Coconut Research — the Past, the Present, and the Future

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The Past

The dawn of the Twentieth Century saw Sri Lanka with a well developed plantation sector based on Tea, Rubber and Coconut. In the pioneering days, there was a useful participation of high officials of the Colonial Service in these enterprises. This factor would no doubt have contributed to the sizeable influence wielded then by plantation interests. There also lay one reason for the sharp dichotomy between the plantations and the indigenous farming community which persists to this day.

In sharp contrast with the unorganized subsistence level agriculture concerned with the provision of food and other produce for local needs, were the systematised and sophisticated arrangements of the export sector. The plantation interests, operating as they did on the basis of competitive efficiency, were not slow in recognizing the research needs of the young plantation industries. They had meanwhile formed themselves into Planter Associations, which had considerable voice and influence in the highest echelons of the Colonial Government. As a result of persistent agitation, Tea, Rubber and Coconut Research Institutes were set up in rapid succession during the 1920's. They took over the specialised function of research into the crops which had hitherto been the responsibility of the Department of Agriculture. The wisdom and vision behind these moves is reflected by the worldwide eminence that the three Research Institutes have each achieved.

A definite proposal for a Coconut Research Scheme was put forward in 1923 and resulted in the Coconut Research Ordinance No. 29 of 1928. The first meeting of the Board of Management took place on 27th April 1929. The finances were generated by a modest cess. The "Scheme" became the "Coconut Research Institute" in December 1950 with the passing of the Coconut Research Amendment Act No. 31 which simultaneously increased the cess.

Following the creation of a separate Ministry of Plantation Industries in 1970, the Coconut Development Act No. 46 of 1971 was promulgated. This created a co-ordinating body, the "Coconut Development Authority" with four separate Boards for Cultivation, Processing, Marketing and Research. Acting under Section 58 (i) of the Act, the Honourable Minister by Gazette notification of 30th March 1972 appointed the seven members to constitute the Coconut Research Board. This Board from then on took over the functions previously carried out by the Coconut Research Institute.

In October 1978, the Government established a Ministry for Coconut Industry, separate from the Ministry of Plantation Industries.

The Coconut Research Institute had its beginnings with just three technical divisions — Soil Chemistry, Chemistry and Genetics. Through progressive enlargement of its activities, the Institute grew to its present state with nine technical Divisions.

In 1951, the Coconut Research Board set up a separate Unit charged with the responsibility of improving the local breed of cattle. This developed into a Division of Agronomy in 1955 which included pasture and mixed-cropping responsibilities. A short time after, the Division was renamed the Agrostology Division and by 1973 had further expanded into two Divisions — Agrostology and Intercropping.

In 1953, the nucleus of the present division of Biometry was established with the appointment of a Technical Assistant (then styled the "Computor").

Initially, the responsibility for pest and disease research lay with a Crop Protection Unit attached to the Division of Botany. In 1955, a separate Crop Protection Division was formed.

From 1949 onwards, the Government commenced a Coconut Replanting Programme operated largely through an organization of Coconut Producers' co-operatives. As the Scheme gathered momentum in the mid-1950's, the responsibility shifted to a Planting Division at the Coconut Research Institute.

This Division still continues to discharge the function of producing seedlings for the use of the industry in its replanting programmes.

With the creation of the Coconut Cultivation Board in 1972, and the entrusting of extension and advisory functions to it, the Institute's own Advisory Division was transferred. This consisted of a number of Advisory Field officers and other supporting staff. This Division also maintained a spraying unit for pest and disease control. The equipment, some staff and materials passed on to the Crop Protection Division.

The Chemistry Division which concentrated its early efforts towards the improvement of coconut based products was, from 1957 relieved of its obligations towards product technology research and obliged to confine its work to agronomic matters. This decision appears in retrospect to have been a retrograde one and a start has been made to recommence product research wherein clearly lie a number of rich rewards. The CRI now has a Division of Processing Research.

Until relatively recently, financial provisions for the Coconut Research Institute can only be described as niggardly. A meagre Government Grant of Rs. 30,000/- bolstered by a variable cess rarely exceeding Rs. 1,000,000. Today the Annual Budget works out at 15 to 20 million rupees and is steadily rising from year to year. Virtually all of it is a Government Grant which provides the requisites of a Staff of about four hundred of whom about forty are at graduate level or above. The present allocation works out at about 1 to 2% of the export value of coconut products but at way below 1/2 to 10 of its gross national value.

The present

The Coconut Development Act No. 46 of 1971 defines the functions of the Coconut Research Board as follows:

(1) Conducting and furthering of scientific research in respect of the growth and cultivation of coconut palms, the growing of other crops and the engagement in animal husbandry on coconut plantations and the prevention and cure of diseases and pests.

