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English edition

Close-up

COCONUT

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Litchi from Madagascar: progress!

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AGRICULTURAL RESEARCH FOR DEVELOPMENT

Coconut

A report prepared by
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in collaboration with
Olivier Audibert
and Roland Bourdeix

Contents

Like passion fruit, coconuts are much better known in processed form than fresh. The processing industry has long focused on this tropical fruit that is rich in flavour and can be used in many ways whereas sales of fresh nuts are smaller in terms of volume. More than other fruits, coconuts are found in extremely varied forms, not only in the food industry but also in sectors such as cosmetics, building and pharmaceuticals. Sales of fresh coconuts are marginal but growing on the European markets. They have a strongly exotic image but are difficult to use, reducing retail sales. A number of innovations to reducing the obstacle of shelling could stimulate consumption in the future.

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The world coconut market

The shell is the problem

World production

With production totalling 60.7 million tonnes (FAO) in 2008, coconut is the sixth most cultivated fruit in the world and is grown in more than 90 countries. Production has increased by 19% in the last decade (50.8 million tonnes in 2000). Asia and the Pacific account for 86% of world production, Latin America and the Caribbean 10% and Africa 3%. More than 70% of world production is concentrated in only three countries: Indonesia (32%), the Philippines (25%) and India (18%). Brazil, Sri Lanka, Thailand, Mexico and Vietnam trail far behind. Côte d'Ivoire and the Dominican Republic are only in the 22nd and 28th positions.

Coconut is essentially a smallholder crop and only 6% of world production is from large estates.

Exports

The coconut trade is mainly in processed products and only 0.6% of world production is sold as fresh nuts. With the exception of Indonesia, the main producer countries are not the main exporting countries.

Coconut exports have increased gradually in recent years. They reached 360 000 t in 2008 in comparison with 222 000 t in 2000, a 62% increase. This overall increase may be the result of an increase in per capita consumption, population growth and the globalisation of trade.

Asia, with its 77% contribution to world exports, is the main supplier of coconuts. The main Asian, source countries are Vietnam, Indonesia, Sri Lanka and Thailand, with re-

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Fresh coconut — European Union — Imports										
tonnes	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total, of which	**28 947**	**30 191**	**31 140**	**31 911**	**30 315**	**31 386**	**34 295**	**33 040**	**32 797**	**33 864**
Côte d'Ivoire	9 260	9 862	10 285	9 126	7 901	8 992	11 231	9 873	10 339	12 157
Sri Lanka	6 773	7 189	5 200	5 195	6 159	9 988	10 556	11 195	8 252	11 611
Indonesia	1 116	946	1 179	466	222	2 826	3 034	2 250	1 986	3 095
Costa Rica	1 177	938	810	1 361	1 361	1 589	1 764	2 260	1 848	1 969
India	62	75	31	12	73	62	156	138	782	1 224
Thailand	529	602	602	742	750	752	968	1 205	1 094	991
Panama	8	-	-	-	-	53	148	-	404	802
Philippines	1 063	1 427	2 368	2 231	1 745	1 636	1 243	771	786	759
Dominican Republic	7 076	7 018	8 574	11 186	10 981	3 495	4 104	4 264	5 995	484
Brazil	62	137	161	536	449	471	218	104	152	192
Ghana	161	3	1	26	11	72	194	72	250	185
Singapore	263	84	220	24	-	140	67	127	159	158
Vietnam	-	21	221	345	98	723	114	374	418	77
Senegal	16	-	44	40	-	-	-	24	119	68
Guatemala	-	-	-	5	1	-	-	-	-	20

Customs code 08011900 / Source: EUROSTAT

Fresh coconut — United States — Imports											
tonnes	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total, of which	**21 708**	**24 442**	**24 797**	**27 445**	**26 340**	**26 708**	**27 310**	**29 090**	**29 785**	**33 522**	**34 342**
Thailand	5 689	7 521	7 231	8 091	9 272	9 307	10 228	11 627	13 498	15 771	15 701
Mexico	4 291	4 830	5 438	6 206	6 069	7 924	8 605	8 964	8 399	11 619	11 797
Dominican Rep.	10 415	11 318	11 700	11 999	10 415	8 934	8 110	7 992	7 257	5 435	5 895
Costa Rica	278	150	20	264	188	153	116	89	-	299	541
Sri Lanka	-	-	9	28	19	23	8	79	173	95	213
Singapore	-	-	-	-	-	-	-	-	-	-	38
Philippines	604	491	224	574	229	176	97	60	21	104	34
Nicaragua	-	-	-	-	-	-	-	-	-	16	28
India	4	13	11	40	74	43	68	123	405	41	25
Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	23
Jamaica	247	38	81	150	-	-	-	-	-	-	19
Hong Kong	-	-	-	-	-	-	-	-	8	1	16

