

READY RECKONER ON COCOA, COCONUT AND ARECANUT



ICAR- Central Plantation Crops Research Institute- CPCRI
Kasaragod, Kerala - 671 124



Ready Reckoner No.: 1

Ready Reckoner on Cocoa, Coconut and Arecanut

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COCOA



READY RECKONER ON COCOA

- 1 Cocoa : The Chocolate tree (*Theobroma cacao* L.)
- 2 Family of cocoa : Sterculiaceae/ Malvaceae
- 3 Chromosome no. of cocoa : $2n = 20$ (Diploid)
- Genome of cocoa sequenced in : 2010 (440 Mb)
- 4 Cocoa is native to : South America (Brazil, Amazon basin)
- 5 Cocoa is known as : Food of the Gods (*Theobroma*)
- 6 Cocoa is grouped as : Beverage, Industrial, Commercial and Plantation crop
- 7 Economic part or cocoa of commerce : Dry beans or cured beans
- 8 The term chocolate derived from : 'Xocoatl'- the bitter, energy drink prepared by Amazonian tribes Mayas, Aztecs, Tolecs
'Cacahuatl' - cocoa beans
- 9 Stimulative alkaloid of cocoa : Theobromine
- 10 Species diversity in *Theobroma* & related genera : 22 species, *Theobroma bicolor*, *angustifolium*, *grandiflorum*, *microcarpum*, *mammosum*, *simiarum*, *speciosum* and *subincanum*.
Cola nitida (*Kola fruit/ Cola drink*), *Herrania nitida*
- 11 Preferred climate of cocoa : Humid tropics
- 12 Cocoa growing models : Agro- Forestry System
(under-storey crop with trees)
Palm based cropping systems
(under arecanut, coconut, oil palm)
- 13 Shade requirement of cocoa : 50% shade and 50% sunlight
- 14 Permanent shade trees for cocoa : Timber trees, Forest trees, Fruit trees, Palms
- 15 Temporary shade trees for cocoa : *Glyricidia*, Tapioca, Plantain, Banana

- 16 Major producers of cocoa in the world : Africa- Ivory Coast, Ghana, Nigeria, Cameroon
Central & South America- Brazil
Asia- Indonesia
- 17 Cocoa introduced into India : 1798, Courtallam Tirunelveli Dt. of TN (old Madras state)
- 18 Suitable agro climatic zone for cocoa : Western ghats hills and plains
Irrigated gardens of palms
- 19 Major states growing cocoa in India : Kerala, Karnataka, Tamil Nadu, Andhra Pradesh
- 20 Growth habit of cocoa : Branching in multiple tiers
- 21 Chupons and Fans in cocoa : **Chupons:** Orthotropic shoots giving vertical, upward growth.
Fans: Plageotropic shoots giving oblique, lateral growth.
- 22 Jorquette/ Jorquetting in cocoa : The point at which fans arise and the process of formation of fan branches.
- 23 Dimorphic shoots of cocoa : In chupons - Spiral leaf arrangement, phyllotaxy 3/8, long petiole, pronounced pulvinus.
In fans - Alternate leaf arrangement, short petiole, inconspicuous pulvinus.
- 24 Nature of bearing in cocoa : Truncate/ Cauliflorous (flowering and fruiting in trunk/ stem)
- 25 Cushions in cocoa : Flower bearing thickened leaf axils are called as cushions, which are distributed over full tree in main stem and branches.
Inflorescence- Compressed Cyme
- 26 Average no. of flowers/ cushion in cocoa : 50
- 27 % of successful pollination in cocoa : 1-5%
- 28 Crazy flowering in cocoa : Immediately after hot season if rained, the tree shows sudden profuse flowering.

- 29 Specific floral parts of cocoa : Staminodes (sterile stamens), pouch like petal (ligule), reddish guidelines in petals
- 30 Pollinating agents of cocoa : Midges- *Forcipomyia*
- 31 Breeding behavior of cocoa : Cross pollinated and presence of self- incompatibility.

Self- incompatibility: Failure of fertilization even though both male and female parts of the bisexual flowers are fully functional.

- 32 Nature of self- incompatibility in cocoa : Majority Gametophytic self- incompatibility (pollen will germinate but does not fuse)

Gametophytic incompatibility: A phenomenon controlled by the complex S locus in which a pollen grain cannot fertilize an ovule produced by a plant that carries the same S alleles as the pollen grain.

- 33 Type of cocoa fruit : Indehiscent Drupe and called as Pod, having thick husk, 30-50 seeds/ beans covered with mucilaginous pulp.
- 34 Cherelles in cocoa : Young immature fruits/ pods
- 35 Cherelle wilt in cocoa : Physiological natural thinning mechanism (wilting at 25, 50, 70 days after pollination)
- 36 Types of cocoa : Criollo (Fine cocoa)
Forastero (Basic cocoa)
Trinitario (Bulk cocoa)- Natural hybrid of Criollo x Forastero

Criollos: Red to orange pods, deeply furrowed, pointed apex, thin husk, white or pale violet, large, plump, round beans, less astringent, good flavour, quick fermentation (3- 4 days), less yield, less adaptive, susceptible to pests and diseases.

Forasteros: Green to yellow pods, smooth surfaced, rounded apex, thick husk, purple, flat beans, astringent, 5-6 days for fermentation, high yield and highly adaptive.

Trinitarios: Heterogenous, mixture of pod and bean characters, high yield and tolerant.

- 37 Amelonado cocoa : Melon shaped Forastero of West Africa, mostly self-compatible types
- 38 International Cocoa Gene Banks : Trinidad, Cost Rica, Colombia, Ecquador, French Guiana, Venezuela, Brazil
- Intermediate Cocoa Quarantine Centre (ICQC) : University of Reading, UK

- 39 National Germplasm Site (NAGS) for cocoa Active : ICAR- CPCRI, Regional Station, Vittal, Bantwal Tk., Dakshina Kannada Dt., Karnataka- 574 243
- 40 Agency giving import permit for collection of exotic germplasm of cocoa : National Bureau of Plant Genetic Resources (NBPGR), New Delhi
- Agency favouring exchange/ export : National Biodiversity Authority (NBA), Chennai
- 41 Cocoa breeding strategies : Introduction- selection- hybridization- clonal selection- resistance to biotic and abiotic stress- marker assisted selection
- 42 Hybrid vigour, Heterosis, Inbreeding in cocoa : **Hybrid vigour:** Superiority of hybrid over better parent.
Heterosis: Tendency of hybrid to show superiority over both parents.
Inbreeding: Breeds parents with some degree of homozygosity for disease resistance. Self- compatible, cross- incompatible cocoa lines are used for selfing.
- 43 CPCRI varieties of cocoa : **Vittal Cocoa Hybrids:** VTLCH 1, VTLCH 2, VTLCH 3, VTLCH 4, VTLCH 5 (Nethra Centura)
Vittal Cocoa Selections: VTLCC 1, VTLCS 1, VTLCS 2
- 44 Cocoa propagules : Seeds and Vegetative means (buds, grafts, rooted cuttings, tissue cultured)
For sale- seed pods, seedlings, clones
- 45 Mother plant or Mother tree of cocoa : A seed producer or a plant from which vegetative portions are selected for propagation.
(>6 year old clonal tree or >12 year old seedling tree yielding >100 pods/tree/year)
- 46 Clonal orchards/ Seed gardens in cocoa : For production of true hybrids.
Established with self- incompatible but cross-compatible lines of known parentage and performance.

Bi clonal orchard: Two self- incompatible and cross- compatible parents.

Poly clonal orchard: Multiple self- incompatible and cross- compatible parents.

- 47 Isolation distance for : 200 m
cocoa seed garden pollen parent: female parent 1: 5.
Seeds should be collected only from self- incompatible parent.
- 48 Seed pod standards for : Forastero/ Trinitario types,
cocoa (fruit) Smooth surfaced without bottle neck,
1 cm husk thickness, >350 g weight, >35 beans/ pod,
Pod value- no. of pods required to give 1 kg of wet beans to be not >12
Pod : Bean ratio- 3 : 1
- 49 Seed standards for cocoa : Wet bean 3 g (extracted from centre of the pod), dry
(bean) bean weight 1 g
Wet bean : Dry bean ratio - 3 : 1
- 50 Type of cocoa seed : Recalcitrant, no dormancy, viviparous

Recalcitrant: Seeds require relatively high moisture content for longevity, when dried below critical moisture level, they rapidly lose viability, cocoa seeds should be sown immediately after extraction from pod.

