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# Genetic Resources of Coconut

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## 1. INTRODUCTION

It is presumed that the generic name, *Cocos* as well as the popular name coconut are derived from the Spanish word 'coco' meaning 'monkey face' probably a reference to the three scars on the base of the shell resembling a monkey's face (Rosengarten, 1984). The origin of coconut was placed by Martius (1850) on the West Coast of Central America near the Isthmus of Panama. On the basis of evidences for the cultivation of coconut in Sri Lanka by about BC 300, as well as the discovery of a fossil (Pliocine) *Cocos* in New Zealand (Hill, 1929) and in the deserts of Rajasthan (Kaul, 1951), the theory of Central American origin has been disputed. Early Spanish explorers discovered the cultivation of coconut on the Pacific Coast of Panama in pre-Columbian times. The first report of appearance of coconut in Western Mexico came around 1540 AD and it is believed to have spread to Mexico in the last decade of the 16th century (Bruman, 1945). Coconut might have been carried to Mexico by ocean currents from Polynesia before the discovery of the New World (Purseglove, 1972). The available evidences point to the domestication of coconut in the Indo-Pacific area (de Candolle, 1886; Beccari, 1917; Vavilov, 1951; Corner, 1966; Child, 1974). According to the most widely accepted theory, the origin of coconut is in the Old World, somewhere in Southeast Asia or the Pacific Islands from where it might have been transported to other regions either by man or by sea currents. Evidences are available in literature regarding the germination capacity of coconut even after floating in sea for a period of 110 days and within this period it is capable of travelling upto 4900 kilometers (Edmondson, 1941). This indicates the possibility of natural dissemination between islands in the Pacific and Indian Oceans (Harries, 1978).

## 2. GENETIC VARIABILITY AND VARIETIES

Tall and Dwarf are the two distinct varieties of coconut.

### 2.1 Tall Palms

The tall palms, sometimes referred as var. *typica* Nar., are the most commonly cultivated in all the coconut growing areas of the world. Tall palms generally grow to a height of 25-30 m and have a comparatively long pre-bearing age of 6-10 years. They

are normally cross-pollinated as there is usually no overlapping of male and female phases. Fruit is generally medium to large in size and nuts mature within a period of 12 months. The copra content is usually over 150 g/nut and oil percentage varies from 66 to 70. West Coast Tall, (Fig. 1a) Laccadive Ordinary, (Fig. 1b) East Coast Tall and Andaman Ordinary are some of the distinct tall types present in India.

### 2.2 Dwarf Palms

Dwarf palms, sometimes referred to as var. *nana* (Griff.) Nar., are characterised by their short stature. They are quicker to come to bearing (3-4 years), easier to harvest and short-lived. They have thin trunks without a swollen base or 'bole' and fully developed fronds rarely exceed 4 m. Though the dwarf palms yield heavily, they have a tendency to irregular bearing. Dwarfs are identified mainly by the colour of their nuts. They are presumed to have originated from tall palms either through mutation (Menon and Pandalai, 1958) or by inbreeding in talls (Swaminathan and Nambiar, 1961). In India, three important dwarf types found are Chowghat Green Dwarf and Chowghat Orange Dwarf mainly described by the colour of their nuts and petiole, from Kerala and Gangabondam, a green dwarf from Andhra Pradesh (Fig. 2). The copra content in dwarfs ranges from 90 g to 120 g/nut and oil percentage is about 65.

### 2.3 Intermediate Types

In India, in addition to these two groups, there are few other distinct tall types such as Laccadive Micro, Kappadam, Andaman Giant, Calangute, Nadora and Benaulim. Ramachandran *et al.* (1977) reported Ayiramkachi an intermediate type between tall and dwarf in Tamil Nadu.

## 3. COLLECTION AND CONSERVATION

The earliest exotic introductions into India were in 1924 from the Philippines, Malaysia, Fiji, Indonesia, Sri Lanka and Vietnam which formed the nucleus population for many of the research programmes. The germplasm exchange programme was further intensified in 1952 and in 1958 surveys for collection of indigenous germplasm was started.