(2) Establishment and maintenance of experimental stations and nurseries.

(3) Establishment and maintenance of pilot plants for the processing of coconut products and the fabrication of experimental processing equipment.

(4) Guiding and advising the coconut industry on all matters of a technical nature.

(5) The training of advisory and extension workers.

With the above objectives in view, the Institute conducts its research and services, through nine divisions whose broad functions towards increasing productivity through genetic and agronomic improvements and increased income from coconut lands, are currently as follows :—

(*a*) Agronomy — The study of pastures as an intercrop. Cattle improvement project. Other crops in association with coconut.

(*b*) Biometry with coconut statistics and Agricultural Economic, Statistical services, Crop forecasting, Agri-meteorology and Economics of coconut culture.

(*c*) Genetics and Propagation - Breeding and genetics of Coconut, Progeny testing, Nurseries and seedling behaviour.

(*d*) Plant biology — Physiology of the coconut palm, Tissue culture.

(*e*) Chemistry — Plant tissue analysis, Sap and carbonaceous products.

(*f*) Crop Protection — Managements of pests, diseases and weeds of coconut.

(*g*) Processing Research - Biochemistry, Microbiology and processing methods and finished products.

(*h*) Extention services — Publication

(*i*) Soils — Fertilizer behaviour, Soil surveys.

The technical Divisions are serviced by the necessary administrative, financial, engineering, transport, housing and library services.

The Institute conducts its activities at Bandirippuwa Estate, three sub-stations, two seed gardens, a progeny trial (all totalling about 1650 acres) and 12 nurseries (with a total seednut capacity of about 15 to 20 lakhs).

It is not possible to detail adequately and comprehensively, all of the major achievements of the Institute since its inception. It would suffice to say — and not immodest to claim — that the Institute has repaid amply the national investment so far made. The Institute has successfully established a firm foundation on which the industry can progress with confidence. Naturally, it would be foolhardy to claim that all the answers have been found for then the CRI would become an Institution with no claim for its continued existence.

In the field of selection and breeding, the basis of selection procedures has been established and criteria identified for recognising promising "mother palms". Much is known of the inheritance of material traits by progeny testing and useful "prepotent palms" have been found. Techniques of controlled pollination by proper collection, processing, storage and utilisation have been developed and imparted to the private sector as well. The Institute was one of the earliest to systematically study inter-varietal hybridisation and produced two valuable strains :—

"CRIC 60" — tall x tall. Late flowering and high yielding. Suited to all areas where coconut can be grown.

"CRIC 65" — tall x dwarf or dwarf x tall. Early flowering and high yielding but more critical in their requirements of soil and climate.

Other promising crosses are under test. Two seed-gardens for the commercial production of hybrid seed have been planted and one will within a few years, be in full production. Hybrid performance is being assessed under different agroclimatic conditions and with and without supplementary irrigation.

Studies on optimum planting distances and methods are being carried out.

A laboratory for attempts to produce plantlets by tissue culture techniques will be commissioned shortly, while some preliminary work has already been done.

Young seedlings in sand culture have been employed to demonstrate visual symptoms of individual nutrient deficiencies and to produce an inventory of use of the nutrient elements in the nut at planting.

Methods of foliar analysis have been intensively investigated, attempts made to establish critical levels, to relate nutrient contents to visual disorders, to compile balance sheets for nutrient uptake and utilization and to explore the validity of using nut water or inflorescence sap in analytical studies.

A series of studies are in hand to study the physiology of tapping trees for inflorescence sap, its biochemistry and fermentation characteristics, its potential utilisation for a number of traditional and unconventional products and microbiological studies of the successions in fermenting sap and the possibility of using isolated strains for consistent and improved quality of fermentation products and to improve the efficiency of the process.

Designs for improved Copra Kilns and drying and storage procedures and an improved "continuous generator" process for the production of vinegar have been released to the industry.

Utilization of by-products and uses for waste products are continuously under scrutiny. Use of coir dust as a mulch, trunks for timber uses or as a starting material for charcoal production, nut water, products from alkaline oxidation and distillation of coconut shell, collection of yeasts from toddy ferments, are some of the studies in progress.

Although the coconut palm in Sri Lanka is subject to attack by only a few fungal parasites, there are several important insect pests of the crop. Principal among them are the Coconut caterpillar (*Nephantis serinopa*), the Leaf Scale (*Aspidiotus destructor*), the Red Weevil (*Rhynqophorus ferrugineus*) and the Black beetle (*Oryctes rhinoceros*).

In addition there are several others which are of sporadic occurrence or less damaging.

Since 1958, when a pupal parasite named *Trichospilus pupivora* was first bred in captivity and released to control a severe outbreak of *Nephantis serinopa*, the accent and emphasis of the Divisions activities has been very strongly in the direction of biological control. This is desirable from the points of view of effectiveness, safety and economy.

