

Souvenir

NATIONAL SYMPOSIUM

ON

PLANTATION CROPS

TRIVANDRUM

Dec. 8—9, 1972

at

TAGORE CENTENARY THEATRE, TRIVANDRUM

Sponsored

by

INDIAN SOCIETY FOR PLANTATION CROPS

CENTRAL SILK BOARD

and

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

SUMMARY OF PROGRAMME

Friday, 8th December 1972

8.00 A.M.	Registration
9.00 A.M.—10.30 A.M.	Inaugural meeting
10.30 A.M.—11.00 A.M.	Tea
11.00 A.M.— 1.00 P.M.	Session I: Genetics and Plant Breeding
	<i>Chairman</i> —Dr. H. K. Jain
1.00 P.M.— 2.30 P.M.	Lunch
2.30 P.M.— 4.30 P.M.	Session II: Agronomy and Soil Science
	<i>Chairman</i> —Dr. J. S. Kanwar
4.30 P.M.— 5.00 P.M.	Tea
5.00 P.M.— 7.00 P.M.	Session III: Plant Pathology
	<i>Chairman</i> —Dr. H. K. Saksena
7.00 P.M.— 7.15 P.M.	Recess
7.15 P.M.— 8.15 P.M.	Variety entertainments
8.30 P.M.	Dinner

Saturday, 9th December 1972

8.15 A.M.— 9.45 A.M.	Session IV: Physiology and Biochemistry
	<i>Chairman</i> —Dr. V. S. Ramadas
9.45 A.M.—10.10 A.M.	Tea
10.10 A.M.—11.30 A.M.	Session V: Technology
	<i>Chairman</i> —Dr. P. T. Joseph
11.30 A.M.—11.40 A.M.	Recess
11.40 A.M.— 1.00 P.M.	Session VI: Entomology
	<i>Chairman</i> —Dr. A. R. Seshadri
1.00 P.M.— 2.00 P.M.	Lunch
2.00 P.M.— 3.45 P.M.	Panel Session
	<i>Chairman</i> —Shri K. V. Ahamed Bavappa
3.45 P.M.— 4.15 P.M.	Tea
4.15 P.M.— 6.00 P.M.	Plenary Session
	<i>Chairman</i> —Dr. M. S. Swaminathan
6.00 P.M.— 7.00 P.M.	Business meeting of the Indian Society for Plantation Crops (Members only)
7.00 P.M.— 8.00 P.M.	Special Lecture by Dr. M. S. Swaminathan “Modern Trends in Agricultural Technology”
8.30 P.M.	Dinner

Sunday, 10th December 1972

Study tour:

1. Kuttanad
2. CPCRI Regional Station,
Kayangulam.

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राष्ट्रपति भवन, नई दिल्ली-४
RASHTRAPATI BHAVAN
NEW DELHI-4

October 27, 1972



I am glad to know that a National Symposium on Plantation Crops will be held in December, 1972. I need hardly emphasise the importance of Plantation Crops in our national economy and hope that adequate facilities would be afforded not only for research and expansion but also for improvement of their quality and output.

I send my greetings to the participants and best wishes for the success of the Symposium.

V. V. Giri
President of India



प्रधान मन्त्री सचिवालय
नई दिल्ली-११
PRIME MINISTER'S SECRETARIAT
NEW DELHI-11

November 3, 1972



The Prime Minister is glad to know that a National Symposium on Plantation Crops is being organised by the Indian Society for Plantation Crops in Trivandrum next month. She sends her good wishes for the success of the Symposium.

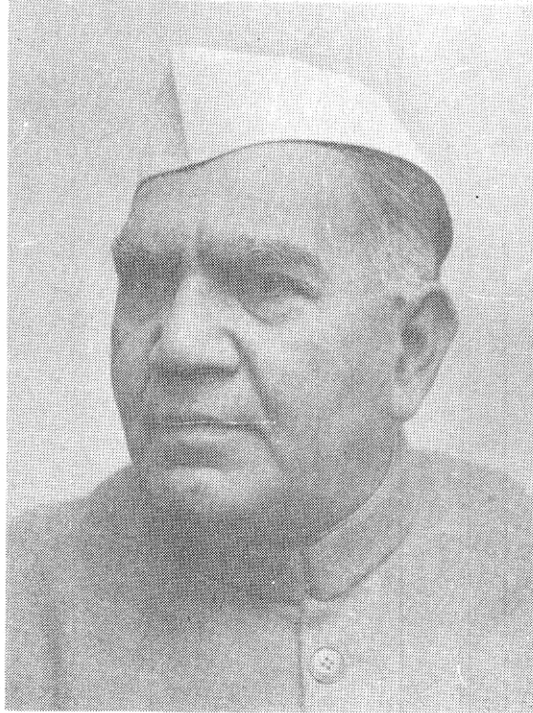
Yours faithfully,

H. Y. Sharada Prasad
Director (Information)



कृषि मन्त्री
भारत सरकार, नई दिल्ली
MINISTER OF AGRICULTURE
GOVERNMENT OF INDIA,
NEW DELHI

October 28, 1972



I am glad to learn that a National Symposium on Plantation Crops is being organised for the first time in the country under the joint auspices of the Indian Society for Plantation Crops, the Central Silk Board and Indian Council of Agricultural Research, in December 1972 at Trivandrum.

