Coconut, tree of life

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PAPER

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by
J.G. Ohler

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PREFACE

Called in various languages as the Tree of Life and the Tree of Heaven, the coconut palm continues to inspire authors to write about the many and diversified uses of its products, its features and growing conditions, and the pests and diseases that affect its life and productivity. The reader is referred to the classical work of Menon and Pandalai "The Coconut Palm", a monograph, 1958, "Coconut Growing" by Piggett, 1964, "Le Cocotier" by Y. Frémond et al., 1966, "Coconuts" 2nd ed, by Child, 1974 and "Handbook on Coconut Palm" by Thampan, 1981.

Particularly since the mid 1970s, considerable advances have been made in coconut research and development, while interest in commercial coconut growing is expanding in tropical Africa and Latin America. There is therefore a need to up-date information on the basis of the world literature.

This publication covers such topics as coconut germplasm, breeding, types and forms of the coconut in different eco-systems, crop production aspects in coconut-based cropping systems. The disease aspect is given adequate coverage, but for more detailed information on coconut pests and products, the reader is referred to the FAO publications, "Pests of the Coconut Palm", 1969 and "Coconut Palm Products", 1975, respectively.

A separate section is devoted to FAO involvement in coconut research and development. The form of presentation is oriented towards utilization by a wide range of readers, ranging from scientists to development planners, extension workers and students.

Mr. J.G. Ohler, a recently retired Senior Agronomist of the Royal Tropical Institute, undertook the assignment of writing this document. Mr. Ohler has been involved in coconut development projects since 1955 when he started in Mozambique on a 20.000 ha coconut plantation. Since 1968, he participated in all the meetings of the FAO Technical Working Party on Coconut Production, Protection and Processing, as well as in numerous missions in Asia, Africa and Latin America. Those gave him an authoritative view of the world's coconut problems and development efforts.

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The author is also very much indebted to the Royal Tropical Institute in Amsterdam for all the technical support received. Special thanks are due to the staff of the library and also to Mr. Leeuwenburg of the Agricultural Documentation Service of the Institute for his cooperation in the collection of the required bibliographical data and for giving the author priority in the reading of recently obtained publications containing interesting articles on coconut. Thanks are also due to the staff of the Photographic Documentation Service who generously provided all the photographs for this book. Last, but not least, the author wishes to thank Ms. Barsony for typing this manuscript and in doing so, correcting the English language.

J.G. Ohler

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Contents

1. HISTORICAL BACKGROUND

1.1. Origin and distribution

The coconut palm is one of the most useful trees in the world. It plays an important role in the daily life of the people living in the humid tropical regions and, undoubtedly, has done so, in its region of origin, from the earliest days of mankind. Harries (1979) called the coconut "the milk bottle on the doorstep of mankind".

The palm supplies not only food, water and oil for cooking, but also leaves for thatch roofs, fibre for ropes and mats, shells that can be used as utensils and ornaments, and the sweet sap of the inflorescence from which sugar and alcohol are made. Even the wood, if cut in the right way, can be used.
In the past, the population of the Maldives used boats, sometimes with a capacity of 100-200 tons, constructed with coconut products, with which they sailed to Arabia and the Philippines (Reyne, 1948). The wood can also be used for furniture and construction.

The original home of the coconut is still unknown. Among the theories which have been developed so far, two have been disputed for a long time. One locates the origin of the coconut palm somewhere at the northern end of the Andes in South America, the other indicated Southeast Asia as its home country. At the time of the discovery of America by Columbus, Oviedo found a grove of coconuts on the West coast of the Isthmus of Panama. But it has been suggested that the supposed *Cocos* from Northern South America which through an incorrect translation was considered to be *C. nucifera* must have been a genus of palms closely related to *Attalea* (Hill, 1929). Heyerdahl (1953), who crossed the Pacific on a balsa-wood raft via the South Equatorial Current was also of the opinion that the American Indians on their sea voyages had carried coconuts to the Pacific islands.
Eden (1963) suggested that it would have been more likely that as soon as the coconut became known in Central America, its distribution along the trade routes of Mayas, Aztecs or Incas would have been rapid. This seems to have been the case north and south of the Isthmus, but not in the Caribbean. Thus the coconut was probably too new an arrival for such a spread.
According to Harries (1977, 1980b), the access to the Atlantic and the Caribbean only began the final phase of the coconut palm's domination of the tropical coastline. The site most likely for the introduction of the coconut to the coast of the Atlantic was the Island of Santiago in the Cape Verde group, or the Island of Goree to the Southeast of the Cape Verde peninsula, when Vasco da Gama returned from India and East Africa in 1499. From these islands the coconuts may have been taken to the Caribbean, and not from Panama where the coconuts are of a different variety.

