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History and research accomplishments of ICAR-CPCRI, Regional Station, Kayamkulam

Coconut is an excellent ecological service provider known since time immemorial, catering to the basic needs, viz. fuel, fibre and shelter for humankind. It is a livelihood provider to more than 12 million farm families and conserves the ecosystem, worth billions of rupees, along coastlines. Let us look back at how a coconut palm disease was first noticed, and thereafter, a research station took shape even before India's independence mainly to address farmers' concerns related to the disease, to decode the cause, to offer a solution for the disease, and thereafter to sustain farmer's welfare. The history recollects how Kerala and coconut became synonymous.

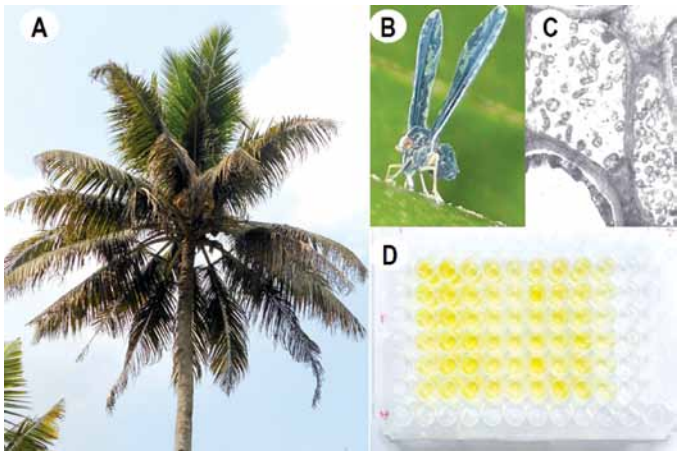
History

In 1882, after the great floods in Erattupetta in Meenachil Taluk, farmers in the region observed the coconut palm disease. Subsequently, the coconut farmers of Kaviyoor and Kalloopara (Thiruvalla Taluk) complained to the State of Travancore about the rampant occurrence of coconut palm disease in 1887. The petitions were referred to Shri M.S. Narayanswami Iyer (the Superintendent of Agricultural Farm, Karamana) in 1900. This was followed by Mr. T.F. Bourdillion's (Chief Conservator of Forest) report in 1907, which concluded the disease to be of fungal origin. The State of Travancore later appointed Sir E.J. Butler, the imperial Mycologist, who gave a report in 1908 titled *'Coconut palm disease in Travancore'*.

Department of Agriculture under the State of Travancore started one separate Mycology Section and T. Padmanabha Pillai was appointed the first State Mycologist in 1918. Later in December 1924, M.K. Varghese was appointed as Mycologist at Agricultural Research Laboratory (ARL), Kollam. From 1925 onwards, M.K. Varghese carried out his experiments and survey work mostly at Kayamkulam. He authored a book titled *'Diseases of the Coconut Palm'*, published by the Department of Agriculture and Fisheries in 1934.

Subsequently, the Travancore government prepared and submitted a project on *'Root disease of coconut'* to the Imperial Council of Agricultural Research. The State Department of Agriculture sanctioned the project in 1937 for a period of three years (1937-1940). Dr K. P. V. Menon, Plant Pathologist, was appointed to the project at ARL, Kollam and Shri M.K. Varghese, State Mycologist, assisted in laying out and supervising field experiments at Kayamkulam. The ICAR project's funding was extended for two years (1940-42) and further extended for another five years (1942-47) with financial assistance from Indian Central Coconut Committee and Travancore State.

In February 1945, the Indian Central Coconut Committee (ICCC) was constituted with Ernakulam as its Headquarters, and the Vice President of ICAR was an *ex-officio* member of the ICCC. The Committee functioned under the administrative control of the Ministry of Food and Agriculture, Government of India. The Committee appointed Dr C.M. John (Oil Seeds Expert) and Dr K.P.V. Menon to identify suitable locations for establishing a Coconut Research Station in India. They surveyed the entire country and



submitted a report to establish two independent coconut stations, one at Kasaragod and another at Kayamkulam. The foundation stone for Central Coconut Research Station (CCRS), Kayamkulam, was laid on 24th April 1947 by his highness Sree Uthradom Thirunal Marthanda Varma, Elayaraja of State of Travancore.

