K. U. K. Nampoothiri *Editor-in-Chief*
V. Krishnakumar · P. K. Thampan
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The Coconut Palm (*Cocos nucifera* L.) - Research and Development Perspectives

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Foreword

The coconut palm is rightly eulogized as "Kalpavriksha" – the tree of life due to the multifarious uses it offers to human kind. Apart from the fascinating fact that all the parts, right from its roots to leaf, have something or the other to offer, the magnanimity of this eco-friendly palm in accommodating a large number of crops in its ambit, giving scope for intercropping, multiple cropping, high-density multispecies cropping and mixed farming, paving the way for additional sustainable income, is adorable. It is not surprising that the crop has spread to 94 countries giving employment opportunities and livelihood options to 64 million families across the world. However, it is a paradox that the small landholders of coconut are now in a dilemma faced with many challenges. The wide gap between the potential yield and the realized farm yield should not go unnoticed. It has to be examined whether the scientific and political worlds have given the attention the crop deserves.

This is the most opportune moment, when coconut research has completed 100 years in 2016, to have an introspection of what has been done so far in the research and development field relating to coconut. Progress is not possible unless we have such information on hand in a most understandable form, and that is what this book, *The Coconut Palm (Cocos nucifera L.) – Research and Development Perspectives*, aims at. A sincere attempt has been made to capture all the available information in one publication. It is in fact a bit surprising that there has been very little effort to comprehensively make available to the world the tremendous amount of knowledge accrued on this crop during the past 100 years. The book, in its 17 chapters, covers all aspects of coconut right from origin to cultivation, breeding, physiology and value addition apart from subjects of topical interest like biotechnology, health and nutrition as well as climate change and carbon sequestration. The publication reminds us that the "bio-happiness" of the small coconut landholders is the ultimate aim of the scientists and developmental agencies and outlines certain important strategies to make coconut farming more remunerative globally. Although there is a preponderance of Indian literature in the publication, which is understandable in view of the prime position the county holds in the field, work in other major coconut growing countries has as well been described adequately. The chapters have been well written by authors who have vast experience in their respective fields and cover the entire spectrum of coconut sector. I congratulate the editors for taking the initiative in bringing out this compilation, which is bound to be of utmost value to researchers, students, extension workers, developmental agencies, progressive farmers as well as all those who love this versatile palm.

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Preface

The coconut palm, being a perennial heterozygous and solely seed-propagated crop and requiring large area and enormous resources for field experimentation, had been hard to research upon and obtain the expected scientific backup. However, exemplifying tribute to the scientific fraternity, most of whom have spent their whole professional career towards fine-tuning research outcome of coconut, a large quantum of information has been accrued over the years, but somehow the coconut researchers have been shying away from a comprehensive compilation of the information after the commendable book- *The Coconut Palm: A Monograph* by Menon and Pandalai in 1960 apart from the one by Child (*Coconuts*, 1974), Ohler (*Coconut, Tree of life*, 1984), Freemond (*le Cocotier*, 1966) and other publications on individual aspects.

It is appropriate to make available the scientific information on hand collated for the next generation to avoid duplication of efforts and form a strong basis for the scientific pursuit and, hence, warranted this publication, when coconut research and developemnt has just celebrated its century.

Farmers in the coconut growing areas have evolved their own ingenious ways of selecting the planting material and managing the palms. A structured research on coconut started during 1916 in India. Now research work is being undertaken in almost all the coconut growing countries especially India, Philippines, Indonesia, Côte d'Ivoire and Sri Lanka. The research outcome on various aspects available from the research laboratories has been dealt in detail in the 17 chapters of this book.

It is a matter of great apprehension that the coconut sector scenario does not present a rosy picture as on today, with decline in productivity and inadequate remuneration at the farm gate. These coupled with unexpected price fluctuation has been a worrisome factor for farmers who are not able to obtain a sustainable income from the crop. One of the factors for low income from coconut is its sole dependence on vegetable oil price which obviously fluctuates with one or the other oils in the market. Fortunately, coconut is quite versatile to counter this auguring many valuable health products apart from coconut oil. Inspired optimism has been expressed in various fora that by popularizing tender coconut water, *kalparasa*, toddy, coconut sugar, coir, shell products, etc. and projecting them in supply value chain, there could be a turnaround in product diversification scenario. However, the impact due to these has been marginal. Though there have been controversies on the health aspects of coconut oil, copra oil as well as the virgin coconut oil are now being accepted to be of high nutritive value with many health benefits attributed, which can also be taken advantage of through effective market interventions.