Candolle (1855) summed up ten arguments in favour of an Asiatic origin, based on sea currents, routes of navigation number of varieties and

number of common names in Asia, and ancient history. The discovery by Beccari of another cocoid palm *Jubaeopsis caffra*, in South America and Madagascar which he believed to be more closely related to the coconut than other cocoid palms (Dennis and Gunn, 1971) put an end to the exclusiveness of America as the home of all cocoid palms.

According to Menon and Pandalai (1958) the coconut was introduced to India in the post-vedic period and in spite of the discovery of fossil *Cocos* species in Rajasthan, India cannot be considered the original home of coconut. According to geographical history, Rajasthan desert was once covered by the sea and it is possible that remnants of trees could have been brought down by oceanic currents. However, if tree remnants can be brought down by sea currents, so can coconuts. The theory of the later import in India is supported by the fact that among the names of the coconut in Malaysia, those of Sanskrit derivation were of a later origin than others already prevalent in the area. Menon and Pandalai came to the conclusion that coconuts originated somewhere in what is now called Melanesia. Child (1974) referred to the close biological association between the coconut and the Robber crab, *Birgus latro*, which is specific on coconuts. Such an association can only have developed after a very long time. This crab appears over almost 180 degrees of the tropical belt but it is unknown on the American and African continents. Ethnological and entomological evidence place the centre of diversity in the area of South East Asia and Melanesia, but this has not been fully substantiated by adequate studies of the coconut germplasm in that region (Report, 1976).

The ability of coconuts to germinate after having floated in the sea for up to 110 days (Harries, 1978, citing Edmondson) supports the theory that coconuts may have been disseminated naturally by being carried away by sea-currents and washed ashore somewhere else. Heyerdahl's (1953) experience that coconuts stored in his raft between the main floating logs and the deck were ruined because of exposure to seawater may have resulted from alternately washing by seawater when there were waves and drying during windless spells, causing a high concentration of salt in the husk. The capacity of coconut to establish itself after having been washed ashore, was demonstrated very clearly after the eruption of the volcano on the island of Krakatau between Java and Sumatra, in 1928 - 1930. New islets appeared near the old volcano and within 18 months after their appearance coconuts had germinated on the shoreline (Hill and Leeuwen, 1929).

Harries (1978) developed a theory on the evolution and dissemination of the coconut palm, and came to the conclusion that no definite answer can be given to the question of its origin. He suggests that this centre of origin may have been in the region of the submerged continental fragment of the Lord Howe Rise-Norfolk Ridge complex. This was isolated from Australia about 80 million years ago and apparently submerged below sea level about 15 million years ago. He also suggests that the natural and human assisted dissemination were equally important, but at different times. At first, the primordial *Cocos* which might have originated on the continent which emerged, or the land which submerged when Gongwanaland

was divided, was established on atolls or in regions where plant and animal competition had been destroyed by volcanic activity. This allowed the evolution of triangular nuts that float well, having thick husks and large cavities in the shell, germinate slowly, increasing the distance the nut could float and remain viable, and with large amounts of endosperm giving the seedlings a long time to survive and compete for establishment with the existing flora. He calls this type of coconut the "Niu kafa" type (fig. 1). Such a natural selection would have produced a coconut palm that

Fig. 1. Triangular "Niu kafa" type of coconut

represents very closely the characteristics of coconut varieties found as far apart as Palmyra atoll in the Pacific and the Seychelles Islands in the Indian Ocean. The coast of America was just at or beyond the limits of natural dispersal. Africa was close to, or within the limit, but large stretches of coastline were unfavourable either because of animals or because it was too dry during the year or part of the year. Australia was

also too dry and, in spite of the proximity of coconut-growing islands to the North and Northeast, the palm did not establish itself there. Only Asia provided a suitable climate. If the plant and animal competition were constraints, human cultivation proved a mitigating factor.
Harries supposes that the coconut grows on the mainland of Southeast Asia not because man took it to the area but he was there to receive it when it arrived.