Dormancy: Condition of a seed or bud characterized by lack of visible growth. Deciduous plants are dormant during winter.

Vivipary: Phenomenon in which seed germinate in the fruit while it is still attached to the mother plant, overripe pods of cocoa tends to be viviparous. It is neither good for sowing nor for processing.

- 51 Seed storage in cocoa : Removal of mucilage, stored in charcoal/ saw dust in polythene bags will extend seed germination beyond 7 days.
- 52 Method of scarification in : Removal of mucilage surrounding seed by rubbing with
cocoa sand or wood ash.
- 53 Potting mixture for cocoa : 2: 1: 1 Soil: Sand: Farm Yard Manure (FYM)
and sowing or vermicompost, coir compost, cocoa husk compost, bean shell compost.

Cocoa Probio- growth promoter

Black polybags of 6”x 9” size of 250 gauge thickness punched with drain holes, poly bag nursery under 50-75% shade net.

Horizontal shallow sowing.

- 54 Type of germination in cocoa : Epigeal germination in 7-10 days (cotyledons taken above soil)
- 55 Soldier phase in cocoa : Early stage of germination, before splitting of cotyledons.
- 56 Grafting method in cocoa : Soft wood grafting (insertion of scion into 4 months old rootstock)
- Budding method in cocoa Patch budding (bud patch- small piece of bark containing a single bud into 6 months old rootstock)

***Scion bank:** Parental/ Mother trees assembled as clonal trees in one place for scion collection. Scion stick (15 cm length) comprised of multiple buds, but will get only one plant.*

***Budwood garden:** Mother trees assembled in one place for bud collection. Budwood/ budstick (15-20 cm length) comprised of multiple buds and will get multiple plants.*

***Clone:** Group of plants produced vegetatively from one original mother plant.*

- 57 Clonal selection in cocoa : Breeding method of asexually propagated plants based on selection of superior clones from a wide range of clones initially based on morphological characters followed by quantitative and qualitative traits.
- 58 Top working in cocoa : A grafting procedure employed to convert an established plant of inferior, incompatible, barren, unwanted variety either by grafting (top- grafting) or budding (top- budding) into a productive tree after decapitation and rejuvenated with new shoots.
- 59 Heading back/ Snapping back in cocoa : Removal of a portion of a stem without decapitation, leaving another portion to promote new growth.
- 60 Spacing of cocoa in arecanut gardens : Arecanut + Cocoa (normal spacing)
Arecanut - 2.7 m x 2.7 m (9 ft. x 9 ft.)
Cocoa- 2.7 m x 5.4 m (9 ft. x 18 ft.) 686 plants/ ha

(i) *Arecanut + Cocoa (dense spacing)*: Arecanut- 2.7 m x 2.7 m (9 ft. x 9 ft.)
Cocoa- 2.7 m x 2.7 m (9 ft. x 9 ft.), 1372 plants/ ha.

(ii) *Arecanut + Cocoa (wider spacing)*: Arecanut- 2.7 m x 2.7 m (9 ft. x 9 ft.)
Cocoa- 5.4 m x 5.4 m (18 ft. x 18 ft.), 343 plants/ ha.

(iii) *Arecanut + Cocoa (new plantation)*: Planting together 3 m x 3 m (10 ft. x 10 ft.),
1111 plants/ ha.

(iv) *Arecanut based multi species cropping system (ABMSCS)*: Arecanut + Cocoa +
Banana + Pepper (trailed on areca) (2.7 m + 5.4 m + 5.4 m + 5.4 m)

- 61 Spacing of cocoa in coconut gardens : Coconut + Cocoa
Coconut- 7.5 m x 7.5 m

Single hedge cocoa- 2.7- 3 m
Double hedge cocoa- 2.5, 2.7, 3 m
(depend on spacing of coconut)
- 62 Coconut based multi species cropping system with cocoa : Coconut + Cocoa + Banana + Pepper
Coconut+Cocoa+Nutmeg+Banana+Pepper
Coconut+Cocoa+Cinnamon+Banana+Pepper
- 63 Spacing of cocoa in oil palm gardens : Oil palm- 9 x 9 x 9 m triangular planting
Cocoa- 2.5 to 3 m
Cocoa at 2 m away from palm basin.

>15 years old oil palm at square system of planting is good to avoid heavy shade.
- 64 Age of seedling for planting and pit size : 4 months old seedlings or 6 months old grafted/
budded plants
60 cm³ pits filled with top soil and compost
Graft/ bud joint should be above soil surface
- 65 Fertilizer dose for cocoa : 100: 40: 140 NPK g/ plant/ year
220: 200: 230 Urea: Rock Phosphate: Muriate of Potash g/ plant/ year

2 splits- April- May (Pre- monsoon)
September- October (Post-monsoon)
- Fertigation in cocoa : Urea- 135 g
Di Ammonium Phosphate (DAP)- 65 g
Muriate of Potash (MOP)- 175 g

- 66 Cocoa farm wastes for composting : Cocoa leaves, pod husk, bean shell
- 67 Cocoa pod husk is rich in : Potassium
- 68 Training technique in cocoa : Practice of giving shape and anchorage to the plant in the first and second year of planting to bear the load of pods in subsequent years.
(Seedling tree - Single main stem
Clones - Multiple branches)
- 69 Types of pruning in cocoa : **Formation pruning:**
(decides height of jorquetting, no.of jorquettes)
Structural pruning:
(umbrella or cone shaped canopy)
Sanitary pruning:
(removal of diseased pods, damaged plant parts)
- 70 Season of pruning in cocoa : September (after main season harvest) in traditional belts
Annual systematic pruning is compulsory when grown as mixed crop under palms
- 71 Nature of cocoa leaves and no. of leaves required to produce 1 cocoa pod : Self- shading effect
20- 30 leaves
- 72 Thinning in cocoa : Removal of extra flowers or cherelles/ cushion, wilted cherelles to avoid overcrowding and to increase the size of developing pods
- 73 Mulching in cocoa : Practice of covering basin away from stem with cocoa leaves, pruned small twigs for conservation of moisture, control of weeds, prevent soil erosion and adds organic matter
- 74 Irrigation for cocoa : Flood - Once in 5 days- 175 litres
Drip - 20 litres/ tree
- 75 Cocoa crop cycle (Vittal) : April - First harvest for nursery
May-August - Main season harvesting
September - Pruning
October - New flushing
November-December - Flowering
January-April - Flower to fruit development
(Will change with different agro climatic regions)

- 76 Farm machineries required for cocoa cultivation : Grafting/ budding knife, cocoa harvester, secateurs, sickle, pruning shear, telescopic tree pruner, sprayers, wooden hammer
- 77 Major diseases of cocoa in India : Black pod rot, stem canker, cocoa dieback, seedling dieback/ blight
- Phytophthora diseases* : *Pre and post monsoon spray with 1% Bordeaux mixture.*
- Stem canker* : *Wound dressing with 10% Bordeaux paste. Wound treatment with Trichoderma coir pith cake and soil application for long term control.*
- Cocoa dieback (Lasiodiplodia theobromae)* : *1% Bordeaux mixture spray and cut ends of pruned branches to be swabbed with 10% Bordeaux paste.*
- Seedling die back/ blight* : *Drenching with 1% Bordeaux mixture or Copper Oxychloride (2.5 g/L of water)*
- 78 Major diseases of cocoa in the world : Witch's Broom, Cocoa Swollen Shoot Virus, Frosty Pod Rot, *Ceratocystis* Wilt
- 79 Cocoa disease observed in Kerala & resistant varieties of Kerala Agriculture University : Vascular Streak Dieback (VSD) & CCRP cocoa varieties (CCRP 1 to CCRP 10)
- 80 Major pests of cocoa : Tea Mosquito Bug, Mealy Bug, Aphids, Stem borer/ girdler, Cocoa fruit borer

Cocoa ecosystem is observed with wide populations of natural enemies and spiders, which offers natural control of seasonal pests and so usage of pesticides can be limited and recommended only in severe cases.