At present, the Central Plantation Crops Research Institute, Kasaragod, is maintaining the World's largest assemblage of germplasm of 41 indigenous and 86 exotic cultivars. The exotic collections from 22 countries of South and South East Asia, Caribbean Islands, Indian Ocean Islands, Pacific Ocean Islands and African countries comprise 72 talls, 12 dwarfs, one semi-tall and one hybrid (Table 1A). These include the collection made by a team of two scientists from CPCRI based on a survey in seven Pacific Ocean Territories during 1981. The purpose of the survey was to collect and conserve coconut germplasm with a view to screening for their reaction to root (wilt) disease prevalent in 8 southern districts of Kerala. A total of 24 collections of which 21 talls and 3 dwarfs were made using the descriptor approved by the IBPGR (1978) and all the tall cultivars were sampled randomly and the dwarf cultivars sampled on a biased basis due to the

(a)

(b)

**Fig. 1 :** Promising coconut talls — (a) West coast tall; (b) Laccadive ordinary.

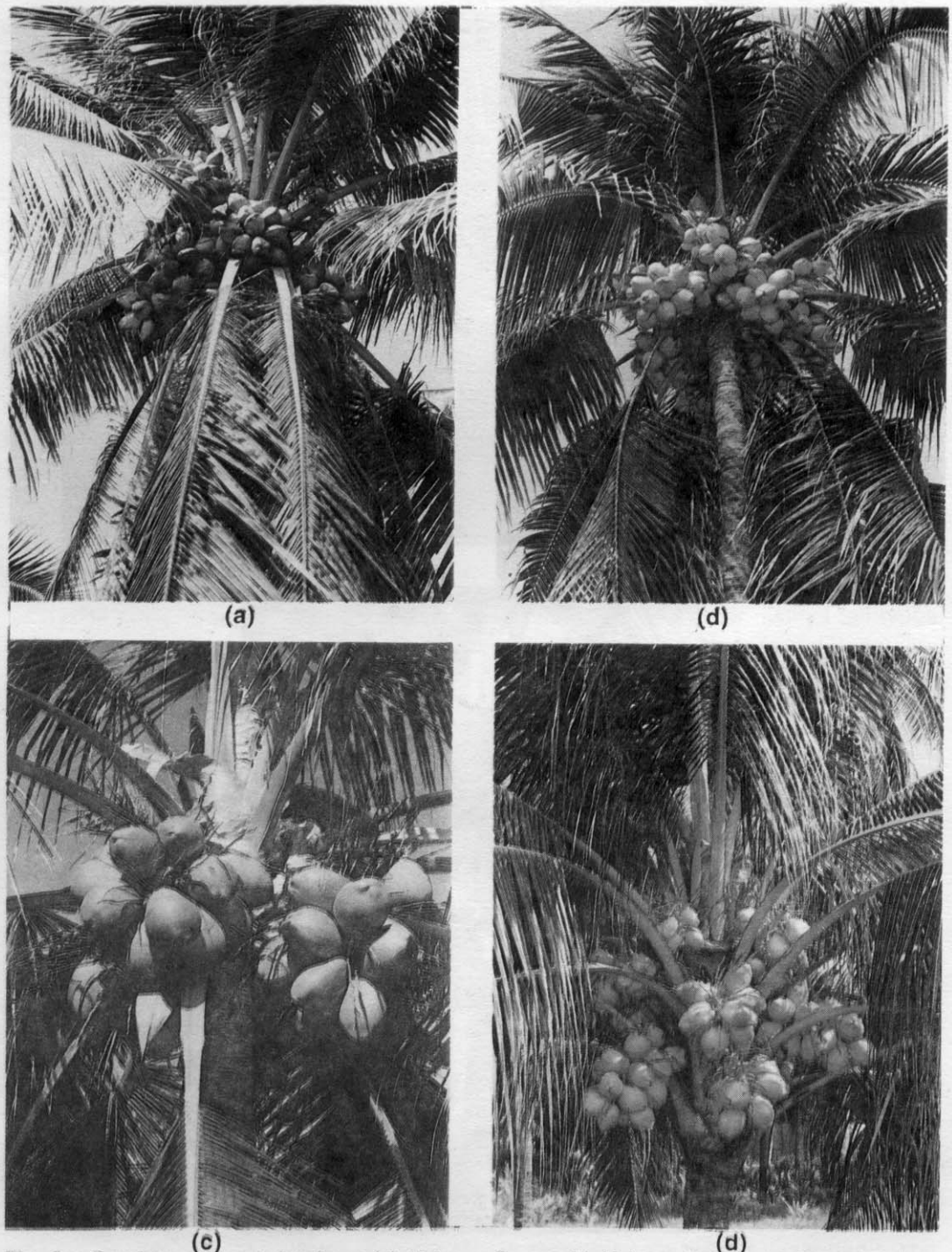


**Fig. 2 :** Promising coconut dwarfs — (a) Malayan Green; (b) Malayan Yellow; (c) Gangabondam; (d) Chowghat Orange.

**Table 1** : Coconut germplasm accessions at CPCRI (Kasargod and Sipighat).

A. *Exotic accessions*

| Source of collection | No. of accessions | Sl. No. | Name of cultivar | No. of Palms | |
|---|---|---|---|---|---|