The importance of plantation crops like coconut, cashewnut, arecanut, spices, cacao and oil palms in improving the economy of our farmers is well known and needs no elaboration. Not only these crops provide edible oils and commodities for daily use, they also earn considerable foreign exchange. I am sure the deliberations of the Symposium will prove to be very useful in focussing the attention of the research workers and plantation crops growers to the pressing problems and their solutions. The Symposium should help in the exchange of scientific knowledge not only among the several plantation crops research centres in the country but also help in mutual exchange of technical know-how with other countries of the world.

I send my best wishes to the organisers of the Symposium for its success.

F. A. Ahmed



विदेश व्यापार मंत्री
भारत
MINISTER OF FOREIGN TRADE
INDIA
NEW DELHI

September 21, 1972

I am glad to learn that Indian Society for Plantation Crops, the Silk Board, and the Indian Council of Agricultural Research are jointly organising a National Symposium on Plantation Crops and also bringing out a Souvenir which would contain authentic articles on this industry.

Plantation crops industry plays a crucial role in the economy of the country and earns large foreign exchange. With a view to have exportable surpluses, it is, therefore, essential to increase the yield of plantation crops. That the symposium will highlight advances in research on different plantation crops particularly rubber, tea, coffee, coconut, arecanut, cashew, pepper, cardamom, ginger, turmeric and oil palm is befitting the occasion.

The articles contained in the Souvenir, I hope, will not only highlight the strong and viable sectors of the industry which require to be further exploited for boosting up their contribution to the national economy, but at the same time will focus attention on those vulnerable sectors that need to be buttressed. Plantation crops have varied problems. It is necessary to give it a concrete thought to evolve suitable policies so that we may not only be able to increase production, but also make the plantation crops industry more export oriented.

I wish the Indian Society for Plantation Crops all success.

L. N. Mishra



औद्योगिक विकास तथा विज्ञान और प्रौद्योगिकी मंत्री
भारत सरकार
MINISTER OF
INDUSTRIAL DEVELOPMENT AND SCIENCE & TECHNOLOGY
GOVERNMENT OF INDIA

New Delhi, the 24th Nov. 1972

I am happy to know that a National Symposium on Plantation Crops is being held in Trivandrum early December this year.

Plantations have played a notable role in our export earnings in the past. They have a great future, provided steps are taken to improve yield and quality by applying the results of scientific research. I hope the Symposium will focus attention on this question of modernisation to make our products cheaper at home and more competitive abroad. I wish the deliberations all success.

(C. Subramaniam)



September 11, 1972



I am happy to learn that the Indian Society for Plantation Crops, the Silk Board and Indian Council of Agricultural Research are jointly organising a National Symposium on Plantation Crops in the second week of December 1972 and that a Souvenir will be published to mark the occasion. This symposium will be of particular interest to Kerala since the State produces a good number of plantation crops.

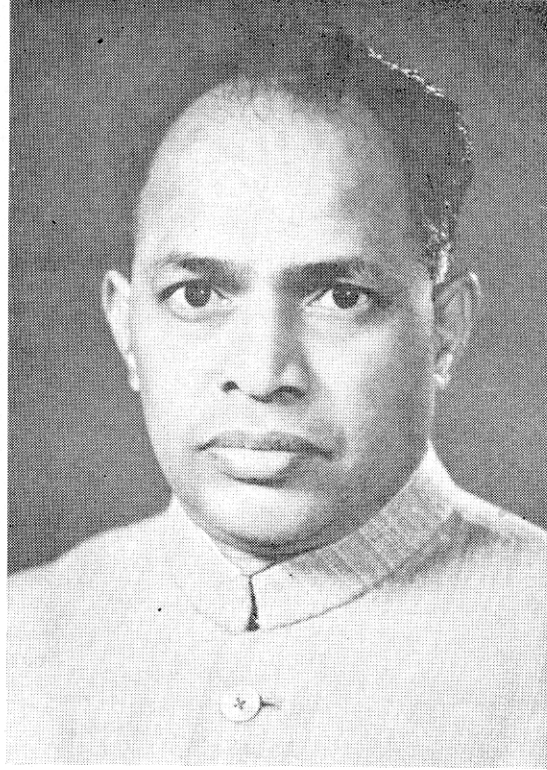
I hope the symposium as well as the Souvenir will prove useful to those who are connected with plantation crops.

C. Achutha Menon
Chief Minister, Kerala



राज्य मंत्री, कृषि मंत्रालय
भारत
MINISTER OF STATE, AGRICULTURE
INDIA
NEW DELHI

November 17, 1972



I am indeed happy to know that a National Symposium on Plantation Crops jointly sponsored by Indian Society for Plantation Crops, Silk Board and Indian Council of Agricultural Research is being held on 8th and 9th December at Trivandrum. Plantation crops which are the mainstay for millions of farmers of the country also earn annually more than 250 crores of rupees as foreign exchange. This first National Symposium on these crops is very timely, because at this juncture in our history, the country is facing keen competition in the international market even in the case of commodities in which we had virtual monopoly. I hope that the deliberations of the symposium while focussing attention on the important problems facing these crops, will also come up with valuable suggestions for their all round improvement.