- Tea Mosquito Bug (Helopeltis spp.)* : **Less infestation:** *Spraying Beauveria bassiana @4g/L or neem oil @3%*
Persistent infestation: *Repeat spray at 20 to 30 days intervals.*
Severe infestation: *Spray any one of the following insecticides viz., Lamdacyhalothrin 5EC (0.003%) 0.3 ml/L (or) Imidacloprid 17.8 SL (0.004%) 0.25 ml/L.*
- Mealy Bug (Planococcus lilacinus and P. citri)* : *Conservation of lady beetles Pullus spp., Lycaenid, Spalgius epius for bio suppression.*

Spot application of 0.5% neem oil emulsion along with 5% soap solution, 2 times once in 15 days.

Need-based insecticides spray: Imidacloprid @ 0.3 ml/L or Dimethoate 30 EC @ 1.6 ml/L.

Stem borer/ Girdler (Zeuzera coffeae/ Sthenias grisator) : Mechanical collection of grubs with iron spike or needle stick and destruction, cleaning webs, excreta, plugging holes with cotton wool soaked with Chloroform, Formalin or Petrol and sealing with mud.

Placing Chlorpyrifos 0.05% soaked cotton and fastening with polythene tape. Swabbing Coal tar + Kerosene @ 1:2 in basal portion of the trunk to prevent egg laying.

Cocoa fruit borer (Conogethes punctiferalis) : Collect and destruct infested pods/ fruits. Plant castor as trap crop in borders.

81 Mammalian pests of cocoa : Rats, Squirrels, Civet Cats

Rats (Rattus rattus) : Keeping 10 g Bromadiolone (0.005%) wax cakes on branches twice at 10-12 days intervals. Placing rat traps with fried coconut pieces as bait.

Squirrels (Funambulus tristriatus and F. palmarum) : Trapping, growing alternate fruit trees, timely harvest of cocoa pods.

82 Major deficiency of cocoa : Zinc deficiency, 0.3% ZnSO₄ as foliar application

83 Index tissue for leaf sampling in cocoa : 3rd leaf from apex

84 General recommendation for prevention of cocoa diseases :

- Swabbing Bordeaux paste after pruning and wound dressing in case of stem canker.
- Pre and post monsoon spray of 1% Bordeaux mixture in traditional belts with high rainfall.
- After pruning, Bordeaux spray to cover the entire tree and main stem.
- Biocontrol agents, natural enemies for pest control.

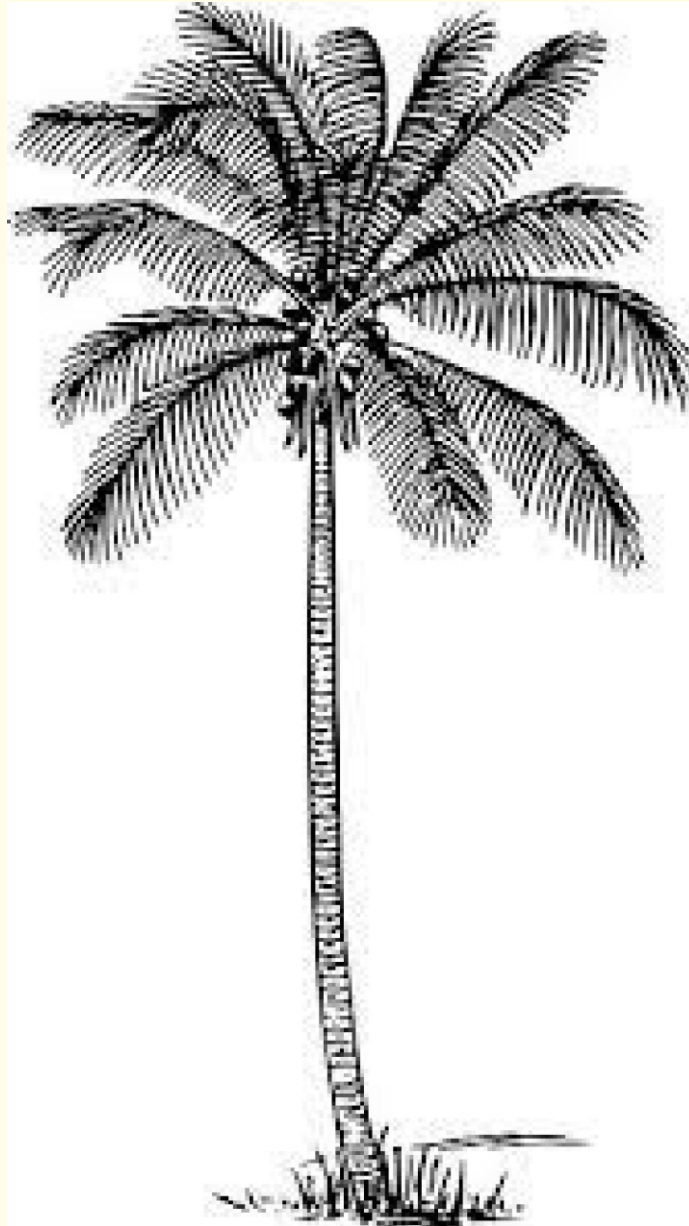
85 Horticultural maturity in cocoa : Green pod changing to yellow colour

- Red pod changing to orange colour
- Detaching of beans from husk/ pod wall giving a loose sound while tapping.
- 86 'Temperao' cocoa crop : Harvested between April- September developed during warmer months, mature in 140- 175 days from flower to fruit
- 87 Cacao and Cocoa : The tree with pods and wet beans, upto fermentation is called *cacao*.
The produce, dry bean, after fermentation and drying is called *cocoa*.
- 88 Colour of fresh beans & fermented dry beans of cocoa : Fresh beans- Mostly purple due to anthocyanin pigmentation
Fermented beans- Brown or chocolate colour
- 89 Primary processing in cocoa (at farm) : Fermentation of wet beans for 1 week and sun or open drying/ artificial drying using hot air oven/ electric oven etc.
- 90 Secondary processing in cocoa (at factory) : Cleaning and sorting dry beans, alkalization, roasting, kibbling and winnowing, blending and grinding, extraction of butter from cocoa mass, making cocoa powder, preparation of multiple type chocolates.
- 91 Methods of fermentation in cocoa : Heap, Box, Basket, Tray, Gunny bag
- 92 Stage and standards for dry beans of cocoa : When crushing in hand to make a cracking sound.
1 gram and above, 6-7% moisture, 10-15% shell, 85-90% nib recovery, >50% fat content
- 93 Pod index in cocoa : No. of pods required to give 1 kg dry beans
- Bean indices/ bean count in cocoa : Bean index: Dry bean weight to be 1.0 g minimum.
Bean count: 100 beans per 100 g
Bean grades:
<100 beans per 100 g
100-110 per 100 g
>120 per 100 g
- 94 Nibs of cocoa : Beans after removal of shell used for preparing cocoa butter, powder and chocolates.

	Cut test in cocoa		Testing colour, fermentation quality and fissuring with 100 dry beans
95	Bean to bar chocolate making equipments	:	Pod breaker, bean roaster, bean breaker/ desheller cum winnower, chocolate grinder, melter, dehumidifier
96	CPCRI chocolate	:	Kalpa Dark Chocolate
97	By-products of cocoa	:	Pod husk (cattle feed), Cocoa juice/ sweatings, Bean shell, Cocoa germ
98	DCCD	:	Directorate of Cashewnut and Cocoa Development, Ministry of Agriculture and Farmers Welfare, Kochi, Kerala
99	CAMPCO Chocolate Factory	:	Central Arecanut and Cocoa Marketing and Processing Co-operative Ltd., Puttur, Karnataka
100	Cocoa Journal	:	The Cashew and Cocoa Journal (DCCD)
	Cocoa book		'Cocoa'- Wood & Lass, Longmans, London



COCONUT



READY RECKONER ON COCONUT

- 1 Coconut : *Cocos nucifera* Linn.
- 2 Family of coconut : Areaceae
- 3 Chromosome no. of coconut : $2n = 2x=32$ (Diploid)
- 4 Genome lengths of coconut cultivars sequenced : Hainan Tall cultivar- 2017 (2.42 Gb)
Catigan Green Dwarf- 2019 (2.15 Gb)
Chowghat Green Dwarf- 2020 (1.93 Gb)
- 5 Coconut is native to : South Pacific Islands of Polynesia and Melonesia at South East Asia
- 6 Coconut is known as : *Tree of Life (or) Tree of Heaven (Kalpa Vriksha)*
Tree of Abundance, Tree of Plenty, The Consols of the East, Mankind's Greatest Provider in the Tropics
- 7 Coconut is grouped as : Commercial, Plantation crop and Oil crop
- 8 Economic part or Coconut of commerce : Nut, Copra, Coir
- 9 The term *Cocos nucifera* derived from : In Portuguese, 'coco' means 'grinning face' or 'monkey face' – (Portuguese for monkey – 'macaco') because that's what the three dark circles on the shell resembled.