Customs code 08011900 / Source: USDA, GATS

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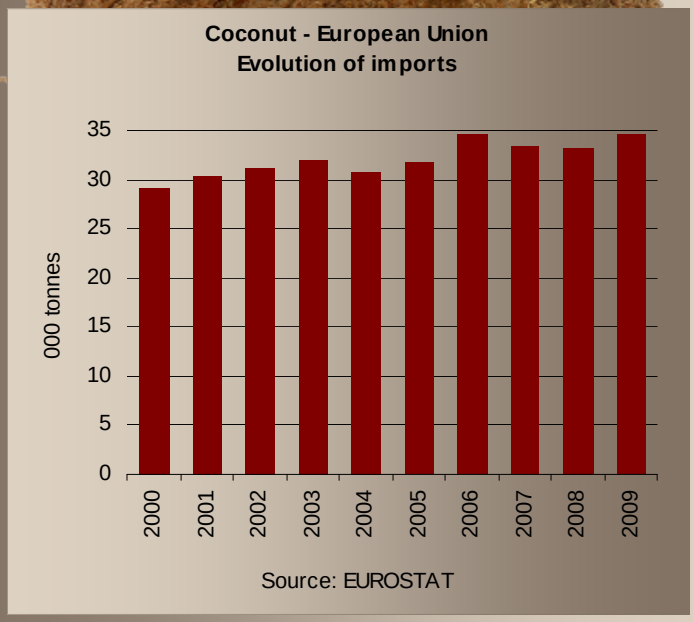

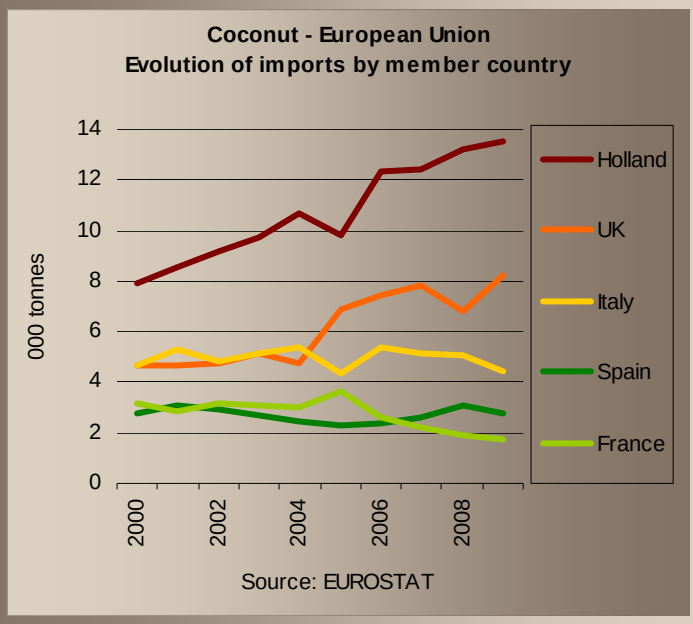

spectively 34%, 31%, 11.4% and 11.3% of total Asian exports.

Other sources such as the Latin American countries and West Africa supply the world market. With 12% of total exports, the Latin American countries form the second largest supplier of coconut in the world, far behind the Asian countries. The two main sources are Mexico and the Dominican Republic which supply North America and, to a lesser extent, Europe.

Africa exports half as much as Latin America and ships nuts mainly to Europe. Côte d'Ivoire accounts for practically all exports from Africa (95%).

Imports

Asia, the leading region for coconut exports, is also the main import zone. The Asian market accounts for 66% of all imports, with most of the produce coming from the Asian countries that are largely dominant in world production. Thus China and Japan purchase most of their supply from their neighbours, such as Vietnam. The intensity of trade in Asia is explained by the eating habits (consumption of fresh produce and, above all, processed coconuts) in these countries where most of production is for domestic consumption.

Europe is the second destination for coconuts, importing 34 000 to 35 000 tonnes per year. Imports are fairly stable although they increased by 17% from 2000 to 2009. The main source countries are Côte d'Ivoire (31%), Sri Lanka (26%) and the Dominican Republic (20%), which between them account for 77% of European imports. This is completed by other sources such as Costa Rica, the Philippines and Thailand, that supply 5.3%, 4.7%, 4.5% and 2.6% respectively of the total quantity shipped to Europe.

The volumes shipped to Europe by source country are steady, with the exception of the Dominican Republic with a substantial decrease in shipments from 2000 and 2009 that has been partially compensated by Sri Lanka.