| | | | | Talls | Dwarfs |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **South East Asia** | | | | | |
| Borneo | 3 | 1 | Borneo | 20 | — |
| | | 2 | Kongthienyong | 8 | — |
| | | 3 | Standard Kudat | 13 | — |
| Indonesia | 1 | 4 | Java | 24 | — |
| Malaysia | 8 | 5 | Malayan Orange Dwarf* | — | 26 |
| | | 6 | Malayan Yellow Dwarf* | — | 40 |
| | | 7 | Malayan Green Dwarf* | — | 37 |
| | | 8 | Malayan Tall | 2 | — |
| | | 9 | F.M.S. | 22 | — |
| | | 10 | Klapawangi | 9 | — |
| | | 11 | S.S. Green | 30 | — |
| | | 12 | S.S. Apricot | 14 | — |
| Philippines | 7 | 13 | Phil. Ordinary | 28 | — |
| | | 14 | Phil. Laguna | 6 | — |
| | | 15 | Phil. Kalambahim | 2 | — |
| | | 16 | Phil. Lono | 13 | — |
| | | 17 | Phil. Palawan | 3 | — |
| | | 18 | Phil. Dalig | 8 | — |
| | | 19 | San Ramon | 56 | — |
| Vietnam | 1 | 20 | Cochin China | 26 | — |
| **Pacific Ocean** | | | | | |
| Papua New Guinea | 9 | 21 | New Guinea | 41 | — |
| | | 22 | Markham Tall | 12 | — |
| | | 23 | Karkar | 14 | — |
| | | 24 | Dwarf spikeless | — | 3 |
| | | 25 | New Guinea I (Kiriwana) | 37 | — |
| | | 26 | New Guinea II (Tall Muwa) | 47 | — |
| | | 27 | New Guinea III (Nikkore) | — | 31 |
| | | 28 | New Guinea IV (Kavieng) | 28 | — |
| | | 29 | New Guinea V (Natava Tall) | 55 | — |
| New Caledonia | 6 | 30 | Nufella | 5 | — |
| | | 31 | Nugili | 7 | — |
| | | 32 | Nuwallis | 2 | — |
| | | 33 | Nu Que Wen | 4 | — |
| | | 34 | Nuwe Hung | 5 | — |
| | | 35 | Nuhimi Kupin | 2 | — |

(Contd.)