Annasaheb P. Shinde



October 23, 1972



Plantation crops can rightly be termed as the back-bone of Kerala's agricultural economy. The State has the unique privilege to be the largest producer of coconut, cashew, rubber, cardamom, ginger etc. in the country.

Hence I am very happy to know that the Indian Society for Plantation Crops, with the assistance of the Indian Council of Agricultural Research and the Central Silk Board, is organising a National Symposium on Plantation Crops with a view to facilitate exchange of scientific knowledge on plantation crops among the research workers.

I am confident, the Symposium will discuss in detail the various problems confronting the farmers in increasing the quality and production of plantation products and will help to evolve useful methods to solve at least few, if not all.

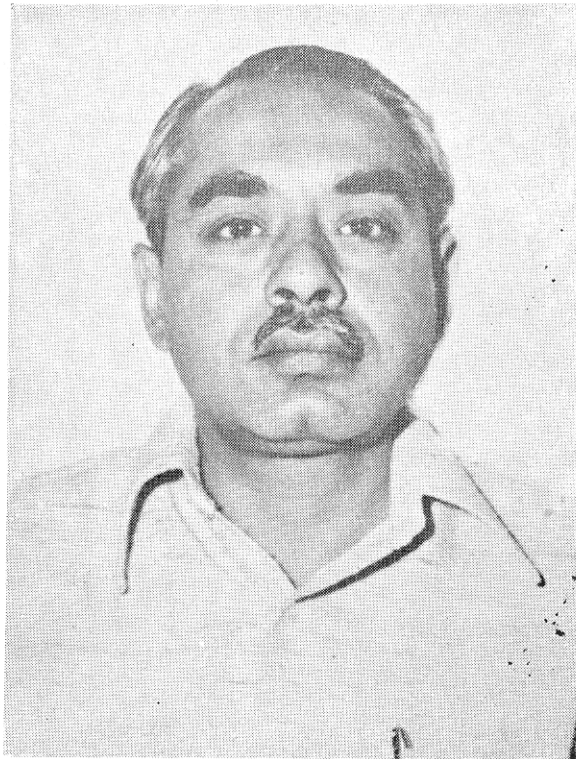
I wish the venture all success.

Vakkom Purushothaman

केन्द्रीय रेशम उत्पादन अनुसंधान और प्रशिक्षण संस्था
केन्द्रीय रेशम बोर्ड
CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE
CENTRAL SILK BOARD

“शान्तिविलास”
नज़रबाद, मैसूर-१०
Camp: “SANTHIVILAS”
NAZARBAD, MYSORE-10

October 26, 1972



It gives me great pleasure to send this message of greetings and good wishes on the occasion of the National Symposium on Plantation Crops being held on 8th and 9th December, 1972 at Trivandrum.

I am indeed happy that a National Symposium has been jointly organised by the Indian Society for Plantation Crops, Indian Council of Agricultural Research, Central Silk Board, etc., which will be attended by a large number of scientists working on various plantation crops. This, no doubt, will afford an excellent opportunity to them for cross fertilisation of ideas and to benefit from the experiences of other fellow scientists working on similar long term or perennial crops.

When the idea was mooted to us that the Central Silk Board should co-sponsor the National Symposium we readily agreed to help in whatever manner we could. I am sure, that because of the joint efforts of so many organisations the National Symposium is bound to be a great success.

I convey my best wishes for the success of the Symposium.

Inder J. Malhotra
Chairman
Central Silk Board

Dr. M. S. SWAMINATHAN
DIRECTOR GENERAL, I. C. A. R. AND
SECRETARY TO THE GOVERNMENT OF INDIA

भारतीय कृषि अनुसंधान परिषद,
कृषि भवन, डा० राजेन्द्र प्रसाद रोड, नई दिल्ली
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI BHAVAN
DR. RAJENDRA PRASAD ROAD
NEW DELHI-1