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Post-harvest

After picking, the nuts are dehusked by hand with a steel point fixed in the ground. This gives commercial nuts. Distinction is made between mature or dry nuts for eating and fresh immature juice nuts

Even if the pulp is partially dehydrated, coconuts are not subjected to a special drying stage.

Packing and sizes

Coconuts are packed mainly in sacks in synthetic material for 20, 25, 40 or 50 nuts. Sacks of 20 and 25 nuts are less common on markets and are found in sources like Indonesia and Cuba. Most of the nuts shipped from Côte d'Ivoire arrive in sacks of 40 weighting 24 to 26 kg. Average nut weight is 550 to 600 g. Those from other sources may be larger, with weight approaching 700 g, such as those from the Dominican Republic.

The nuts are often repacked after import in boxes of 6 or 8 (30 x 40 cm) or 15 to 16 (40 x 60 cm) for sale to retailers or on wholesale markets.

The main European importing countries are the Netherlands (33%), the United Kingdom (19%), Italy (16%), France (9%) and Spain (8%), making a total of 85% of imports. The Netherlands is the main European importer, re-shipping 60% of its total exports to EU partners. It is supplied directly from source countries (13 500 t) and also indirectly from other community countries (1 800 t).

The United Kingdom and Italy draw their supplies directly from source countries and import little from other EU countries. Spanish imports are mainly from source countries, and an average of 50% of the total is exported to other European countries. France imports as much from source countries as from other European countries such as the Netherlands.

Intra-community trade has thus developed in the last ten years, with better distribution of produce. Import flows in

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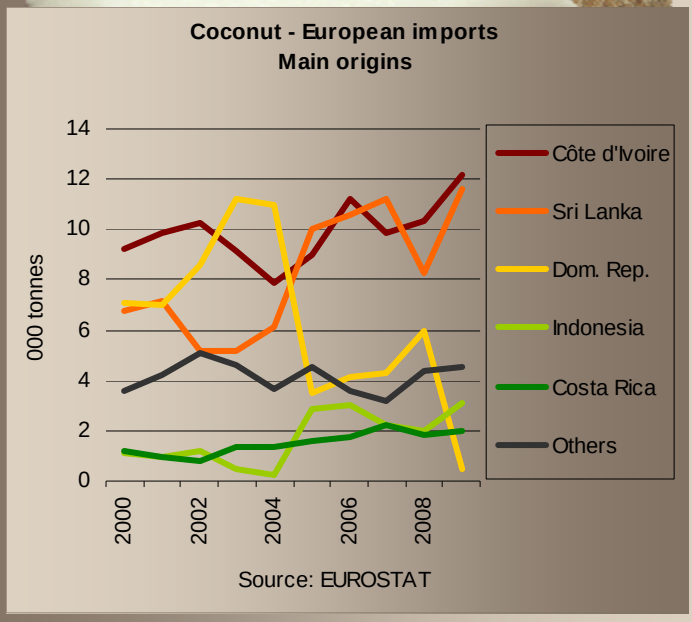

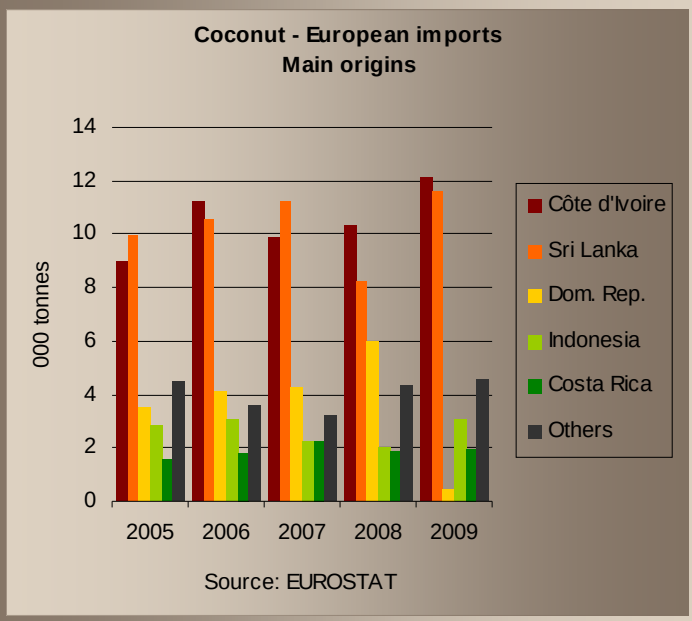

the various EU countries still seem to be determined by the heritage from the past. Most of UK coconut imports are from Sri Lanka while those on the French market are shipped from Côte d'Ivoire.

North American imports are slightly smaller than those of the European Union. Contrasting with geographic logic, Thailand is the leading supplier, followed by Mexico and the Dominican Republic.