**Table 1** : Contd.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| New Hebrides | 1 | 36 | New Hebrides Tall | 1 | — |
| Tonga Islands | 3 | 37 | Niu Ui | 43 | — |
| | | 38 | Niu Taukave | 9 | — |
| | | 39 | Niu Hako | 83 | — |
| Fiji Islands | 9 | 40 | Fiji Ringed Nut | 1 | — |
| | | 41 | Fiji Longtongwan | 7 | — |
| | | 42 | Fiji Rotuma | 30 | — |
| | | 43 | Fiji Tall | 44 | — |
| | | 44 | Niu Leka | — | 13 |
| | | 45 | Waini Gata | 58 | — |
| | | 46 | Niu Drau | 22 | — |
| | | 47 | Fiji III (Niu Leka II) | — | 71 |
| | | 48 | Niu Bulavu | 53 | — |
| American Samoa | 3 | 49 | Tutiala | 58 | — |
| | | 50 | Niu Oma | — | 10 |
| | | 51 | Samoan Tall | 27 | — |
| French Polynesia | 7 | 52 | Mataica | 30 | — |
| | | 53 | Pao Pao | 45 | — |
| | | 54 | Haapiti | 34 | — |
| | | 55 | Bora Bora | 10 | — |
| | | 56 | Hari Papua | — | 24 |
| | | 57 | Rangiroa Tall (Avatoru) | 19 | — |
| | | 58 | Tiputa | 10 | — |
| Guam | 3 | 59 | Guam I | 8 | — |
| | | 60 | Guam II | 8 | — |
| | | 61 | Guam III | 3 | — |
| Lifou | 1 | 62 | Lifou Tall | 10 | — |
| Solomon Islands | 3 | 63 | B.S.I. | 13 | — |
| | | 64 | Solomon Tall | 3 | — |
| | | 65 | Rennel Tall | 2 | — |
| **Central America, South America and Atlantic Region** | | | | | |
| Surinam | 2 | 66 | Surinam Tall | 7 | — |
| | | 67 | Surinam Dwarf | — | 5 |
| Jamaica | 2 | 68 | Jamaica Tall | 8 | — |
| | | 69 | Jamaica Sanblas | 28 | — |
| Trinidad | 2 | 70 | St. Vincent | 16 | — |
| | | 71 | Blanchissuse | 11 | — |
| Panama | 1 | 72 | Panama Tall | 5 | — |
| **African Region** | | | | | |
| Nigeria | 2 | 73 | Nigerian Tall | 6 | — |

(Contd.)

**Table 1** : Contd.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| | | 74 | **Nigerian Dwarf** | — | 6 |
| Kenya | 1 | 75 | **Kenya Tall** | 22 | — |
| Ivory Coast | 3 | 76 | **Cameroon Dwarf** | — | 11 |
| | | 77 | **West African Tall** | 19 | — |
| | | 78 | **Mawa (PB 121)**** | 25 | — |
| Zanzibar | 1 | 79 | **Zanzibar Tall** | 15 | — |
| **Indian Ocean** | | | | | |
| Sri Lanka | 6 | 80 | Ceylon Tall | 11 | — |
| | | 81 | Gonthembili | 7 | — |
| | | 82 | King Coconut | — | 14 |
| | | 83 | Ceylon Yellow Dwarf | — | 1 |
| | | 84 | Ceylon Green Dwarf | — | 2 |
| | | 85 | Ceylon Orange Dwarf | — | 1 |
| Seychelles | 1 | 86 | Seychelles | 7 | |
| | | | Talls | 69 | |
| | | | Dwarfs | — | 16 |
| | | | Hybrid | 1 | — |
| | | | | 70 | 16 |
| | | | **Total** | | 86 |
| *B. Indigenous accessions* | | | | | |
| Kerala | 6 | 1 | Chowghat Orange Dwarf | — | 84 |
| | | 2 | Chowghat Green Dwarf | — | 36 |
| | | 3 | Kaithathali | 1 | — |
| | | 4 | Kappadam | 14 | — |
| | | 5 | Spicata | 19 | — |
| | | 6 | West Coast Tall | 77 | — |
| Tamil Nadu | 8 | 7 | Adirampatnam | 1 | — |
| | | 8 | Ayiramkachi | 18 | — |
| | | 9 | Kulasekharam Green Dwarf | — | 55 |
| | | 10 | Kulasekharam Orange Dwarf | — | 30 |
| | | 11 | Kulasekharam Yellow Dwarf | — | 50 |
| | | 12 | Pattukottai Green Dwarf | — | 4 |
| | | 13 | Pattukottai Red Dwarf | — | 1 |
| | | 14 | East Coast Tall | 35 | — |
| Karnataka | 3 | 15 | Kenthali | — | 4 |

(Contd.)