In the emerging scenario on climate change and consequent upsurge of pests and disease problems, greater emphasis on strengthening quarantine, systematic surveillance and constant vigilance in transborders are the need of hour to counter biosecurity risks. It is the experience in all the coconut growing countries that the technologies emanating from research organizations are not adequately transformed to field realities and level of adoption is very low, as is adequately explained in Chapter 14 of this book. The reasons could be many such as the lack of knowledge, practical difficulties in implementation, slackness on the part of the implementing agencies and financial constraints. Very effective transfer of technology mechanism supported by strong policy decisions is necessary to help the farmers to come out of this crisis. The fact that coconut is not in the priority list of agricultural crops in many countries indicates the inadequate attention it attracts from governments.

Area under coconut has not been increasing globally, and this situation can be expected to continue in the wake of growing demand for land for nonagricultural purposes. So the only option is to increase the productivity per unit area, which on the contrary has been dwindling due to the large proportion of neglected and senile palms raised under rain-fed condition as well as poor management. The problem is worsened further with fragmentation of land resulting in coconut cultivation resting mostly with the small holders who have their own special problems in managing a profitable coconut garden. Cooperative farming ably aided by government support is one way to help the comparatively resource poor coconut farmers. It is possible to bring back the glory of coconut sector through government support and with the fortitude of the farming community. The few international agencies related to coconut research and development have also become defunct or nonfunctional, APCC being the only exception. Increased international cooperation is necessary to revive this crop considering its unique problems and the voluminous ecosystem services it provides to mankind.

A publication of this nature cannot be expected to be entirely perfect in spite of the best efforts taken by the editors, which means that it has to be necessarily revised from time to time, incorporating the latest research findings as well as considering the appropriate suggestions for improvement from well meaningful readers.

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The editors wish to thank the authors of all the chapters for their sincere efforts in collecting the large volume of information and compiling them within the time frame. We have received immense and valuable support from many, and we are happy to acknowledge their help. Our special thanks go to Mr. S. Thajudin, Asst. Chief Technical Officer, and Mr. E. R. Asokan, Technical Officer of ICAR-CPCRI (Regional Station, Kayamkulam) for their sincere help in literature collection and preparation of figures.

Any mistakes which might have occurred inadvertently are regretted. It is our pleasure to thank the publishers, M/s Springer Nature for the excellent printing and time-bound publication in a commendable manner.

A compilation of this nature would not have been possible without the effort of many individuals, whose names have not been possible to be individually mentioned. We greatly appreciate their professionalism and encouragement, and we are indebted for their support and would like to profusely thank all of them. We are personally indebted to our family members, but for whose support and forbearance, it would not have been possible to bring out this publication in time.

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Abbreviations

AC	Activated carbon
AD	Alzheimer's disease
ADOT	Andaman ordinary
AGT	Andaman giant tall
AIFTA	ASEAN-India Free Trade Agreement
AIS	Alien invasive species
APCC	Asian and Pacific Coconut Community
API	Annual productivity index
ATARI	Agricultural Technology Application Research Institute
BGD	Brazilian green dwarf
BSR	Basal stem rot
BUROTROP	Bureau for the Development of Research on Tropical Perennial Oil Crops
CABI	Coconut for Agro-Based Industry Indonesia
CAD	Coronary artery disease
CBFS	Coconut-Based Farming System
CBOs	Community-based organizations
CBT	Cambodia tall
CCRI	Cocoa and Coconut Research Institute
CCV	Complex coconut varieties
CDKA	Cyclin-dependent kinase
CDM	Clean development mechanism
CFDV	Coconut foliar decay virus
CFTRI	Central Food Technological Research Institute, Mysore
CGD	Chowghat green dwarf
CGRD	Coconut Genetic Resources Database
CHD	Coronary heart disease
CHRC	Chumphon Horticulture Research Centre
CIAE	Central Institute of Agricultural Engineering
CIBA	Central Institute of Brackish Water Aquaculture