The Station at Kayamkulam was established specifically for research on coconut pest and disease management, and Dr K.P.V. Menon became the first Director. In 1966, the Indian Council of Agricultural Research (ICAR) took over the Research Stations (both at Kasaragod and Kayamkulam) from the ICCC and later, in 1970, the CCRS was renamed as Central Plantation Crops Research Institute (CPCRI), with its headquarters at Kasaragod.

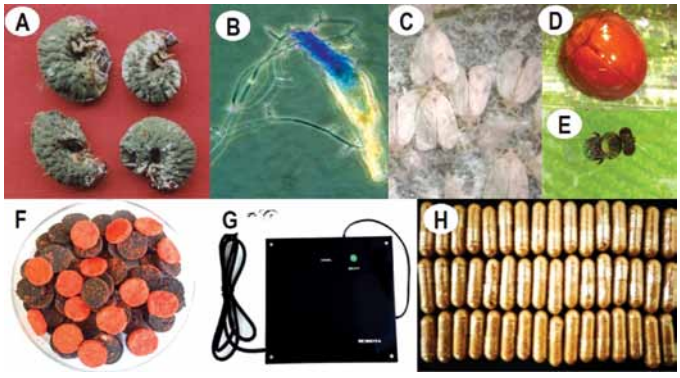
Achievements

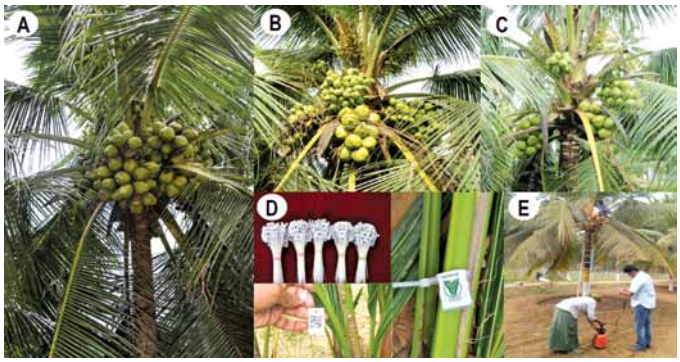
The Central Coconut Research Station at Kayamkulam was established with four major departments (Pathology, Entomology, Soil Chemistry and Physiology). The total scientific strength was 16, with four scientists in each section. Plant Physiology under Prof. T.A. Davis, Entomology under Dr K.K. Nirula and Soil Chemistry with Dr K.M. Pandalai and Dr K.P.V. Menon looked after Plant Pathology Section. The '*Coconut palm-A monograph*', considered the bible of coconut, was published by Dr K.P.V. Menon and Dr K.M. Pandalai in 1958.

Crop protection: Work continued to elucidate the exact etiology of root (wilt) disease. Though it was suggested as a fungal origin, later bacterial and viral origin was proposed. In 1983, the phytoplasmal association with root (wilt) disease was confirmed based on electron microscopy. Research on leaf rot disease management, a disease superimposed on root (wilt) diseased palm, was also undertaken. From 1960-1990, efforts were mainly focussed on developing management strategies for root (wilt) and leaf rot diseases. The building to house the Transmission Electron Microscope (TEM) was inaugurated in 1981, and the first TEM was purchased and installed in 1983 under the World Bank-funded project. Two hemipterans, viz. the lace bug (*Stephanitis typica*) and the plant hopper (*Proutista moesta*), were established as insect vectors of root (wilt) disease through electron microscopy and transmission experiments. Recently in 2021, a lethal wilt disease associated with phytoplasma [*Candidatus* Phytoplasma asteris' (16SrI-B)] was reported on coconut from the East Coast of India, which kills the palm within a span of 3-5 months. Effective integrated management for leaf rot disease was evolved as well as biocontrol of leaf rot using *Pseudomonas* @ 50 g per litre of water after removal of the rotten portion was adopted for recovering the health and improving the yield of the palms. Integrated management of root (wilt) disease involved balanced nutrient application, including 500 g magnesium sulphate per palm, leaf rot disease control, basin management with mulching, green leaf manures, and soil/water management. The Institute successfully demonstrated the efficacy of this management practice as a participatory technology transfer approach (PTTA) in a 25 ha contiguous area involving 200 farm families during 2001-2003, facilitated as a team effort of scientists and stakeholders. The innovative approach proved conclusively that the health of root (wilt) affected palms improved, and 'disease severe' and 'disease middle' categories of palms were shifted to 'disease early' or 'apparently healthy' categories. This was coupled with an improvement in nut yield by 92.8% after adopting the recommended package. The farmer participatory approach was further extended to all the root (wilt) disease-affected districts of Kerala as a comprehensive approach for managing the disease. It was later adopted by the State Department of Agricultural Development and Farmers Welfare in the Keragramam program in the entire state, improving the yield as per State Planning Board records.