Prices

Coconut prices are stable in Europe. The average is EUR 14 to 15 for a sack of 50 nuts, EUR 11 to 12 for a sack of 40 nuts, EUR 8 to 9 for a box of 15 to 16 and EUR 5 to 6 for a box of 8. However, prices depend on the source of the nuts, with those from the Dominican Republic, Costa Rica and Sri Lanka often being more expensive (about EUR 19 per sack of 40) than those from Côte d'Ivoire (about EUR 11.50 for the same quantity). This variation in price result from production and transport costs and also the average size of the nuts. Coconuts from Côte d'Ivoire are generally smaller and fetch a lower price than those from competing sources. The prices of boxed (hence repacked) coconuts at the import stage varies from EUR 0.40 to 0.80 per nut according to quality, sources and possibly the time of year.

Temporary changes in price may result from exceptional events. The tsunami that hit Sri Lanka in December 2004 caused serious damage to plantations, making exports impossible for a long time. Sri Lanka is an important source of supply and the quantity shortfall on consumer markets soon resulted in higher prices.

Likewise, the political disturbances in Côte d'Ivoire from February to April 2011 resulted in the suspending of exports to foreign markets and hence higher prices on the European markets. Especially on the French market, scarce supply from Côte d'Ivoire resulted in a rise in prices from EUR 0.40-0.60 per nut to EUR 0.80 until June, when the shortage was gradually made up.

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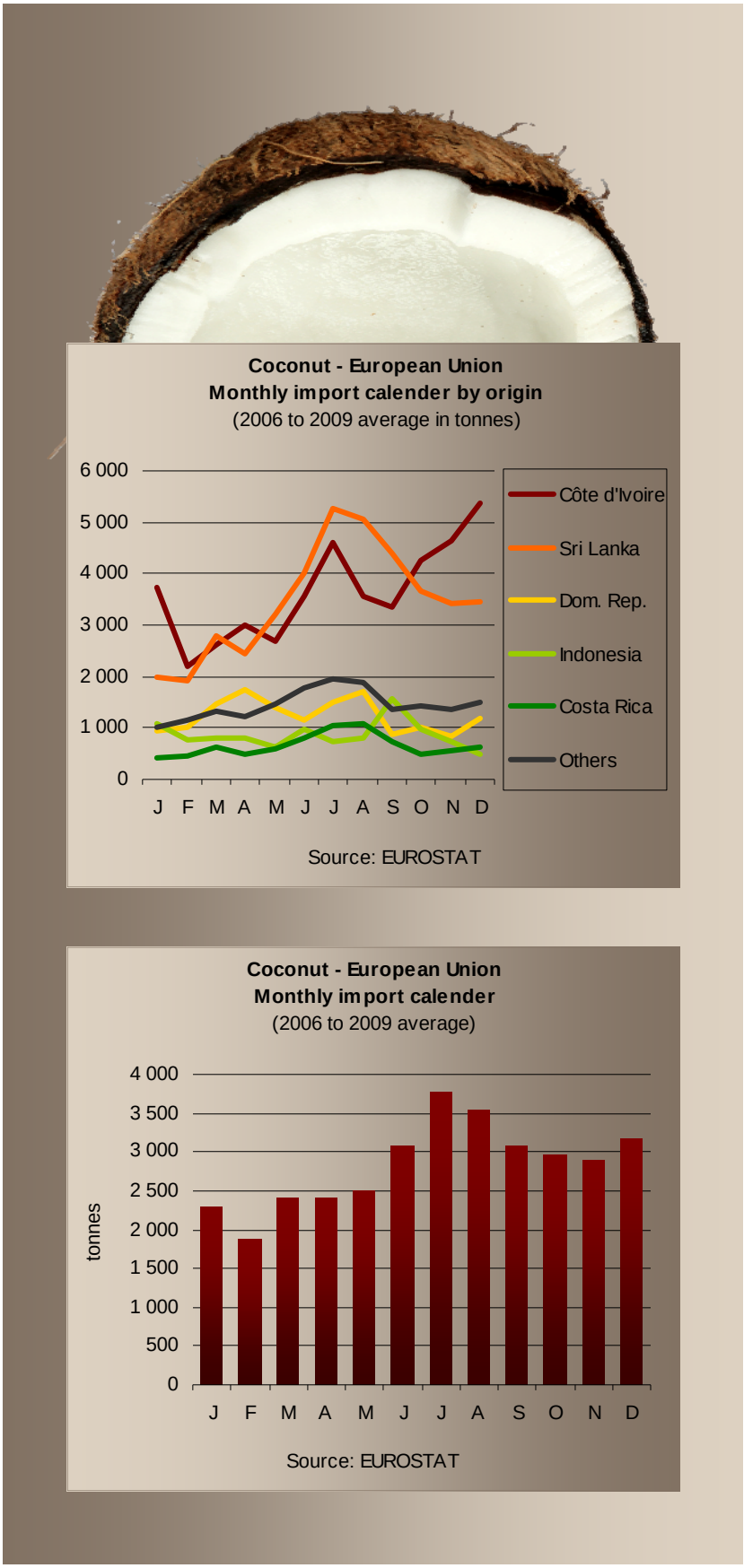