Perhaps the most effective demonstration of this valuable technique was when a hitherto not experienced outbreak of the coconut leaf-miner *Promecotheca cumingi* made its sudden appearance in 1961. An estimated 30,000 acres was rapidly invaded by the pest. The attack was so devastating that the total destruction of the coconut industry in Sri Lanka seemed a distinct and imminent possibility. In an epic example of scientific co-operation and effective logistics, the new Ministry of Plantation Industries assembled nearly the totality of entomological talent available in the country for a concreted and harmonised attack on this new threat. Suitable parasites were imported from Fiji and Singapore, an insectary was established in Colombo (the focal point of the pest attack) to avoid transfer of the pest to the more concentrated coconut areas North and Eastwards, and strict quarantine and sanitation methods enforced. In a few months and after thousands of parasites (*Dimmockia javanica* and *Pediobus parvulus*) had been multiplied and released, the scales tilted in favour of the industry. Within a year or two, the pest had all but disappeared as dramatically as it had descended. Total cost of operations-less than US dollars 30,000 for an industry worth well over $30 million each year.

Less spectacularly but just as relentlessly, the Division continues to combine the use of parasites and predators field sanitation and judicious use of chemical control methods in the management of other major pests (e.g. the Leaf Scale) and the weed *Eupatorium odoratum*. For the control of red weevil, insect traps and systemic insecticides are used, for black beetle, the viral agent Baculovirus is being tried out. Experiments have also been done on the bacterial pathogen *Bacillus thuringiensis*.

Until recently, the Institute maintained three insectories but in 1977, with the successful control of the leaf miner, the one at Colombo was transferred and in 1978, the cyclone all but destroyed the other in the Eastern Province. Only the one at Headquarters continues to function.

A major problem to which attention is being given is the problem of "Leaf Scorch". This is akin to, but no where near as serious as, any of the "diseases of unknown etiology" that plague the the coconut palm in several other regions of the globe.

Another concern is the phenomenon of "duds" or unproductive palms which are distressingly common. Our principal hope is that we would discern remediable metabolic disorders as the cause of these two problems.

Plantation industries in Sri Lanka have always been deeply quality conscious. Such traditional attitudes have found application to the coconut industry as they have to tea and rubber as well. Consequently, the major export commodities — desiccated coconut, oil, fibre and shell charcoal have enjoyed good reputations and favourable prices in world markets. Copra, though now not exported, probably takes the first place for quality among producing countries.

Effective laboratory services for monitoring the produce, assistance in upgrading quality, produce testing and grading and the control of marketing and export arrangements seek to ensure the maintenance of this superiority.

The future

Curiously, coconut seems to suffer from a general paucity of precise information within the producer countries, of the basic features of growth and performance of the palm itself. Significantly, there are very few research centres concerning themselves with coconut palm physiology. In recent years, there have been some steps towards remedying this situation, notably by studies of the biochemistry of the nut and its edible components and efforts to evolve a technique for the vegetative propagation of palms. This latter is recognized as a potentially powerful tool to support and extend the efforts of coconut breeders.

The coconut palm is doubtless foremost among crop plants in the multiplicity of products that it is capable of providing. Hitherto unfortunately, the overwhelming emphasis applied to the conventional coconut products entering into world commerce, has tended to obscure the immense potentialities available for it to yield more products of nutritional and utility value within the producer countries themselves. It may be argued that pre-occupation with coconut as an oil crop or as merely a provider of industrial raw material is almost misguided. In Sri Lanka and perhaps elsewhere, coconut performs an often unrecognised yet vital role in meeting a a large part of the protein needs of rural people and in providing sugar substitutes and beverage products for a large part of the population.
In economic terms, it will be no surprise if it is found that these "incidental" values will surpass the earnings from the conventional articles of commerce now obtained from the palm.

From the point of view of providing basic nutritional needs, the coconut kernel is an unbeatable material. Combining as it does, extremely favourable quantities of fat, protein and assimilable carbohydrate, it also possesses excellent texture, a good proportion of fibre as roughage and a highly acceptable, nutty flavour. In coping with protein malnutrition, it has the special feature, that unlike most other protein-rich foods which capriciously perform better in countries already possessing an adequacy of protein, coconuts grow best in those very regions where the protein is most needed (less developed countries in the tropics).

Perhaps the only constraint to advocating a greater, utilization of coconut as food is the fear that surrounds the linkage between partially saturated oils such as coconut oil, cholesterol and coronary disease. However, it has to be acknowledged that this supposition is based largely on circumstantial evidence that falls somewhat short of proof.

Coconut research has progressed to varying extents along several lines which can confidently be expected to yield advances in the near future.

