. The cultivation area, after falling below the 6000 ha mark in 2008, seems to have risen very slightly over the past few years. However, with a production level currently insufficient to cover local demand, the return of Greece to the international market is difficult to imagine.



Maglini Variety.

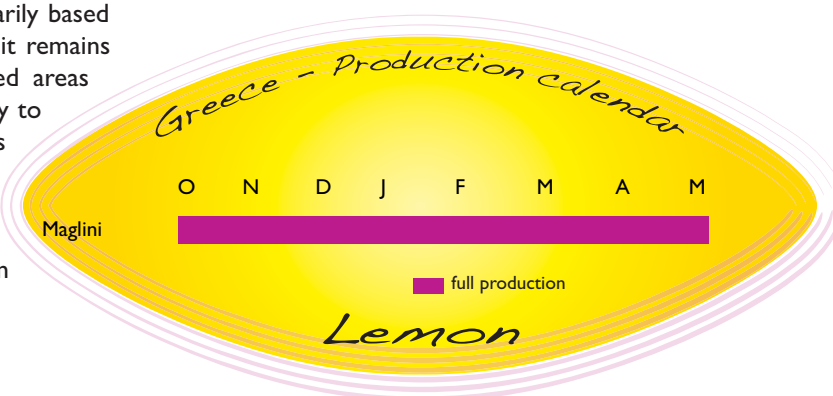
Breakdown of production by outlet



Exports, which peaked at 60,000 t and absorbed 40 % of production, now represent an utterly marginal outlet, at present only 1300 t per year on average. The industrial sector, which processed 20,000 t of lemons in the late 1990s (approximately 15 % of production), has now completely disappeared. Practically all production is aimed at supplying the local market, which comprises nearly 11 million inhabitants. However, the 35,000 t sold are insufficient to meet the needs of the population. Greece has become a net importer country, having received 30,000 t over the past few years, primarily from Argentina and Turkey.

Varieties and production calendar

At its apogee, Greek production was primarily based on one variety, Maglini. However, although it remains dominant, this cultivar has seen its planted areas shrink considerably because of its sensitivity to mal secco. The area dedicated to Comune is stable. There is a current development trend for local varieties tolerant to this disease, such as Adamopoulou, Vakalou and Zambettakis. The fruits are available from October to May.

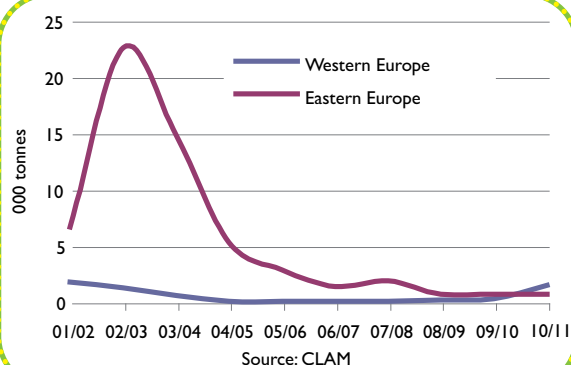


FRESH EXPORT

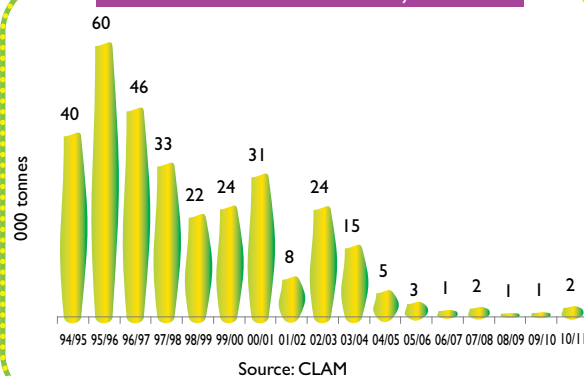
Summary

- World no. 10 exporter (1,300 t)
- Winter season

Lemon - Greece
Exports by destination



Lemon - Greece - Exports



As a historic player in international trade, the export sector had its golden age from the early 1970s to the end of the 1980s. During this period, annual exports, punctuated by steep falls due to frosts, varied between 80,000 and 90,000 t, making this country the world number three exporter. The decline set in from 1988. On the one hand, the weather continued to have a heavy impact. On the other hand, from the mid-1990s, competition from Turkey rose on Greece's natural markets in Eastern Europe. Volumes declined gradually, reaching 15,000 t in 2003-04, when a final period of frost practically put an end to the export activity.



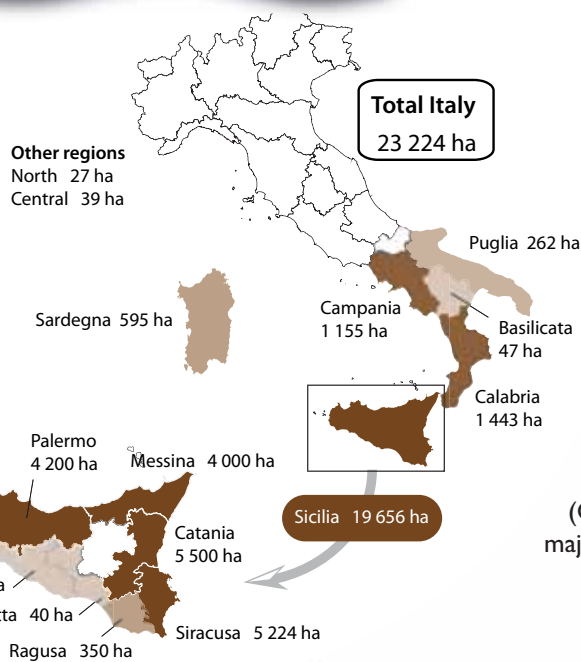
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Italy

THE Italian industry is still one of the world's biggest, despite a very significant decline since the early 1970s, especially in exports. The world number five producer, with an average harvest of approximately 550,000 t, it still plays an important role on the derivative products market. Weakened by recurrent structural problems in terms of organisation and phytosanitation impairing its profitability, the sector has re-focused on the top-end, both for fresh and processed lemons. The cultivation area, mainly shrinking over the past few years, could stabilise with the current resurgence in interest in the agricultural sector due to the economic crisis.



PRODUCTION



Production zones

Sicily accommodates 85 % of the Italian cultivation area, which amounts to an estimated 23,000 ha. Most of the cultivation area of this island is packed into the east, on the coastal strip of the provinces of Syracuse and Catania. The rest of the Sicilian cultivation area is located on the coastal strip of the provinces of Palermo and Messina, in the north and north-east. The coastal part of this island enjoys a Mediterranean climate highly favourable for lemon growing: the winters are mild (average temperature of 10°C), and frost risks limited. On the other hand, irrigation is necessary. The rest of the Italian cultivation area is situated in the south-west of the country, on the coast of the regions of Calabria (Cosenza), Campania (Sorrento, Amalfi) and Puglia (Foggia). In the vast majority of cases the farms are very small-size holdings.



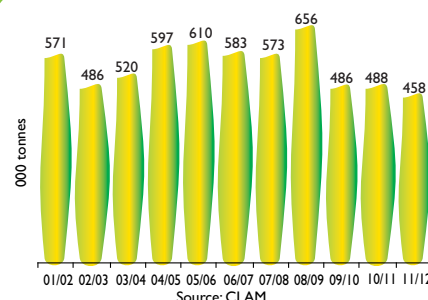
© Simone Gatto

Evolution of production

Along with California, Italy dominated the world lemon sector until the early 1970s. Driven by a big local market, growing European demand and one of the oldest processing industries on the planet, the sector grew from the post-war period to the late 1960s, when production peaked at more than 800,000 t, and surface areas at more than 36,000 ha. Hindered by the small-sized farms, the presence of mal secco and a lack of organisation, the industry started to weaken in the early 1970s. The market share of Italian exporters in Europe started to drop, in the face of the rise of more competitive rivals such as Spain. Between 700,000 and 800,000 t until the mid-1980s, production waned for more than a decade, before stabilising in the past few seasons at an average level of approximately 550,000 t. Now focused on the local market and industrial sector, the industry remains fragile. The problem of lack of competitiveness remains intense, with the very

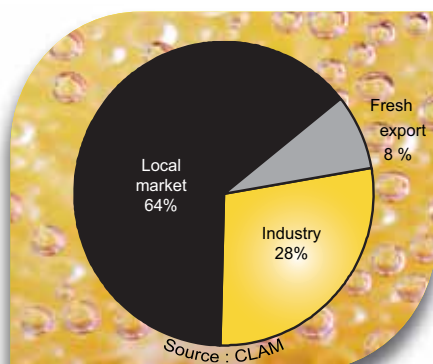
high level of labour costs and tristezza adding to the underlying problems described above still weighing heavily. Threatened by their competitors even on their local market during the production period, Italian professionals have developed a strategy of refocusing on the top-end niches, both for the fresh lemon (organic and six IGPs obtained between 2000 and 2012: “Limone Costa D’Amalfi, di Rocca Imperiale, di Siracusa, di Sorrento, Femminello del Gargano and Interdonato di Messina”) and for derived products. However, the return to agriculture due to the economic crisis that has hit Southern Italy hard could help provide some consolidation of the sector.

Lemon - Italy
Production



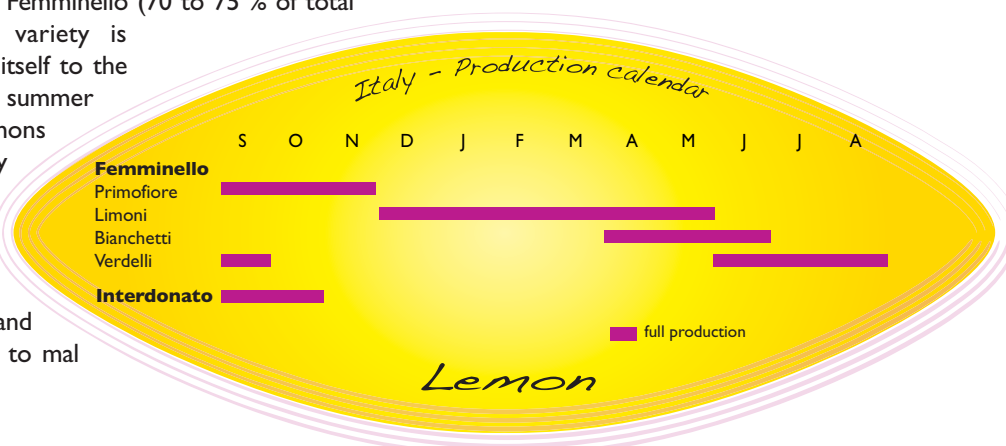
Breakdown of production by outlet

The Italian industry is now focused on two main outlets: the local market and industrial sector. Exports are only a secondary market, absorbing on average 7 % of production. The local market, amounting to nearly 60 million inhabitants, clears on average 55 % of annual production. The official data report a very high consumption level, stabilised at around 300,000 t/year. The industrial sector is still a major outlet, absorbing between 25 and 30 % of volumes over the past few seasons. Nonetheless, the official figures report a very steep fall in volumes earmarked for it since the end of the system of direct aid to citrus processing granted by the EU.



Varieties and production calendar

Italian production relies primarily on Femminello (70 to 75 % of total volumes). This highly productive variety is multiple-flowering, and readily lends itself to the forcing technique (intensification of summer flowering periods to produce lemons outside the production peaks). They refer to the “Primiofiore” lemon in Autumn, “Limoni” in Winter, “Bianchetti” in Spring and “Verdelli” in Summer. However, Femminello is tending to lose out to Monachello and Interdonato, which are less sensitive to mal secco but also less productive.

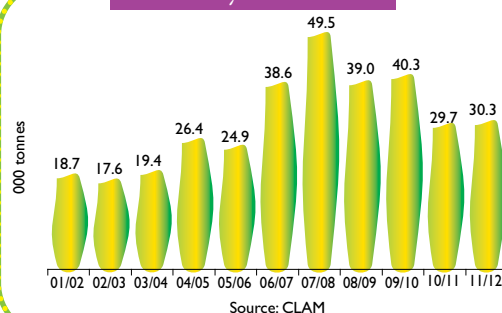


FRESH EXPORTS

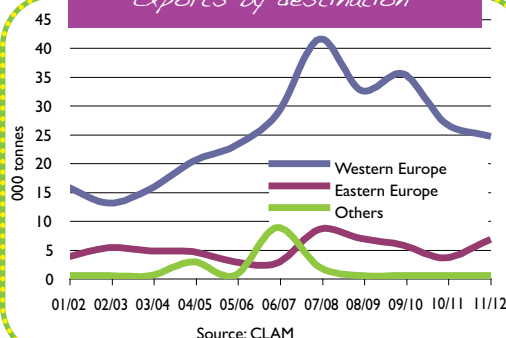
Summary

- World no.7 exporter (37,000 t)
- Winter season
- Consumption markets:
Western Europe (85 %),
Eastern Europe (15 %)

Lemon - Italy Exports



Lemon - Italy Exports by destination



Italy dominated the world fresh lemon trade until the early 1970s, with average exports reaching 350,000 t throughout the 1960s, thanks to growing demand from the European markets. The rise of Spain, which was more competitive, ended this golden age. Shipments waned gradually through the 1970s, and more steeply during the 1980s with Spain's entry into the Common Market, with volumes falling below 100,000 t per year from 1987. The low point was reached in the early 2000s, with exports dropping below the 20,000 t mark. The policy of quality differentiation through IGP has enabled the industry to bounce back over the past few seasons, with volumes returning to a level fluctuating between 30,000 and 40,000 t. More than 80 % of shipments are aimed at West European markets (especially Germany and Austria, with France, Greece, Slovenia and Hungary absorbing most of the remainder).

Logistics

The logistics are exclusively by road to serve the EU markets.

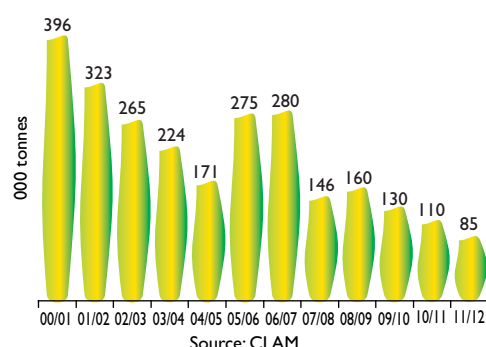
INDUSTRY

Summary

- 110,000 to 160,000 tonnes of lemons processed per year
- World no.4 processor (7%)

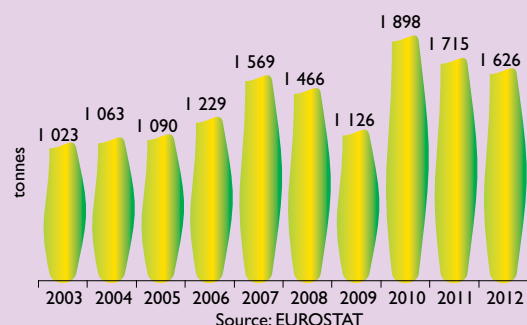


Lemon - Italy
Volumes for industrial use



The Italian lemon derived products industry is still among the biggest in the world. It occupies fourth place in terms of volumes processed, amounting to between 110,000 and 160,000 t over the past few seasons. Faced with high production costs, professionals have sought to develop high-end production, thanks to extraction techniques enabling them to make the most of their quality raw material (sfumatrice). Italian essential oils are particularly prized in the perfumes sector. The Italian industrial sector is concentrated between around ten operators of all sizes (two processing more than 20,000 t, four between 10,000 and 12,000 t, and five approximately 5000 t). These companies generally have little involvement in production, and procure directly from the producers. Exports, derived from both local production and re-exports, appear to be relatively stable, at around 10,000 to 12,000 t per year for concentrated juice, and 1500 to 1700 t per year for essential oil. The vast majority of volumes are aimed at Western Europe, with the remainder primarily exported to the United States and Asia.