Latin name for the palm: *Cocos nucifera* ('nucifera' means nut-bearing)
- 10 Coconut water : Liquid endosperm of immature nut used as refreshing drink
- 11 Species diversity in coconut & related genera : Coconut is monotypic species; Varieties can be differentiated by their stature, size, shapes and color of the nuts and pests and disease resistance qualitatively.
- 12 Inflorescence of the coconut is called : Spadix
- 13 Terminal bud of the coconut is called : Cabbage

- 14 The trunk wood of the coconut is called as : Porcupine wood, is used in construction and furniture making
- 15 Coconut types based on growth of stem and the age of fruiting : The Dwarfs and Talls
- 16 Tall cultivars commonly grown in India : West Coast Tall (WCT), Tiptur Tall (TPT) and East Coast Tall (ECT)
- 17 Tall coconut varieties start producing inflorescence : In 5 to 9 years after planting
- 18 Average height and life span of tall coconut palms : 15 m to 18 m or more
: 80- 90 years
- 19 Pollination in talls : Highly cross pollinated (male phase ends before female flowers of the inflorescence become receptive)
- 20 Dwarf cultivars commonly grown in India : Chowghat Orange Dwarf (COD), Chowghat Green Dwarf (CGD), Malayan Yellow Dwarf (MYD), Malayan Green Dwarf (MGD), Malayan Orange Dwarf (MOD), Gangabondam (GBGD), and Gudanjali Dwarf
- 21 Dwarf varieties starts producing inflorescence : In 2- 4 years after planting
- 22 Average height and life span of dwarf coconut palms : 5- 7 m
40- 50 years
- 23 Pollination in dwarfs : Some degree of self pollination is seen (Due overlapping of male and female phases in the same inflorescence)
- 24 Other important Coconut types : ***Spicata***: Unbranched inflorescence (or) rarely with one or two small spikes
- Androgena***: Tall bearing palms with only male flowers
- Plicata***: The palms with fused leaflets

Makapuno: Makapuno nuts have soft buttery endosperm and used in preparation of specific coconut delicacies

Aromatic Types: A pandan like aroma is released when cut open a tender coconut

- 25 Conversion of flower bunches into vegetative shoots in coconut : Bulbils
- 26 Preferred climate of coconut : Humid Tropics
- 27 Coconut is highly suitable for cropping systems because : Availability of 22.3% average land space, 30% air space and 50% solar radiation interception
- 28 Growth stages of coconut palm :
 - Young palm up to 10 years
 - Middle aged palm (9 to 25 years)
 - Grown up palm (>25 years)
- 29 Major producers of coconut in the world : Indonesia, Philippines, India, Sri Lanka, Brazil Thailand , Viet Nam, Mexico
- 30 Major states growing coconut in India : Kerala, Karnataka, Tamil Nadu, Andhra Pradesh
- 31 Growth habit of coconut : Woody perennial monocotyledon with the trunk being the stem
- 32 Coconut is : Monoecious, produces male and female flowers separately on same tree
- 33 Root system of the coconut : Adventitious/Fibrous root system
- 34 Time taken for development of inflorescence (initiation to opening of the spathe) : 34 months
- 35 Average number of spadices produced by coconut in a year : 12
- 36 Estimated pollen grain number of each male flower : 272 million pollen grains
- 37 Viability of pollen grains lasts up to : 6 days

38 Female flower of the coconut : Button
is popularly known as

39 Average interval between end : 2- 6 days
of the male phase and the
commencement of the female
phase

Average duration of male phase in coconut : 21 days

Average duration of female phase in coconut : 8 days

40 Breeding behavior of coconut : Cross pollinated,
self fertilization within the inflorescence also reported
in dwarf varieties

41 Pollinating agents : Wind, insects (House fly, Lasila, Honey bees, Black
ants etc.)

42 Coconut varieties and hybrids : **Selections:**
released from ICAR- CPCRI

Dwarfs: Chowghat Organge Dwarf, Kalpa Jyothi,
Kalpasree, Kalpa Surya, Kalparaksha

Talls: Kera Keralam, Kalpa Dhenu, Kalpatharu,
Kalpa Pratibha, Kalpa Mitra, Kera Chandra, Chandra
Kalpa, Kalpa Haritha, Kalpa Rathna, Kalpa Shatabdi

Hybrids: Kalpa Sankara (CGDxWCT), Kera Sankara
(WCTxCOD), Chandra Sankara (CODxWCT), Kalpa
Samrudhi (MYDxWCT), Kalpa Sreshta (MYDxTT),
Chandra Laksha (LOTxCOD)

Varieties for making ball copra: Kalpatharu, Kalpa Mitra and Kera Keralam.

Varieties tolerant to Root (wilt): Kalpasree, Kalparaksha and Kalpa Sankara.

Variety tolerant to eriophyid mite: Kalpa Haritha.

*Dual purpose varieties for copra and tender nuts: Kalpa Pratibha, Kalpa Haritha, Kalpa
Samrudhi, Chandra Sankara, Kalparaksha, Kera Chandra, Chandra Laksha, Kalpasree,
Kalpa Shatabdi, Kalpa Sankara and Kalpa Sreshta.*

*Varieties tolerant to drought : Chandra Kalpa, Kera Chandra, Kalpa Mitra, Kalpa
Dhenu, Kalpa Pratibha, Kalpatharu, Kalpa Haritha, Kalpa Shatabdi, Chandra Laksha,
Kera Sankara and Kalpa Samrudhi .*

- 43 Coconut varieties of Kerala Agricultural University (KAU) : Lakshaganga, Keraganga, Anandaganga, Kerasree, Kerashowbhagya, Kerasagara and Keramadhura
- 44 Coconut varieties of Tamil Nadu Agricultural University (TNAU) : ALR (CN) 1, ALR (CN) 2, ALR (CN) 3, VHC1, VHC2, VCH3 and VHC4
- 45 Coconut varieties of Andhra Pradesh and Telengana : Gauthami Ganga from ANGRAU, AP
Vasista Ganga and Abhaya Ganga from Dr. YSRHU, Telengana
- 46 Coconut varieties from Assam : Kamrupa
- 47 Coconut varieties from Maharashtra : Pratap, Konkan Bhatye, Coconut Hybrid -1
- 48 AICRPP : All India Co-ordinated Research Project on Palms
- 49 Breeding methods followed in coconut : Introduction, selection and hybridization
- 50 Fruit type of the coconut : Drupe
- 51 Commercial propagation method : Seed
- 52 Isolation distance for coconut seed gardens : 500 m
- 53 Coconut seed garden : Planting Talls and Dwarfs in alternate rows and by simple emasculation of female parent both D x T and T x D hybrids could be produced.