On the agronomic side, there will be an increasing availability of information on the most effective utilization of production inputs (mainly fertilizer).
This will arise from a better understanding of the fundamental physiology and growth characteristics of the coconut palm and its reactions to different climatic, soil and management factors.

In breeding, there will be accelerated testing of world collections of coconut varieties (or types) and the evaluation under comparable conditions, of these and their hybrids in various possible combinations.

A breakthrough in the field of tissue culture or other means of vegetatively propagating elite palms, will place in the hands of coconut breeders, a potent technique for the rapid multiplication into "clones" of identical desired genotypes. This will also help in many other research sectors.

With escalating costs of petroleum products, the most economic and effective means of using farm energy and synthesized fertilizers, are bound to develop.
This would result in a heightened concern with agro-economic parameters in relation to coconut culture.
An area where this will find application is in the field of mixed farming, multiple-cropping and intercropping where hitherto a vast store of empirical experience has been used to a considerable extent.

Increasing costs and difficulties in procuring farm labour will lead to considered mechanisation, subject to constraints dictated by simultaneous needs to conserve energy inputs.

Sophisticated techniques using refined instruments and isotopic materials will certainly lead to practically important gains in understanding water and fertilizer needs of the coconut palm.

Future advances on the production side are bound to be dwarfed by the unexploited possibilities that exist in the field of processing.

There are already encouraging signs that unconventional uses of the palm and its products are being seriously considered. In fiercely competitive markets, success depends on cheapness, quality, consistency uniform availability, versatility in use and several similar product attributes.

It is impossible to do more than take a glimpse at some of the potentials that will emerge for a diversified use of the enormous variety of products that the different portions — some of them hitherto virtually wasted — of the coconut palm could provide.

Sri Lanka, foremost among the producer countries, has been extravagant in the direct consumptive use of coconut kernel. It is estimated that traditional extraction methods can leave no less than a half of the oil and protein unextracted. Hence it is certain that suitable methods of extracting and preserving (e.g. canning) of coconut milk, will progress with the existing technology, until it becomes a commonplace processed commodity.

Work in the Philippines and elsewhere has shown the possibilities of evolving processing methods that will preserve and extract the oil, proteins and carbohydrates in one composite and continuous process. The protein fraction in particular would be the most versatile in its use for protein enrichment of cereal and bakery products and in non-dairy creamers, beverages and similar uses.

Producer countries could also move towards a greater share of processing profits by moving away from desiccated coconut alone to such products as toasted, candied, sugar coated, salted and canned kernel products. By an extension of this trend, the endosperm at the "jelly" stage would be a strong candidate for the preparation of syrup-based conserves.

Coconut palm inflorescence sap is richer in sugars than most expressed cane juices. The flow is relatively profuse and with suitable, and essentially, simple precautions, the sap could be evaporated to yield a sugar of highly acceptable qualities. The partially inverted sap is already widely employed to produce treacle and jaggery. By slight modifications, a very good imitation of "Golden Syrup" is easily prepared.

While on the subject of sweeteners, mention should be made of the potential coconut offers as "honey bee pasture". Ample quantities of pollen available year round and exceptionally copious and sweet stigmatic exudates, must doubtless provide a bountiful source of food for bees.

Coconut oil has had a long traditional role as fuel for domestic and festive lighting. The intriguing report of its successful use as an automobile fuel while not being entirely a surprise — offers the exciting possibility of a rapidly renewable and cultivable energy source.

Great scope also exists for a systematic economic use of the several wastes incidental to the process employed in the production of traditional export commodities. The most notable are expeller oil-cake, coconut water and fibre dust.

Copra cake may contain sixteen per cent of sucrose in a form which allows of its ready extraction with boiling water. The sugar is virtually useless to the livestock commonly fed on this material. Improved copra-making and expelling technology could help to yield the protein-rich expeller cake in a directly consumable form.

The use of coconut water (which may contain around 2% to 4% of dissolved sugar) for the cultivation of fodder or food yeasts is a clever exploitation of a biological concentrator where ordinary physio-chemical methods are impractical for reasons of cost. Sadly, not much information is available from the Philippines on this study which was pioneered by that country. The use of coconut water for the production of the delicacy 'Nata de Coco' is already well established.

The use of fibre dust as a soil-conditioner or as a bulking agent in the production of bricks or the manufacture of particle board is of vital importance to any country with a sizeable coir industry.

New needs and modes will also stimulate the industry to widen its offerings of coconut palm based products. Research activities have also to develop with due heed to the realities of socio-political factors in underdeveloped countries such as constitute the world's coconut producers. Thus intensification, modernisation and innovaton at all stages in the cultivation, processing and marketing of coconut must proceed in a co-ordinated and harmonious fashion.