Lemon - Italy Essential oil exports

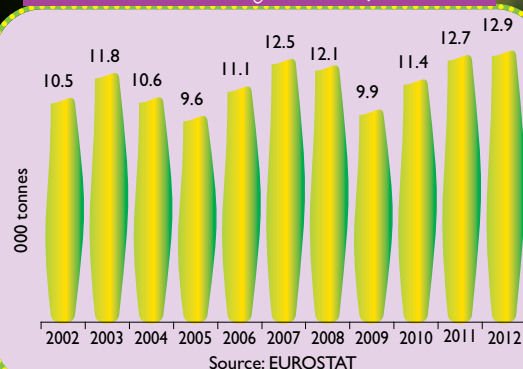


Lemon - Italy - Essential oil exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------|------|------|------|------|-------|------|------|
| EU-27, Switzerland | 803 | 974 | 888 | 624 | 1 012 | 913 | 972 |
| USA, Canada | 121 | 168 | 158 | 118 | 425 | 374 | 240 |
| Japan | 155 | 176 | 141 | 112 | 97 | 118 | 76 |
| Other Asia | 80 | 152 | 180 | 167 | 253 | 197 | 227 |
| Latin America | 24 | 37 | 54 | 49 | 57 | 54 | 67 |
| Others | 46 | 62 | 44 | 56 | 54 | 60 | 45 |

Source: EUROSTAT

Lemon - Italy Concentrated juice exports



Lemon - Italy - Concentrated juice exports by destination

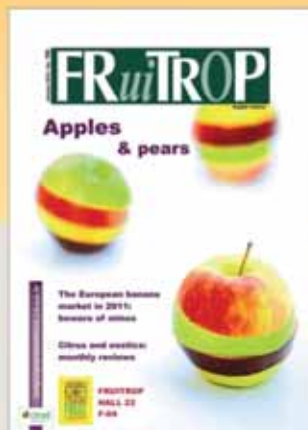
| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------|-------|-------|-------|-------|-------|-------|-------|
| EU-27, Switzerland | 7 449 | 9 262 | 7 833 | 7 989 | 8 967 | 7 814 | 5 874 |
| USA, Canada | 135 | 287 | 639 | 631 | 1 267 | 2 050 | 1 801 |
| Japan | 2 926 | 2 396 | 3 133 | 856 | 675 | 1 983 | 3 738 |
| Other Asia | 309 | 368 | 232 | 241 | 100 | 228 | 640 |
| Eastern Europe | 10 | 15 | 56 | 62 | 53 | 173 | 285 |
| Mediterranean | 98 | 77 | 194 | 45 | 110 | 213 | 211 |
| Others | 179 | 68 | 55 | 116 | 262 | 202 | 338 |

Source: EUROSTAT

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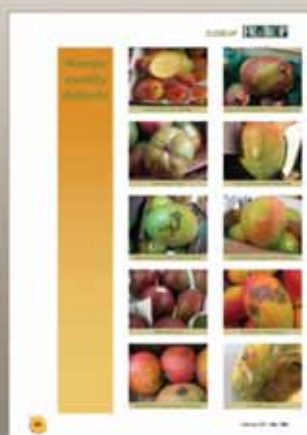
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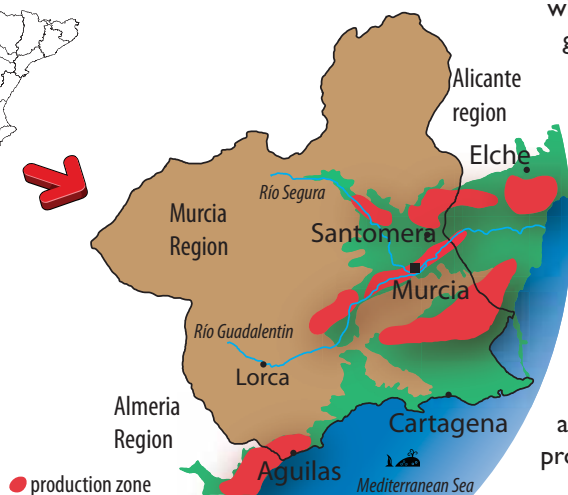
Spain

the strength of a production of approximately 800,000 t concentrated in the Murcia region Spain, along with Turkey, dominates the international fresh lemon trade, and is among the world's leading processors. The industry, facing a severe overproduction crisis in the 2000s, has been able to recover some degree of balance over the past few seasons. Nevertheless, the high level of production costs, the competitiveness of Argentina in derivatives, and of Turkey in fresh lemons, makes it hard to foresee significant growth in surface areas.

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PRODUCTION

Production zones



Nearly 90% of the cultivation area, which amounts to approximately 41,000 ha in total, is packed into a zone spanning the extreme south of the province of Alicante and the centre of the province of Murcia, within around fifty kilometres of the coast. Most of the crop is grown around the city of Murcia (Murcia's so-called "Huerta Tradicional"), and in the lowland valleys of the rivers Segura (from Murcia to Almoradi) and Guadalentín (from Murcia to Almaha). The plantations of "Campo de Cartagena" complete the production of this zone. Thanks to the rampart of the Baetic Cordillera, it has a typically Mediterranean climate. The very mild winters, with a minimum frost risk, are particularly suitable for this demanding crop. The aridity of the region (less than 100 mm of rain a year) limits sanitary problems, but imposes the use of irrigation (water from the Tage supplied by a canal 400 km long). The rest of the Spanish cultivation area is located in Andalucía (regions of Málaga and Almería). Family smallholdings are on the wane, but still represent a significant share of production, especially around Murcia.



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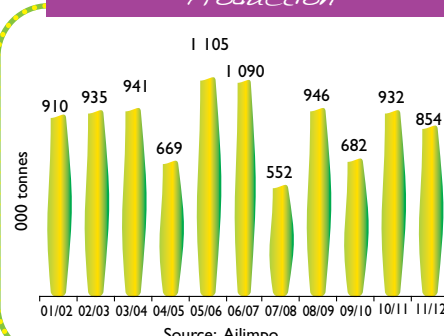
Evolution of production

A traditional crop since the 15th Century, the lemon is one of the pillars of the regional economy. There was an initial production growth trend in the 1970s with the expansion of the varietal range. Growing demand from the East European markets (especially

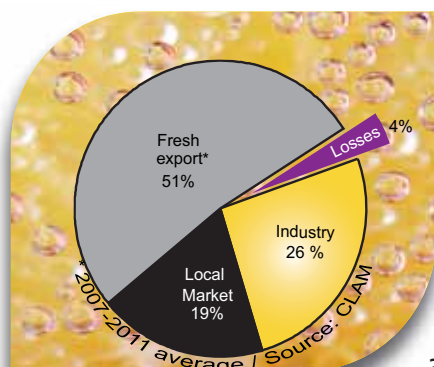
Russia) for fresh lemon generated another period of strong growth from

the mid-1990s, fuelled by the planting of highly productive cultivars. The Spanish industry experienced an unprecedented overproduction crisis throughout most of the 2000s. Production is still on an upward trend, and in excess of one million tonnes, while exports are slowing in the face of rising competition from Turkey in Eastern Europe and from Argentina in Western Europe. The fragmentation of the industry, the concentration of the supply during November and December and the rising costs of certain production factors (energy and in particular labour for harvesting) are impeding the competitiveness of the sector. Frost attacks and the reduction in surface areas due to the abandonment of the least profitable orchards have helped restore the balance to some extent over the past few years. Hence, though the downward trend in surface areas seems to have been curbed, the prospects for growth appear very limited, with the exception of some plantations in the end-of-season niche.

Lemon - Spain
Production



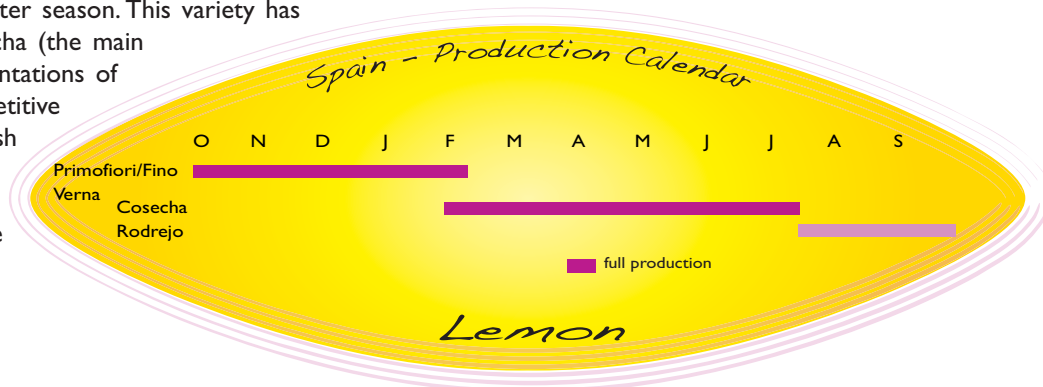
Breakdown of production by outlet



The Spanish industry is primarily focused on the fresh market. Thanks to the proximity of the European market and the production quality level, the export sector is the main outlet, absorbing approximately half of production. However, the industrial sector occupies a big place, with 9 to 10 units primarily of medium size, amounting to a total capacity of approximately 300,000 t. Despite the end of the system of direct EU aid to processing in 2008, the volumes aimed at this outlet have followed the rising trend in the derivative products market prices over the past few years, peaking at 300,000 t. The local market, on the strength of 46 million inhabitants, absorbs between 120,000 and 150,000 t per year.

Varieties and production calendar

70% of production relies on the Fino variety (also known as Primofiori), with nearly 55 % grafted on Macrophylla. Use of this rootstock grew considerably during the 1990s (better yield than on the sour orange, and earlier), despite the inferior fruit quality (less juice and less acidity, more limited shelf life). Verna makes up most of the rest of production, and supplies the end of the winter season. This variety has several flowering periods: Cosecha (the main one), Secundus and Rodrejo. Plantations of this more profitable and competitive cultivar (compared to the Turkish lemon in particular) have seen a growth trend over the past few years. There are also some Eureka plantations.



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BOUQUET



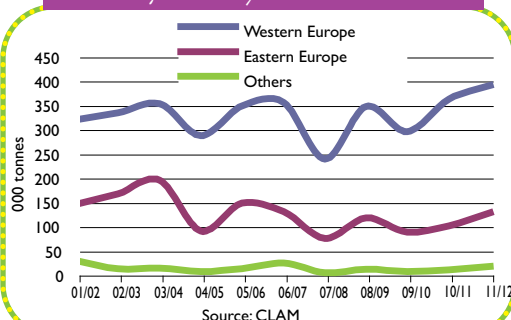
FRESH EXPORTS

Summary

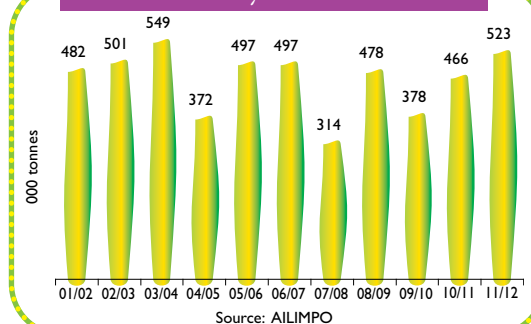
- World no. 1 exporter (446,000 t)
- Winter season



Lemon - Spain
Exports by destination



Lemon - Spain
Exports



Lemon - Spain - Organisation of export sector

| Tonnage exported | Number of companies |
|-------------------|---------------------|
| < 15 000 t | 100 |
| 15 000 – 40 000 t | 20 |
| > 45 000 t | 3 |

Source: AILIMPO



© Eric Imbert



Spanish lemon exports grew steeply during the 1990s thanks to the combined growth of the Community market and of the East European markets. This growth period ended in 2003-04, when volumes reached a record level of 550,000 t. From this time, though Spain has managed to hold a near-monopolistic position on the West European markets during the winter season, volumes shipped to Eastern Europe have waned considerably with the rise of Turkey. Argentinean competition also had a negative impact on the Fino trade at the start of the season, and above all on the Verna trade at the end

of the season, until the late 2000s. Spanish exports have had an average level

of 460,000 to 500,000 t over the past few seasons, excluding weather problems in Spain or its competitor Turkey. The export sector, dominated by private companies (a single cooperative), is highly fragmented. It is based on nearly one hundred packing units of significant size, a small number of which make approximately 50 % of shipments. A certification process of these units was set up by the interprofessional association in the early 2010s. Among big companies, exporters are increasingly establishing a foothold in production, though this is still limited. Indeed, a large proportion of the supply has been purchased from independent producers via an intermediary, the "Corredor", in contractual form since the early 2010s. During the summer Spanish packers process some of the Argentinean volumes shipped to the EU with a view to cost rationalisation and customer service ("category management").

Logistics

Logistics are exclusively by road for serving the European Union markets. Some volumes pass via the Saint Charles platform, near Perpignan in France. Nonetheless, most fruits are dispatched directly to the end customer. It takes approximately three days to reach the United Kingdom.

We are leaders in the **export of** **Fresh lemon**

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R&

Research & Development



R&D to grow our own plantations
R&D for the growth of our packing facilities
R&D to ensure the food safety of our products
R&D to improve our bio products

R&D pour cultiver nos propres vergers
R&D pour le développement et l'amélioration de nos unités de conditionnement
R&D pour assurer la totale sécurité alimentaire de nos produits
R&D pour améliorer nos produits biologiques

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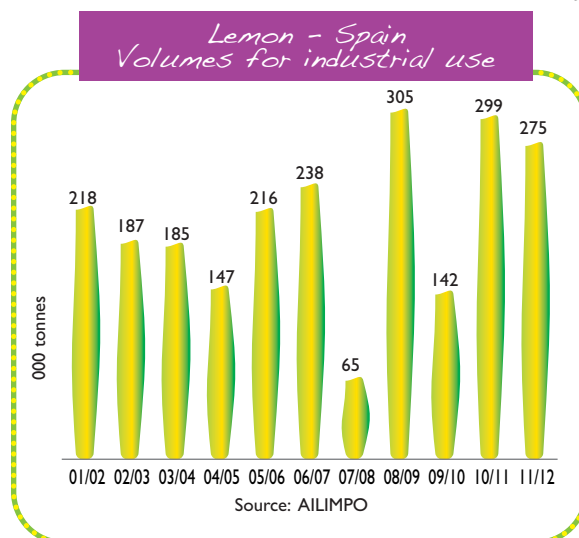
Lemons at their very best | Le meilleur du citron

INDUSTRY

Spain

Summary

- 211,000 tonnes of lemons processed per year
- World no. 3 processor



Although processing is not the primary role of the Spanish lemon industry, this country's industrial sector is among the world leaders. The volumes processed by this sector, with low upstream integration and profitability for producers, are irregular but high, between 200,000 and 300,000 t over the past few seasons, excluding weather vagaries. Despite the direct aid to processing granted by the European Union, the quantities processed have increased thanks to a booming international market. Sector professionals estimate Spanish production of concentrated juice at between 15,000 and 18,000 t, with that of essential oil at between 700 and 900 t. Unlike the fresh sector, the industry is controlled by a limited number of operators, with the leading five processing more than 50 % of volumes (25 % of which for the leading one alone). Spanish professionals are seeking to segment their range to withstand the highly competitive Argentinean derivatives (integrated industry benefitting from big economies of scale, and cheaper labour) and to better harness by-products such as peel. The development of direct supply to the processing units is another direction to work on, in order to produce higher added-value oil with no traces of post-harvest products.

Derivatives exports from Spain do not consist of just local production, but also re-exports, especially from Argentina. Essential oil exports, of a level between 400 and 500 t in a normal production year, are primarily aimed at other EU Member States (Western Europe) and at North America. Destinations are the same for concentrated juice, annual export volumes of which are approximately 14,000 to 16,000 t.



THE EUROPEAN LEMON PRODUCTS COMPANY



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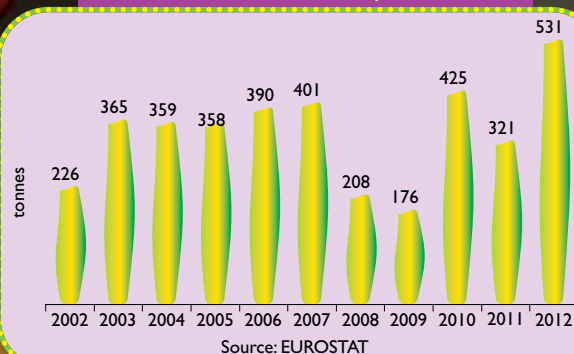
ORGANIC & NON ORGANIC PRODUCTS



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Lemon - Spain Essential oil exports

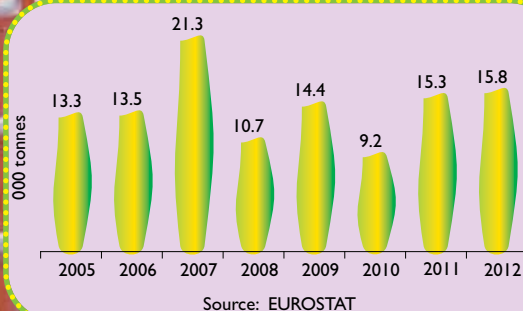


Lemon - Spain - Essential oil exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----------------------|------|------|------|------|------|------|
| EU | 255 | 197 | 112 | 134 | 234 | 179 |
| United States/Canada | 123 | 143 | 36 | 21 | 147 | 102 |
| Others | 13 | 61 | 61 | 22 | 45 | 40 |

Source: EUROSTAT

Lemon - Spain Concentrated juice exports



Lemon - Spain - Concentrated juice exports by destination

| Tonnes | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|--------------------|--------|--------|--------|-------|--------|-------|--------|--------|
| EU-27, Switzerland | 13 013 | 12 888 | 18 277 | 9 688 | 13 274 | 7 831 | 12 046 | 11 903 |
| Mediterranean | 54 | 310 | 2 185 | 575 | 777 | 992 | 1 647 | 2 801 |
| Japan | 158 | 138 | 108 | 152 | 118 | 181 | 181 | 336 |
| United States | 0 | 1 | 461 | 119 | 16 | 9 | 1 119 | 283 |
| Other Asia | 0 | 29 | 0 | 0 | 0 | 150 | 110 | 393 |
| Others | 51 | 110 | 242 | 155 | 243 | 30 | 180 | 79 |

Source: EUROSTAT

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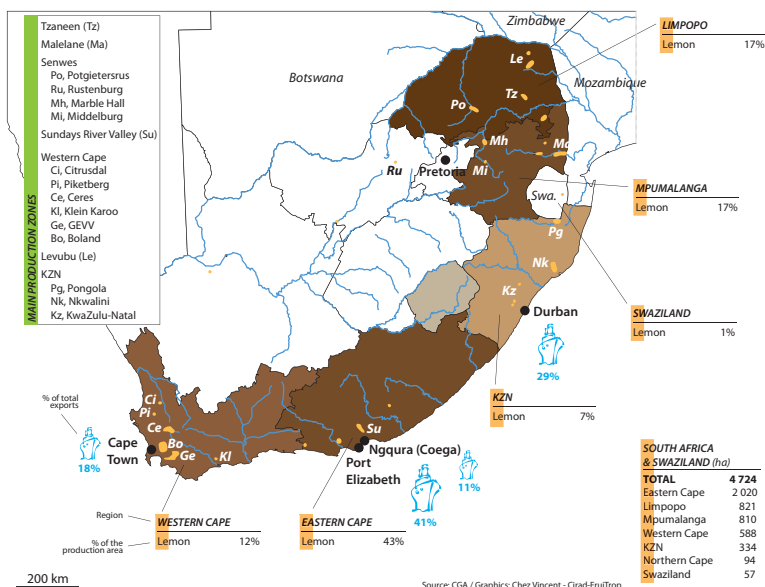
South Africa

THE world number four exporter of fresh lemons, with average volumes of approximately 150,000 t, South Africa is now one of the main players in world counter-seasonal trade. Renowned for the quality of their production, South African exporters have managed to gain a foothold on the main world markets (Western and Eastern Europe, Middle East and Asia). The industry is in development in the country's two big production centres, sometimes replacing other less lucrative citrus crops.