The quality of imported coconuts

In spite of their apparent toughness, coconuts, like other fruits, may have quality defects that can affect sales conditions. It is difficult to assess the quality and freshness of a coconut. It is considered that coconuts keep for about two to three months but this period depends on storage conditions. Coconuts are generally shipped at 8 to 12°C. Storage temperature at the import stage is about 10° C. In contrast, downstream the produce is often stored at ambient temperature and this is not favourable for the conservation of the quality of the fruit. It is also difficult to find out the time elapsed between the harvesting of the nuts and shipping from the source country. Some importers ask shippers to perform tests at the source by opening a representative number per batch. On reception, quality verification can be performed by checking that they contain milk and that the eyes are not germinating.

The main defects observed in coconuts are:

- broken nuts because of poor sack handling;
- nuts wetted by the juice of other fruits, enhancing the growth of moulds;
- germination of eyes.

Shell strength varies according to variety. For example, the shell of 'West African' tall is thicker than that of the hybrid cultivar 'PB 121'. The latter are more fragile, with a higher risk of broken nuts in the batches sold.

Consumption in Europe

Coconut consumption is fairly small in Europe and has hardly changed in recent years. Certain professionals consider that consumption per household is 1 coconut every 4 years. It is a complement to the range of exotic fruits and often not out forward by retailers. How-

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Nutrition

Coconuts have a high fibre content and are a good source of minerals and trace elements: magnesium, iron, manganese, copper, etc.). It is a fresh fruit but the pulp contains only 45% water in contrast with other fresh fruits.

Coconut Nutritrional value (100 g)	
Protein (g)	3.4
Carbohydrate (g)	5.9
Lipids (g)	35.1
Fibre (g)	9.5
KCal	353

Regulations

There is no specific standard for fresh coconut. However, several international standards apply to processed coconut:

- **Codex Alimentarius standard for dried grated coconut (Standard 177, 1991 revised in 2011);**
- **Codex Alimentarius standard for coconut-based aqueous products (Standard 240, 2003);**
- **Code of Hygienic Practice for Desiccated Coconut.**

ever, it has a strongly exotic image not only because of the palm and the distant source but also because of the special, much-appreciated taste of the flesh. It is also well-known by the public via a broad range of processed products (biscuits, beverages, ice cream, exotic cuisine, etc.). The main feature that slows consumption is obviously its inconvenience. Its hard shell and consumers' lack of knowledge of how to open it give it a secondary role in the range of exotic fruits that does not match its image. Innovative attempts at making opening easier (several pre-cutting procedures) have been tried from time to time but there has never been a truly practical and economically satisfactory system.

The association with coconut-based processed products (beverages, dried fruits, etc.) has been a line of research in marketing for the promotion of consumption. The results do not seem to have come up to the expectations of those involved. The only pathways that currently seem positive for increasing consumption are ethnic markets consisting of people who know more about how to use coconuts and the fresh-cut produce sector. The presentation of trays of coconut segments in supermarkets can encourage the European public to consider the fruit with more enthusiasm. This is in fact just a transposition of older practices when sellers were to be found in the street and fairgrounds.

Consumption is fairly steady throughout the year although it speeds up at times in the summer and, like all exotic fruits, during the Christmas period. In addition to its exotic image, a significant asset is its price. It is inexpensive and much cheaper than other tropical produce. Its form, colour and originality also make it stand out, with liquid to drink and pulp to eat in the same fruit.

Innovations in coconut

Innovations to promote coconut sales in Europe are few and far between and the few attempts have rarely been truly successful. Developing the pre-cutting of

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Coconut — World production (tonnes)	
World	**61 600 000**
Indonesia	20 532 850
Philippines	15 493 550
India	10 521 000
Brazil	2 366 205
Sri Lanka	2 154 900
Thailand	1 432 455
Mexico	1 125 555
Vietnam	1 111 800
Papoua	920 000
Tanzania	572 799
Myanmar	462 704
Malaysia	457 524
Solomon Isl.	408 000
Ghana	316 400
Vanuatu	308 500
China	304 100
Mozambique	267 500
Nigeria	235 350
Côte d'Ivoire	216 659
Jamaica	182 134
Samoa	161 334
Venezuela	157 055
Fiji	150 000
Kiribati	136 666
French Polynesia	101 032