Investigations on describing the pests of coconut were done during 1950-1970, which included bionomics and management of major pests, viz. coconut rhinoceros beetle, red palm weevil, leaf eating caterpillar, coried bug, ash weevil, slug caterpillars, white grub, etc. The green muscardine fungus, *Metarhizium anisopliae,* was found to cause epizootics on the grubs of rhinoceros beetle as early as 1955 and was later used as an effective bioagent in the bio-suppression of rhinoceros beetle by area-wide delivery on breeding sites through farmer-participatory mode. Biological pest suppression has been the central focus and augmentative release of stage-specific parasitoids, viz. *Goniozus nephantidis*, *Bracon brevicornis*, *Elasmus nephantidis* and *Brachymeria nosatoi* in the bio-suppression of black headed caterpillar (*Opisina arenosella*), is a classic success story which led to the establishment of Parasite Breeding Stations in most of the districts in Kerala.

Investigations on plant parasitic nematodes associated with coconut were initiated in 1964, and organized research programmes were started from 1972 onwards.





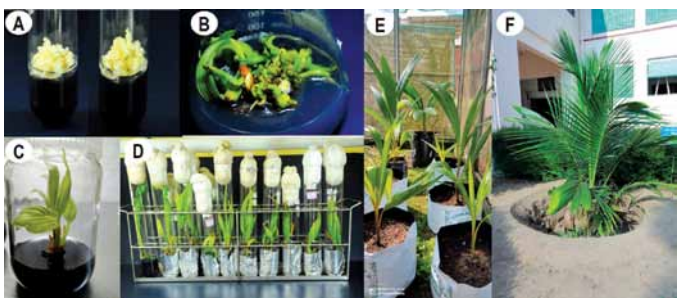
More than 30 plant parasitic nematodes were documented in the coconut rhizosphere, which includes many new descriptions. The distribution, pathogenicity, host range, biology and life cycle of burrowing nematode infesting coconut were systematically studied and effective management strategies were evolved.

A biocontrol laboratory under the PL-480 scheme and a parasite breeding station were later established with facilities for the mass production of parasitoids. An amplifier-based red palm weevil detector was designed in 1964, and the release of sterile males of red palm weevil in collaboration with BARC for managing red palm weevil was attempted in 1973. The use of baculovirus, later christened as *Oryctes rhinoceros* nudivirus in 1983, was another success story in the bio-suppression of coconut rhinoceros beetle through the release of virosed beetles in the Island system of Lakshadweep and Andamans. The discovery of non-native coconut eriophyid mite in 1998 from Kochi was another contribution from this Regional Station. ICAR-CPCRI has evolved botanical and nutrition-based pest management modules as pan India recommendations. Identification of the weed plant, *Clerodendrum infortunatum,* with insect growth regulatory properties in 2000 and later its extract could became a part of the botanical cake and paste used in the prophylactic leaf axil filling and spear leaf smearing, respectively, in the management of coconut rhinoceros beetle in juvenile palms during 2011. Occurrence of exotic whitefly complex with the report of rugose spiralling whitefly (*Aleurodicus rugiopercualtus*) in 2016 and later the first report of nesting whiteflies (*Paraleyrodes bondari* and *Paraleyrodes minei*) in 2018 and palm whitefly (*Aleurotrachelus atratus*) in 2019 gained nation-wide attention. The discovery of the sooty mould scavenger beetle (*Leiochrinus nilgiranus*) involved in the bio-cleansing of palms infested by the whitefly complex was reported in 2018 for the first time. Conservation biological control using the aphelinid parasitoid (*Encarsia guadeloupae*), the predator (*Apertochrysa* sp., *Cybocephalus* sp. lady beetles) and *in situ* conservation of sooty mould scavenger beetle (*L. nilgiranus*) was another success that reduced the invasive potential of exotic whitefly complex. An acoustics-based red palm weevil detector embedded with a machine learning algorithm and artificial intelligence realizing 80% field efficacy in pest diagnosis was launched in 2021. Agro-ecosystem-based pest management through crop pluralism reduced pest incidence and increased farm income (>155 nuts/palm/year). Area-wide delivery of bioagents in the bio-suppression of coconut rhinoceros beetle, black-headed caterpillar and exotic whitefly complex are success stories in pest management. A potent and novel entomopathogenic nematode, *Steinernema* sp., with high virulence and shelf life, was found effective in managing red palm weevil, and *Galleria mellonella* cadaver-based bio-capsule of EPN delivery was developed, and field efficacy is in progress.