**Table 1** : Contd.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| | | 16 | Tiptur Tall I | 4 | — |
| | | 17 | Tiptur Tall II | 5 | — |
| Andhra Pradesh | 5 | 18 | Gangabondam | — | 44 |
| | | 19 | Gangabhavani | 2 | — |
| | | 20 | Gangapani | 5 | — |
| | | 21 | Rangoon Kobbari | 9 | — |
| | | 22 | Verrikobbari | 4 | — |
| Goa | 3 | 23 | Benaulim | 13 | — |
| | | 24 | Calangute | 10 | — |
| | | 25 | Nadora | 11 | — |
| Gujarat | 1 | 26 | Gujarat Zanzibar | 9 | — |
| Orissa | 1 | 27 | Sakhi Gopal | 7 | — |
| Andamans | 11 | 28 | Andaman Ordinary | 34 | — |
| | | 29 | Andaman Giant | 25 | — |
| | | 30 | Andaman Ranguchan | 19 | — |
| | | 31 | Andaman Dwarf | — | 5 |
| | | 32 | Carnicobar | 58 | — |
| | | 33 | Auck Chung | 36 | — |
| | | 34 | Tamaloo | 36 | — |
| | | 35 | Kimos | 36 | — |
| | | 36 | Kimmai | 36 | — |
| | | 37 | Katchal | 35 | — |
| | | 38 | Campbell Bay | 34 | — |
| Lakshadweep | 3 | 39 | Laccadive Ordinary | 76 | — |
| | | 40 | Laccadive Micro | 37 | — |
| | | 41 | Laccadive Orange Dwarf | — | 2 |
| | | | Talls | 30 | — |
| | | | Dwarfs | — | 11 |
| | | | **Total** | | **41** |

**Hybrid

low frequency of their occurrence. These collections included the well-known cultivars such as Rennel Tall, Solomon Tall, Fiji Tall, Samoan Tall, Tahiti Tall, Rangiroa Tall and Dwarf Yellow (American Samoa), Dwarf Orange (Rangiroa) and Niuleka Dwarf (Fiji). These collections were planted at the CPCRI World Coconut Germplasm Centre, Sipighat, Andamans for quarantine consideration (Rao and Koshy, 1982). The indigenous collections from Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Orissa, Andaman & Nicobar Islands and Laccadive Islands comprise of 30 talls and 11 dwarfs (Table 1B).

Germplasm collections are also being maintained at Pilicode under Kerala Agricultural University and four Coordinated Centres in Tamil Nadu (Veppankulam),

Karnataka (Arsikere), Andhra Pradesh (Ambajipeta) and Maharashtra (Ratnagiri) to assess their regional adaptability (Table 2).

As most of the exotic types available at CPCRI have been assembled through germplasm exchange, data on the site of collection and source characters are not available. The recording is confined to appropriate entry in the Introduction Register

**Table 2 :** Coconut germplasm available in the co-ordinating centres.

| S.No. | Centres | Exotic | Indigenous | Total |
|---|---|---|---|---|
| 1. | Aliyarnagar | 13 | 6 | 19 |
| 2. | Ambajipeta | 6 | 5 | 11 |
| 3. | Andamans | — | 8 | 8 |
| 4. | Arsikere | 11 | 2 | 13 |
| 5. | Coimbatore | 2 | 5 | 7 |
| 6. | Jagadalpur | 11 | 5 | 16 |
| 7. | Jalalgarh | 11 | 5 | 16 |
| 8. | Konark | 11 | 2 | 13 |
| 9. | Mondouri | 11 | 1 | 12 |
| 10. | Pilicode | 28 | 34 | 62 |
| 11. | Ratnagiri | 11 | 6 | 17 |
| 12. | Veppankulam | 15 | 15 | 30 |

[illegible] details about the source, country of origin and local names mostly derived based [illegible] colour (green, yellow, orange etc.) bearing capacity (e.g. Ayiramkachi—1000 [illegible] size of nut (e.g. Kappadam-big nut), leaf characteristics etc. In some cases the name indicates the secondary source of introduction (Gujarat—Zanzibar, Kulasekharam—Malayan Dwarfs etc.) (Rao and Nayar, 1980).