September 15, 1972

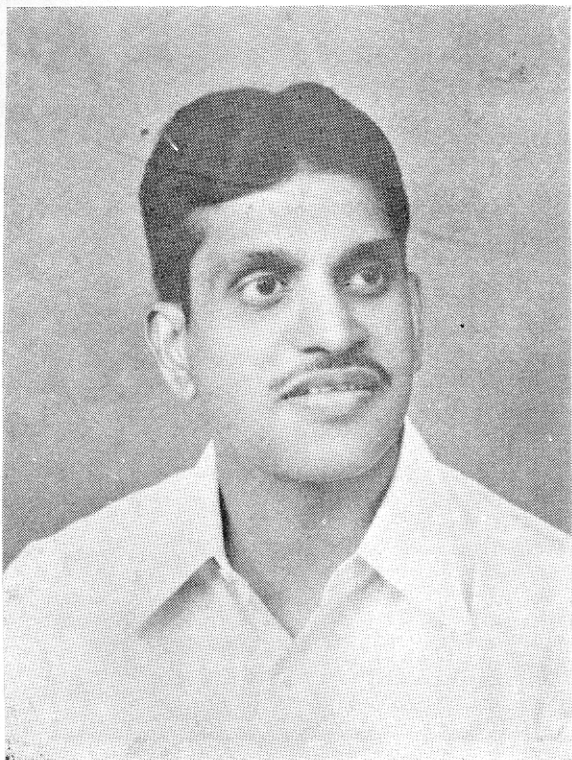


I am happy that the Indian Society for Plantation Crops is organizing a National Symposium on Plantation Crops in collaboration with other agencies. Although these crops have provided us with most of our foreign exchange earnings we have not paid them the scientific attention they deserve and require. Recent advances in various fields of agricultural science have opened up altogether new vistas in improving the yield and quality of major economic plants. I am sure the National Symposium would help to formulate sound programmes for future research on the basis of a careful assessment of past achievements and current problems.

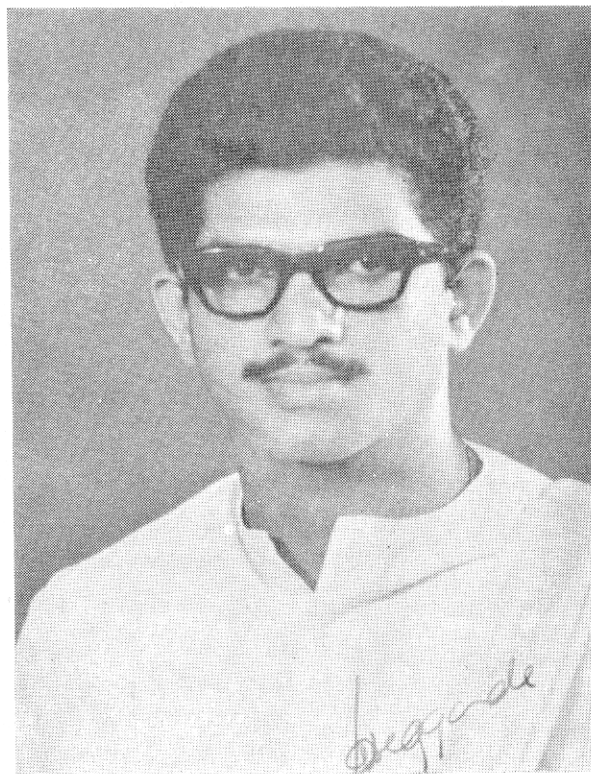
M. S. Swaminathan

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FOREWORD

Plantation Crops, which include perennial crops like tea, cashew, coffee, coconut, arecanut, rubber, cacao, oil palm and spices such as cardamom, pepper etc. have a unique role in the national economy of the country. Apart from earning valuable foreign exchange to the tune of Rs. 250 crores annually, these crops form the backbone of the economy of the States like Kerala and provide basic raw materials for a number of industries. Despite the physical dissimilarities in the growth habits and requirements and diversities in the nature of the economically useful parts of these plants, there are broad resemblances in problems concerning improvements in their plant type, environments in which they grow, their protection from biological hazards and their post harvest technology.

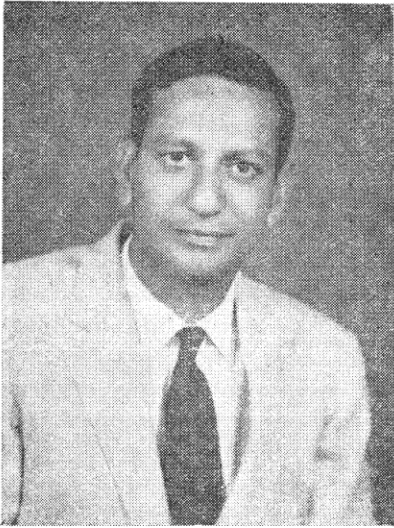
In independent India the lion's share of agricultural research and developmental programmes was confined, naturally, to the food crops, with the result that attention was focussed on plantation crops rather belatedly. The scattered and isolated units carrying out researches on individual plantation crops were brought together under a single agency of I.C.A.R. with the exception of coffee, rubber and tea, to constitute the Central Plantation Crops Research Institute in 1970. Simultaneously, two All India Coordinated Crop Improvement Projects pertaining to these crops were also initiated so as to coordinate and elaborate the work done by various agencies in different parts of the country.

Consequent to the inception of the Institute, it was felt that a common forum be established to bring together all scientists working on these crops so as to facilitate free exchange of ideas and experiences. It was with these motives that the Indian Society for Plantation Crops was founded in 1971 with headquarters at Kasaragod. To disseminate the knowledge accruing from plantation crops research and air the scientific developments in these institutions, the Society also decided to bring out a quarterly scientific journal.

The Working Group on Plantation Crops of the Conferences on Interorganisational Cooperation in Research recommended that a National Symposium on Plantation Crops may be organised. Accordingly the Indian Society for Plantation Crops, as its first venture, took up the organisation of this Symposium with the main objectives of providing an opportunity for unified thinking, working out general as well as specific formulae to approach the problems, derive benefits of discussion and establish personal contacts among scientists. This idea was well received by allied institutions and agencies promoting research on plantation crops in the country.