CICY	Centro de Investigacion Cientifica de Yucatan Merida
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique pour le Development
CKP	Coconut kernel protein
CLB	Coconut leaf beetle
CLP	Coconut leaf pruning
CMA	Coconut monoethanolamide
CMC	Carboxymethyl cellulose
COD	Chowghat orange dwarf
COGENT	International Coconut Genetic Resources Network
CPCRI	Central Plantation Crops Research Institute
CPE	Cumulative pan evaporation
CRD	Cameroon red dwarf
CRI	Coconut Research Institute, Lunuwila, Sri Lanka
CRICATAS	Chinese Academy of Tropical Agriculture Sciences
CSA	Climate-smart agriculture
CSM	Coconut skim milk
CSMP	Coconut skim milk powder
CVD	Cardio vascular disease
CYD	Coconut yellow decline
DC	Desiccated coconut
DFR	Differential fertilizer requirement
DNA	Deoxyribonucleic acid
DRIS	Diagnosis and Recommendation Integrated System
DSC	Differential scanning calorimetry
DUS	Distinct, Uniformity and Stability
ECT	East coast tall
EFA	Essential fatty acid
EPN	Entomopathogenic nematodes
ERP	Eppawala rock phosphate
ET	Evapotranspiration
ETo	Estimated actual evapotranspiration
FFA	Free fatty acid
GALD	Galas green dwarf
GBGD	Gangabondam green dwarf
GHGs	Greenhouse gases
GI	Glycaemic index
GMP	Good manufacturing practices
HDL	High-density lipoprotein
HDMSCS	High-density multispecies cropping system
HI	Harvest index
HPLC	High-performance liquid chromatography
HRI	Horticulture Research Institute
HRM	High-resolution melt
IARI	Indian Agricultural Research Institute

ICAR	Indian Council of Agricultural Research
ICECRD	Centre for Estate Crops Research and Development
ICOPRI	Indonesian Coconut and Other Palmae Research Institute
INM	Integrated nutrient management
IRHO	Institut de Recherches Pour les Huiles et Oleagineux
ISSR	Inter simple sequence repeats
ISTR	Inverse sequence-tagged repeat
JAT	Jamaica tall
KAU	Kerala Agricultural University
LAGT	Lakshadweep green tall
LAMP	Loop-mediated isothermal amplification
LAW	Liquid albumen weight
LCFA	Long-chain fatty acid
LCT	Laccadive ordinary
LDL	Low-density lipoprotein
LYD	Lethal yellowing disease
MAD	Malayan dwarf
MAP	Modified atmosphere package
MARDI	Malaysia Agriculture Research and Development Institute
MARI	Mikocheni Agricultural Research Institute
MAWA	Malayan dwarf x West African Tall
MCFA	Medium-chain fatty acid
MCW	Mature coconut water
MGD	Malayan green dwarf
MIT	Mineralization and immobilization turnover
MRD	Malayan red dwarf
MSP	Minimum support price
MYD	Malayan yellow dwarf
MZT	Mozambique tall
NAM	No apical meristem
NFDM	Non-fat dry milk
NGT	New Guinea tall
NIST	National Institute for Interdisciplinary Science and Technology
PBCk	High-potential buffering capacities of potassium
PBR	Plant breeders' rights
PCA	Philippine Coconut Authority
PGPR	Plant growth-promoting rhizobacteria
PHILCORIN	Philippine Coconut Research Institute
PHOT	Philippines ordinary
PNT	Panama tall
PNUE	Photosynthetic nitrogen use efficiency
PPVFRA	Plant Varieties and Farmers' Rights Authority
RCA	Revealed comparative advantage
RDF	Recommended dose of fertilizers
REE	Rare earth elements