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PRODUCTION



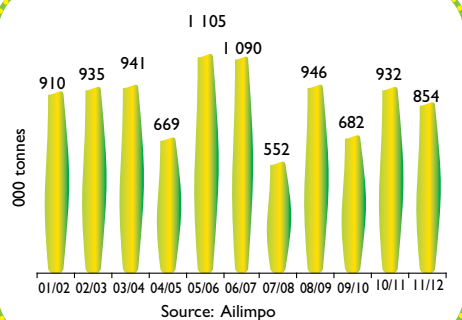
Production zones

The cultivation area, covering a total of just over 4700 ha in 2011, is divided into two climatically distinct regions. Approximately 55 % of the surface area is concentrated on the south coast, between Port Elizabeth and the Cape of Good Hope (Eastern Cape and Western Cape provinces). The heart of this traditional production zone is in the Sundays River valley north of Port Elizabeth. The Mediterranean climate makes for fruits with a good qualitative reputation (homogeneous sizes, and peel quality). Most of the rest of the production is concentrated in the more northern provinces, where the production calendar is earlier thanks to a tropical climate (Limpopo and Mpumalanga, which represent approximately one third of the surface area).



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Lemon - South Africa Production



Evolution of production

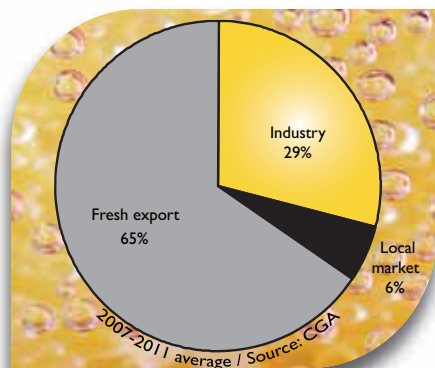
The South African industry started to really take off from the mid-1990s with the growth of a counter-seasonal fresh lemon market in Western Europe and the Middle East. Production, then approximately 60,000 t, rose to more than 200,000 t in the early 2000s, especially thanks to the planting of highly productive cultivars such as Eureka. Growth, very slow during the 2000s, seems to have recovered over the last few years, with

the harvest peaking in 2011 at nearly 260,000 t. Despite the local market still being underdeveloped, and relatively low economic returns from industry, the profitability of the sector has proven highly satisfactory these past few years thanks to fresh exports. Hence the downward trend in surface area has come to an end in Eastern Cape, while the cultivation area is expanding at a fairly high rate in the northern provinces (particularly Mpumalanga). The professionals believe that growth should continue in these two main centres over the years to come. However, the agricultural water quotas are restrictive, and the government policy aimed at improving the living standard of the black population (BEE) is a challenge. The highly structured industry funds several support bodies whose actions are coordinated by the CGA (Citrus Research International, Fresh Produce Exporter Forum).



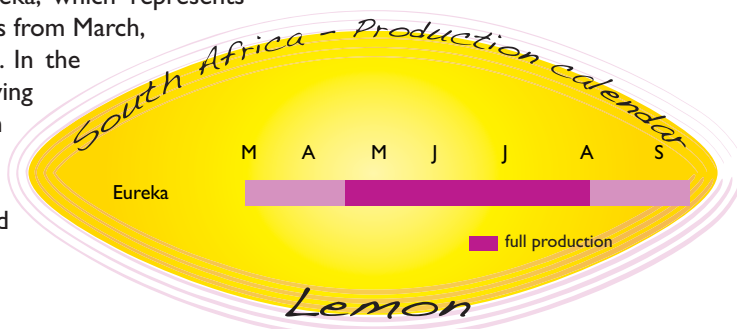
Breakdown of production by outlet

The South African industry is increasingly focused on a fresh market which has absorbed nearly two thirds of the country's production over the past few years, and which brings the producers the biggest economic return. Exports are the number one outlet, with annual volumes of around 145,000 t. The local market, though amounting to 50 million inhabitants, remains underdeveloped and accounts for just 12,000 t. The industrial sector absorbs significant volumes, but is just a way of making use of the rejects from sorting. Volumes processed have fluctuated between 50,000 and 80,000 t over the past few years.



Varieties and production calendar

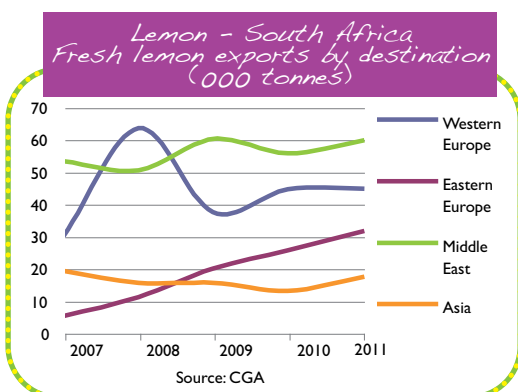
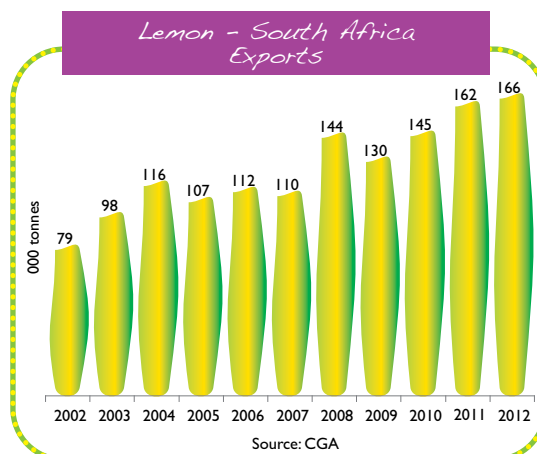
South African production is based primarily on Eureka, which represents nearly 85 % of cultivated surface area. The season starts from March, thanks to the early fruits from the northern regions. In the Sundays River region, four flowering periods of varying intensity mean that production can be staggered from April to September. Seedless varieties are under development, but technical mastery has not yet been fully achieved (low yields, high production costs, and sanitary problems).



FRESH EXPORTS

Summary

- World no. 4 exporter (145,000 t)
- Summer season



Exports first took off from the mid-1990s with the combined growth of counter-seasonal lemon demand from the Middle Eastern markets (United Arab Emirates and Saudi Arabia) and from Western Europe. Volumes, still limited at approximately 30,000 t, exceeded 100,000 t within a decade. Since the end of the 2000s, the East European markets have managed to give the industry another boost. The strong growth in shipments to Russia enabled overall exports to exceed 160,000 t in 2011. Asia (Hong Kong, Japan) is the number four market for South African lemons, absorbing volumes of between 15,000 and 20,000 t.

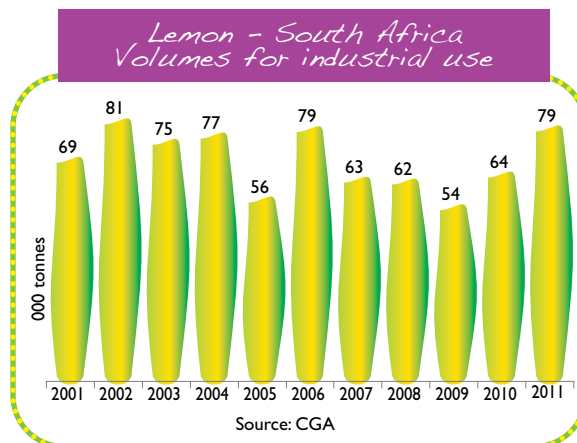


INDUSTRY

Summary

- 65,000 tonnes of lemons processed per year
- World no. 5 processor

The industrial sector only operates as a complement to the fresh export activity. It is still unprofitable for producers. The volumes processed, which have grown in step with production, have stabilised at a level of approximately 65,000 tonnes on average. Concentrated juice exports have grown steeply since the mid-2000s driven by American demand, and more recently demand from European customers. They were close to 9000 t in 2011. Essential oil exports are fairly stable at approximately 400 t/year. They are primarily aimed at the United States and Western Europe.





Lemon - South Africa - Essential oil exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----------------|------|------|------|------|------|------|
| United States | 156 | 217 | 253 | 123 | 182 | 221 |
| Western Europe | 68 | 71 | 88 | 129 | 280 | 129 |
| Africa | 0 | 1 | 1 | 1 | 2 | 4 |
| Other | 0 | - | 20 | 5 | 0 | 20 |

Source: COMTRADE



Lemon - South Africa - Concentrated juice exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----------------|------|-------|-------|-------|-------|-------|
| United States | 372 | 2 646 | 2 710 | 2 960 | 2 511 | 2 945 |
| Western Europe | 218 | 403 | 647 | 1 266 | 2 873 | 2 891 |
| Africa | 632 | 1 258 | 1 593 | 1 390 | 1 786 | 1 825 |
| Other | 617 | 193 | 422 | 754 | 701 | 870 |

Source: COMTRADE

Turkey

WITHIN the space of a decade, Turkey has become the world number three yellow lemon producer, and one of the main global trade players in this product during the winter season. Exporters, concentrated in the Mersin region in the south of the country, have been able to exploit their assets in terms of proximity, price competitiveness and trade organisation to take full advantage of the steep growth in demand for fresh lemon from the East European markets. In the face of increasing production costs and more profitable alternative crops such as small citruses, the cultivation area should not see any more significant growth over the next few years.



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PRODUCTION

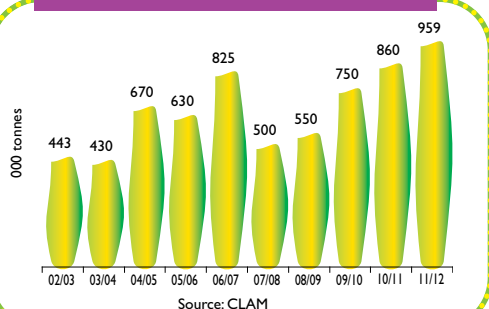
Production zones



The Mersin region in the south of the country packs in approximately 70 % of the cultivation area, which covered a total of 25,320 ha in 2010. The plantations are located on a narrow coastal strip approximately 60 km long, between Mersin and Silifke. The climate there is typically Mediterranean thanks to the protection provided by the Taurus Mountains from the influences of the northern cold. Water availability is relatively high (average rainfall of approximately 600 to 700 mm), and winters are milder and less frost-prone than in neighbouring zones. The zone further north, between Mersin and Adana, contains a significant share of the cultivation area. These regions, colder and more frost-prone, are specialised in growing Interdonato, an early harvest variety. Under urban development pressure, lemon plantations are tending to move away from the Mediterranean coast, and be concentrated further inland (pioneering excavated terrace cultivation, on the first foothills of the Taurus Mountains). The rest of the plantations are concentrated in the Antalya region (around Antalya and Alanya), and on the Aegean coast between Izmir and Mugla. There are also some orchards in the Hatay region.

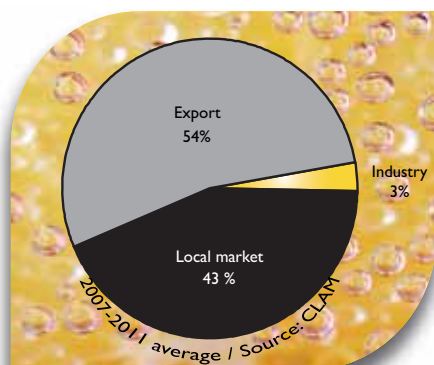


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Lemon - Turkey
ProductionEvolution
of production

Growth of production of this traditional crop was very gradual until the late 1990s, when the harvest fluctuated between 350,000 and 400,000 t. From that time, growth accelerated considerably, with the boom in demand from the local market and above all from Eastern Europe. The decade of growth that followed, punctuated by fairly frequent frost episodes, enabled production to

exceed 950,000 t in 2011-12. This trend should slow down considerably over the next few years. The planting rate is now limited, with a slight expansion of the surface area in the traditional zone on the Aegean coast and in the Dörtöl region on the Syrian border. Citrus growers are favouring the more profitable small citruses (Satsuma, W. Murcott), especially in a context of steeply rising production costs (from 0.45 TL/kg in 2008 to 0.58 TL/kg in 2012, according to Mustafa Kemal University), largely due to the increase in labour costs. The sector is highly fragmented and unstructured, with producers' organisations at present only exercising little power. Farms are generally very small in size (on average less than 1 ha) and with a low technical level on the coastal strip, where producers also work other crops (market gardening, temperate fruits). The technical level is higher and orchard size bigger in the north of Mersin. The main sanitary problems are mal secco, *Phytophthora* and mites.

Breakdown
of production by outlet

Nearly all production is aimed at the fresh market, with exports absorbing most of the volumes. The local market is able to sell the large grade fruits, more difficult to export. It has grown considerably over the past few years thanks to a growing population which reached 75 million inhabitants in 2012. The rise in revenue also enabled a consumption increase of more than 1 kg/inhabitant in 15 years. The industrial sector is still in its infancy, absorbing less than 5 % of production. As such, processing units not specialised in citrus have appeared in the Adana, Mersin, Izmir and Istanbul regions over the past few years, to keep up with growing local demand for lemon derivative products (lemon juice and lemonade).

Varieties and production calendar

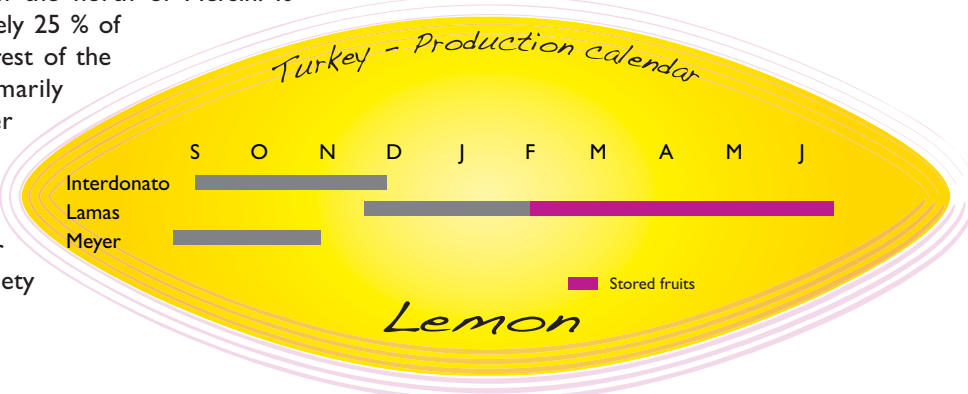


Production comprises approximately 60 % Kütdiken and its clones, chief among which is Lamas. The harvest, derived from a single flowering period, must be collected before the harshest part of winter (frost risk). However, marketing extends until August, thanks to fruit storage in natural caves in the Urgup region. Interdonato, an early variety harvested before winter, is primarily planted in the most frost-exposed zones, in the north of Mersin. It

represents approximately 25 % of total production. The rest of the cultivation area primarily

comprises the Meyer

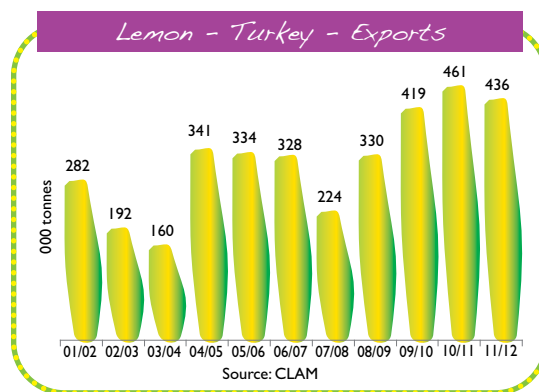
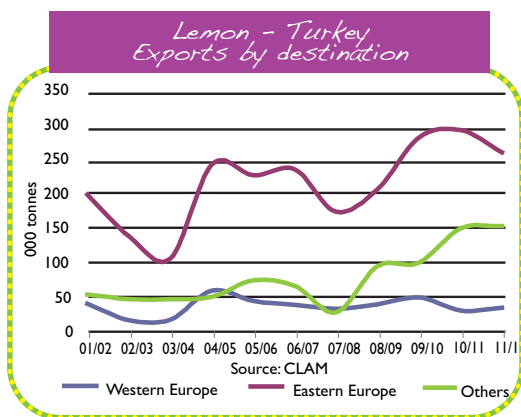
lemon, sold locally and exported to certain markets for its early availability. We can list some other cultivars such as Molla Mehmet or "Italien Memeli", and a seedless variety derived from local research.