We take this opportunity to thank all our benefactors and well-wishers, whom we find it difficult to single out for special mention. To our readers, we request them to overlook the shortcomings, if any. We admit we are ambitious, for we THINK AND PLAN HIGH.

Organisers



TEA RESEARCH IN SOUTHERN INDIA

K. S. Venkataramani

*Director, UPASI Tea Research Station
Cinchona P.O., S. India*

Dr. K. S. Venkataramani (48), Director of Research, UPASI Tea Scientific Department, graduated from Madras Christian College in 1942 with a First Class degree in Botany. He was engaged in horticultural research from 1942 to 1948 and was awarded the M.Sc. and Ph.D. degrees of the University of Madras. He entered the services of the Tea Scientific Department of the UPASI in 1948. His main interest lies in tea clonal selection and propagation and he has developed a number of potentially useful tea clones; one of them named 'Sundaram' thrives at different elevations yielding high crops of quality tea.

For a short while in 1959 Dr. Venkataramani served as Reader in Horticulture at the Post Graduate School of Agriculture in Coimbatore. He was deputed to work on special assignments relating to other plantation crops. He has visited the tea growing areas of the U.S.S.R. in 1969 as an Indian delegate.

Dr. Venkataramani was elected a Fellow of the Indian Academy of Sciences in 1968. He is a member of various scientific bodies and has to his credit a large number of publications on fruits, vegetables and plantation crops.

The United Planters' Association of Southern India established a Tea Scientific Department four decades ago and today the Department consists of a main research station in the Ana-

mallai hills of Coimbatore District (Tamil Nadu State), a sub-station in Vandiperiyar (Kerala State) and a tea clonal centre at Coonoor on the Nilgiris (Tamil Nadu State). The Scientific

Department is financed by the UPASI by levying a research cess on its membership. This cess has varied from time to time and today it works to Rs. 10/- per hectare of tea. The Tea Board has offered a capital grant for buying land and putting up the new laboratories at Cinchona and Vandiperiyar; it also partly finances an Advisory Service and a small project on chemistry of tea.

The Department comprises five Divisions and as is to be expected in a field research organisation, lines of work overlap and all divisions cooperate in the resolution of the problems facing the tea industry in Southern India. The divisions, division heads and research activities are briefly outlined here.

The Botany Division (Dr. K. S. Venkataramani from 1948 to 1972; Dr. V. S. Sharma from 1972) is concerned with tea clonal selection and propagation, weed control in tea fields and growth aspects of the tea bush. The Chemistry Division (Dr. W. S. Shaw and Dr. K. B. W. Jones until 1938, Mr. V. Jayaraman from 1935 to 1962, Dr. K. Raman from 1962 to 1967 and Mr. V. Ranganathan from 1968) studies the fertilizer requirements of tea bushes and is responsible for analytical work involving fertilizer, soil, plant and pesticide analyses; several field experiments are carried out by this Division. The Entomology Division (Mr. S. Ananda Rau, from 1932 to 1959, Mr. N. R. Ananthakrishnan from 1959 to 1964 and Dr. G. N. Rao from 1964) investigates the life-histories and ecology of insect pests and carries out field and laboratory trials for the control of pests. The Plant Pathology Division (Mr. M. K. Subba Rao from 1932 to 1947, Dr. K. S. Venkataramani from 1948 to 1958 and Dr. C. S. Venkata Ram, from 1958) deals with all diseases of the tea bush and ancillary crops, conducts experiments on disease control in tea plantations and tests various chemical formulations for the control of fungal parasites both under laboratory and field conditions. A division of Technology was formed in 1964 (Mr. T. N. Ramakrishnan from 1964-1969) with a view to undertaking research on tea manufacture; for want of adequate facilities this work has been temporarily suspended, but investigations on chemistry of

tea have been revived (Dr. (Mrs.) S. Kanthamani from 1968).

It will not be out of place to present a concise account of the achievements of the Scientific Department.

During the first fifteen years, the Scientific Department was actively engaged on investigations on the Chemistry of tea and the work of Dr. Shaw and Dr. Jones was well recognized. Dr. Jones' book on tea manufacture in Southern India, which is now out of print, is still considered to be a useful publication. The work of the Chemistry Division on manuring showed without question how the tea bush responds to fertilizer applications. That potash is required for proper functioning of the tea bush under our conditions was well demonstrated for the first time in the country.

The Division of Entomology was responsible for the economic control of the tea mosquito bug (*Helopeltis*). There is no denying the fact that the control of this pest alone has resulted in the economic running of tea estates in Central Travancore. Mites and thrips have recently posed serious problems, but we have been able to tackle them. The control of another important pest, the shothole borer which is gaining importance, is receiving attention.