RGA	Resistance gene analogue
RI	Refractive index
RIT	Rennell Island tall
RPW	Red palm weevil
RSW	Rugose spiralling whitefly
RWD	Root (wilt) disease
SAW	Solid albumen weight
SBTN	Snow ball tender nut
SCoT	Start codon-targeted polymorphism
SEM	Scanning electron microscopy
SGD	Sri Lanka green dwarf
SMCFA	Short- and medium-chain fatty acid
SNT	Solomon tall
SSAT	Strait Settlements
SSR	Simple sequence repeats
SV	Saponification value
TAG	Tagnanan tall
TAT	Tahiti tall
TCW	Tender coconut water
TDM	Total dry matter
TNAU	Tamil Nadu Agricultural University
TTPT	Tutupaen tall
VCO	Virgin coconut oil
VRD	Vanuatu red dwarf
VTT	Vanuatu tall
WAT	West African tall
WCLWD	Weligama coconut leaf wilt disease
WCT	West Coast tall
WTA	World Trade Agreement

Chapter 1
Introduction

N. M. Nayar

Abstract This chapter introduces the coconut palm to the reader. The coconut, *Cocos nucifera* L. (family Arecaceae), has been the most useful plant to the humans since every part of it has been finding an active economic use. Its importance has been diminishing in the present era. Coconut palm is the hallmark of the tropical beaches with its often slanting trunks and symmetrical crown. The members of the family Arecaceae are unique among plants because they are the longest living plants, since stem cells of several kinds remain throughout the life of palms.

For about a century from the dawn of the Industrial Revolution, the coconut oil was the most traded among all the vegetable oils. Its importance began to diminish with end of the Second World War. When the FAO began to publish area-production figures in 1961, the rank of the coconut oil had come down to 4th out of 14 traded vegetable oils in the world, and in 2011, it ranked as low as 11th. The reasons for the downslide have been analyzed. There are certain unique aspects of the coconuts in the world in matters of production and consumption that have been recorded for general information.

1.1 Introduction

The coconut palm (*Cocos nucifera* L., family Arecaceae) has been the most useful plant species to the humans (Nayar 2016). Every part of the palm was being put to active economic uses from very ancient times. The setting in of the Anthropocene Age has been marked in the coconut including those who habit the regions where the coconut is the "staff of life," but the status of coconut palm has continued largely as before in most of the regions of the world where the coconut matters. The coconut palm is the most ubiquitous plant species in the more than 30,000 islands that jot the tropical and subtropical seas of the Old World and in their littoral regions.

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It has been an integral component of the legends, lores, ethnobotany, and lives of the people of these vast regions from prehistoric times (Nayar 2016).

The coconut oil was the most traded vegetable oil for about a century from the mid-1850s until the end of the Second World War (1950s). Some of the European imperial powers had then set up large coconut plantations in their overseas colonies. In the years following the Second World War, the preeminent position began to slip down steadily, and presently, it is in a pathetic 11th position among the 14 oil crops for which the FAO reports production figures. There are several reasons for this. This may find an analysis in some of the following chapters.

1.2 The Uniqueness of the Palms

John Dransfield, the best known authority on palm taxonomy, has observed about the coconut palm that "the often slanting stems and graceful crowns of the coconut are largely responsible for the palms being considered the hallmark of the tropics" (Dransfield et al. 2008). Peter Tomilinson, the doyen of palm biology, has stated that "the palms are emblematic organisms of the tropics." They are the world's longest living trees, because stem cells of several kinds remain active in different tissues, throughout the life of the palms. Palms are distinctive from the other groups of organisms in that they can make tall and long-lived trees entirely by primary developmental processes, i.e., all the tissues are the direct result of continuously active root and shoot apical meristems. These explain why we are able to successfully transplant palms of any age at any new location. These are the attributes that make the palms in general and the coconut in particular unique and different from other plant species (Tomlinson 2006).

1.3 Development Perspectives of the Coconut Sector

The present status and the outlook for the coconut do not present a rosy picture. In the early 1960s, the coconut accounted for nearly ¼ of the total oil crops production and ranked 4th during the year 1961 in nut production among all the 14 vegetable crops recognized by the FAO – the first year from which the FAO began to maintain production statistics. In 2011 AD, after 50 years, it had come down to less than 1/7th (Tables 1.1 and 1.2) of the total oil seeds production. Presently, in 2018 the coconut is grown – or it occurs naturally – in 94 out of 284 countries and territories of the world (FAO STAT 2018).