Seed gardens in Konark (Orissa) & Navalok (Tamil Nadu).
- 54 Varieties/cultivars identified for hybrid seed production : **Tall cultivars:** WCT, LCT, ADOT, SSAT and ECT
Dwarf parental lines: COD, MYD, MOD, MGD and GBGD
- 55 For artificial pollination the percentage of pollen germination should be : More than 50%.
- 56 The ideal time for assisted pollination : 8-11 am

- 57 Duration of first appearance of inflorescence tip in the leaf axil and completion of opening : 75- 90 days
- 58 Coconut ovary : Tricarpellate
- 59 International Coconut Gene Bank for South Asia & Middle East (ICG –SA) : ICAR- CPCRI, Research Centre, Kidu, Nettana (near Subramanya), Karnataka
- 60 World’s largest repository of coconut germplasm maintained at : ICAR- CPCRI
- 61 Ideal mean temperature for coconut : 27±5°C
- 62 The coconut palm grows well up to an elevation of : 600 m above mean sea level
- 63 Soil type suitable for coconut : All types of soils viz., sandy, laterite, swampy, alluvial, black and saline soils, with proper drainage, absence of rock or a hard substratum within 2 m of the surface. It tolerates salinity.
- 64 Selection criteria for mother palms : Middle aged palms, upto 20 years,

Talls:

- *Straight stout trunk, closely spaced leaf scars,*
- *Spherical or semi-spherical crown with short fronds,*
- *Short and stout bunch stalks without tendency of drooping,*
- *>30 leaves and 12 inflorescences, Inflorescence with 25 or more female flowers, consistent yield of about 80 nuts under rainfed conditions and 125 nuts under irrigated conditions, 150 g per palm copra per nut,*
- *Free of pests and diseases.*

Dwarfs:

- *Palms of 12 years old or more,*
- *Yielding >60 and 100 nuts per year under rainfed and irrigated conditions respectively,*
- *Minimum of 30 leaves, nut weight >400 g.*

65 Collection and selection of seed nuts : Seed nuts can be collected throughout the year.
West Coast Region- January to May – sowing with onset of south-west monsoon.
East Coast Region- May to September – sowing with onset of north-east monsoon.
Fully matured nuts i.e. about 12 months old should be harvested.

- *Nuts which are too big or too small in a bunch, nuts of irregular shape and size should be discarded.*
- *Seed nuts of tall varieties to be sown 2-3 months after collection.*
- *Seed nuts of dwarfs to be sown within 15-30 days after harvest.*

66 Nursery : Flat bed- normal areas
Raised bed- stagnated areas
In palm groves or under shade net in open condition
Sowing nuts at 40 cm x 30 cm spacing in 20-25 cm deep trenches
Vertical or Horizontal sowing.

67 Polybag nursery : Transplanting in 45 cm x 60 cm polybag, 500 gauge thickness, with 8-10 drain holes.
Potting mixture: Top soil: Sand 3: 1

*Soil: Sand: FYM 3: 1: 1, Sand: Vermicompost 3:1 can also be used.
25 g biofertilisers- Azospirillum spp. and Phosphobacterium Bacillus sp.*

PGPR based bioinoculants- 'Kera Probio' (talc formulation of Bacillus megaterium) @ 25 g/seedling and 'KerAM' (Arbuscular Mycorrhizal bioinoculant) @ 50 g/seedling for vigour and health of seedlings.

68 Selection indices for quality seedlings : 1 year old, vigorous,
collar girth of 10 cm and above,
100 cm height, 5- 6 leaves and
early splitting of leaves.
>1 year old in water logged areas

69 Recommended spacing for coconut : 7.5 m x 7.5 m to 8.0 m x 8.0 m in square system, 177 or 156 palms/ ha

70 Other recommended system of planting in coconut : Triangular system – can accommodate additional 25 palms.
Hedge system – 6.5 m along the rows and 9.5 m between rows.
For multiple cropping- wider spacing of 10 m x 10 m

71 Pit size : Laterite soil with rocky substratum- 1.5 m length x 1.5 m breadth x 1.2 m depth, filled with loose soil, cow dung and ash upto 60 cm.

Laterite soil: Application of 2 kg of common salt to loosen the soil.

Loamy soil with low water table: 1 m x 1 m x 1 m filled with top soil upto 50 cm.

High water table: planting at the surface or on mounds.

72 Irrigation Requirement : Irrigation with 45 litres of water once in 4 days
Drip irrigation: 32 liters/palm/day when the evaporation rate is 4 mm day

73 Recommended dose of fertilizer : 500 g N, 320 g P₂O₅ and 1200 g K₂O per palm per year

First application: 3 months after planting, 1/10th dose.

Second year: 1/3rd in two splits in May- June and September- October, to be doubled in third year.

Fourth year onwards: full dose.

74 Fertigation : 91 g Urea, 33 ml Phosphoric Acid and 170 g Muriate of Potash (MOP) per palm per application.

Or 70 g Urea, 60 g DAP and 170 g Muriate of Potash for a single dose per palm and a total of 6 such applications.

75 Symptoms of Boron deficiency : Wrinkled leaves, bent leaflet tips, failure of leaves to split, leaves have a serrated zigzag appearance, crown choke disorder.
Chronic stage- multiple unopened spear leaves, poor nut setting, button shedding, immature nut fall and barren nuts.

76 Soil amendments : Acidic soil- 1 kg dolomite or lime/ palm/ year
Mg deficiency- 0.5 kg MgSO₄
B deficiency- 75 g Borax at bi monthly interval

Organic manures- Farm yard manure, compost, green leaf manure or vermicompost @ 50 kg per palm can be applied and spread in circular basins of 1.8 m radius and 20 cm depth during August-September

77 Vermicompost of CPCRI : Kalpa Organic Gold

Coircompost of CPCRI Kalpa Soil Care

- 78 Cropping system suitable for initial stage of coconut plantation (up to 5-7 years) : Intercropping
- 79 Cropping system suitable for later stage of coconut plantation (>20 years of age) : Mixed cropping
- 80 Suitable crops for intercropping under coconut : Tubers and Rhizomatous Spices, Cereals and Millets, Pulses and Oil seeds, Vegetables, Fruits, Plantation Crops and Spices
- 81 Other systems : High Density Multi Species Cropping System (HDMSCS)
Mixed farming- Coconut + Dairy, Fishery, Poultry, Goats
- 82 Soil and water conservation measures : Coir pit, coconut leaves, husk mulching in basins, husk burial, catchment pits, half moon bunds
- 83 Major pests of coconut : Rhinoceros beetle, Red palm weevil, *Eriophyid* mite, Leaf eating caterpillar, Rugose spiralling whitefly and White grub

Integrated Pest Management (IPM) for major pests of coconut

- Rhinoceros beetle (Oryctes rhinoceros Linn)* : Top most three leaf axils may be filled with powdered neem cake/ marotti cake/ pongamia cake @ 250 g + fine sand (250 g) per palm during pre and post monsoon months.
- Red palm weevil (Rhynchophorus ferrugineus Olivier)* : Spot application of 0.02% Imidacloprid 17.8 SL (@1.12 ml/L) or 0.013% Spinosad 2.5 SC (5 ml/L) or 0.04% Indoxacarb 14.5 EC (2.5 ml/L).
- Eriophyid mite (Aceria guerreronis Keifer)* : Spraying with neem oil (200 ml) garlic (200 g) soap mixture (50 g) @ 2% concentration in 10 litres of water.
Spraying neem formulations containing 1% Azadirachtin @ 4 ml/L during Apr.- May, Oct.-Nov. and Jan.- Feb.
- Leaf eating caterpillar (Opisina arenosella Wlk.)* : Augmentative release of stage specific parasitoids

Rugose spiraling white fly (Aleurodicus rugioperculatus Martin) : Application of 1% starch solution on leaflets to flake out the sooty moulds. In severe case, spray neem oil 0.5%.

White grub (Leucopholis coneophora Burm) : Soil application of aqua suspension of entomopathogenic nematode, *Steinernema carpocapsae* in the interspaces at 5-10 cm depth with 1.5 billion IJ/ha and need based repeated application.

- 84 Major diseases of coconut : Bud rot, Root (wilt) disease, Stem bleeding, *Ganoderma* disease/ Thanjavur wilt, Grey leaf spot and Leaf blight

Integrated Disease Management (IDM) for major diseases of coconut

Bud rot (Phytophthora palmivora) : Bordeaux mixture (BM) (1%) before and after monsoon and at 45 days interval in high rainfall zones. About 300 ml 1% BM may be poured in the base of the spindle.

Root (wilt) disease (Phytoplasma) : Removal of all disease advanced and uneconomic palms with annual yield of <10 nuts, replanting tolerant varieties or elite seedlings from high yielding disease free palms located in hot spot endemic areas.

Stem bleeding (Thielaviopsis paradoxa) : Apply a paste of talc based formulation of *Trichoderma harzianum* (Isolate CPCRI TR 28) on bleeding patches. Apply neem cake (5 kg/palm) enriched with *Trichoderma harzianum* (CPTD 28) during September-October.