FRESH EXPORTS

Summary

- World no. 2 exporter (422,000 t)
- Winter season



Since the second half of the 1990s, exports have taken off, rising from 120,000-130,000 t to approximately 470,000 t over the past few seasons, enabling this source to be among the two main world fresh lemon exporters, along with Spain. Turkish professionals have been able to take advantage of the strong growth in demand from East European countries, thanks to their geographic proximity and downstream integration, enabling them in particular to secure payments on these sensitive markets. The countries in this zone, chiefly Russia and Ukraine, have absorbed between 40 and 50 % of total exports over the past few years. Turkish professionals have very considerably strengthened their presence in the Eastern EU countries, at which approximately 20 % of volumes are aimed (especially Romania, Poland, Bulgaria and the Czech Republic). The proportion of shipments to the Middle East is tending to grow very considerably, approaching 30 % in 2011, in particular thanks to growing low-price fresh lemon demand from Iraq, the number two market in the zone behind Saudi Arabia. Western Europe, where quality and traceability requirements are higher, is only a secondary outlet, primarily worked between the end of the summer season and the start of the Spanish season. Barring rare exceptions, exporters do not have their own orchard, and procure on a contract or spot basis from independent producers. The export industry is supported by Government incentive measures, which have been stepped up over the past few years. It is represented internationally by AKIB, the fruit and vegetables coordinator of the Exporters Union.

Logistics

Fruits intended for Russia and Ukraine are first transported by road to the Black Sea ports (Sinop, Zonguldak, Bartın). They are then loaded onto ships bound for Novorossiysk (Russia), Odessa or Ilichevsk (Ukraine). The average transit time to these two countries is six days. The other Eastern and Central European countries are served by road logistics (Bulgaria, Romania, Hungary, Slovakia, Poland and the Baltic States). Fruits for the Western EU are also mostly exported by road. There are several routes, via Central Europe or Italy. The average transit time is six days. Purely shipping logistics concerns just 20 % of volumes. The fruits are loaded in the ports of Mersin and Iskenderun, and shipped to the Mediterranean ports (Marseille), or more commonly the British ports (Thamesport, Sheerness) or North European ports (Antwerp, Rotterdam). The transit time to the latter destination is approximately 16 days.



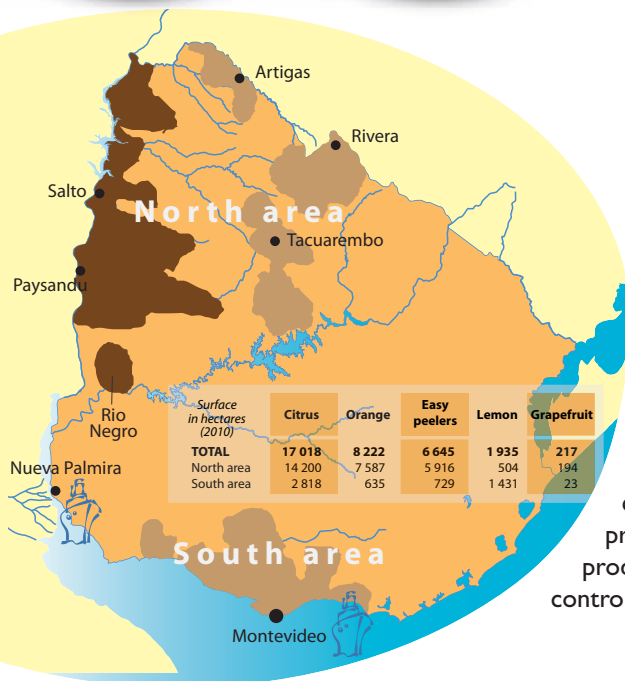
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Uruguay

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WITH a harvest stabilised at approximately 40,000 t over the past few years, Uruguay is among the world's top twelve producers. Weakened by the arrival of citrus canker and successive devaluations of the peso, the industry has lost ground on the world fresh lemon market, and now aims most of its production at the industrial sector. The possible recovery of a planting trend, with the prospect of the opening of access to the United States market in 2013 and the implementation of a strategic plan, should be of more benefit to small citruses and oranges than to lemons.

PRODUCTION



Production zones

80 % of the cultivation area, which in total amounts to approximately 2000 ha, is packed along the south coast of the country, in the regions to the east and west of Montevideo (departments of San José, Montevideo, Canelones and Maldonado). The country's main citrus growing zone, in the north-west along the River Uruguay in the departments of Salto and Paysandu, with a warmer and wetter climate, contains only approximately 20 % of the citrus farms. Small traditional production facilities with a low technical level provide most of the production. They coexist alongside a limited number of large plantations which control most of the volumes, while medium-sized facilities are few in number.

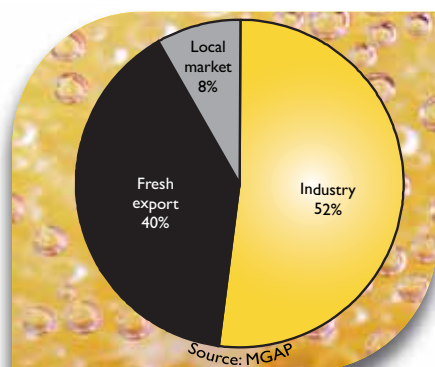
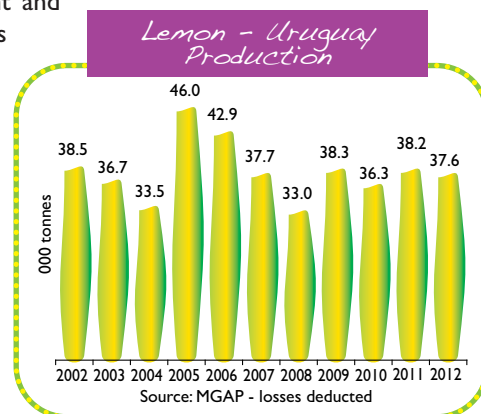
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Evolution of production

Uruguayan citrus growing exports started to take off in the 1960s with foreign investors setting up in the north of the country. The plantations, then aimed at supplying the local market, saw rapid growth during the 1970s and 1980s, leading to a quintupling of lemon production, which peaked at more than 50,000 t in 1987. However, the arrival of citrus canker in 1986, as well as successive devaluations of the Uruguayan peso (1982 and 2002) and the high dependence on the European market, resulted in a steep fall in profitability. For lack of investment and active support from the State, with little connection to the sector, the citrus



growing industry lost part of its international competitiveness, and wilted. The lemon orchards surface area, in excess of 4500 ha in 1980, had fallen to less than 1600 ha in 1996. A slight recovery occurred in the last decade, enabling production to maintain a level of approximately 40,000 t over the past few years. The implementation of a strategic plan to revive the industry and the likely opening of access to the United States market in 2013 could revitalise the citrus growing sector. However, planted areas are not expected to grow very significantly.



Breakdown of production by outlet

Industry, which is the leading outlet, absorbs approximately 50 % of production, with annual quantities of nearly 20,000 t over the past few years. Most of the volumes aimed at the fresh market are exported. The local market is small, with the national population numbering just 3.5 million.

Varieties and production calendar

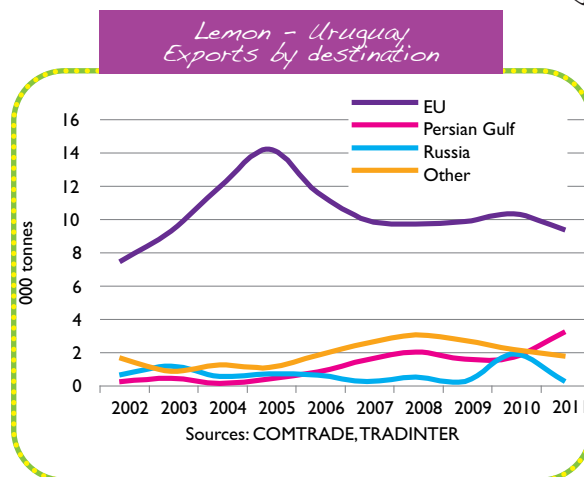
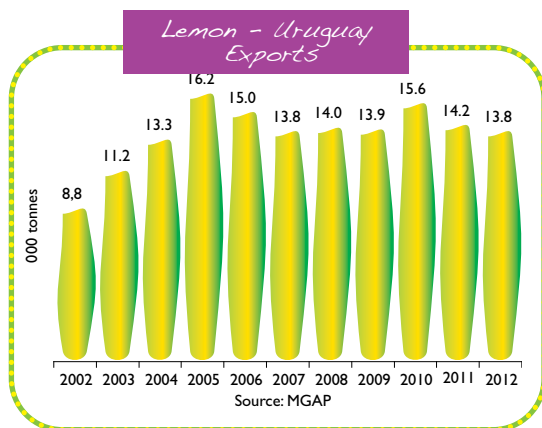
Lisbon, locally known as “Criollo” or “comun”, represents most of production. Eureka lemons supplement the volumes and enable production to be spread year round, thanks to their multiple flowering. A local seedless variety is also cultivated: Ana Claudia.



FRESH EXPORTS

Summary

- World no. 9 exporter (14,600 t)



Exports grew steeply from the early 1970s to the mid-1990s, boosted by growth of the counter-seasonal market in Europe. Volumes exceeded 25,000 t in 1995. During the next extremely difficult decade, exports fell below the 10,000 t mark. Lacking competitiveness, Uruguay saw its market share on the European market struggle against the rise of Argentina and South Africa. Furthermore,

exporters were unable to diversify their outlets because of the closure of the United States market for sanitary reasons, access difficulties to neighbouring Brazil and low penetration of the Asian markets. Shipments have stabilised

at approximately 15,000 t over the past few seasons. The European Union still absorbs approximately two-thirds of volumes. The major entry points are the South European ports (Italy, Spain, Portugal) and the Netherlands. The remainder is primarily aimed at Russia. Some shipments are also made to the Persian Gulf and Brazil. The sector is concentrated among a few very large operators. Four companies share three quarters of exports. They are generally highly integrated with the upstream industry, and possess their own production. More than mere exporters, these operators are very often among the country's leading industrial groups.



| Main shipping lines | | | Shipping time | Observations |
|---------------------|----------------|--------------|---------------|--------------|
| Markets | Departure port | Arrival port | | |
| EU | Montevideo | Rotterdam | 22 to 23 days | Maersk |
| | Montevideo | Antwerp | 27 to 28 days | Maersk |
| | Montevideo | Algeciras | 17 days | Maersk |

Lemon - Uruguay - Exports by company and by destination in 2010.

| Tonnes | EU | Asia | Eastern Europe | Brazil | Other | Total |
|---------------------------|--------|-------|----------------|--------|-------|--------|
| TERMINAL FRUTERA SA | 2 517 | 798 | 328 | 7 | 580 | 4 229 |
| AGRISUR CARL | 2 186 | 314 | 96 | 382 | 128 | 3 106 |
| CITRICOLA SALTEÑA SA | 1 516 | 60 | 771 | 27 | | 2 374 |
| AZUCITRUS SA | 1 380 | 222 | 220 | 35 | 65 | 1 921 |
| EL REPECHO SA | 324 | 484 | 360 | | | 1 167 |
| FORTICO SA | 665 | | | | | 665 |
| RAUDIN SA | 373 | 74 | 50 | 82 | | 579 |
| NETINOR SA | 326 | | 51 | 41 | | 418 |
| DON RUFINO SRL | 389 | | | | | 389 |
| ARBOLEDA CITRUS URUG. SRL | 217 | | | | | 217 |
| RAFELIR SA | | | | 135 | | 135 |
| DE SOUZA FERREIRA ANTENOR | 57 | 24 | 24 | | | 105 |
| VIRGILI CARABALLO ORLANDO | 87 | | | | | 87 |
| MIELESUR SA | 84 | | | | | 84 |
| LEGAFOX SA | 60 | | | | | 60 |
| NITRAX SA | 24 | | | | | 24 |
| SANDUPAY SA | 5 | | | | | 5 |
| LAGUNA BRILLANTE SA | 2 | | | | | 2 |
| PERENNE SA | | | | | 2 | 2 |
| NOREPLEND SA | 0.1 | | | | | 0 |
| Total | 10 210 | 1 975 | 1 899 | 709 | 775 | 15 568 |

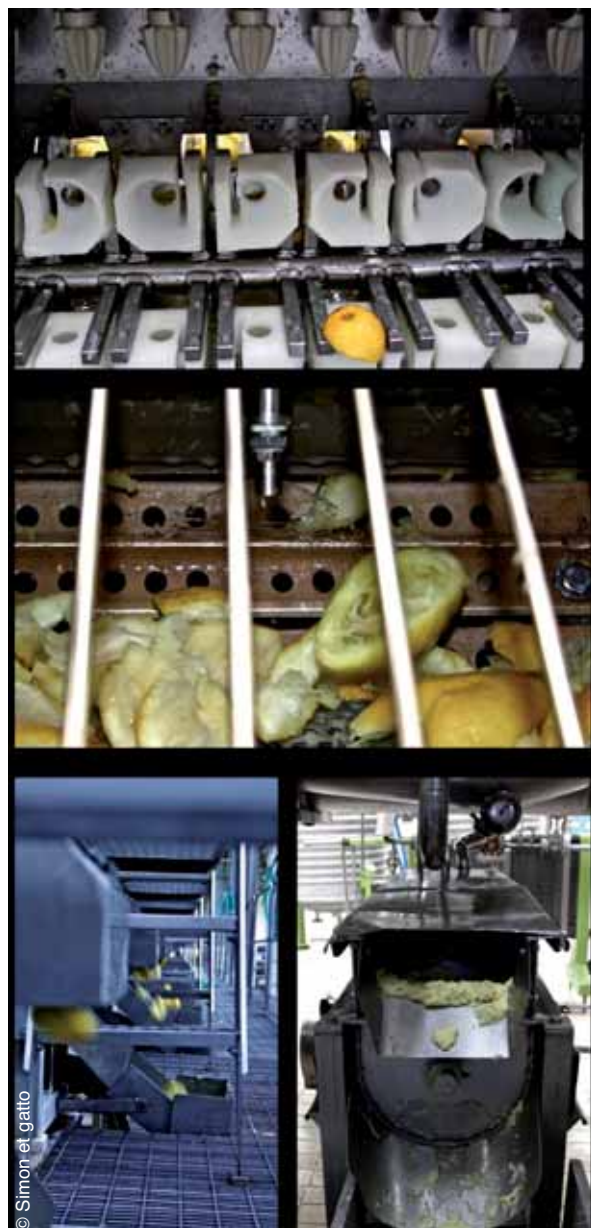
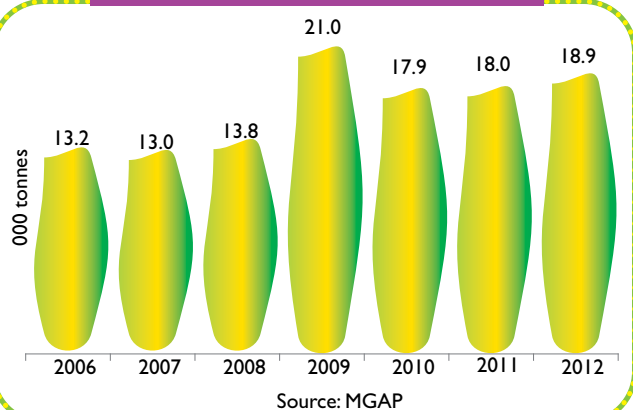
Source: TRADINTER

INDUSTRY

Summary

- 19,000 tonnes of lemons processed per year
- Production: 1,200 t of concentrated juice, 80 t of essential oil

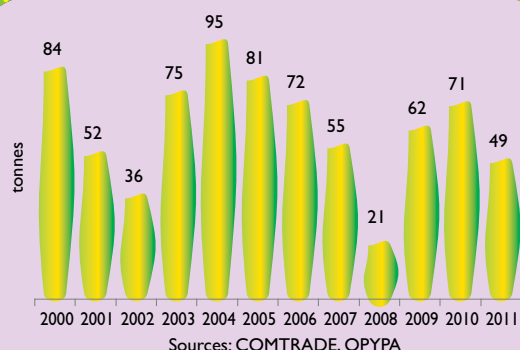
Lemon - Uruguay
Volumes for industrial use



Uruguay remains a relatively minor player on the derivatives market. However, volumes have grown over the past few years, boosted by the price recovery. The industrial sector now absorbs nearly half of production, as opposed to approximately one third in 2006-07. Over the past few years, concentrated juice production has been approximately 1000 t, and that of essential oil approximately 55 to 60 t. Most of these volumes were intended for export (United States, EU and Argentina for essential oil and juice). The industrial sector is concentrated among a few large-scale operators. These companies are generally highly integrated with the upstream industry, and possess their own production.