The Division of Plant Pathology has been alive to the disease problems in tea. The blister blight disease of tea took the planters by surprise in the year 1946 and at one time it was feared that it could mean the ruin of the tea industry. Today we could proudly write on our achievements in the control of this disease. We were the first to lay out proper field trials within a year of the advent of the disease and prove that tea bushes could be adequately protected against the disease by spraying them with copper fungicides. Similarly, the usefulness of colloidal copper formulations with low copper content (20%) and the potentialities of mist blowing very low volumes of spray fluids for economic control of the disease were demonstrated within the first six years of the history of the disease in Southern India and for the first time in the coun-

try. The usefulness of nickel chloride for the control of the blister blight disease is now well established and we have also shown that nickel chloride prevents undue build-up of purple mite. Some systemic fungicides have been screened in the laboratory for the control of blister blight of tea and two of them, which have proved very promising, are being tried out in the field.

Recent observations have revealed the occurrence of zinc deficiency in tea in most tea districts and it has been shown that foliar applications of zinc sulphate cures the deficiency and boosts up the crop. Indeed, spectacular increase in yield following sprays of zinc sulphate has already been obtained and foliar application of zinc sulphate has now become a routine practice. We have also demonstrated how moribund tea bushes could be rejuvenated by a system of surgery and building up of a new frame.

The Division of Botany has been engaged on several problems. 'Defoliation', or deterioration noticed in the health of the tea bush, caused real concern in 1948, but within a couple of years we were able to show that it was only the concomitant result of potash deficiency and/or moisture stress, and that by proper bush management and field culture, this physiological disorder could be readily overcome. Work on chemical weedkillers led to the recommendation of the safe use of dalapon for keeping grasses under check, and triazine, paraquat and 2,4-D for controlling broad-leaved weeds. Recent work has shown the usefulness of MSMA (Ansar 529) in weedkiller mixtures in controlling perennial grasses and certain recalcitrant weeds.

Investigations on tea clonal selection have been extremely promising and today we have a dozen or more tea selections which are likely to

prove useful in both mid and high elevations. Their performance is being carefully examined and we have already released some to the industry. Three promising tea selections have been named 'Sundaram', 'Athrey' and 'Pandian'.

Work on chemistry of tea clones is in progress and our aim is to develop a chemotaxonomy of tea clones. This will also enable selection of tea clones for 'quality' on the basis of certain chemical constituents. Pilot trials have also shown that quality of the common teas may be improved by use of certain additives (in this case some chemical constituents normally present in quality teas) at the time of manufacture. Attempts are also being made at bottling of tea liquors with different aromas.

Advisory work is carried by the Research Officers as well as a team of Advisory Officers (Messrs. V. Ranganathan, T. S. Padmanabhan, R. Padmanaban, P. Swaminathan and H. Subramanian). Each principal tea district has an Advisory Officer with ancillary staff and close, active and effective liaison is established and maintained between planters and scientists.

The Department publishes an Annual Report which details the work carried out during the year under review. A Scientific Conference is held every year, when papers are presented by the staff of the department and problems raised by delegates from the different tea districts are discussed. The proceedings of the scientific conference are also published. In addition to these, occasional bulletins are issued. These publications are distributed free of cost to the members of the UPASI subscribing to the Tea Scientific Department and to scientific institutions directly connected with research on plantation crops.



SILK INDUSTRY AND SERICULTURE RESEARCH

S. Krishnaswami

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Dr. Sheshayya Krishnaswami, Director, Central Sericultural and Training Institute has a brilliant academic career to his credit. He was awarded Ph.D. degree by the University of Madras for his thesis on Agricultural Entomology in 1951. Starting his career with the Madras Agricultural Department, he later joined the services of the Indian Lac Research Institute as Biologist and later became the Head of the Division (Entomology); he was the Director of the Institute for more than a year. In September, 1961 he took over as Director of Research of the Central Sericultural Research Station, Berhampore and continued in that capacity till 1969 when he became Director of the Central Sericultural and Training Institute, Mysore. Though selected for appointment to the post of Joint Director, Export Inspection Council, he gave it up in the interest of scientific research. Dr. Krishnaswami is a member of various scientific bodies and he is the Editor of the Indian Journal of Sericulture. He has visited the U.S.S.R. and Japan and has worked as an FAO consultant in Sri Lanka for a period of three months in 1972.

Introduction

Sericulture industry occupies a very prominent place among the Cottage and Village Industries of India. The manufacture of silk popularly known as the "Queen of Textiles" is a very old industry probably dating back to prechristian era. According to Tariff Board's report 1938,

the silk industry in India was a flourishing one with an annual production of two million pounds before 1857, but unfortunately the production declined between 1857 to 1915 due to ravages of the 'Pebrine' disease. It miraculously escaped extinction and was resuscitated in the beginning of the twentieth century and