Ganoderma disease/Thanjavur wilt : Application of *Trichoderma* (CPCRI TR 28) enriched neem cake @ 5 kg neem cake/palm/year and irrigating the palm once in 4 days and mulching around the basin.

Grey leaf spot and Leaf blight (Pestalotiopsis palmarum/ Lasiodiplodia theobromae) : Spraying with Bordeaux mixture (1%)

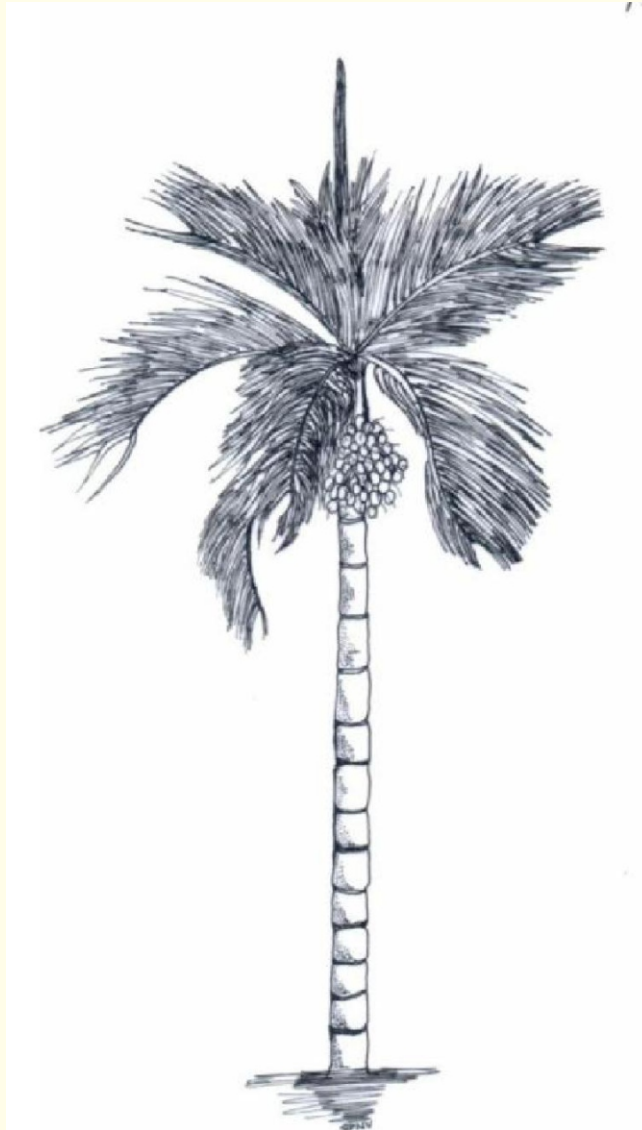
- 85 Larval parasitoids of leaf eating caterpillar : *Goniozus nephantidis* (Bethyridae), *Bracon brevicornis* (Braconidae) @20 parasitoids/palm
Prepupal parasitoid : *Elasmus nephantidis* (Elasmidae) @49/100 pre-pupae
Pupal parasitoid : *Brachymerianosatoi* (Chalcididae) @32/100 pupae

- 86 Aphelinid parasitoid of rugose spiralling whitefly : *Encarsia guadeloupae*
- 87 Biological control of rhinoceros beetle : Release of *Oryctes rhinoceros* nudivirus (OrNV) inoculated rhinoceros beetle @ 10-12 per ha
- 88 Pheromone traps used to control Rhinoceros beetle : PVC pheromone traps ‘Oryctalure [ethyl 4 methy octonate]’ (1/ha) and field delivery using nanomatrix @ 1 trap / ha in farmer participatory community mode
- 89 Harvesting : 6-7 months old nuts for tender nut purpose
11-12 months old nuts for nut and copra purpose
11 months for husk, coir fibre
Harvesting once in a month in well maintained and managed garden.
- 90 Farm machineries : Climber, telescopic sprayer, drones, dehusker, deshellers, copra driers, copra moisture meter, oil expeller
- 91 Coconut products : Neera, snow ball tender nut, coconut chips, sugar, jaggery, mushroom from coconut substrate
- 92 Neera or Kalparasa : Phloem sap extracted from the unopened inflorescence
- 93 Coco- sap chiller of CPCRI : Inflorescence sap is collected under low temperature keeps it fresh and unfermented without addition of any chemicals
- 94 Virgin coconut oil (VCO) : Oil obtained from fresh, mature endosperm by mechanical or natural means, with or without use of heat, no chemical refining, bleaching or de-odorizing and maintains the natural aroma and nutrients
- 95 Different process involved in VCO production : Hot-processing method, Natural fermentation method, Centrifugation process and extraction from dried grating (EDG) method
- 96 Coconut oil is a source of : Saturated fatty acids and small & medium chain fatty acids (70%)

- 97 Coconut oil is widely used in soaps and cosmetic manufacturing industries because : It contains Lauric acid (C:12)
- 98 For copra oil extraction, moisture content : 7%
- 99 Developmental agencies : Coconut Development Board (CDB), Ministry of Agriculture and Farmers Welfare, Kochi, Kerala
- Coir Board : Coir Board, Ministry of Micro, Small, Medium Enterprises, Kochi, Kerala
- 100 Coconut Journal : The Coconut Journal (CDB)
- Coconut Book : *'The Coconut Palm- A Monograph'* Menon and Pandalai, Central Coconut Committee



ARECANUT



READY RECKONER ON ARECANUT

- 1 Arecanut : The betel nut tree (*Areca catechu* L.)
- 2 Family of areca : Arecaceae
- 3 Chromosome no. of areca : $2n = 32$
- 4 Areca is native to : Malayan Archipelago, South East Asia
- 5 The name areca originated from : Malayan word 'cluster of nuts'
- 6 Areca is grouped as : Masticatory, Commercial and Plantation crop
- 7 Arecanut is chewed as : Betel quid (tender, ripe or processed form), Supari, Pan
- 8 Economic part of arecanut : Dry kernel (Chali/ Kottappak)
- 9 Stimulative alkaloid of arecanut : Arecoline
- 10 Species diversity in areca and related genera : *Areca triandra* Roxb., *A. concinna*, *A. mikrocalyx*, *Actinorhysis calapparia*, *Normanbya normanbyii*
- 11 Preferred climate of areca : Tropics and sub tropics
- 12 Distribution : 28°N and 28°S of equator
- 13 Preferred soil type : Gravely laterite soils of red clay type and fertile clay loam.
It can come up in soils acidic to neutral pH
- 14 Optimum rain fall, temperature and Relative humidity : 200-250 cm
 14°C to 36°C and RH 80%
- 15 Areca growing models : Monocropping
Intercropping with annuals, biennials
Mixed cropping with perennial crops
Mixed farming with dairy, fishery, poultry, piggery, goats
- 16 Shade requirement of areca : Sensitive to sunlight, nursery should be under 50-75% shade net and young seedlings needs shading with banana plants

- 17 Major countries growing areca : India, Indonesia, Bangladesh, China, Sri Lanka
- 18 Major producer of arecanut in the world : India
- 19 Suitable agro climatic zone for areca : Western ghats hills and plains
North Eastern and Terai regions
- 20 Major states growing areca in India : Karnataka, Assam, Kerala, West Bengal, Meghalaya, Tamil Nadu
- 21 Growth habit of areca : Monoecious palm
- 22 Botanic description : Erect and unbranched palm.
Stem has scars of fallen leaves in a regular annulated form.
Palm has adventitious root system. Root hairs are absent. Maximum concentration of roots is within a radius of 1 m from bole and in top 60 cm of soil.
Leaves are paripinnate with long sheathing base. Life of an unfurled leaf is 2 years.
- 23 Nature of bearing in areca : Spadix produced in leaf axil covered in boat shaped spathe
- 24 Average no. of nuts in an areca bunch : 100-125 fruits
- 25 % of successful pollination in arecanut : 12-40%
Full bloom to maturity 35 to 47 weeks
- 26 Flowers/ Inflorescence of areca : Main rachis, secondary and tertiary rachis.
Female flowers confined to tertiary and distal end of secondary rachis.
Male flowers in filiform branches below or beyond female flowers.
Both male and female flowers are sessile having two whorls of perianth.
- 27 Male and female phase of areca : Male flowers open on same day or a few days after spathe bursts open exposing spadix.
Male phase lasts for 25-46 days.
Female flowers starts opening after all male flowers are shed.