Lemon - Uruguay Essential oil exports

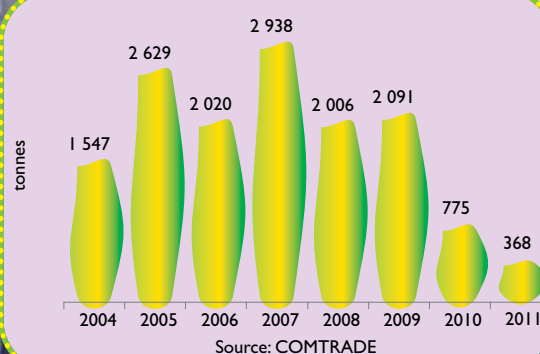


Lemon - Uruguay - Essential oil exports by destination

| Tonnes | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|--------------------------|------|------|------|------|------|------|
| Argentina, other | | | | | | |
| Latin American countries | 12 | 55 | 19 | 4 | 0 | 37 |
| EU | 37 | 13 | 25 | 27 | 20 | 13 |
| USA | 46 | 12 | 27 | 16 | 0 | 12 |
| Other | 0 | 0 | 0 | 8 | 0 | 0 |

Source : COMTRADE

Lemon - Uruguay - Concentrated juice exports



Lemon - Uruguay - Juice exports by destination

| Tonnes | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|--------------------------|------|-------|-------|-------|-------|-------|
| EU | 721 | 1 630 | 1 136 | 685 | 390 | 1 085 |
| Israel | 790 | 673 | 525 | 1 422 | 1 276 | 755 |
| United States | 0 | 0 | 53 | 97 | 262 | 233 |
| Argentina, other | | | | | | |
| Latin American countries | 0 | 169 | 280 | 594 | 28 | 18 |
| Other | 36 | 156 | 26 | 141 | 50 | 0 |

Source: COMTRADE

United-States

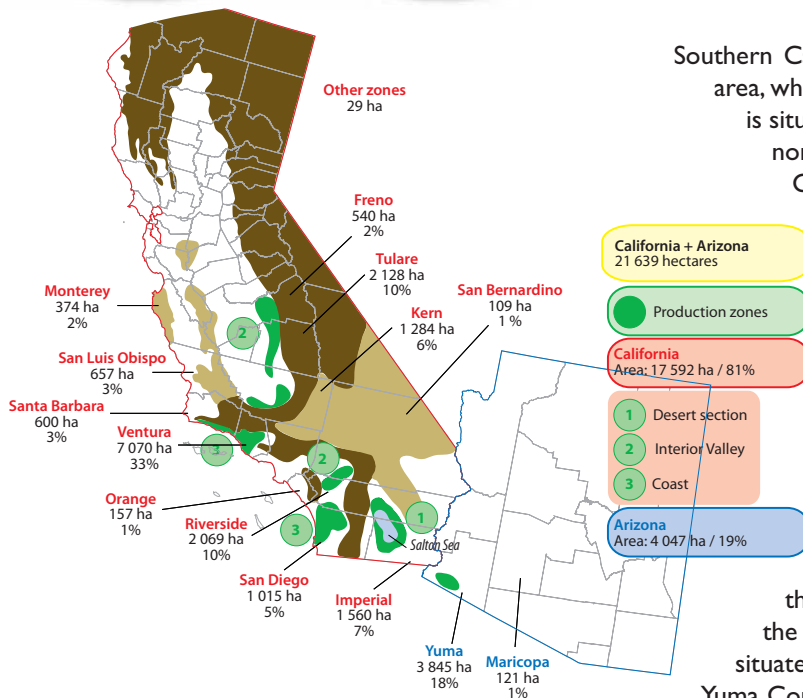
THE USA occupies the position of the world's number four lemon producer, with a harvest stabilised at approximately 800,000 t per year, concentrated in the west of the country. Most of the volumes are aimed at the local market, which amounts to more than 300 million inhabitants with high consumption levels. While the United States plays a major role in international trade of derivative products, fresh lemon exports have fallen significantly, to below 100,000 t. Despite a fairly satisfactory profitability level, the cultivation area has stopped expanding because of real estate pressure and the cost and lack of certain production factors (water and labour).



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PRODUCTION

Production zones



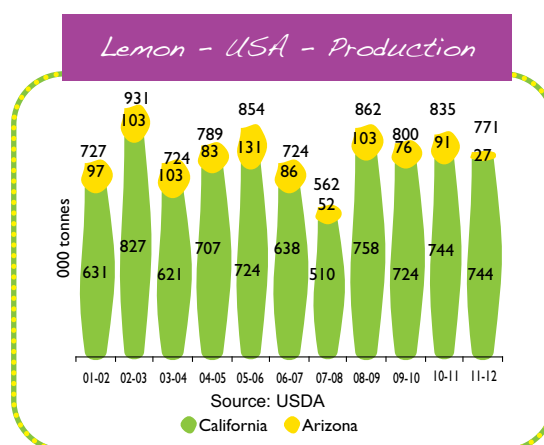
Southern California packs in approximately 80% of the US cultivation area, which covers a total area of 22,200 ha. 45% of the surface area is situated on the coast, in the zone between San Luis Obispo and north Los Angeles, and further south around San Diego. Ventura County, to the north of Los Angeles, is the heart of American lemon production, with more than 30 % of the cultivation area. The Californian coastline has a mild climate favourable for this crop. Its rainfall level is generous, though irrigation is required. The inland valley is the other main Californian production centre, and represents 25 % of the American cultivation area (Tulare County and Kern County in the south of the central zone, and Riverside County further south). The desert zone of Imperial County represents the remainder of Californian production. According to the 2007 survey, more than half of farms had a surface area of less than or equal to 2 ha. However, productivity is very high thanks to the possibility of taking up to three harvests a year. Arizona is the country's other big lemon production centre. The orchards situated in the south-west in Maricopa County and in particular Yuma County represent 20 % of the country's total surface area. The proportion of small farms is lower than in California, though productivity is also very considerably lower.



Evolution of production

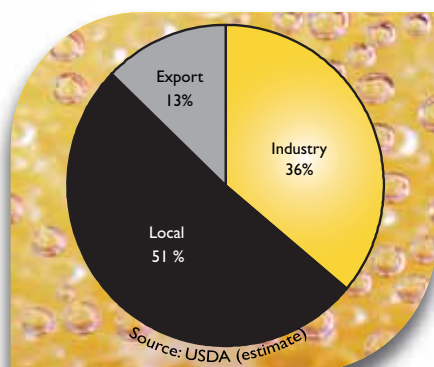
Californian citrus growing really took off in the late 19th Century, thanks to the growth of trade enabled by the rail network. After seeing considerable growth in the 1960s, production peaked at approximately 850,000 t in the 1980s. Since the 1990s, volumes have stabilised at an average of 800,000 t/year, though prone to weather vagaries in this region of significant frost risks. However, the surface area is on a downward trend in both California and Arizona. Profitability remains satisfactory, but production costs, already very high, are tending to increase (direct production costs

and harvesting costs reached 15,000 USD/ha in 2010 according to the University of California). Water and labour are two increasingly problematic production factors, both in terms of cost and availability, especially in the inland valley. Furthermore, the price of land is particularly high in California, where urban pressure is very high. The invasion of Palm Beach County in California by greening in March 2012 is an additional constraint, which leads us to conclude that production should at best hold up over the coming years.



© J.-C. Lorente

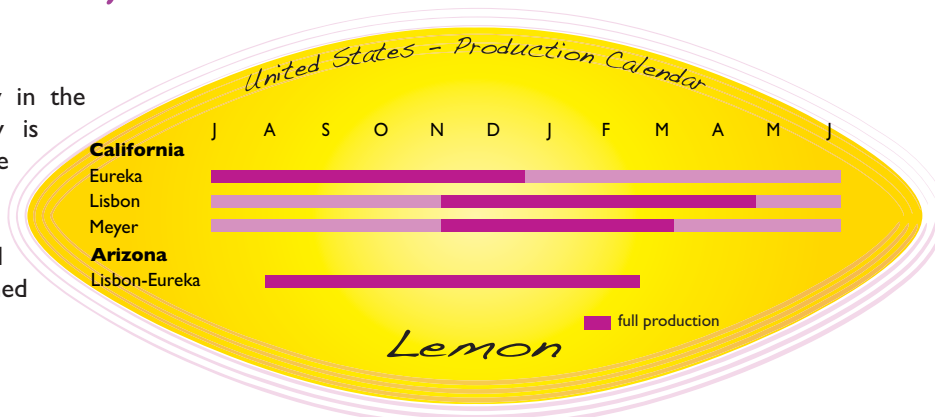
Breakdown of production by outlet



Approximately three-quarters of American production are aimed at the local market, which amounts to no fewer than 313 million inhabitants. Consumption per inhabitant is still among the highest in the world, with an average level of 1.7 to 1.8 kg/year. Imports of approximately 40,000 to 50,000 t per year, primarily from Mexico and Chile, supplement the supply chain. The industrial sector is also a big outlet, which has absorbed volumes of between 300,000 and 350,000 t over the past few years. Fresh lemon exports are only in third position, and have represented approximately 90,000 t over the past few seasons.

Varieties and production calendar

Eureka remains dominant, particularly in the coastal zone, although its popularity is tending to wane in favour of Lisbon. The latter variety, more productive and cold-resistant, has a big presence in the inland valley, the San Joaquin region and the desert zone. Meyer is also established in California.

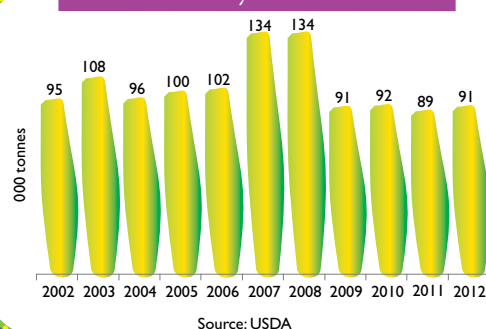


FRESH EXPORTS

Summary

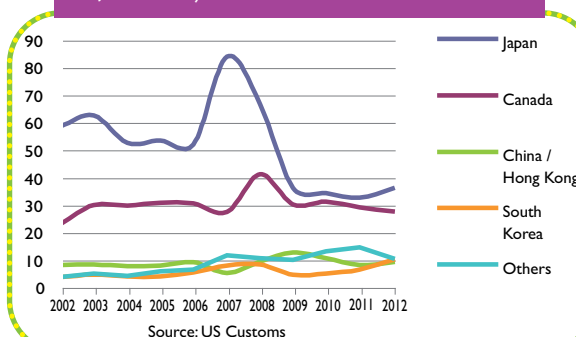
- World no. 5 exporter (105,000 t)
- Winter season
- Consumption markets:
Japan (37 %), Canada (33 %)

Lemon - United States Exports



American lemon exports saw a considerable boom in the 1970s, reaching their maximum level of 236,000 t in 1977-1978. The trend reversed in the early 1980s, with the gradual closure of the European market due to the rise of Mediterranean competition. Exported volumes fell steeply by nearly 100,000 t. The trend has been for slow decline since the mid-1980s. Exportations were approximately 90,000 to 100,000 t in the early 2010s. Approximately 70 % of shipments are aimed at Canada and Japan, where the United States has comparative advantages in terms of logistics, and is practically the sole supplier during the winter season. While shipments to Canada are still stable, shipments to Japan are following the declining trend for yellow lemon consumption. The other markets, primarily in Asia (South Korea, China) and Oceania (Australia), are absorbing moderate and stable volumes. Sunkist, an iconic citrus growing cooperative of the American West, remains a major player in the industry, both in export and local distribution, with a turnover of more than 1 billion USD in 2011, and approximately 300,000 t of fresh lemons sold.

Lemon - United States Exports by destination (000 tonnes)



| Main shipping lines | | | Shipping time | Observations |
|---------------------|-----------------|------------------------------------|---------------|--------------|
| Markets | Departure port | Arrival port | | |
| Japan | Los Angeles | Yokohama | 15 to 18 days | Maersk |
| | Los Angeles | Kobe | 17 to 19 days | SL |
| Australia | Los Angeles | Sydney | 23 to 24 days | CMA CGM, JPO |
| China | Los Angeles | Shanghai | 28 to 29 days | Maersk |
| EU | Houston (Texas) | Rotterdam, Felixstowe, Bremerhaven | 15 to 16 days | Sea Land |

Logistics

Lemons are transported to Japan by sea from the port of Los Angeles. Canada is served by road.

INDUSTRY

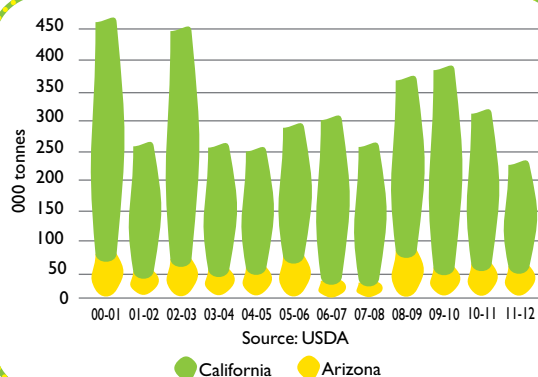
Summary

- 250,000 to 300,000 tonnes of lemons processed per year
- World no.2 processor (18 %)



© R. Domergue

Lemon - United States
Volumes for industrial use

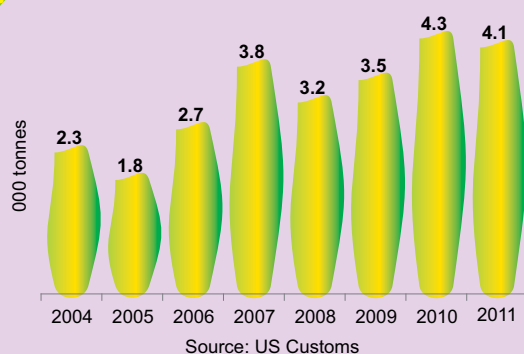


The industrial sector is a particularly big outlet, which absorbs on average between 30 and 40 % of production, i.e. 250,000 to 300,000 t. Its share actually exceeded 40 % between 2008 and 2010 because of the very high price levels of derivatives. Despite the production share dedicated to derivative products being lower than in Arizona, California processes 85 % of the country's industrialised volumes, thanks to its large production base. The country is among the world's leading importers and exporters of derivative products. Essential oil

exports have followed an upward price curve since 2005, peaking at 2500 t in 2007. They have stabilised at 1500 t since 2009, and are still mainly aimed at Western Europe and Asia. The upward trend has remained in place for concentrates since the mid-2000s. Volumes, primarily aimed at Canada and Asia (Japan, South Korea and Hong Kong), have been in excess of 4 million litres since 2010.