Harries (1981 b) suggests that there are three ecological situations which correspond to the natural conditions encountered by coconut seednuts before germination. On the isolated coral atolls, where the coconut probably evolved and where, in some instances, it may still be possible to find a wild Niu kafa type, there are three places only where the ripe fruit may fall. They may drop directly onto the ground, more or less below the crown of the palm and possibly in the shade, where they will remain unless washed away by a higher than usual tide or by a tsunami. They may fall into the restricted and relatively calm waters of the lagoon and float a short distance before reaching another part of the same atoll. Or they may fall into the open and turbulent ocean and float thousands of kilometers before reaching another beach - even a beach where no coconuts have grown before. The seednuts on the ground under the palm are in a situation equivalent to a nursery. Relying on rainfall, germination will tend to be slow, particularly where heavy shade lowers the air temperature. In Edmondson's trials coconuts set on beach sand showed no visible sprouting whilst under observation for nearly three months. Slow germination under an adult palm, according to Harries gives the best chance of a seedling being available to replace the adult palm if that should be destroyed by lightning, pest, disease or just old age at any time within 200 to 300 days. Edmondson observed that 23% of the coconuts that had not been stored before, floating on a seawater reservoir, produced visible shoots within 74 days. Thus, seednuts floating in a lagoon give the best chance of becoming established as soon as possible after they have washed up a short distance away.
The possible delayed germination of seednuts in the ocean increases the chances of reaching other beaches.
Referring to Villiers' (1975) opinion, that wet storage might be useful where the maintenance of a high degree of stability is required, Harries (1981 b) concluded that coconut may be another seed that retains its viability when fully imbibed. Its germination adaptability might lead to continuity, homogeneity and genetic stability of coconut populations. Superimposed on these factors is the uniformity of the coral atoll environment, whether in the Pacific or Indian Ocean, which exerts strong selection pressure on all characteristics of the Niu kafa genotype. Phenotypes of coconuts on Palmyra Atoll in the Pacific and Seychelles Islands in the Indian Ocean are remarkably similar, although the islands are 16 000 km apart. Harries (1979) suggests that it was not until the coconut reached the coast of Southeast Asia that man's early ancestor, the apelike *Ramapithecus* came down from the trees some twelve million years ago. It was there that a close relationship began from which Man was to emerge.

Whatever we believe, the finding of fossil coconuts as far apart as the

Eocene deposits in the dry deserts of Rajasthan in India, ranging in age from fifteen to forty million years, and the Pleiocene deposits in North Auckland. New Zealand, ranging in age from one to fifteen million years indicate that without further evidence any theory remains a speculation.

Natural dispersal of the coconut by floating on the sea currents may have reached far away beaches. Later, Polynesian, Malayan and Arab navigators undoubtedly have played an important role in further distribution of the coconut. On the continent, the distribution into the interior can only have been accomplished by their human inhabitants. The early European navigators contributed their share in further dissemination of the coconut, carrying it from Asia and East Africa to West Africa, the Atlantic coast of America and the Caribbean. But not until the 19th century did coconut products appear on the European market. Between 1820 and 1830 the first coconut oil was exported from Sri Lanka to England to be used for soap manufacturing (Reyne, 1948). A change to coconut production suited many sugar plantation owners when the high and seasonal demands of that crop could no longer be met in the decade following the abolition of slavery.

The use of coconut oil for the manufacturing of margarine by the end of the 19th century highly favoured the development of coconut plantations throughout the tropics. This explains the fact that so many coconut groves today have become senile and of low productivity, as coconuts can reach over one hundred years of age and farmers are reluctant to cut down fruit trees as long as they still produce fruit. Replanting requires much labour and time as well. Notwithstanding the increasing interest in coconut oil, only relatively few large plantations have been established. In general, coconut was considered to be a smallholders' crop.

1.2. World production

In the twentieth century, the expansion of the coconut industry was more commercially oriented and planting, in general, was done on a larger scale than ever before. Before World War I, coconut oil had become the most important vegetable oil. There is no country or region in the humid tropical world where coconut has neither been planted commercially nor for subsistence. Apart from its value as a cash crop, it has always been a main source of oil for the continuously expanding population in this part of the world. Domestic consumption has always had priority over surplusses which were marketed. For this reason important exporting countries such as Indonesia and Thailand saw their export gradually decline as domestic consumption increased with increasing population and with a rising standard of living.

Coconuts are consumed in the household kitchen, for the preparation of coconut milk, for the preparation of crude oil or as so-called "drinking nuts". The surplus is either prepared as copra and sold. or the nuts are sold on the local markets, or to the desiccated coconut factory. Because of these various ways of consumption and processing, and because of the large portion being produced and consumed in millions of households, it is

difficult to present definite figures on acreage, production, consumption and trade. Statistics have to be based on estimates and usually all end uses are converted into one unit, either copra or oil. However, such statistics do not often mention if household consumption of the home garden was included.