Source: FAO - 2008-09 average

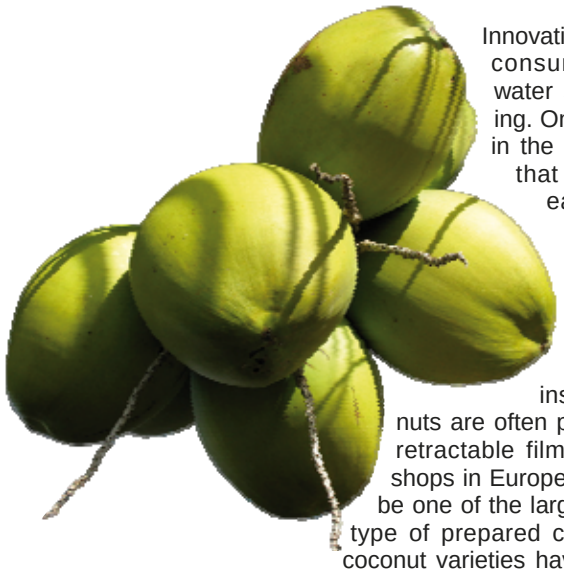
Fresh coconut World exports (tonnes)	
World	**362 300**
Vietnam	107 373
Indonesia	92 230
Sri Lanka	39 906
Thailand	30 832
Dom. Rep.	18 709
Côte d'Ivoire	20 596
India	21 005
Mexico	9 289
Malaysia	4 863
Guatemala	2 635
Venezuela	1 516
Philippines	1 909
United States	1 732
Singapore	2 087
Samoa	963
Tonga	901
Guyana	711
France	400
Tanzania	467
Cambodia	342
St Vincent, Grenadines	359
Dominica	352
Panama	173
China	322
Kenya	185

Source: FAO - 2008-09 average

Dry coconut World exports (tonnes)	
World	**275 000**
Philippines	129 533
Indonesia	51 069
Sri Lanka	39 356
Singapore	25 658
Malaysia	7 995
Mexico	5 516
Costa Rica	3 014
India	2 112
Venezuela	1 690
France	1 517
Dom. Rep.	1 072
Kenya	1 024
Panama	1 017
Thailand	984
Madagascar	751
Uganda	673
United States	585
Brazil	413
Cuba	250
Sao Tome, Principe	205
South Africa	143
Peru	130
China	95
Senegal	91
Australia	89

Source: FAO - 2008-09 average

the shell is technically difficult and not very profitable, given the retail price. Another technique developed was the insertion of a wire to break open the nut but the result was not convincing.



Innovations focused on the consumption of coconut water seem more promising. One consists of a hole in the shell with a closure that the consumer can easily remove to insert a straw. Another is immature nuts with the husk cut in the shape of a roof. It is easy to pierce the sell to insert a straw. These nuts are often packaged in thermoretractable film and sold in Asian shops in Europe. Thailand seems to be one of the largest suppliers of this type of prepared coconuts. 'Aromatic' coconut varieties have also been developed there.

The coconut-based beverage sector is also a substantial market and has developed strongly in recent years. In Brazil, for example, annual sales are some 300 million dollars. Coconut water in Tetra Pak packaging is a great success in the USA and in English-speaking European countries. Recommended by the FAO, the drink is made from green coconuts and has virtues for health (low carbohydrate, low fats, rich in minerals, etc..) and in particular for rehydrating the body. The name 'Fluid of Life' is used. And coconut is used of course in the composition of numerous beverages with other ingredients. Removing the difficulties involved in consumption, the sector is growing markedly faster than sales of nuts.

Pieces of coconut flesh in trays seems to be the main innovation for this traditionally imported fruit. Processed in Europe, it is sold in the fresh produce department and keeps for about three weeks ■

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Coconut cultivation

Cocos nucifera L. (Arecaeae)

Historical background

The coconut palm is a tropical plant that originated in Melanesia. The last traces of coconut fossils found in India and New Zealand date back several million years. Coconut spread around the world in several waves. The first occurred thanks to the fact that the fruits float and can therefore cross the sea to populate neighbouring islands. In the Middle Ages, the Arabs set up a substantial trade in the Indian Ocean and enhanced the dissemination of coconuts. In the sixteenth century, European colonists contributed to its spread from the Indian region to West Africa and the west coast of America.

The fruit was just called 'coco' until the seventeenth century, but the word 'coconut' subsequently prevailed. The word 'coco' comes from a Portuguese term that meant monkey face, referring to the appearance of the nut.