Lemon - United States Concentrated juice exports

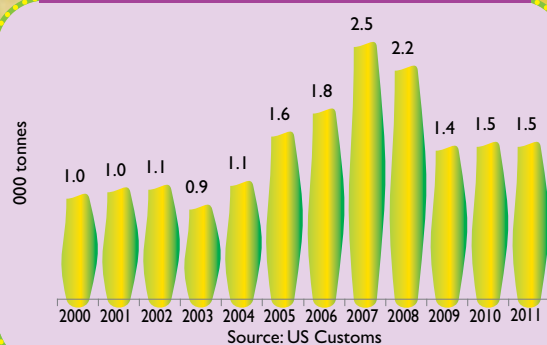


Lemon - United States - Juice exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|-------------|-------|-------|-------|-------|-------|-------|
| Canada | 1 285 | 1 604 | 1 579 | 1 810 | 2 895 | 2 648 |
| Japan | 400 | 861 | 401 | 909 | 732 | 668 |
| Other Asian | 582 | 815 | 576 | 185 | 176 | 532 |
| Middle East | 201 | 368 | 355 | 225 | 140 | 81 |
| Others | 224 | 128 | 246 | 414 | 315 | 174 |

Source: COMTRADE

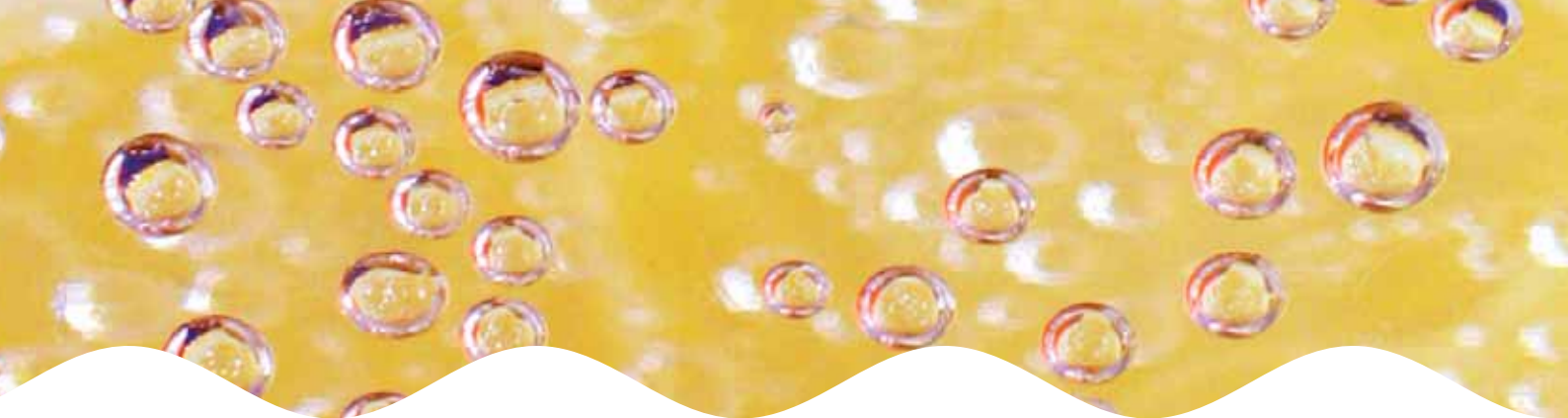
Lemon - United States Essential oil exports



Lemon - United States - Essential oil exports by destination

| Tonnes | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|-------------|------|-------|------|------|------|------|
| EU | 633 | 1 057 | 896 | 557 | 480 | 543 |
| Japan | 423 | 295 | 327 | 178 | 250 | 349 |
| Other Asian | 195 | 269 | 224 | 219 | 273 | 286 |
| Canada | 379 | 445 | 419 | 232 | 173 | 143 |
| Others | 178 | 385 | 356 | 256 | 305 | 162 |

Source: US Customs



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POST-HARVEST

The lemon is a non-climacteric fruit, and so must be harvested when mature. It is generally its grading that determines the cutting point, regardless of its coloration and internal qualities. The characteristic yellow colour of the lemon is not always a good indicator, since under certain climate conditions, green to greenish fruits may have reached internal maturity. They can be kept in long-term storage, for up to six months. Over a reasonable period, this operation may improve the internal qualities (juice content) and external qualities (epidermis appearance) of the fruit (curing). According to European regulations, the juice content, expressed as percentage by weight, must reach at least 20 %. Fruits harvested too late are less rich in juice, and lose their aroma.

The skin is thick, with the outer part comprising a waxy exocarp (flavedo), and lined on the inside with a spongy mesocarp (albedo). This provides good protection against damage during harvesting and desiccation during storage. The physiological development of the fruits after harvesting is relatively slow. Hence provided that the harvesting, packing and transport are performed under appropriate conditions, the lemon is a robust fruit with a long storage life, varying from several weeks to nearly six months. After prolonged storage, the fruit acidity decreases due to its respiration, and it becomes insipid. The storage temperatures are 10 to 14°C, according to the varieties and production regions. Below 10°C, the lemon is highly sensitive to chilling injury. Fungal attacks are the main source of post-harvest fruit deterioration. They only become visible when it is too late to take action. Development of these diseases is managed by means of the cleanliness of the plots, the care taken in the harvesting and the handling of the fruits, the integration of prophylactic measures during packing, and using suitable fungicides at the packing station.

Packing

There are numerous types of packing station, incorporating various technologies and requiring more or less labour. They are generally organised based on the same system, which can be outlined as follows. Upon arrival at the packing station, an initial sort is performed to separate all the non-grade or visibly damaged fruits, and eliminate the plant debris. The fruits are then washed with soapy water, or water plus a detergent. At this stage, it is preferable to avoid immersing the fruits in tanks, as this process promotes the dis-



semination of fungal spores and fruit contamination. The lemons are then rinsed, brushed and dried. A second sort is then performed to eliminate all fruits with signs of deterioration (injuries and bruises, insect holing, apparent fungal or physiological diseases). They then undergo fungicide treatment, followed by waxing, and are then glossed. After that, they are graded and packed. All of these operations must be performed with care, to avoid injuring the fruit skin, as any injury is a doorway for fungal infections. If the fruits are turgescent (picked in wet weather), they must be dried after washing, to slightly dehydrate the fruits. Turgescence makes lemons more sensitive, especially to bursting of the

essential oil glands in the skin, which causes spots on the epidermis, oleocellosis. Furthermore, surface moisture promotes the development of pathogenic fungi.

Anti-fungal treatment must be applied as quickly as possible after harvesting. Besides use of chemical fungicide, soaking in hot water (50-53°C for 2 to 3 minutes) or dipping in hot water (55°C for 20 to 30 seconds) ensures good surface disinfection. Lower temperatures (35-38°C) would also appear to be effective against certain fungi such as *Penicillium* and *Botrytis*. Waxing is used to replace the natural wax in the skin, which is broken down by washing and brushing. As well as protecting the epidermis from minor injuries, it also reduces fruit dehydration during the storage phase. Certain waxes can also alter the respiratory exchange of the fruits, and affect their storage and chilling injury resistance. An anti-fungal treatment is sometimes incorporated in the wax, thereby replacing the anti-fungal treatment. According to the type of wax used, hot air blast-drying may either follow waxing (aqueous phase wax) or precede it (wax in a non-aqueous solvent). In this second scenario, the fruits will be air blast-dried again at ambient temperature after waxing, since they must enter the packing boxes dry.

Inside the packing stations, the “no post-harvest treatment” lemon sector and organic lemon sector require the installation of specific lines, where fungicidal treatments are not applied, alongside the conventional lines.

The characteristic yellow coloration of lemons is the result of depigmentation of the epidermis, which happens only when temperatures are below 13°C. Within the tropics and at certain times of year in Mediterranean climates (particularly the early autumn), the absence of a temperature fall limits or even inhibits the disappearance of chlorophyll pigments. The fruits remain green to greenish upon maturity. In this case, a degreening treatment is sometimes applied. Ripe fruits are exposed to ethylene (1-10 ppm) for one to three days at between 20 and 25°C. This treatment is accompanied by faster ageing of the skin, and higher fruit sensitivity to pathogen attacks. Besides the packing operations, the packing station must be regularly cleaned and disinfected, in order to limit sources of fungal inoculation into the fruits. The practice of de-greening is widely employed at the start of the season to supply the various consumption markets, and secure decent sale prices.

Grading concordance/number of fruit by box.

Professional sources

| Grade | Diameter (mm) | Argentina | | | | Spain | | | Turkey | | South Africa | |
|-------|---------------|-----------|---------|-------|-------|---------|-------|-------|---------|-------|--------------|---------|
| | | 18 kg | 15 kg | 10 kg | 6 kg | 15 kg | 10 kg | 6 kg | 15 kg | 10kg | 7,5 kg | 15 kg |
| 1 | 72-83 | | | | | 60 | | | 60 | | 32 | 64 |
| 2 | 68-78 | 80 | 64 | | 27 | 72 | | 30 | 72 | 45 | 36/40 | 75 |
| 3 | 63-72 | 88/100 | 72/80 | 48/54 | 32/36 | 84 | 48/54 | 35/40 | 84 | 54 | 45 | 88/100 |
| 4 | 58-67 | 113/138 | 88/113 | 63/75 | 45/50 | 100/120 | 63/75 | 45/50 | 100/120 | 60/72 | 55 | 113 |
| 5 | 53-62 | 150/162 | 125/138 | 83/93 | 55/60 | 140/160 | 83/93 | 55/60 | 140/160 | 80 | 72/81 | 138/162 |
| 6 | 48-57 | 180/198 | 150/162 | 102 | | 180/210 | 102 | | 180/210 | | 90/108 | 189/216 |
| 7 | 45-52 | | | | | | | | | | | |



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In Europe, the lemon is governed by the specific citrus marketing standard. This stipulates a minimum juice content of 20 % and a minimum grade size of 45 mm. It also sets out the correspondence between each grade and the diameters of fruits marketed in the European Union. Grade differences between products in the same package are permitted, but to a limited degree. The most frequent packages are



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shown in the table below. 18 kg telescopic boxes or bushels are particularly commonly used by South American exporters (Argentina, Uruguay). A large part of this merchandise is then repacked in Europe in packing stations handling Mediterranean production during the winter season, for the purpose of “category management”. However, shipments of smaller packages from these sources have been on the rise for the past few years (1-row compartmented trays, 6 kg-packages or even girsac bags, net bags or packets).

Storage

Once they have been packed, the fruits must be transferred to a cooler. By slowing down the respiratory exchange and transpiration, the temperature reduction slows down tissue ageing and dehydration of the fruits. It also reduces the development of certain micro-organisms. This fall is limited by the sensitivity of lemons to chilling injury, which occurs at around 10°C. Nevertheless, storage between 0 and 10°C is possible, but for periods of less than one month.

Of all citruses, the lemon is the fruit with the greatest storage potential. In practice, according to the variety and the fruit maturity development, the storage temperatures are between 10 and 14°C, with a relative humidity of between 85 and 95 % to minimise weight loss. Air is regularly renewed to prevent any accumulation of CO₂ and ethylene, which would cause the appearance of bad flavour; ageing of the epidermis and increased rotting. The storage life is highly dependent on the epidermis coloration: the greener the epidermis, the greater its storage potential (up to 6 months). The table below shows the storage life of lemons according to their epidermis colour.

Lemon – California – Recommended storage life according to state of fruit maturity

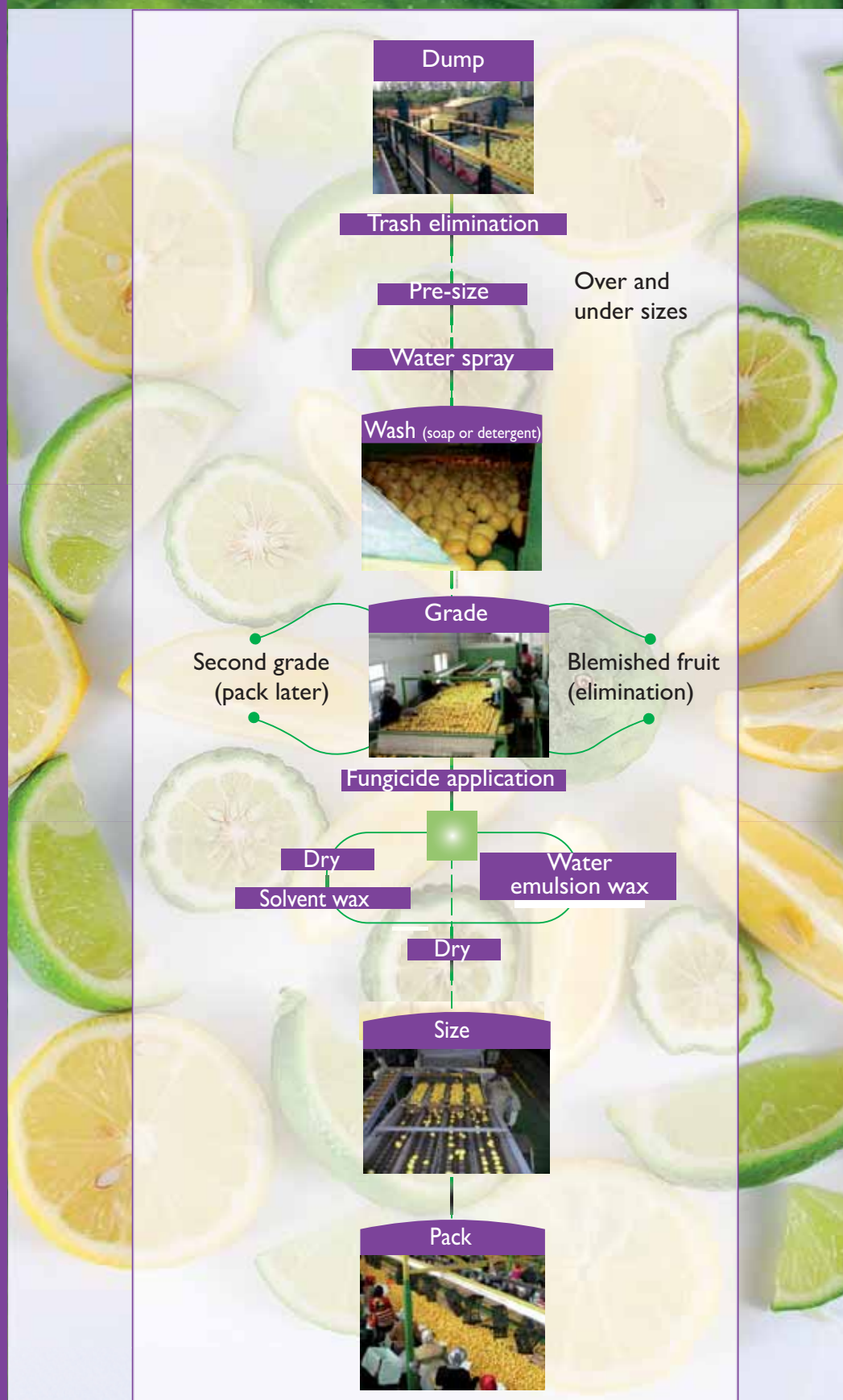
| Epidermis colour | Storage Temperature | Storage life |
|--------------------|---------------------|---------------|
| Dark green | 12 to 14.5°C | 3 to 6 months |
| Light green | 12 to 14.5°C | 2 to 4 months |
| Slightly yellowish | 12 to 14°C | 1 to 2 months |
| Jaune | 12 to 14°C | 3 to 4 weeks |

According to “Les agrumes”, J.-C Praloran, 1971



© Eric Imbert

LEMON — A basic packingline layout after Grierson et al., 1978)





CURING

Lemons are harvested primarily taking into account their grade, regardless of their external coloration or their internal quality. A sort performed on epidermis colour enables homogeneous batches to be put together. During prolonged storage under optimum conditions, the lemon undergoes a sort of curing process, which often proves beneficial in terms of its quality:

- progressive appearance of yellow coloration of epidermis,
- significant increase in juice content (up to + 16 %) and acid content (up to + 24 %),
- thinner skin,
- firmer epidermis, making it less sensitive to post-harvest fungal attacks.

This ability has been used in certain citrus growing regions to manage the marketing flows using modern equipment, such as in California, or natural cave systems as in Turkey.

CONTROLLED ATMOSPHERE

A controlled atmosphere of 5-10 % O₂ and 0-10 % CO₂ can delay fruit senescence, and in particular the loss of the epidermis green colour. The rarefaction of oxygen and accumulation of CO₂ can cause the formation of necrosis spots on the surface, incipient fermentation and the development of undesirable aromas.

Major fruit alterations to be monitored

The lemon is a robust fruit, and alterations detected during preparation upon arrival are fairly rare, provided that packing is performed correctly. From the importers' viewpoint, the lemon is not a problematic fruit. Below is a recap of the major lemon alterations which must be constantly monitored, particularly chilling injury, and *Penicillium* or *Geotrichum* spots.

CHILLING INJURY

The appearance of this symptom may result from a cold chain malfunction during the fruit packing and storage. The causes of these disruptions can be revealed by a quick diagnostic. The first symptoms appear after several days' exposure to temperatures below the fruit's tolerance threshold (generally 10°C for the lemon). Small indented brown spots, sometimes surrounded by a lighter halo, appear on the epidermis.



They are distributed at random, and some may join together and take on a reddish colour. The essence glands may also burst, causing small brown necroses. The fruit's tolerance threshold depends on the variety, but also on its development conditions on the tree (soil, nutrition, and climate). Sensitivity to chilling injury varies according to the production area, the seasons and degree of fruit maturity. Lemons harvested late will be less sensitive than those harvested at the start of the season. A slight hydric stress occurring before harvest may also

reduce fruit sensitivity to low temperatures. Drying before packing appears to reduce fruit sensitivity. Waxing is another way of reducing the sensitivity of lemons to chilling injury.



GREEN ROT AND BLUE ROT



These two rots remain the main source of post-harvest lemon deterioration. As soon as the harvest conditions become unfavourable (rain) or the fruits are packed while still slightly damp, this fungus will appear. However, the damage remains minor and localised if packing is performed correctly.

These rots are caused by fungi: *Penicillium digitatum* (green rot) and *Penicillium italicum* (blue rot). *Penicillium digitatum* is an injury parasitic fungus. The

risk of contamination in the orchard is minor, and most infections occur in the post-harvest phase. The symptoms are highly characteristic: the affected area of the epidermis becomes lighter and then softens, and a fine white mycelium extends out in a circular shape. The centre of this spot is covered with green spores. Gradually, the whole of the fruit is covered. At the start of the infection, the lemon adopts an undesirable flavour. The spores are rapidly carried by air, and contaminate the neighbouring injured fruits. *Penicillium italicum* can attack an intact epidermis just as well as injured fruit. Hence it is more serious than *Penicillium digitatum*. The symptoms are similar, except that the spores are blue.