again flourished well till 1928 when the prices of the silk remained at remunerative levels. The industry later suffered due to keen competition from Far East countries like Japan and China. Japan, though a premier raw silk producing country in the world is now facing problems of making the industry competitive and attractive in spite of technological and scientific advancement. This is perhaps due to lure of the more prosperous urban industries which are far less laborious and also due to huge labour costs. India, unlike other countries has enough cultivable land and plenty of rural labour in need of employment and, therefore, is ideally suited for the industry. Our country with an agrarian economy, suitable climate, soil and a rich tradition going back to antiquity can compete successfully with other countries in the production of silk. Having realised the need to exploit natural resources that the country has, and the rich export potential that the industry possesses the Government of India encouraged Sericulture Research to evolve high yielding varieties of mulberry and silkworm races adaptable to varied climatic conditions of different sericultural states. Research endeavours particularly for the last ten years have resulted in substantial improvement in the technology of silkworm rearing and mulberry cultivation. These include certain changes in the age old practices and concepts of silkworm rearing and mulberry cultivation. The new techniques evolved through research in the country are now enabling the sericulturists to more than double their mulberry yields, cocoon production, raw silk production and finally their incomes, as well. These remarkable results have pushed the sericulture industry at the threshold of an "Yellow Revolution".

Nature of the Industry

India though predominantly an agricultural country, is being industrialised after the attainment of independence. Indian farmers because of limited holdings find it very difficult to make both ends meet unless they subsidise their income. Sericulture fits in admirably as a subsidiary occupation to Agriculture giving substantial additional income throughout the year. The activities of Agriculture and Sericulture are so adjusted that one aids the other. However, the

recent breakthrough in productivity has enabled the industry to be practised on an intensive scale and as a major cash crop.

It is an agroindustry having an agricultural base in the cultivation of food plants and an industrial base in unwinding the filament from cocoons and weaving into fabric. These together provide employment either directly or indirectly to 3.2 million people of which six to seven lakhs constitute scheduled castes and scheduled tribes. As a cottage industry it gives occupation to women at home during spare hours. Usually the male members of the family attend to cultural operations in mulberry fields and the female members attend to silkworm rearing.

Varieties of silk & production

India is unique in the world in producing all the four types of natural silks commercially known viz. Mulberry silk, Eri silk (from *Philosamia ricini*) feeding on castor leaves, Tasar silk (from *Antheraea mylitta*) feeding chiefly on the leaves of *Terminalia tomentosa*, *Terminalia arjuna* and *Shorea robusta*, Muga silk (from *Antheraea assama* feeding on 'Sam' *Machilus bombycina* and Soalu *Litsaea polyantha*). Our country stands fifth in the sericultural world with an annual production of 2,256 metric tons, the first being Japan (20,515 M.T.), second China (10,164 M.T.), third U.S.S.R. (3,000 M.T.) and fourth South Korea (2,562 M.T.). As regards the production of nonmulberry silk India comes second with an annual production of 5.58 lakh kg after China.

Mulberry silk is produced extensively in the States of Mysore, West Bengal and Jammu and Kashmir contributing nearly 98% of the total production of India. In Mysore and West Bengal multivoltine silkworms are reared by which sericulturists harvest 5-6 crops in a year whereas univoltine silkworms are reared in Jammu and Kashmir that give only one crop in a year which is characteristic of temperate climatic regions. Silk is also produced on a small scale in the States of Andhra Pradesh, Assam, Tamil Nadu, Uttar Pradesh, Himachal Pradesh and Punjab.

Eri culture is practised mainly in Assam claiming 90% of eri silk production and on a minor scale in the states of Bihar and West Bengal. Tasar worms are reared traditionally by the tribal people of Madhya Pradesh, Bihar, Orissa, Andhra Pradesh and Maharashtra. Muga silk is produced nowhere in the world except in Assam. The golden yellow silk of Assam is still a ceremonial dress which the Assamese proudly wear.

The production of mulberry and non-mulberry silks in different states in India is given in the following table.

Production of mulberry and non-mulberry silk in different states. (kg)

States	Mulberry	Eri	Muga	Tasar
Andhra Pradesh	77	3	—	325
Assam	12,250	165,750	71,500	—
Bihar	94	—	—	167,835
Jammu and Kashmir	50,696	—	—	—
Madhya Pradesh	490	—	—	125,000
Maharashtra	—	—	—	1,036
Mysore	17,55,344	—	—	—
Orissa	—	—	—	13,000
Punjab	1,438	—	—	—
Tamil Nadu	2,190	—	—	—
Uttar Pradesh	3,727	—	—	—
West Bengal	250,000	300	—	2,000
Himachal Pradesh	1,000	—	—	—
Manipur	—	1,000	—	—
Tripura	5	386	—	—
Total	20,77,311	167,439	71,500	309,196

It may be seen that India produces 26.35 lakh kg of silk of which 20.77 lakh kg is mulberry silk and 5.58 lakh kg is non-mulberry silk. In the world statistics of silk production, the term silk refers to only mulberry silk as it constitutes over 95% of all the silk output.

Mulberry Silk

The Mulberry Silk Industry comprises mulberry cultivation, silkworm rearing and raw silk reeling.

Mulberry Cultivation

Mulberry is the basis for flourishing sericulture industry. It is a fast growing deciduous tree occurring in subtropical, tropical and temperate climates of northern hemisphere. The silkworm *Bombyx mori* feeds fastidiously on the leaves. There are many species and varieties and forms introduced from other countries from time to time in addition to four Indian species viz. *Morus alba*, *Morus indica*, *Morus serrata* and *Morus laevigata*. It is propagated through seeds or more commonly through cuttings. However, other methods of vegetative propagation such as root grafting,

bud grafting and layering are also followed depending upon the variety to be propagated and the area.