Crop improvement: Sir E. J. Butler suggested in his report that there could be resistance to coconut root (wilt) disease in the local cultivars grown in the diseased tract. In 1934, M.K. Varghese initiated the studies to identify coconut palms resistant/tolerant to root (wilt) disease and surveyed about 10 sq. miles in and around Kayamkulam, but in vain. Way back in 1953, researchers reported the occurrence of high-yielding palms among the heavily diseased palms. Attempts to screen the available coconut germplasm from ICAR-CPCRI, Kasaragod (a disease-free area) were made as early as 1961 at CPCRI, Regional Station, Kayamkulam. In the evaluation trials undertaken at the Regional Station and in cultivators' gardens during 1961-1987, wherein 50 varieties and 38 hybrid combinations were evaluated, it was observed that none of the cultivars and hybrids was resistant to root (wilt) disease. In 1987, the classical 'Hot spot' breeding work in coconut was initiated based on recommendations of ISOCRAD-I. The systematic germplasm screening work and 'hot spot' breeding programme led to the release of the Kalparaksha variety in 2008, followed by the release of Kalpasree and Kalpa Sankara in 2012. The later trials, initiated in 2012, included evaluation of D × Ts, Green Dwarfs and promising tall accessions.

During the last four years (2017-2021), approximately 20,000 seedlings of released varieties of coconut were distributed annually to farmers. This station also developed QR code imprinted durable labels for labelling coconut seedlings. The label has a QR code and the variety name on one side, batch number/serial number/year of production and ICAR-CPCRI emblem on the reverse side. Scanning the QR code will enable the farmer to get specific information about the characteristics of each variety being distributed from CPCRI. Innovations to serve the farming community resulted in developing a modified ground pollination technique wherein the control of assisted pollination was shifted from coconut crown to ground.

The work on coconut tissue culture was initiated during 1991-92. Induction of multiple shoots using embryos collected from West Coast Tall variety was done by mechanical and chemical treatments. During 2000-01, root culture was initiated with the objective of long-term preservation of root (wilt) disease-free palms in slow



growth media. The work on direct organogenesis from floral primordia was initiated in 2003 and successfully regenerated plantlets from rachillae bits. The tissue culture laboratory of the station was renovated in 2014, and efforts were continued to refine the protocol of direct organogenesis using immature inflorescence. Systematic work on tissue culture led to the production and field planting of the first tissue culture-raised coconut plantlet in November 2020. The tissue culture plantlet was planted by Shri V. Muraleedharan, Hon'ble Minister of State for External Affairs, Government of India on 25th November, 2021.