Fruit contamination occurs by air or directly through contact. Green rot and blue rot can coexist on the same fruit, with blue rot appearing after green rot. They are managed through use of curative and preventive fungicides. Since these rots readily develop resistances to fungicides, it is essential to arrange alternation in the fungicide molecules used. They are also managed by means of maintaining the sanitary condition of the whole post-harvest chain as far as the consumer, the care taken in packing to prevent contamination of healthy fruits, and the absence of surface moisture on fruits (rain, dew, washing) that would promoting rot development

BITTER ROT

This rot is caused by a soil fungus which can parasite on fruit injuries: *Geotrichum citri aurantii*. Contamination can occur in the field, when fruits fall from the tree, or during storage when the fruits come into contact with the earth particles soiling the harvest boxes. Mature fruits are the most vulnerable. The first symptoms are similar to those of *Penicillium*: softening of the fruit, and development of a milky white mycelium. The epidermis, partitions and juice vesicles are completely broken down. The undesirable odour released, associated with the advanced stages of rotting, attracts drosophilae (vinegar flies), which spread the disease from fruit to fruit during storage. Post-harvest treatment based on sodium ortho-phenylphenate enables partial control of disease development. The storage of the fruits at low temperatures may also delay the appearance of the symptoms. Bitter rot is frequently associated with green and blue rot.



Other less common alterations

BLACK ROT *ALTERNARIA CITRI*



BROWN ROT *PHYTOPHTHORA*



OLEOCELLOSIS



PETECA (IN-STORAGE ALTERATION, SMALL EPIDERMAL NECROSES)





LEMON JUICE MANUFACTURE AND BY-PRODUCT PRODUCTION

THE industrial sector, through which a quarter of world lemon production is sold, is concentrated in a few sources such as Argentina, Spain, California, Italy and South Africa. The volumes processed, between 1.5 and 2 million tonnes per year, are used for making lemon derivatives, chief among which are plain juices, concentrated juices (approx. 110,000 t per year), and essential oil (approx. 7000 t per year). The by-products from extraction can also be used (pulp, peel, pips and membranes).

The process

Upon arrival at the processing factory, the lemons are unloaded and then used immediately or stored in silos. After being fed under water spray ramps, the fruits are sorted, most often by hand. They are washed in order to eliminate waste, sand, leaves, and also pesticides. The sorting operation is used to remove damaged, injured or rotten fruits that could alter the quality of the products obtained when processing is complete. The fruits are then divided according to their diameter in the grading stage. This is the most important part of the process, since it determines the quality and yield of extraction. The grading process arranges the fruits so that each is placed into an extractor suitable for its size. There are two main modes of citrus juice extraction, which are named after the companies that developed these processes: FMC (Food Machinery Corporation) and Brown. The FMC method presses the citrus vertically with metal cups, whereas the Brown extractor is more similar to traditional citrus presses (fruit cut in half and pressed horizontally). Another extraction process, the sfumatrice, may also be used. The operating principles of these devices are described in the inset below. At this stage, the main by-products are recovered: essential oil, ground peels, pips and membranes.

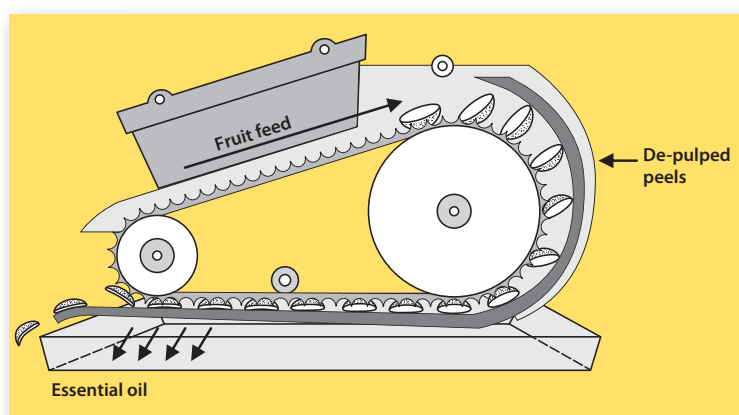
After extraction, the lemon juice has a high pulp content. The refining (or “finishing”) stage separates the juice from the pulp. The finishers will strain this pulpy juice and separate the coarse pulps and other undesirable parts (fibres, pips, etc.). Centrifuging is applied to reduce the fine pulp content. The elimination of the coarser pulp reduces the viscosity of the juice, thereby helping meet consumer expectations. The

manufacture of concentrated juice requires two additional stages: concentration by evaporation, followed by freezing.

Once extracted, the essential oil is kept in stainless steel tanks maintained at between -5°C and -25°C . The temperature decrease causes insoluble particles to precipitate out, so that a clear product is obtained after separation. These insoluble particles primarily comprise waxes. Essential oils can be concentrated by deterpenation (reducing the proportion of non-oxygenated terpene compounds such as limonene, which is less useful in terms of aroma).

The ground peels (as well as the pips and membranes) are recovered, and can then be dehydrated using large dryers. Some of their constituents, especially pectins, are indeed particularly sought after by the food and pharmaceutical industries.

Processed juice extractors



"Special" Sfumatrice, model GR

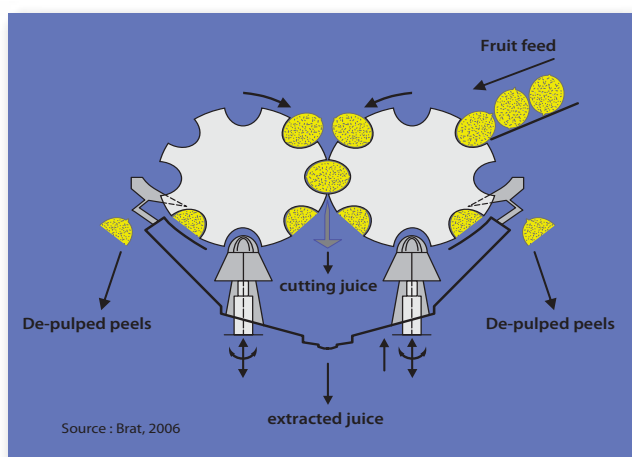
SPECIAL SFUMATRICE / INDELICATO

The sfumatrice can recover essential oil after extracting the juice, from half-fruits. The peels, carried on a moving chain, are folded and then pressed against a fixed ribbed horizontal plate, to rupture the oil-bearing sacs. Surface water jets are used to collect the oil contained in the peel. The water-oil emulsion is then centrifuged. The most recent sfumatrice are capable of processing more than 100,000 lemons a day. This process is very common in Italy (Sicily).

BROWN EXTRACTOR

The Brown extractor recovers the essential oil before the juice, using so-called "pelatrice" peeling machines. Toothed rollers are used to extract the essential oil contained in the fruit peel. The oil-bearing glands are pierced by little blades, releasing the essential oil into a water flow. The emulsion formed is then centrifuged.

The peeled lemons are then cut in half, and then pressed using two perforated half-spheres, one concave and the other convex. The operating principle of the extractor is similar to that of the traditional citrus press. The extracted juice is then transported to the collector.



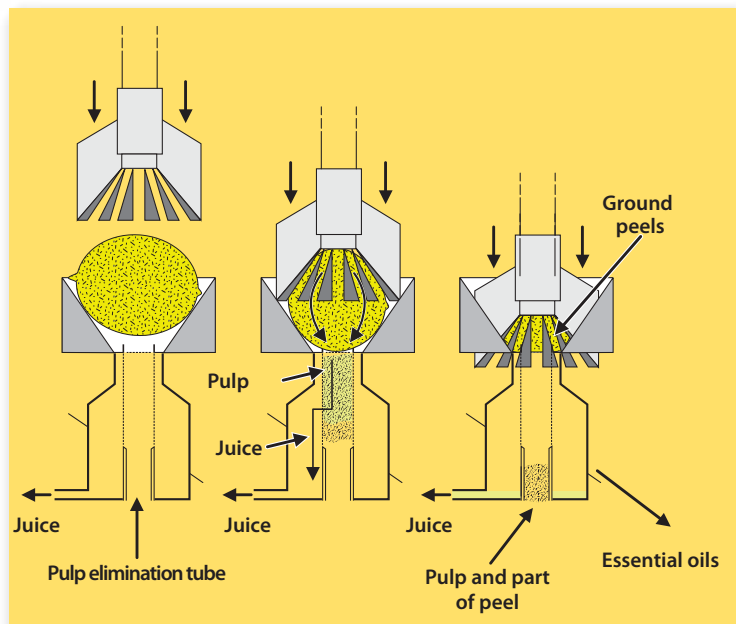
FMC extractor

FMC EXTRACTOR

The FMC method has the particular feature of being able to extract the juice and essential oil at practically the same time, without contact between them.

This technique is based on applying mechanical pressure to the walls of the fruit, fixed in the extractor by two cups with metal fingers. The juice is extracted using a tube inserted at the base of the fruit, and then transported to the collector. A surface water jet is used to collect the essential oil contained in the fruit peel. The water-oil emulsion is then separated by centrifuging. The ground peels are then recovered, and the pulped juice is refined.

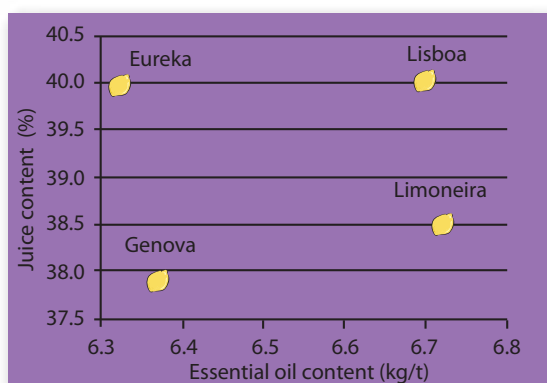
Juice and oil yields are generally higher than with other methods. FMC extraction is now the most widespread method.



FMC Extractor. Source: Brat, 200

YIELD

The juice and essential oil content varies according to the lemon variety. Cultivars generally have a profile aimed at one or other of these outlets. The Lisbon and Eureka varieties, with a juice content of nearly 40 %, have a considerable advantage for manufacturers in terms of yield. The variety Limoneira 8A is the richest in essential oil; its content is on average 15 to 20 % greater than that of other lemon varieties. The extraction technique used also greatly affects the juice and oil yield (see inset about extractors). On average, 65 % of the oil present in the peel is recovered (an estimated 5.5 kg of essential oil is contained in a tonne of Primofiori variety lemons). Essential oil yields are extremely variable between countries: they can vary from 0.35 for South Africa and Italy to 0.5 for Argentina.



Source: Navarro, 2009.



Plain juice and concentrated juice

SOME DEFINITIONS

Juices and fruit nectars are governed by several national and international regulatory texts, which define the various categories of fruit juice¹. The table below reiterates the definitions of the three main types of juice made from lemon: plain juice, concentrated juice and reconstituted juice. In the case of citruses, the juice must come from the endocarp. The pips, seeds and skin are not normally part of the juice. Aromas, pulps and cells obtained from fruits of the same species may be re-used in the various types of fruit juice (plain, concentrated and reconstituted).



Main types of juice made from lemon.

| Juice type | Definitions |
|---------------------|--|
| Plain juice | Fermentable but non-fermented product obtained from edible parts of healthy and ripe fruits, fresh or stored by refrigeration or freezing, of one species or several mixed species, with the colour, aroma and taste characteristics of the juice of the fruits of origin. |
| Concentrated juice | Product obtained from juice of fruits of one or more fruit species, through physical elimination of a specific proportion of the constituent water. If the product is intended for direct consumption, elimination is at least 50 % of the constituent water. |
| Reconstituted juice | Product obtained through reconstitution of concentrated fruit juice, using drinking water |

Source: European Directive 2012/12/EU

Particularities of lemon juice

DEGREE BRIX OR GPL?

Although degree Brix is generally used to characterise the various types of juice, acid weight is preferred in the case of the lemon and lime. Degree Brix determines the content of soluble particles present in the medium (sugars, organic acids, alcohols, etc.). It is frequently likened to the sugar content of the product: i.e. one degree Brix corresponds to one gram of sucrose per 100 g of liquid solution. Since lemon juice contains a high percentage of organic acids, the concentrations are determined by the weight of anhydrous citric acid (ACA) per litre of juice, or GPL (grams per litre). GPL values are determined from the degrees Brix. Most lemon juices are concentrated to 400 or 500 +/- 5 GPL. The minimum soluble solids content for lemon juice reconstituted from a concentrate is 8 °Brix (Directive 2012/12/EU).

CLOUDY OR CLEAR JUICE?

Juice cloudiness is due to the suspension of insoluble particles in the liquid solution. The composition of citrus cloudiness may be estimated as follows: 30 % proteins, 20 % hesperidin, 10 to 15 % cellulose and hemicellulose, and 5 % pectins. All of these constituents come from the content of the juice vesicles, as well as the fruit internal membranes. Centrifuging is used to eliminate these insoluble particles and thereby reduce the juice viscosity.

¹ Decree No.2010/1041 (French Law), European Directive 2012/12/EU, Codex general standard for juices and fruit nectars (CODEX STAN 247/2005)

Essential oil

Essential oils form in the plant cell, and build up in the various plant organs - fruit pericarps, leaves, flower petals –from where they are extracted by cold squeezing or distillation. Lemon essential oil is primarily contained in the fruit pericarp (flavedo). It is generally extracted by cold squeezing, a mechanical process which ruptures the oil-bearing sacs in the pericarp. It is the main aromatic product extracted from lemons. Professionals also recover aromatic essences from condensation of the evaporation water released during the juice concentration stage.



Composition

The composition of a lemon essential oil varies according to the varieties used, the age of the lemon trees cultivated, the type of orchard soil, and the climate conditions. Therefore the growing location, the seasons and weather vagaries have a particular influence on the oil composition. Furthermore, the extraction technique used also influences composition. Citrus essential oils are complex mixtures comprising more than 200 compounds, grouped into non-volatile and volatile fractions. The table below gives the contents of the main constituent volatile compounds of the Primofiori lemon essential oil. Volatile compounds are highly predominant. They are present mainly in the form of terpenes (90 % monoterpenes and sesquiterpenes), plus a small quantity of aldehydes (4 %), alcohols (4 %) and esters (0.4 %). Limonene is the predominant monoterpene (66 % of the oil). The large presence of aldehydes (including neral and geranial), compounds sensitive to oxidation and heat, can explain why lemon essential oils are extracted by cold squeezing rather than distillation. Non-volatile compounds (coumarins, psoralens) are also present, at 2 %. They act as natural antioxidants, and stabilise the oil during storage.

Main volatile compounds of a lemon essential oil (Primofiori variety, in %).

| Terpenes | 90.13 | Aldehydes | 4.30 | Alcohols | 4.18 | Esters | 0.35 |
|-----------------------|--------------|---------------|------|-------------------------------|-------------|---------------------|------|
| Monoterpenes | 89.17 | Geranial | 2.90 | Geraniol | 1.70 | Geranyl acetate | 0.32 |
| Limonene | 66.23 | Neral | 1.13 | Nerol | 1.07 | Citronellyl acetate | 0.03 |
| β-pinene | 8.97 | Citronellal | 0.10 | α-Terpineol | 0.63 | | |
| γ-terpinene | 8.07 | Nonanal | 0.07 | Linalool | 0.26 | | |
| α-pinene | 1.53 | Decanal | 0.04 | β-Citronellol | 0.19 | | |
| Sabinene | 1.52 | Dodecanal | 0.03 | Terpinen-4-ol | 0.13 | | |
| β-myrcene | 1.45 | Octanal | 0.02 | Cis-Sabinenehydrate | 0.07 | | |
| α-Terpinolene | 0.38 | (E)-2-Hexenal | 0.01 | Sesquiterpene alcohols | 0.13 | | |
| α-thujene | 0.33 | | | Camphene | 0.05 | | |
| β-phellandrene | 0.28 | | | α-Bisabolol | 0.05 | | |
| α-terpinene | 0.17 | | | (E)-Nerolidol | 0.03 | | |
| (E)-β-Ocimene | 0.09 | | | | | | |
| p-Cymene | 0.07 | | | | | | |
| (Z)-β-Ocimene | 0.06 | | | | | | |
| l.8-Cineole | 0.02 | | | | | | |
| Sesquiterpenes | 0.96 | | | | | | |
| trans-α-Bergamotene | 0.52 | | | | | | |
| β-Caryophyllene | 0.33 | | | | | | |
| cis-α-Bergamotene | 0.08 | | | | | | |
| α-Humulene | 0.03 | | | | | | |

Source : Brat et al., 2001.



Quality

The quality of a lemon essential oil depends on three main factors:

CITRAL CONCENTRATION (ALDEHYDE)

This is by far the most important factor in determining the quality of a lemon essential oil, and therefore its price. Citral (association of neral and geranial) gives the oil its aromas and particular scent. The best oils comprise on average 4 to 5 % citral.