1.4 The Poor State of Affairs of the Coconut

This is obvious from the data given in Tables 1.1 and 1.2. During the 50-year period, 1961–2011, the areas under coconut and total oil seeds increased by 2 $^{1/2}$ times and of rice by about 2 times. During this period, while the production of rice and oilseeds increased by more than five time each, that of the coconut increased by 2 $^{1/2}$ times only.

Table 1.1 Area and production of coconut, oil seeds, and rice 1961–2011

Commodity particulars		Year		
		1961	2011	Increase (%)
Coconut	Area M ha	5.3	12.0	251.2
	Production Mt	22.9	57.2	249.8
Oil seeds	Area M ha	113.6	280.1	246.6
	Production Mt	104.8	550.9	525.7
Rice[a]	Area M ha	115.3	215.7	187.1
	Production Mt	162.3	738.2	455.5

Source: Calculated from data downloaded from FAOSTAT, 11 July 2014
[a]Rice data given for comparison

Table 1.2 Production of vegetable oils in the world[a]

Crops	Production 10^6 t and ranking	
	1961	2011
Coconut oil	1.6 (4): 8.6%	3.1 (9): 1.95%
Cotton seed oil	2.2 (3)	5.2 (7)
Groundnut oil	2.5 (2)	5.7 (6)
Maize germ oil	1.5 (6)	2.3 (10)
Olive oil	1.3 (7)	3.6 (8)
Palm kernel oil	1.1 (8)	6.0 (5)
Rape and mustard	0.1 (12)	22.9 (3)
Rice bran oil	0.4 (10)	1.1 (11)
Sesame oil	0.4 (10)	1.1 (11)
Soybean oil	3.0 (1)	41.9 (2)
Sunflower oil	1.0 (5)	13.4 (4)
Other oil crops	2.2 (Not applicable)	16.1 (Not applicable)
Palm oil	0.4 (9)	48.5
Vegetable oil, total	18.6	159.2

[a]Calculated from data downloaded from FAOSTAT, 11 July 2014

The total production of oil has remained stagnant in 4/14 oil crops, coconut, cotton seed, groundnut, and maize germ; the production has increased 2–6 times in another four oil crops – olive, palm kernel, rice bran, and sunflower – those of oil palm, rape and mustard, and sunflower have increased phenomenally.

Each success story has been a different one: in a nutshell, in oil palm through low pricing and deft marketing, in cotton seed and rape and mustard through the removal of anti-nutritional factors, and, in sunflower, by improving its adaptability and expanding cultivation. In the coconut, no effort whatsoever has been done to either remove the stigma, about its consumption, or expand its uses. Hybrid coconuts give enhanced yields, but its impact on overall yield may be still insignificant.

1.5 Causes for Decline of Coconut

Let us now analyze the reasons for the decline of coconut from the 1950s. From this time, the soybean lobby in the USA mounted a strong lobbying against the palm-based vegetable oils (meaning coconut and oil palm oils highlighting the presence of anti-nutritional factors in them). There was then a prevailing suspicion that the polysaturated fatty acids present in the palm oils can cause cardiac problems. They managed even to get the American Medical Association to promote their stand. The palm oil industry undertook massive R&D efforts, to overcome the problem. They soon managed to develop a technique to fractionate the polysaturated fatty acid and market a liquid form of palm oil (palm olein) and market it at highly lower prices. No similar efforts were done in the case of coconut oil, even though it had the advantage that most of the saturated fatty acids contained in the coconut oil consist of medium- and short-chain fatty acids (Nayar 2016). For this reason, coconut oil continues to carry the stigma of having high levels of saturated fatty acids, while the case of palm oil is hardly ever raised because of its great price advantage also. This situation has had an adverse effect on the use and consumption of coconut and its oil (Tables 1.3 and 1.4).