- Female phase extends for 3-10 days.
Maximum receptivity is between 2nd and 4th day of opening.
- 28 Pollinating agents of areca : Wind is the main agent of pollination
- 29 Breeding behavior of areca : Cross pollinated
- 30 Type of areca fruit : Monolocular, one seeded berry with fibrous outer husk, enclosing single seed
- 31 Germplasm conservation : *Ex situ* conservation: Field gene bank
In vitro conservation: Cryopreservation of pollen and embryogenic calli
- 32 National Active Germplasm Site (NAGS) for arecanut : ICAR- CPCRI, Regional Station, Vittal, Bantwal Tk., Dakshina Kannada Dt., Karnataka-574 243.
- 33 Alternate gene banks for arecanut : CPCRI, Research Centre, Mohitnagar, West Bengal
CPCRI, Research Centre, Kahikuchi, Assam
- 34 ICAR Ad hoc Arecanut Committee : 1947
Central Arecanut Research Station (CARS) at Vittal : 1956
Under CPCRI : 1970
- 35 Arecanut breeding strategies : Germplasm collection- selection- hybridization- resistance breeding- marker assisted selection
- 36 Hybridization in areca : Dwarf x Tall
Interspecific hybrids
- 37 CPCRI varieties of arecanut : Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala, Kahikuchi Tall, Madhuramangala, Nalbari, Shathamangala
- 38 Dwarf hybrids of areca : VTLAH 1- Hirehalli Dwarf x Sumangala
VTLAH 2- Hirehalli Dwarf x Mohitnagar
- 39 Cultivars of areca : South Kanara Local, Thirthahalli Tall, Sirsi, Shimoga, Sagar, Hirehalli Tall, Hirehalli Dwarf, Sreewardhan, Mettupalayam

- 40 Propagules of areca : Seed nuts, sprouts, seedlings, tissue cultured plantlets
- 41 Mother palms of areca : Early bearing, stabilized yield, regular bearing, high percentage >50% of fruit set, more leaves on the crown (8-9), shorter internodes
- 42 Isolation distance for areca : 200- 300 m
- 43 *Interse* gardens of areca : To select purelines
Mangala x Managala
Mohitnagar x Mohitnagar
- 44 Seed nuts standards for arecanut : Fully ripened nuts with weight of >35 g, harvest the nuts with rope without dropping to the hard soil, nuts should float vertically in water
- 45 Type of arecanut seed : Recalcitrant, no dormancy
Polyembryony
- 46 Arecanut seed storage : Critical moisture content for arecanut seed is 32.8%.
In plastic bag or moist saw dust or seeds mixed with moist sand (1:3 ratio) with 0.2% potassium dihydrogen phosphate and storing in polythene bag
- 47 Potting mixture for arecanut : 7 : 3: 2 (Soil: Compost: Sand)
- 48 Primary nursery : Sow the nuts immediately after the harvest in soil or sand beds.
Sow at 5 cm distance in vertical position with calyx end just covered with sand.
The beds may be mulched lightly using areca leaf or paddy straw.
Water daily to get early and good germination.
- 49 Secondary nursery : Transplant 3 months old seedlings in polythene bags (25 x 15cm, 150 gauge) filled with potting mixture.
Provide proper shade, water regularly during summer.
- 50 Germination in arecanut : Commencement of germination : 53 days
Completion of germination : 94 days

- 51 Early stage of germinated arecanut : Sprouts (3 month old, 2 or 3 leaves)
- 52 Seedlings suitable for planting : 12- 18 months
5 or more leaves
- 53 Seedling selection index : Number of leaves x 40 – seedling height
- 54 Micropropagation in areca : Explants: Leaf and immature inflorescence (8 – 12 cm)
- 55 Spacing and method of planting : Arecanut- 2.7 m x 2.7 m (9 ft. x 9 ft.) in square, north south line should be deflected at an angle of 35⁰ towards west
Dwarf hybrids- 2.2 m x 2.2 m
- 56 Traditional closer spacings : 1.8 m x 1.8 m (5.9 ft. x 5.9 ft.), 2 m x 2 m (6.6 ft. x 6.6 ft.), 2.5 m x 2.5 m (8 ft. x 8 ft.)
- 57 Arecanut based multi species cropping system : Arecanut + Cocoa + Banana + Pepper
Arecanut + Nutmeg + Banana + Pepper
- 58 Arecanut cropping models in different regions :

Maidan parts of Karnataka: Arecanut- Pepper- Cocoa, Areca- Banana- Acid lime

Coastal Karnataka and Kerala: Arecanut- Cocoa- Pepper- Banana

North Bengal region: Arecanut- Pepper- Banana, Arecanut- Pepper- Acid lime

Wayanad dist. of Kerala and Uttara Kannada: Arecanut- Cardamom

Hilly tracts of Karnataka: Arecanut- Coffee

- 59 Planting : **Time:** May-June in well drained soils
August- September in water logging areas
Pit size : 60 x 60 x 60 cm³
and 90 x 90 x 90 cm³ also recommended
Method : Half fill the pits with top soil, cow dung & sand. Plant the seedlings at the centre and cover up to the collar region with soil
- 60 Initial care after planting : Banana can be planted between rows up to 4 to 5 years to provide shade.
Stems are protected from sun scorch by covering with dry leaves and spathe of arecanut or white opaque polythene films.

- 61 Fertilizer dose for arecanut : 100: 40: 140 NPK g/ plant/ year
12 Kg green leaf and 12 Kg compost/ cattle manure
1/3rd in April- May and 2/3rd in Sept.- Oct.
- 62 Fertigation for arecanut : Fertilizers in the form of Urea, DAP and Muriate of Potash at 20 days interval during irrigation period.
- 63 Arecanut farm wastes for composting : 5.5 to 6.0 tonnes of organic wastes are available from one hectare of areca garden per year.
Arecanut leaves, areca leaf sheath, inflorescence/ bunches, husk.
- 64 Vermicomposting of organic wastes in areca garden : Areca wastes are chopped into pieces of 10 cm filled in tanks or pits and mixed with cow dung slurry at the rate of 10% by weight.
One Kg earthworms (*Eudrilus eugeniae*)/
1000 kg organic wastes.
70% conversion in 60 days.
About 8 kg of vermicompost/palm/year meets crops nutrient demand.
- 65 Mulching : The practice of covering palm basin with areca leaves and husk for water conservation.
- 66 Green manure cum cover cropping, protection from weeds : *Pueraria javanica*, *Mimosa invisa*, *Calapogonium mucunoides*, *Centrosema pubescens* and *Sesbania speciosa*.
- 67 Water requirement of arecanut through drip : 20 litres/ palm, Provide adequate irrigation during summer, Provide 75 cm deep drainage channels during rainy season.
- 68 Major diseases of arecanut : Yellow leaf disease (YLD), fruit rot, crown rot, bud rot, basal stem rot/ foot rot, inflorescence dieback and button shedding, leaf spot/ blight

Integrated Disease Management (IDM) for diseases of Arecanut

Yellow Leaf Disease (YLD) : (Phytoplasma)

- In mildly affected area : Eradication of YLD affected palms.*
- In heavily diseased area : Removal of disease advanced and juvenile palms, balanced fertilizer application, recommended dose + additional dose of super phosphate (1 kg/palm) and micronutrients based on soil test.*