Botany

The coconut palm, *Cocos nucifera*, is a member of the Araceae or Palmaceae family. Like all members of this family, the coconut has palms (pinnate leaves). The species name *nucifera* is from the Latin *nux* (nut) and *fero* (to bear): nut-bearing. In spite of their appearance, coconut palms are not trees in the botanical sense of the term but giant herbs that can grow to a height of 30 metres. Reference is not made to the 'trunk' but the 'stipe', formed by the healing of points of section of palms shed in preceding years. The stipe has a single terminal bud that continuously shoots palms up to 7 metres long. They are arranged in a spiral, forming the crown of the

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palm tree. The number of bunches of nuts can be determined by counting the leaves as there is an inflorescence in the axil of each palm. The latter consists of about forty spikelets each bearing male and female flowers. The mode of reproduction varies according to the species.

The coconut palm fruits all the year round and the fruits reach maturity after 11 to 12 months. Each palm produces 50 to 150 nuts each year. Coconut palms are herbaceous and can bear fruit for more than 100 years but the maximum is generally reached after 10 to 20 years.

The fruit is an ovoid or ellipsoid drupe weighing 1.5 kg on average. It contains a single seed, the coconut, that forms some 60% of total fruit weight. Coconuts sold by retailers display fibres that are the remains of a thick husk that has been removed (dehusking). A second, very thin envelope covers the husk, forming a smooth green, orange, yellow or ivory skin.

Young nuts contain much coconut water and a thin, white gelatinous coating on the inner surface of the nut. As the nut ripens, the coating becomes thicker and solidified, giving a very white pulp (the 'meat'). Various extraction techniques are used to obtain different oily by-products: copra, milk, cream and oil.

Ecology of the coconut palm

The coconut palm is a very familiar plant in humid tropical regions. It adapts fairly well to climatic conditions and is so appreciated in certain countries that it is found beyond its ecological niches. Cultivation of coconuts requires substantial light and the optimal temperature for growth of the palms is 27°C, with extremes of 13°C and 35°C. Although most coconut palms are planted at an altitude of less than 500 metres, they can nonetheless do well above 1000 metres although low temperatures compromise growth and yields. Coconut palms generally grow in regions where precipitation is distributed evenly throughout the year and totals some 1 500 to 2 500 mm and where relative humidity is high. This is why they are found in particular in coastal zones that are temperate and where sea winds bring high humidity.

The coconut palm has leathery semi-xerophile leaves and can withstand drought periods lasting for several months. However, insufficient water may cause the

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abortion of flowers, premature fruit fall and a decrease in the size of the nuts.

The coconut palm is very adaptable as regards soils as it can grow in marginal zones and even those that are unsuitable for other crops. Palms are thus found in highly saline sandy soils, acid sulphate mangrove soils and deep peat soils. Salt has a beneficial effect on the size of coconuts.

The slender stipes and long pinnate leaves mean that these palms can resist strong winds and even hurricanes.

The tree with a hundred uses or the Tree of Life

Coconut palms have many uses both for local populations and in developed countries.

The wood is used in making sculptures, handles for tools, domestic utensils, piles for houses, bridges, boats, flooring and furniture.

The inflorescences are incised to tap sweet sap served as a beverage (called 'toddy' in India). Fermented, this gives palm wine with a low alcohol content but that can be distilled to make stronger 'arak'. Coconut vinegar is made from palm wine.


© Denis Loeillet

Palm leaves are used for roofing. They are plaited to make mats, hats, brooms, baskets, fans and geotextiles. Husk fibres are used to make matting, doormats, brooms, ropes, mattresses, horticultural substrates and even car seats.

White and tender palm hearts (also called 'palmito', 'burglar's thigh', 'chonta', 'palm cabbage' or 'swamp cabbage') are a much-appreciated food. Coconut shells are used as recipients and also have industrial uses such as the manufacture of active carbon for filtering gases and vapours (cigarette filters, filters for certain nuclear radiation, etc.). The coconut palm is also used for fuel as it is or as charcoal, and palm ash is used as a fertiliser.

Young coconuts provide a refreshing, thirst-quenching drink. Coconuts form a plentiful food supply and are usually the main source of vegetable oil for the populations of atolls. The pulp can be eaten raw or processed. It is dried to form copra that is pressed to obtain coconut oil.

Production of coconut oil is nearly 2.1 million tonnes a year and is No. 7 in world vegetable oil sales. First pressure oil is used in food products. However, hot-processed oil is used to make soap, shampoo, cosmetics, detergent, paint and pharmaceuticals. Many names are used for it in the food industry: Végétaline®, copra oil, etc.; it is also used in the manufacture of margarine. In addition to its taste qualities, this oil is also appreciated for its ability to remain solid at high temperatures (24°C) thanks to its saturated fatty acid composition. Coconut is used in the food industry to flavour pastries, biscuits, chocolate, dairy products, ice cream, etc.