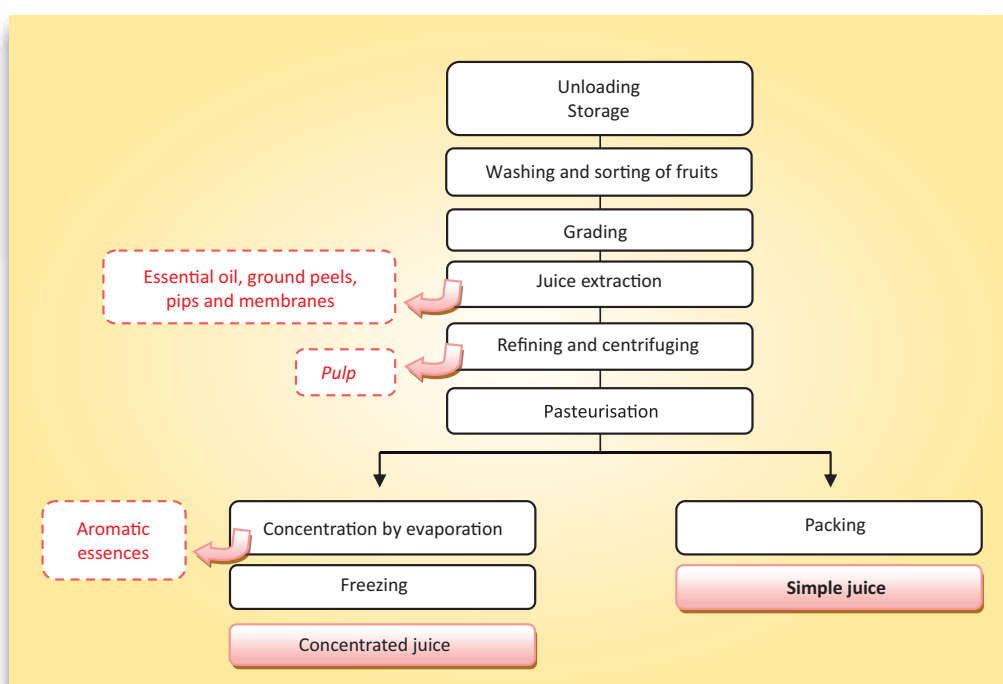
EXTRACTION PROCESS USED

Sfumatrici appear to be able to produce optimum quality essential oils (minimised contact between essence and albedo). Pelatrice machines, with their more drastic action, generally produce less intense aromatic profiles: other compounds are recovered in the extraction process.

FRUIT QUALITY

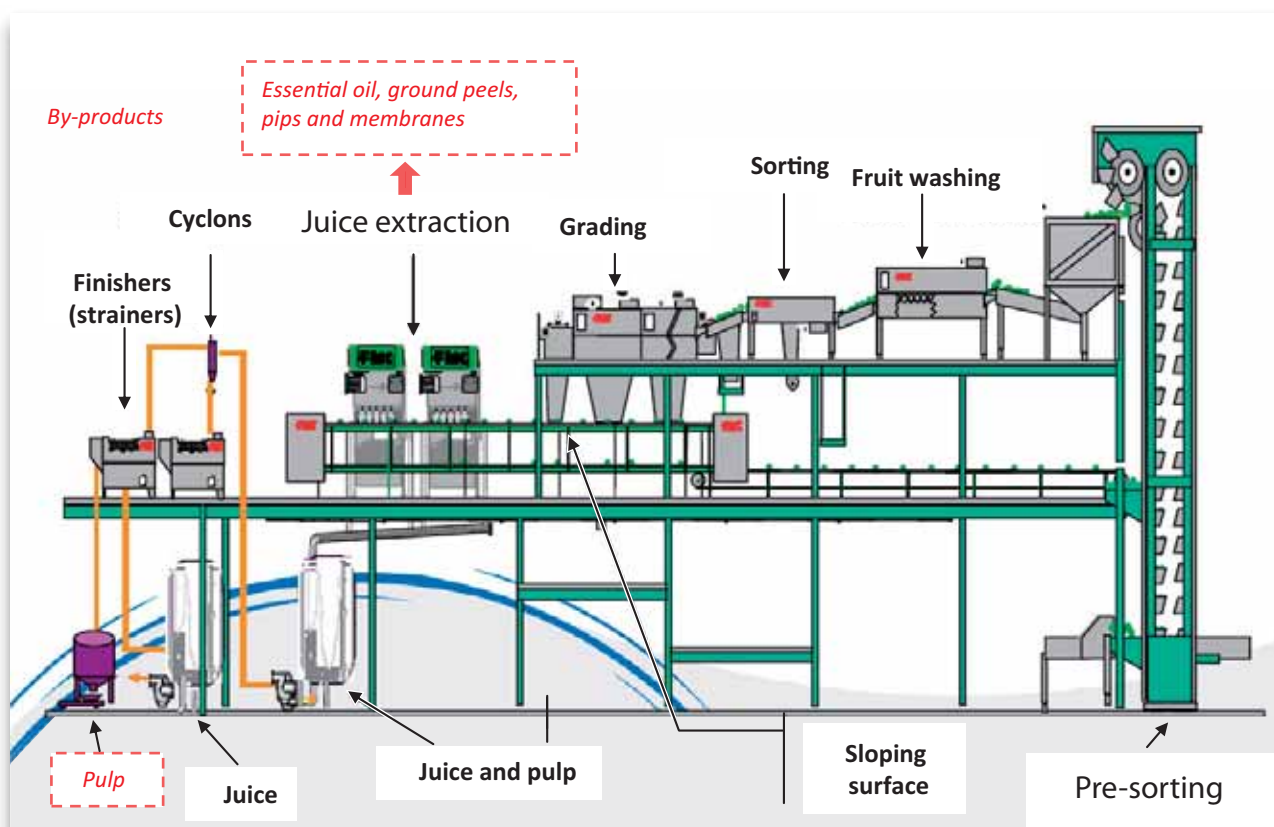
The variety and degree of maturity are important criteria. So the harvest timing is crucial: the lemon must be harvested green/yellow in order to provide a quality essential oil.

The absence of pesticide traces has also become a crucial commercial challenge. The current trend in countries specialising in the fresh lemon trade is to process fruits arriving directly from the field, rather than from packing chains. The advantages are not just qualitative but also quantitative, since the extraction yield is higher: the storage conditions, combined with multiple handling operations, reduce the turgor of the essential oil glands and the juice sacs.



Lemon juice manufacturing process (plain and concentrated), and by-product production.

Sources: Berlinet, 2006; Braddock, 1999



Initial processing of lemon: juice extraction (FMC method), and by-product production

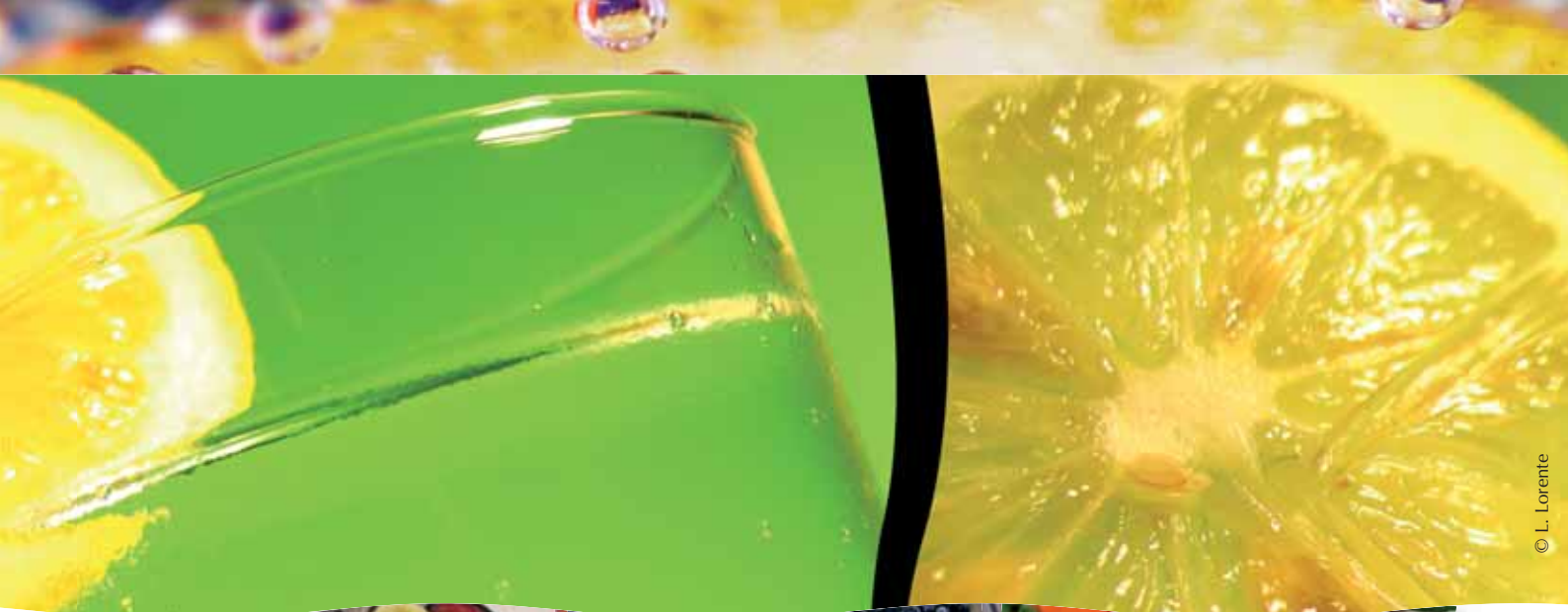
Sources: Braddock, 1999; JBT, 2012.

Substitution and fraud

Practically all the components of a lemon essential oil can be obtained individually on the market at prices well below those of natural substances derived from the lemon. These compounds are synthesised, or extracted naturally from less expensive plants. By way of example, citral can be extracted from other plants such as aromatic litsea (*Litsea cubeba*) or lemon grass. In order to minimise costs, many companies manufacture fake products, by topping up pure essential oil with other natural or synthetic molecules.

Peels and membranes

Peels and membranes are the main by-products after extracting the juice and essential oil. They can be used in hydrated or dehydrated form. The particularity of citrus peels, and especially lemon peels, lies in their pectins content, of approximately 30 %. The albedo is their main source. However they are not systematically dehydrated, as this requires appropriate equipment (large dryers). As a result, peels and membranes are most often used for cattle feed.



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NUTRITION



The lemon has a good nutritional image, which is not limited to its high vitamin C content. Despite this fruit's proven health assets, its main use as a condiment (fresh fruit slices, juice extracted from the pulp, zest from the peel) is increasingly reducing its consumption as a fresh product in favour of derived products, particularly on Western markets.

Nutritional qualities

The lemon is a low-calorie fruit, particularly recognised for its high vitamin C content, of around 50-55 mg per 100 g of pulp. A fresh lemon pulp provides on average 60 % of an adult's daily vitamin C requirement. With the protection of the acidic medium and the skin, this vitamin C does not break down, or hardly breaks down, when the fruit is stored. It promotes general assimilation of calcium by the body, and speeds up absorption of iron, as well as scarring. The lemon is also rich in organic acids (primarily in citric form), which give it alkaline properties. The organic acids combine with minerals and release alkaline component which are crucial in calcium retention (20 to 30 mg per 100 g of pulp). The lemon thereby contributes to the acid-alkaline balance of the body. As paradoxical as it might appear, these organic acids help to combat gastric acidity, and promote digestion. The fibres, primarily contained in the quarter membranes and the albedo, are practically absent from the juice. More widely, the vitamin and mineral composition of the lemon contributes non-specifically to general dietary balance.



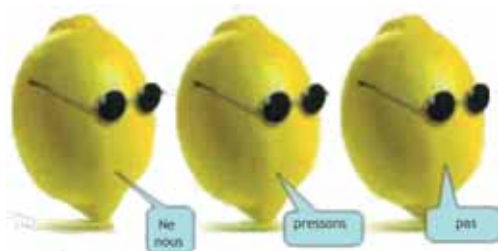
Health

The lemon has a high antiseptic capacity, which enables it to combat around twenty germs effectively. Its antiseptic properties are in particular used to combat infections and treat any type of skin injury or ulcer. Whole lemon juice (pulp with the fruit peel) also appears to be a remedy for fever, particularly in the case of the cold or flu. This use is observed in particular on Eastern markets, where fresh lemon consumption increases considerably in the winter.

Besides their nutritional qualities, lemons have useful contents of vitamin P or flavonoids (especially hesperidin and eriocitrin, approx. 26 mg per 100 g of pulp) and of limonoids (limonin, and in lower quantity nomilin), antioxidant compounds which, among other things, appear to help prevent the appearance of some cardiovascular diseases. Their antioxidant properties appear to have a positive impact on reducing cholesterol levels, and on thinning blood circulation. Flavonoids and limonoids also appear to be useful in combating certain cancers, in particular contributing to slowing the growth of certain tumours. However, the mechanisms involved are complex and still little known; medical research is ongoing.

Lemon pectins, contained primarily in the fruit peel and the albedo, appear to be able to treat certain gastro-intestinal disorders, and to affect cholesterol and glucose levels in the body.

The contents of these components vary according to the variety and climate (production region and season). These components are also unequally divided between the pulp, quarter membrane, pips and the fruit peel.



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of the fruit and vegetables.

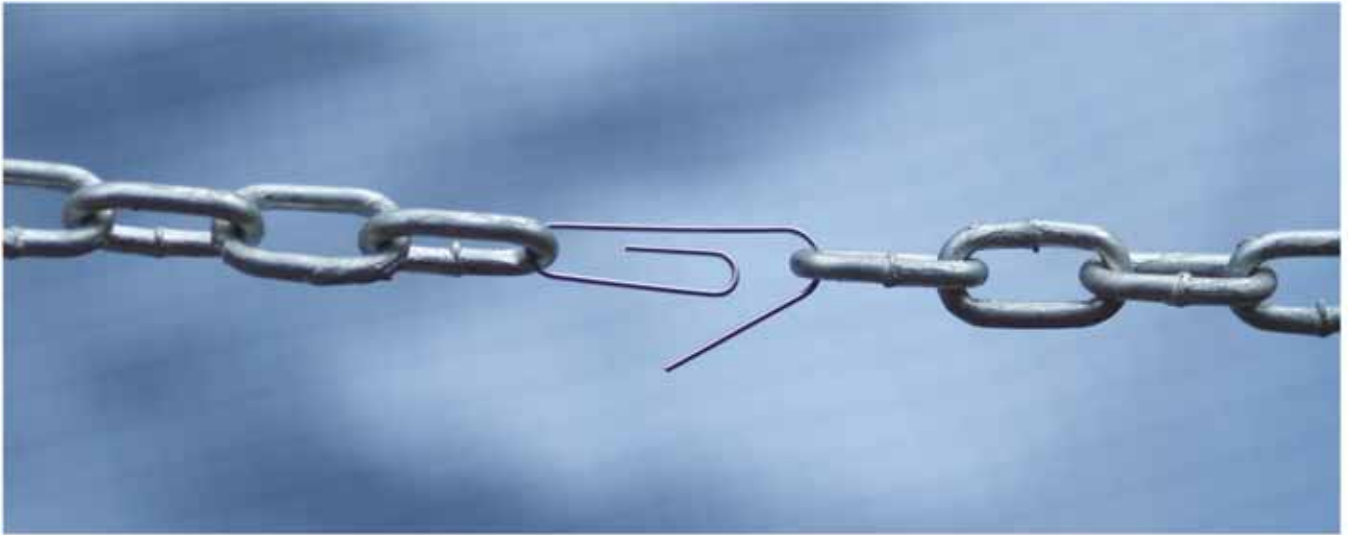
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Composition of yellow lemon per 100 g of pulp.

| | Units | Raw lemon |
|----------------------|-------------|-----------|
| Energy value | kcal | 29 |
| Water | g | 88.98 |
| Proteins | g | 1.10 |
| Lipids | g | 0.30 |
| Carbohydrates | | |
| (by difference) | g | 9.32 |
| Fibres | g | 2.8 |
| Total sugars | g | 2.50 |
| Minerals | | |
| Calcium | mg | 26 |
| Iron | mg | 0.60 |
| Magnesium | mg | 8 |
| Phosphorus | mg | 16 |
| Potassium | mg | 138 |
| Sodium | mg | 2 |
| Zinc | mg | 0.06 |
| Vitamins | | |
| Vitamin C | mg | 53.0 |
| Thiamine (vit. B1) | mg | 0.040 |
| Riboflavin (vit. B2) | mg | 0.020 |
| Niacin (vit. B3) | mg | 0.100 |
| Vitamin B6 | mg | 0.080 |
| Folate, total | µg | 11 |
| Vitamin B12 | µg | 0.00 |
| Vitamin A | IU | 22 |
| Vitamin E | | |
| (alpha-tocopherol) | mg | 0.15 |
| Lipids | | |
| Fatty acids, | | |
| total saturated | g | 0.039 |
| Fatty acids, total | | |
| monounsaturated | g | 0.011 |
| Fatty acids, total | | |
| polyunsaturated | g | 0.089 |

Source: according to US Department of Agriculture,
Agricultural Research Service, USDA National
Nutrient Database for Standard Reference, Release 25 (2012)
Nutrient Data Laboratory Homepage
http://www.ars.usda.gov/main/site_main.htm?modecode=12-35-45-00

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