## 4. DOCUMENTATION

The IBPGR Consultation on Coconut Genetic Resources held in January, 1978 at FAO Headquarters identified a minimum list of descriptors to be used in collecting the field data (IBPGR, 1978). The IBPGR descriptor list is mainly based on the descriptor made available by CPCRI and includes information on collection, evaluation, maintenance and occurrence of diseases.

## 5. EVALUATION

### 5.1 Nursery Stage

Descriptors used for evaluation at the nursery stage fall into two categories i.e. identifier and actual measurements. The local name and accession number fall into first category. The number of days for germination, leaf length, leaf width, girth at collar and leaf showing first splitting fall into the second category.

### 5.2 Juvenile Stage

From the time the seedlings are transplanted into the field, the palm number has an important role as the identification is based on this number. As there is a time lag of 15-20 years between the initial introduction and final yield evaluation, it is absolutely necessary to maintain the individual identity within the accession for any numerical evaluation. The data on leaf production, leaf length, increment in girth and other growth parameters are recorded in the juvenile stage (before flowering, 5-6 years old).

### 5.3 Evaluation for Agronomic Characters

Three registers are used for recording the data collected from the time the palm starts bearing. The Flowering Notes Register includes description on duration of male phase, duration of female phase, female flower distribution, length of peduncle, number of inflorescences produced and aboration of bunches. The Harvest Register (Yield Register) includes the mean number of female flowers per bunch, number of nuts harvested, and setting percentage. The Nut Characters Register includes data collected from nut analysis, fruit shape and nut shape (qualitative descriptors) and weight of fruits, nut and nut without water, meat (kernel) and copra (at 6% moisture content) (IBPGR, 1978).

### 5.4 Evaluation for Yield

Evaluation of coconut germplasm is a long drawn process due to its long juvenile phase and also time taken for stabilisation of yield. For evaluating at the nursery stage, seedling characters such as the sprouting period of seed nuts, number of leaves, girth at collar and seedling height are generally used (Satyabalan and Mathew, 1976). Most of these characters have correlation with the adult palm bearing. An index was developed by Rao and Mathew (1981) using mean and CV of these characters for evaluation and characterisation of coconut germplasm at the nursery stage. The number of days taken for germination has negative and significant correlation with yield and mean value for this characters were ranked in ascending order and characters with positive correlation were ranked in desending order. The graph with mean on x axis and cv. on y axis has been arbitrarily divided into 4 sectors, taking the mid values on both axes. The cultivars in sector 1 are with high mean values for characters scored and low variability. Their low CV indicated relative homozygosity. Sector 4 accounts for cultivars with low mean value and high variability indicating highly heterozygous nature of these cultivars. Those cultivars falling in group 1 can be considered as promising. Usually the performance of a cultivar is evaluated against the local material only after stabilisation of yield, which may take 15-20 years after planting. However, Rao, Satyabalan and Mathew (1978) found that it is possible to evaluate the germplasm accession at an early stage as the cumulative yield of first eight years had high correlation ($R^2 = 0.95$) with the stabilised yield.

Among the exotic cultivars Fiji Tall, Fiji Longtongwan from Fiji Islands, Philippines Ordinary, Philippines Laguna from Philippines and Strait Settlement Green (SS Green)

from Malaysia are superior to the local cultivar West Coast Tall yielding over 30 per cent more nuts and 80 per cent more copra. Among the indigenous cultivars Kappadam, Andaman Ordinary and Laccadive Ordinary have higher yield potential than the local West Coast Tall. The performance of promising cultivars of exotic and indigenous origin is given in Table 3.