Crop production: Work on establishing a meteorological observatory at Kayamkulam started in 1955. The station has continuously provided daily weather data to Indian Meteorological Department, Pune and other departments since then. A sand culture experiment with coconut seedlings was carried out during 1955-56 to study nutrient deficiencies in relation to leaf disease. Based on field trials, the dose of 500 g N, 300 g P_2O_5 and 1000 g K_2O along with 500 g MgO per palm per year was recommended in 1982 for optimum productivity of COD × WCT hybrids under rainfed conditions. Experiments on High Density Multi Species Cropping System (HDMSC) started in 1970 with the coconut-pepper-nutmeg-cinnamon cropping system. Mixed farming systems with livestock, *Azolla*, biogas, vermicompost, fodder, along with several inter and mixed crops such as tubers, spices, nutmeg, fruit crops, flower crops, fodder, cereals and pulses were found to be suitable for improving income in the coconut based cropping/farming systems.

Micronutrient spraying on coconut leaves (copper, zinc, boron, iron, manganese, molybdenum and magnesium) at monthly intervals was undertaken with a favourable response. Investigations were conducted in 1956-57 on using sodium chloride as a substitute for potash and evolved low-cost recommendations for coconut nutrition. Studies on the uptake pattern of nutrients of the healthy and the root (wilt) disease-affected palms in Entisols indicated that uptake of N, P, K, Ca, Mg, S and B were significantly more in the apparently healthy palms compared to the root (wilt) disease affected palms irrespective of the intensity of the disease. In the apparently healthy palm, potassium recorded the highest total uptake in magnitude (1075 g/palm), followed by N (889 g/palm), calcium (389.7 g/palm) and P (109.4 g/palm). The critical level of boron in the soil and leaves of coconut palms were standardized as 0.87 mg/kg and 13.27 mg/kg, respectively. Applying 160 g of borax in four splits could alleviate boron deficiency symptoms in coconut. Fertigation studies (2017 onwards) in Hybrid coconut

(Kalpa Sankara) indicate that fertigation promotes early flowering and fruit set compared to the basal application of nutrients. Higher doses of nutrients through fertigation provide an early advantage in fruit set and higher yield in the palms compared to lower doses of nutrients.

The role of soil on the expression of root (wilt) disease symptoms formed the basis of earlier research in the Soil Science division. Systematic studies conducted during the late 1970s ruled out the role of soil types on the root (wilt) disease incidence. The role of heavy metals in the root (wilt) disease was also studied during the 1980s. In 1983, researchers found that N, P, K, Ca, Mg, and all combinations of micronutrients had no effect on the root (wilt) disease incidence and yield gradually decreased as the disease intensity increased. Boron was found as the limiting nutrient of crown choking disorder of coconut. The positive role of magnesium on the number of functional leaves, female flowers and nuts was established. Nutrient mixtures, Kalpa Poshak and Kalpa Vardhini, were developed for juvenile and adult palms, respectively. By 2021, the total nutrient uptake of NPK in 25-year-old apparently healthy coconut palms was studied through destructive sampling.

Social sciences: Efforts for surveying the root (wilt) affected area in Kerala State uncovering the economic loss of the disease; contributed to the policy framework for Coconut Research and Development efforts. Developed Participatory Technology Transfer Approach (PTTA) and extension strategies for adopting improved management technologies for economic management of root (wilt) disease. Projects for demonstrating technologies associated with line departments have led to close contact with farmers and the farming community. Training programs for entrepreneurs, farmers, farm women, rural youth, extension officials, students and agri-technocrats benefit more than 5000 participants annually. Innovative and evolved strategies were adopted in extension methods like Farmer Field Schools (FFS) in coconut along with international experts, Farm schools in coconut and community approach in demonstrating coconut seedling management. Studies on cluster approach among small and marginal farmers, social intelligence and leadership behaviour of coconut farmer leaders, participatory bioresource management in coconut-based homesteads and climate resilience farm model documentation were also contributed to the social science sector. 'e kalpa', the

cloud-based mobile application was launched in 2018, and is available in Google play store in a multilingual (English, Hindi, Malayalam, Bangla and Kannada) and interactive mode. The features included technology snippets, a knowledge base, crop information on 79 crops in coconut systems, a fertilizer calculator and a field issue reporting window. It is accessible in offline and online mode. Besides this, an 'e plantation survey App' was also evolved for digitized and GPS-tagged data collection and digitization of field and farmers' data documentation to ensure accurate and paperless data management.