Notwithstanding the above, the local populations of the countries of the world continue to use significantly high quantities of the coconut, its oil, and/or both

Table 1.3 Changes in production and the use of coconut and coconut oil, 1961 and 2011

Crops	1961			2011		
	Production 10^6 t	Food %	Processing %	Production 10^6 t	Food %	Processing %
Coconut	22.9	31.0	62.8	57.2	35.8	40.1
Oil seeds total	104.8	14.4	70.6	550.9	8.7	76.7
Coconut oil	16.0	88.8	0.12	3.1	67.8	0.42
Vegetable oil total	18.6	77.1	0.35	159.2	50.6	0.28

Source: Data from FAOSTAT, 11 July 2014

Table 1.4 Changes in food supply of coconut and coconut oil, 1961, 2011[a]

Item	Food supply capita^{-1}			
	(kg year^{-1})		Kcal day^{-1}	
	1961	2011	1961	2011
Coconut/copra	2.3	3.0	9.0	11.0
Oil seeds (total)	4.9	7.0	38.0	57.0
Coconut oil	0.5	0.3	11.0	7.0
Vegetable oils total	4.7	11.7	113.0	280.0

[a]Domestic supply, and not production, is used for calculation

Table 1.5 Countries of the world where the food supply of coconut and coconut oil is among the highest, 2011

Countries	Food supply			
	Coconut		Coconut oil	
	(kg cap^{-1}year^{-1})	(Kcal cap^{-1}day^{-1})	(kg cap^{-1}year^{-1})	(Kcal cap^{-1}day^{-1})
Fiji	62.9	190.0	3.2	77.0
Kiribati	123.2	62.1	5.0	120.0
Philippines	3.4	10.0	3.4	82.0
Samoa	173.8	530.0	3.7	91.0
Sao Tome and Principe	136.7	348.0	1.4	34.0
Solomon Island	143.0	226.0	0.8	22.0
Sri Lanka	66.3	272.0	2.2	55.0
Vanuatu	136.4	374.0	3.7	50.0
World	3.0	11.0	0.3	7.0

Source: FAOSTAT, downloaded 11 July 2014

(Table 1.5). Incidentally, there are no reports of any higher incidence of any coronary health problems in these countries.

1.6 Major Coconut-Growing/Coconut-Using Countries

The major coconut-growing countries of the world are listed in Table 1.6. Generally, such lists give advantage to the larger countries. To provide a better perspective, the countries are ranked with four criteria. They provide revealing insights. For instance, the Philippines, which ranks first or second in 3/4 criteria, is ranked last in the terms of yield ha^{-1}.

Further, there are some countries that have more area under coconut than the reported net cropped area of the respective country (Table 1.7). This appears to happen because coconut occurs naturally in such countries.

Table 1.6 Leading coconut-producing countries of the world, 2013[a]

Country	Area (M ha)[b]	Area (% net cropped area)[b]	Production (Mt)[b]	Yield (t/ha)[b]
Brazil	0.26 (6)	0.35 (11)	2.82 (4)	11.0 (1)
India	2.16 (3)	1.38 (9)	11.93 (3)	5.5 (5)
Indonesia	3.00 (2)	12.77 (3)	18.3 (1)	6.1 (4)
Malaysia	0.11 (11)	3.67 (7)	0.61 (10)	5.4 (7)
Mexico	0.17 (9)	8.50 (4)	1.10 (8)	6.5 (3)
Philippines	3.55 (1)	65.02 (2)	15.35 (2)	4.3 (10)
Sri Lanka	0.42 (5)	8.00 (5)	2.2 (5)	5.2 (8)
Thailand	0.20 (8)	1.26 (10)	1.01 (9)	4.8 (9)
Tanzania	0.68 (4)	4.69 (6)	0.58 (11)	0.9 (12)
Vietnam	0.14 (10)	2.14 (8)	1.31 (6)	9.6 (2)
Papua New Guinea	0.22 (7)	73.44 (1)	1.20 (7)	N.A. (6)

[a]Source: FAOSTAT downloaded 21 October 2014
[b]Figures in parenthesis give relative ranking in the respective item

Table 1.7 Coconut-growing countries of the world having relatively large areas under coconut

Countries	Country area (000 ha)	Arable area (000 ha)	Coconut area (000 ha)	% area under coconut
Fiji	1827.0	165.0	65.0	39.4
French Polynesia	400.0	2.5	22.0	880.0
Kiribati	81.0	2.0	30.0	1500.0
Maldives	30.0	3.0	1.1	36.7
Marshall Islands	18.0	2.0	6.5	325.0
Micronesia	70.0	2.0	17.0	850.0
Papua New Guinea	46,284.0	300.0	220.0	73.3
Samoa	284.0	8.0	27.0	337.5
Solomon Islands	2890.0	19.0	53.0	278.9
Sri Lanka	6561.0	1250.0	420.0	33.6
Tonga	75.0	16.0	9.3	38.1
Vanuatu	1219.0	20.0	98.0	490.0

Source: Calculated from data sourced from FAOSTAT, downloaded 21 October 2014

1.7 History of the Taxonomy of Coconut

The coconut is taxonomically *Cocos nucifera* L. (Sp. pl.1188 (1753)) (Dransfield et al. 2008). The classification of the species from the family downward is given below.