**Table 3 : Performance of promising coconut cultivars at CPCRI, Kasargod.**

| Cultivar | Mean Yield of nuts/palm/year (17-20 years) | | Copra yield | | |
|---|---|---|---|---|---|
| | No. | % over WCT | *Nut (gm) | Palm/year (kg) | % over WCT |
| **Exotic** | | | | | |
| 1. Fiji Tall | 106 | 55.9 | 179 | 19.0 | 86.3 |
| 2. Fiji Longtongwan | 104 | 52.9 | 210 | 21.8 | 113.7 |
| 3. Philippines Ordinary | 108 | 58.8 | 198 | 21.4 | 109.8 |
| 4. Philippines Laguna | 88 | 29.4 | 209 | 18.4 | 80.4 |
| 5. S.S. Green | 108 | 58.8 | 189 | 20.4 | 100.0 |
| **Indigenous** | | | | | |
| 1. Kappadam | 90 | 32.4 | 299 | 26.9 | 163.7 |
| 2. Andaman Ordinary | 94 | 38.2 | 169 | 15.9 | 55.9 |
| 3. Laccadive Ordinary | 98 | 44.1 | 169 | 16.6 | 62.7 |
| 4. West Coast Tall | 68 | — | 150 | 10.2 | — |

Based on the overall performance in the four co-ordinating centres in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and at CPCRI, Kasargod, Laccadive Ordinary has been recommended for release under the name 'Chandra Kalpa'. This cultivar gave 33 per cent more yield in terms of nuts and 30 per cent more copra yield at stabilised bearing period (Anonymous, 1985). Recently, Banawali Green Round with a mean number of 151 nuts and copra out turn of 22.8 kg has also been released.

The classification system based on fruit component analysis (Harries, 1978) and time taken for germination were adopted by Rao and Pillai (1982) to identify the degree of introgression in 40 accessions.

## 5.5 Evaluation for Special Characters

### 5.5.1 *Drought*

Rajagopal, Kasturi Bai and Voleti (1990) screened ten tall and six dwarf cultivars for the tolerance to drought using the sensitive parameters namely stomatal resistance (rs), leaf water potential ($\psi$) and epicuticular wax content (ECW). They observed that the coconut genotypes have varying response to the prevailing soil and atmospheric droughts during the summer months. In June, tall genotypes had relatively high rs, $\psi$

and ECW as compared to the dwarfs. They concluded that it is possible to identify desirable drought tolerant characters in coconut genotypes under field conditions.

### 5.5.2 *Root (Wilt) Disease*

Studies on identifying coconut genotypes resistant/tolerant to root (wilt) disease were initiated by Varghese in 1934. Starting from 1961, CPCRI Regional Station, Kayamkulam has made considerable efforts to screen the available cultivars for their tolerance to root (wilt) disease (Menon, Thommen and Sukumaran, 1981). Large scale field experiments were undertaken during 1972 in CPCRI Regional Station, Kayamkulam and also in cultivators' gardens in 63 villages of Alleppey, Quilon and Kottayam districts. Further screening trial involving 27 cultivars were laid out in cultivators' gardens during 1982. Twenty-four exotic accessions collected from South Pacific Ocean Islands during 1981 are under evaluation at the CPCRI World Coconut Germplasm Centre, Sipighat in Andamans. *Inter se* and *selfed* seed nuts are being produced from these accessions and the first batch of seedlings from these sources were planted in the 'hot spot' areas for screeing for resistance/tolerance to root (wilt) disease. Thirty five West Coast Tall high yielding palms were identified based on intensive survey covering heavily diseased tracts ('hot spots') of Alleppey, Kottayam, Quilon and Pathanamthitta districts. These palms were confirmed to be disease free based on serological and physiological tests and these palms are being utilized in breeding programme to evolve resistant/tolerant varieties in root (wilt) disease (Jacob and Rawther, 1991).

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