- Improve soil and plant health* : *Plant growth promoting Rhizobacteria and Trichoderma (100g) enriched neem cake (2 kg/palm) for root regeneration. FYM @ 12 kg/palm/year, summer irrigation (20 L water /palm/day) and drainage during rainy season.*
- Fruit rot**
(*Phytophthora meadii* Mc. Rae) : *Removal and destruction of fallen rotten arecanuts, bunches and dead palms in the garden. Prophylactic spraying of 1% Bordeaux mixture or Mandipropamide @ 0.5 % to bunches just before the onset of monsoon and one more spray at 30-45 days interval.*
- Crown rot and Bud rot** : *Removal of rotten spindle and apply 1% Bordeaux paste to the wound, cover with polythene sheet till the new shoot emerges. Drenching crown of surrounding palms with 1% Bordeaux mixture.*
- Basal stem rot/ Foot rot**
(*Ganoderma lucidum* (Leys) Karst and *G. applanatum*) : *Isolation trenches of 60 cm depth and 30 cm width between diseased and healthy palms. Addition of FYM (25kg) or green leaves/palm/year. Application of Trichoderma harzianum (CPCRI TR 28) enriched neem cake @2.5 kg/palm at quarterly intervals for one year. Root feeding with Hexaconazole @ 2% (100 ml solution per palm) at quarterly intervals for one year and soil drenching with 25 liters of 0.2% Hexaconazole or with Bordeaux mixture (1%).*
- Inflorescence dieback**
(*Colletotrichum gloeosporioides* Penz) : *Removal and destruction of completely dried inflorescence. Spraying with Propiconazole@ 0.1% (1ml/L), two sprays, at 30-35 days interval. Initial spraying on production of female flowers.*
- Leaf spot/ Blight**
(*Phyllosticta arecae* Hohnel, *C. gloeosporioides* Penz and *Pestalotiopsis palmaru*) : *Collection and destruction of infected leaves. Spraying with Propiconazole or Hexaconazole @ 0.1% (ad-hoc) (or) Bordeaux mixture @ 1% at an interval of 30-35 days.*
- 69 Nursery diseases : *Collar portion of seedlings in nurseries and transplanted seedlings is affected by bacteria. Fusarium spp., Rhizoctoniaspp., Pythium spp. and Phytophthora spp. accelerate rotting of young bud and root decay, Soil drenching with 1% Bordeaux mixture or Copper oxychloride @ 0.1 %.*
- 70 Major pests of arecanut : *Root grub, Spindle bug, Mites, Pentatomid bug, Scale insect, Inflorescence caterpillar
Emerging pests: Red palm weevil, Ambrosia beetle*

Root grub (Leucopholis spp.) : 3-4 ploughings from October-December to expose the grubs to predators.

Hand picking of adults during peak emergence period May- June in plains and August in hills at 6.30 PM -7.30 PM.

Application of neem cake @ 2 kg/palm/year during June to July in the basin.

Application of Entomopathogenic nematode liquid suspension, Steinernema carpocapsae @ 1.5 billion infective juveniles (IJ's)/ha (approximately 1 crore IJ's/palm) during September - October in plains and November - December in hills or Patch application of chlorpyrifos 20EC @ 10 litre/ha or bifenthrin 10 EC @ 20 litre/ha covering interspaces and root zones.

If needed, second round root zone application of chlorpyrifos 20 EC @ 7 ml/palm or bifenthrin 10 EC @ 14 ml/palm after 45 days may be given.

Spindle bug (Mircarvalhoia arecae) : Placement of Thiamethoxam 25 WG (2 g) in perforated poly-sachets in the inner most two leaf axils of areca palms during April-May.

Spraying with Thiamethoxam 25 WG (0.25 g/L) in and around the spindle and inner whorl of leaves.

Red mite (Raoiella indica) and white mite (Oligonychus indicus) : Conserve predatory mites *Amblyseius channabasavanni*. Application of neem oil emulsion (5 ml/L) two-times at 15 days intervals.

Pentatomid bug (Halyomorpha picus) : **Low/less infestation** : Neem oil emulsion (5 ml/L) spray, two - times in fortnightly intervals only to the infested and surrounding palms not to spray on freshly opened inflorescence. **Severe infestation** : Clothianidin (0.24 g/L) or Pymetrozine (0.6 g/L) to the developing bunches.

Scale insect (Aonidiella orientalis and Ischnaapsis longinostris) : Temperature favors population build up, so provide proper shade. Conservation and augmentation of lady bird beetle, *Chilocorus nigrita*. Neem oil emulsion spray @ 5ml/L two-times in 15 days intervals.

Inflorescence caterpillar (Tirathaba sp.) : Cut and burn the infested female flowers and inflorescence. Open the spadices and spray lambda cyhalothrin (0.3 ml/L).

- 71 Storage pests of arecanut : Arecanut beetle, Coffee bean weevil, Cigarette beetle, Rice moth
- 72 Physiological disorders in arecanut : Disorders are due to abnormal environmental conditions, improper nutrition and without involvement of primary parasite. Tendernut dropping, Button shedding, Nut splitting, Bandh disease
- 73 Imbalance of nutrients : Crown bending, oblique ring, crown choking, bandh disease, nut splitting, nut shedding
- 74 Protection from sun scorch/ stem breaking : Stem should be covered with areca leaves/ areca sheath. Painting/ white washing with lime in some areas.
The outermost row of palms on the southern and south western sides can be protected by covering and grown with tall shade trees like *Casuarina*.
- 75 Forking/ Digging in areca garden : To break up surface crust practiced forking or digging after cessation of monsoon during October- November.
- 76 Index tissue for leaf sampling : 3rd or 4th leaf from top
- 77 General recommendation for prevention of arecanut diseases : Pre and post monsoon spray of Bordeaux mixture in traditional belts with high rainfall and with 45 days gap if rain continued.
- 78 Horticultural maturity in arecanut : Green nuts turn to yellow/ orange colour
- 79 Areca and Arecanut : Tree with inflorescence and fruit bunches
Ripe and dehusked nuts
- 80 Harvesting in arecanut : June- July for tender nuts and November- March for ripe nuts
- 81 Method of traditional harvesting : Climbing from one end of the garden, jumping to next palm through oscillation of thin upper stem, completing whole garden and getting down at other end of the garden.

- 82 Types of processed nuts : Dried ripe nuts, Kalipak, Scented supari
- 83 Processing : Tender nut (Kalipak) processing
Matured nut (Kottappak) processing

Tender nut processing: 6 to 7 months green nuts are dehusked, cut into pieces, boiled in water, kali coating is given from previous boilings and dried.

Ripe nut processing: Fully ripe 9 months old yellow or orange nuts dried in sun for 35 to 40 days, cut longitudinally, scoop out dry nut and again dried for 10 days.

- 84 Bura tamul and Neettadaka : In Assam, fresh fruits are preserved in thick layers of mud.
In Kerala, fresh fruits are stored by steeping in water, resulting in discolouration of outer husk and foul smell due to bacterial attack but inner core is preserved.
- 85 Taste of arecanut : Astringent (contracting, drying sensation or puckeriness felt all over the mouth)
- 86 Grades of tender nut : Hasa (I quality), Bettae (II), Gorblu (III), Nuli (IV)
- 87 Types of processed tender nuts based on no.of cuts, shapes and sizes : Unde or Api, Batlu or Ottavettu, Choor, Podi, Erazel, Iylon, Nayampak
- 88 Grades of dry nut (chali) : Mora, Moti, Srivardhan, Jamnagar and Jini
- 89 Moisture content in dry kernels : 6-7%
- 90 Constituents of arecanut : Tannin, Fat, Polyphenols
- 91 Other products from arecanut : Arecanut husk- fibre, hard boards & plastics, pulping & paper boards.
Areca stem & leaves- building materials, utility articles, furnitures.
- 92 Areca leaf sheath products : Throw away cups & plates, plyboards, decorative veneer panels and picture mounts, house sandals, gin washers other household items

- 93 Areca plate making unit : Ecovision/ Ecoblizz, Vittal
- 94 Medicinal uses : Antihelmintic and are effective against tape worms and round worms.
- Antibacterial and inhibits growth of *Escherichia coli*, *Staphylococcus typhi* and *Staphulococcus aureus*
- Arecoline lowers blood sugar level.
- 95 Uses of arecanut constituents : Tannin (16-22%): For dying clothes, leather, rope, black writing ink and food color
Fat (8-12%): rich in myristic acid.
- 96 Areca Farm Machinerries : Dehusker, Climber, Sprayer
- 97 DASD : Directorate of Arecanut and Spices Development, Kozhikode, Kerala
- 98 CAMPCO : Central Arecanut and Cocoa Marketing and Processing Co-operative Ltd., Mangalore, Karnataka
- 99 Areca Journal : Indian Journal of Arecanut, Spices, Medicinal and Aromatic Plants (DASD)
- 100 Areca Book : 'The Arecanut Palm'- Bavappa, Nair, Premkumar, CPCRI, Kasaragod



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