Family – Arecaceae/Palmae

Subfamily – Arecoideae (one of the five subfamilies)

Tribe – Cocoseae (1 of the 14 tribes)

Subtribe – Attaleinae (one of the three subtribes)

Genus – *Cocos* (1 of the 12 tribes)

Species – *nucifera* (monospecific)

Linnaeus used as type specimen the figure of the coconut palm and its parts given in the chapter on coconut – "Thengu" in the 10 volumes on the herbals of Malabar Coast, *Hortus Malabaricus* (1678–1693) written in Dutch language and published from Amsterdam. The figure of the type specimen and chapter on coconut are reproduced as annexure to the chapter.

1.8 Brief History of *Cocos* Classification

The genus *Cocos* is now monospecific. But it has been so only since 1966. Prior to this, new species were being added to the coconut. Beccari (1916) transferred all the more than 90 *Cocos* species and then included *Cocos* to other genera (except *nucifera*), mostly to Butia and *Syagrus*, (refer also IPNI list 2015). This list has 180 extant names of *Cocos nucifera*.

Annexure I: Description of Coconut (*Cocos nucifera*) Given in Linnaeus C (1753)

HORTUS MALABARICUS

ON VARIOUS KINDS OF TREES
AND PODDED FRUITS

Described in Latin, Malayalam, Arabic and Brahmanic characters and names,
with the addition of a true delineation of flowers, fruits and seeds in their natural size
and with an accurate description of (their) colours and properties

Adorned by
The Most Noble and Generous Lord
HENRY VAN RHEDE TOT DRAAKESTEIN,
Chief ruler in Mydrecht, once the Governor of the Supreme Council of the Malabar Kingdom,
Extraordinary Senator among the Indian Belgians but now one among the Renowned and
Most Valiant Nobles of Utrajactine Province under the name of Equestrian Order

and
THEODORE JANSON of ALMELOVEEN, M.D.

Enriched with notes and illustrated with commentaries by
JOANNES COMMELINUS

Printed at Amsterdam
with the expense met by: Widow of John van Someren, heir of John van Dyck,
Henry and Widow of Theodore Boom
in the year 1678.

PART ONE OF THE MALABAR GARDENS ON TREES

Tenga

TENGA, in the language of the Brahmins *Mado*, is a tree with erect stem, rising high and growing in sandy soil. The root with thick bark (which is) reddish and turns dark is internally with soft wood, spreading (its) fibres copiously and transversely.

The stem erect, one foot thick, with the maximum thickness coming up to two feet in one part with leafy branches which arise only from the apex growing taller and taller (higher and higher) surrounded at the tip in a decussate manner like a crown, and in the bark on rind turning dark, which cannot be peeled off, grooved (furrowed) with semicircular rings and marks by which the base of the branches were attached, and consists of less hard wood, and interwoven with thick filaments and becoming red or reddish, inwardly soft and more hard towards the bark, when older, is more hard and more dark, which when exposed to open air, is liable to rooting within two or three years, is more durable under water, the apex of which is surrounded by tender branches, while becoming taller and taller tapers into a cone and consists of a soft and whitish pulp or core which is called *Palmita* in Portuguese language, which on the outside is covered with various mutually intertwining coating