Coconut milk and coconut cream are made by pressing a mixture of fresh grated albumen and water. It is a traditional ingredient in several African and Asian dishes and is used increasingly in Northern countries. The roots and milk of young palms and coconut oil are also considered to have medicinal virtues. The palm is also used as an ornamental plant. The gracious crown and slightly inclined trunk make it a symbol of the tropics.

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Varieties and mode of multiplication

There are thought to be more than 400 traditional varieties of coconut in the world. Two ancestral lines probably formed the base of this varietal richness. The 'Niu Kafa' type has elongated triangular fruits with a thick husk, floats easily and germinates slowly and is though to have been disseminated by marine currents. 'Niu Vai' has round fruits and a thicker husk. It does not float as easily, it is early and rich in liquid albumen. It was probably cultivated and then disseminated by navigators. Repeated crosses between the two lines gave the various coconut cultivars seen today.

The varieties can be classified simply in two large groups: 'dwarf' and 'tall'. More than 95% of the palms grown in the world belong to the second group. The main cultivars are 'Malaysia', 'Rennel', ' Vanuatu', 'Jamaica', 'West African' and 'East Africa'. This type of palm can grow to 30 metres, bears large nuts but does not fruit until it is 5 to 7 years old. The dwarf type is rarer and has a more slender trunk, a more rapid succession of inflorescences and fruits earlier (after two years). The most common varieties include 'Malayan Yellow Dwarf', 'Brazilian Green Dwarf', 'Ghana Yellow Dwarf' and 'Equatorial Guinea Green Dwarf'.

Dwarf x Tall crosses (hybrid varieties) can combine or even amplify the agronomic advantages of the two groups. Results of research in Côte d'Ivoire show that 35 of out of 135 hybrids tested produced 65% more than the standard 'West African' tall variety. Some even yield twice as much, such as 'PB 12'1 (hybrid of 'Malayan Yellow Dwarf' x tall 'West African') which has been widely planted in South-East Asia. It is estimated that hybrid varieties form 15% of all the coconut palms planted in the last ten years. They include the 'KB' and 'KINA' series from Indonesia, the 'PCA 15' series from the Philippines and the 'PB' (such as 'PB 121') from Côte d'Ivoire.

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Coconut palms are generally multiplied using seeds. They are grown in nursery seedbeds or in polybags with regular applications of fertiliser. The seedling are planted out after 5 to 7 months.

Pests and diseases

Coconut is targeted by numerous pests and diseases that cause varying degrees of damage. One of the diseases that forms the greatest threat to production is 'lethal yellowing'. Caused by a *phytoplasma* (bacterium), it results in depigmentation of the palms, premature nut drop, the death of the single bud and finally of the palm itself. Kerala wilt in India and cadang-cadang in the Philippines are serious viral diseases. The conditions of cultivation of coconuts are ideal for the development of certain fungal pathogens such as *Phytophthora palmivora*, *Ganoderma boninense*, *Pestalotia palmarum*, etc.

Pests include numerous insects such as beetles (*Oryctes monoceros* in Africa, *Promecotheca* spp., *Brontispa longissimo*, *Rhynchophorus* spp. in Asia and the Pacific). Biological control with *Bacillus thuringiensis* can be used to control caterpillars (*Hidari irava*, *Latoia pallida*, etc.) that eat young shoots. Bugs (*Pseudotherapus wayi* in East Africa and *Pseudotherapus devastans* in equatorial Africa) attack flowers and young fruits and can be managed using weaver ants, their worst natural enemy (*Oecophylla longinoda* in Africa and *Oecophylla smaragdina* in Asia and the Pacific). Damage by termites must also be prevented in nurseries and in young plantations. Coconuts are generally picked directly from the palms to prevent production losses caused by rats and thefts in the plantations. In some countries, bamboo canes 25 metres long are used; they have a knife at the end to detach ripe bunches. In Thailand, some farmers use trained monkeys (*Macacus nemestrina*) that become true agricultural workers as they can gather up to a thousand nuts a day! ■

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Packaging

Coconut carved in the shape of a conical coolie hat

Palette of coconuts: 40 sacks of 40 nuts, totalling 1 tonne

Opening a sack of coconuts

Box of 16 nuts

Box of 15 nuts

Box of 8 nuts

Box of 8 nuts

Photos © Pierre Gerbaud

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Quality defects

External

Size defects

Uneven shape

Differences in dehusking

Breakage

Moulds on part of the shell

Moulds caused by seepage of coconut water from another nut

Moulds on the entire surface of a nut

Coconut wetted by water from another nut

Internal

Deteriorated pulp

Internal moulds and oxidation

Germination

Germination starting at an eye

Start of germination and juice flow

Germination of an eye and sinking of the latter into the cavity of the nut

Photos © Pierre Gerbaud

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