The approval of the Remanded Zonal Agricultural Research Station (RZARS) in 2000 reflected the innovative and active outreach programs and impact, culminating in the sanction of the full-fledged Krishi Vigyan Kendra (KVK) of the Alappuzha district in 2004. The station operates the Farmer FIRST Project (FFP) involving 1000 farm families in a 1647 ha area in Pathiyoor panchayath, Alappuzha district of Kerala, as an effective farmer participatory technology outreach program auguring responsive extension. The Odanadu Farmers Producers Company (OFPC), supported by NABARD for which ICAR-CPCRI, RS is the POPI (Producer Organization Promoting Institution) is proving its potential as a technology promoter through augmented technology support of recent technologies such as KeraProbio (biofertilizer), nutrient mixture Kalpavardhini for bearing palms, CPCRI vermicompost methodology of converting organic coconut residues to manure and support services for coconut farmers through Coconut Care and Cover Program (CCCP). Other social innovations were the pilot testing and experimentation of Area wide community adoption of bio management (AWCA) of the major pest of coconut Rhinoceros beetle and Participatory Community Management of Red Palm Weevil (RPW) in a contiguous area of 2000 ha. In addition, the flagship *Mera Gaon Mera Gaurav* (MGMG) program translates technologies to farmer's doorstep, reducing the gap in technology generation and field-level adoption. Extension literature in multiple languages, interactive videos on technologies, social media content mobilization on YouTube channels, Facebook and WhatsApp groups, diagnostic field visits, RAWE programs for agricultural students and training for national and international participants cater to the augmentation of academic excellence linkage and networking. A full-fledged helpdesk is also open in the Institute to the visitors and stakeholders to extend help and services as per their customized needs. The station thus caters to the need of the coconut community and has served the society with technologies and active outreach programmes since 1947, therefore befitting the Platinum Jubilee celebrations.

Inaugural ceremony of Kalpa Vajra (Platinum Jubilee Celebrations) held on 24th April 2022 at Kayamkulam

As a part of *Azadi Ka Amrit Mahotsav* and *Annadata Devo Bhava*, the station organized a grand inaugural function of the yearlong '*Kalpa Vajra'* celebrations (2022-2023) on the 24th of April 2022, the very day when the foundation stone was laid and the station commenced its scientific journey 75 years back. The ceremony was inaugurated by Shri P. Prasad, Hon'ble Minister for Agriculture, Government of Kerala, by virtual mode, presided by Adv. A.M. Arif, Hon'ble Member of Parliament, Alappuzha.

Dr P. Anithakumari, Acting Head, ICAR-CPCRI, Regional Station, Kayamkulam, welcomed the gathering and highlighted the significant accomplishments of the station. In her introductory remarks, Dr. Anitha Karun, emphasized the scientific journey of the Institute since 1947, serving the coconut community and released the coffee table book on '*ICAR-CPCRI, Regional Station, Kayamkulam @75-Serving Coconut Farmers since 1947*', highlighting the historical science journey and technological solutions offered to coconut farmers. An exhibition was conducted with the participation of different Government agencies and the farmer's group under the Farmer-FIRST programme, *Mera Gaon Mera Gaurav* (MGMG), marking a smart technological display for effective dissemination. The year-long programs include the Kalpa Quiz for 750 school students from 70 schools in seven districts on the theme 'Science and development - Coconut as provider of ecological service and livelihood' supported by the Coconut Development Board (CDB). Release of Special Postal Cover and My Stamp to commemorate the Platinum Jubilee, National Mentoring Workshop for FPOs in collaboration with NABARD, Seminars and demonstration plots on launching of Stingless bees and pollinators for natural services in coconut, reaching out to 7500 coconut farmers through linkages and convergence with other agencies, launching Coconut care and Cover program for 75000 coconut palms of small and marginal farmers, 'International Conference on Recent Advances in Coconut Plant Protection', 'Kalpa Sangamam' of staffs and workers of the Institute and 'Kisan Mela' are the major highlights.

SUMMARY

The Institute has evolved pathbreaking technologies for the welfare of the coconut community during the past 75 years, and the societal outreach approaches through farmer-participatory mode have delivered enormous dividends. The year-long programme will further narrow down the technology delivery and empower the coconut community for easy access to technologies for doubling income.

For further interaction, please write to:
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