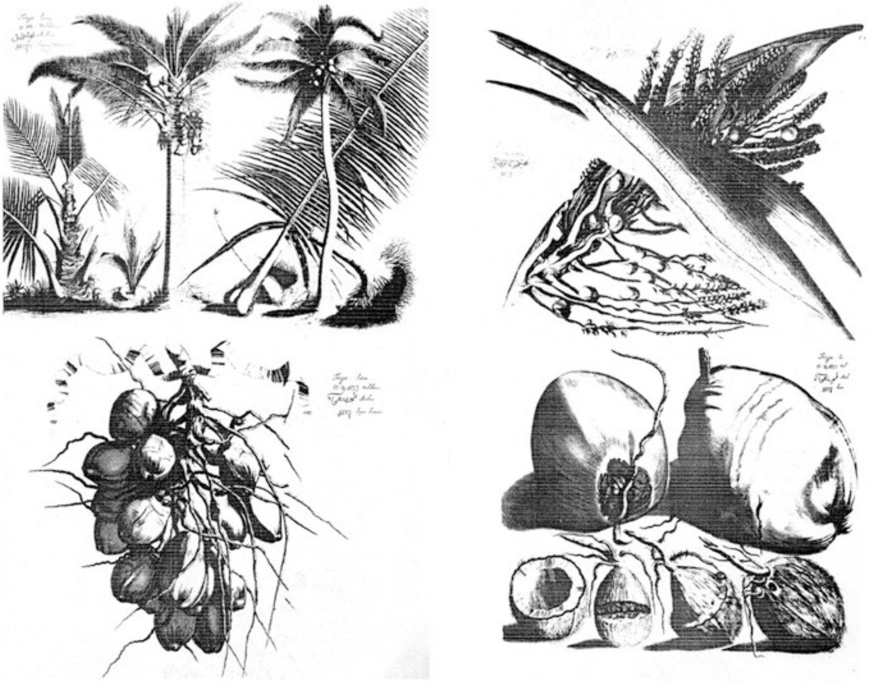

Fig. 1.1 The type specimens of coconut *Cocos nucifera* L .
Figures givenin Linnaeus C (1753)

and inside is solid. When *Tenga* is young and one cubit in height, this is sweet and is of pleasing taste, when older, of less pleasing and astringent taste, and with no sweetness at all, when taller and older is of more sweet and most pleasing taste, emulating our walnuts, and is edible, and is much sought after by elephants, which because of its extreme liking, uproots these trees. The foliage branches are simple, not divided into others, in the base by which they tightly cling to them, interiorly plane and concave and from above interiorly reduced to a pointed curving protuberance, externally on the whole convex, broader in the lowest part of its base and thence gradually becoming narrow and becoming thin at the edges, and with a red-brown, reticulate, smooth rind the filaments of which arise from the margins of the base on both sides, first clothe all around the stem and mutually cover themselves, and are as if with a yellow green bark and inside consisting of hard woody filaments covering soft, whitish flesh. Those that are older droop down from the stem and are curved, then fall down one after another at fixed time, while others arise anew from the apex of the stem.

The leaves which cover the upper part of the branches up to their flat part where they are thinned down to the belly and arise obliquely in the margins and are placed opposite to each other, and are narrow, oblong, more or less six cubits in length, three transverse fingers in breadth, from the origin (base) gradually contracted to a narrow point, with a very flat surface, grooved (marked) lengthwise on the lower side, with parallel and subtle veins, towards the base with a whitish light yellow suture curving to an angle, are inserted and towards the exterior part somewhat closed from the angle of the suture and in the interior which meets with the interior surface of the branch is a rib standing out very much, which marks the exterior part with a furrow, situated in the middle, is of dark and shining greenness, when they wither they turn yellow, are of no taste and smell except that of forest (wild).

From above the origin of the foliaceous branches from the stem, there arise oblong capsules in which tender flowers and fruits inserted to stalks are enclosed; these capsules are round and somewhat smooth, three or four spans long, more narrow and more yellow towards the base and at the tip constructed into a cone, almost half a finger in breadth, the thick rind striated lengthwise with veins and woody filaments, externally green and marked with furrows and layers which deepen towards the tip, internally and smooth.

The fruit – bearing stalks, while enclosed within the case are smooth and shining and are glandular towards the base, (are) angular and curved with undulating hollow spaces, some (are) more straight others proceed in a somewhat zig-zag fashion (and) are placed around a more thick middle branch, and tapers to a point towards the tip of the case (capsule) and are closely packed together and on rupture of the capsule they spread out