Table 1 presents the coconut production of the main producing countries between 1948 and 1981, expressed in millions of nuts, thus before any consumption has taken place. The figures are based on the FAO Production Yearbook, 1971 and 1981. This table shows that the Philippines and Indonesia have always been by far the most important producers of coconuts. In 1981, they produced about 60 per cent of the total world production. The other two major producing countries, India and Sri Lanka, with 12.3 and 4.7 per cent of total world production respectively are also located in the same region of South and South East Asia producing 84 per cent of the world's coconuts. The remaining 16 per cent are fairly equally distributed among the other producing regions of Africa, Oceania and Latin America.

Main coconut producing countries in the regions are Mexico in Latin America, 2.3 per cent, Papua and New Guinea in Oceania, 2.2 per cent, Mozambique, 1.2 per cent and Ivory Coast is worth mentioning because of its rapid increase in production.

The largest producers are not always the most important exporters. The Philippines export more than 90 per cent of their coconut products, but Indonesia with an almost equal production uses the total of it for domestic consumption because of its very high population density.

The increase in the world's coconut production during the last decades was obtained mainly through the increase in area planted to coconut. The results of the intensified research in the last twenty years, particularly the progress made in the production of improved planting material, reinforced the position of the coconuts' potential competitive position among the vegetable oils and fats. Smith and Allen (1981) stated that with the advances in breeding and agronomy, traditional coconut yields may be increased as much as five times at least. Theoretically, this may be true, but in practice such changes require a lot of time. Even if the average yield per unit area could be doubled in the next twenty years, this would mean an enormous improvement and a breakthrough in the coconut situation of today in which the coconut is threatened to be pushed out of the world market by other oils. Under the influence of these developments and also as a result of a great deal of coconut groves having become senile and their yields being very low, huge planting and replanting programmes are being implemented in several countries. The situation in the most important coconut producing countries is reviewed below.

Table 1

World coconut production, 1948-1981 (based on FAO Production Yearbook 1971 and 1981)

Country	1948-1952 million nuts	%	1961-1965 million nuts	%	1981* 1000 mt nuts	%
Philippines	4,453	22.9	7,293	26.0	11.050	30.1
Indonesia	4,217	21.7	5,924	21.2	10.800	29.4
India	3,656	18.8	4,835	17.3	4.500	12.3
Sri Lanka	1,975	10.2	2,848	8.9	1,716	4.7
Malaysia	1,006	5.2	1,044	3.7	1,204	3.3
Thailand	413	2.1	891	3.1	900	2.4
Others	185	0.9	345	1.2	630	1.8
Asia	15,905	81.7	22,816	81.5	30.803	84
Mozambique	320	1.6	383	1.4	420	1.2
Tanzania	246	1.3	253	0.9	320	0.9
Nigeria	150	0.8	200	0.7	90	0.2
Ghana	73	0.4	191	0.7	160	0.4
Ivory Coast	10	-	18	0.1	159	0.4
Kenya	65	0.3	65	0.2	95	0.3
Others	287	1.5	279	1.0	271	0.7
Africa	1,151	5.9	1,389	5.0	1,515	4.1
Papua New Guinea	377	1.9	628	2.2	800	2.2
Vanuatu	135	0.7	182	0.7	240	0.7
Fiji	215	1.1	235	0.8	225	0.6
W. Samoa	107	0.5	109	0.4	200	0.6
Solomon Islands	77	0.4	156	0.6	193	0.5
Tonga	100	0.5	67	0.2	122	0.3
Others	340	1.8	339	1.2	495	1.3
Oceania	1,351	6.9	1,716	6.1	2,275	6.2
Mexico	204	1.0	843	3.0	827	2.3
Brazil	241	1.2	475	1.7	254	0.7
Jamaica	74	0.4	118	0.4	193	0.5
Venezuela	74	0.4	175	0.6	150	0.4
Ecuador	13	0.1	17	0.1	93	0.3
Trinidad Tobago	129	0.7	119	0.4	77	0.2
Others	321	1.6	341	1.2	480	1.3
Latin America	1,056	5.4	2,088	7.4	2,074	5.7
World	19,463	100	28,009	100	36,667	100

* Note: 1 mt nuts is about 800 nuts