Different methods of mulberry cultivation are followed in different sericultural states in India depending upon the climate, soil conditions, system of plantation etc. Mulberry is grown as a field crop in the states of Mysore and West Bengal while it is grown as tree in Jammu and Kashmir. In Mysore and West Bengal the

crop is raised in the form of bush under rainfed and irrigated conditions, whereas in the state of Jammu and Kashmir which is a major univoltine area mulberry is raised in the form of trees which supply the leaves required by the silkworm. There are in all 3.6 million trees which are under exploitation for silkworm rearing.

The total area under mulberry in India is 1,04,765 ha of which 23,522 ha are under irrigation and the rest are under rainfed conditions. The mulberry leaf yields are of the order of about 3,000—4,000 kg per ha under rainfed conditions and 10,000 to 15,000 kg under irrigated conditions.

Silkworm Rearing

The technical operations involved in silkworm rearing are very delicate and intricate. Silkworms thrive best in temperatures ranging from 20°C to 30°C and humidity between 70 to 80%. There are a number of silkworms grouped in different ways according to the place of origin, nature and characteristics of the worm, colour, size of cocoons and larval markings. Silkworms may be either univoltine giving only one crop in a year as in the case of Jammu and Kashmir or multivoltine giving 5 to 7 crops in a year as in West Bengal and Mysore. The multivoltine races reared in West Bengal and Mysore have shorter larval life and therefore the cocoons are comparatively smaller. As a result the silk quality obtained from the multivoltine races is also inferior as compared to that of the univoltine or bivoltine races. In India of the total production of mulberry raw silk over 95% comes from the multivoltine variety and therefore the bulk of the Indian silk produced is of inferior grade in terms of the International standards.

The silkworms have a larval life span of three to four weeks depending upon the climatic region and weather conditions. The worms, being domesticated, are fed indoors with leaf pulcked from the mulberry gardens or trees. During the larval period the worm undergoes four moults gaining in weight to over 10,000 times from birth till it is mature and ready to spin the cocoons. For this growth the multi-

voltine varieties consume about 400 to 500 kg of mulberry leaves for rearing about 100 layings of the silkworm each laying comprising on an average about 400 eggs, whereas the univoltine varieties will require about 800 to 1,000 kg of mulberry leaves for rearing about the same quantity of silkworm eggs.

Invariably only silkworm hybrids are reared for steady and uniform quality production of cocoons. As compared to the standards of other leading sericultural countries the average cocoon yield in the case of Indian Sericulture is low and on an average 20 to 25 kg of cocoons may be obtained from 100 layings.

Silk Reeling

The process of reeling consists of cooking the cocoons at a temperature of about 95 to 97°C for about 10 to 12 minutes so that the 'Sericin' the gummy substance covering the silk filament gets softened and the unwinding of the silk filament continuously from the cocoon without frequent breaks becomes possible. Silk in India is mostly reeled through country type Charka (61%) or in improved cottage type basins (29%). Regularly organised factory scale filature reeling is very limited and is only of the order of 8% of production. Only organised reeling with proper attention paid to quality can give superior grades of silk.

Problems of the Industry and Sericulture Research

The two shortcomings of Indian raw silk are the high cost of production and the inferior grade of silk. The high cost of cultivation results directly from the low productivity which is of the order of about 10 kg of raw silk per hectare in the case of dry gardens and about 60 kg in the case of irrigated gardens as against 125 kg obtained in Japan. Further in view of the fact that the bulk of Indian production is of the multivoltine variety, the quality is also poor compared to International standards and these are the twin problems that need to be solved on a priority basis by the research centres in the country.

As a result of intensive research carried out during the last ten years even under conditions

of limitations of resources and facilities, it has been possible to improve productivity quite significantly almost revolutionising the silk industry and the country today is poised for a big break-through and ushering an "Yellow Revolution".

The achievements of sericulture research are summarised in Figure 1 from which it may be seen that the leaf production and the cocoon yield have been almost doubled in the case of both rainfed and irrigated mulberry. Besides the quality of cocoon produced is also superior with the result the ultimate silk yield per hectare has been stepped up from 10 kg to 25 kg in the case of rainfed mulberry and from 60 kg to 140 kg in the case of irrigated mulberry. This is no doubt an astounding breakthrough in productivity which has enabled cutting down the cost of production of raw silk appreciably and also at the same time improving the quality of the raw silk.

A new era bivoltine silk in Mysore

Mysore is synonymous with Indian silk as over 80% of the total mulberry raw silk production comes from Mysore state. As pointed out earlier the bulk of Indian silk is not of high quality. Although India exports silk worth Rs. 80 to 100 million per annum it is almost exclusively as fabrics. The Indian raw silk as such does not figure in the export list of the country. The potential for export trade through raw silk is immense which can be built up on a sustained basis to several times the present value of silk fabrics export when the quality of the Indian raw silk is further improved.

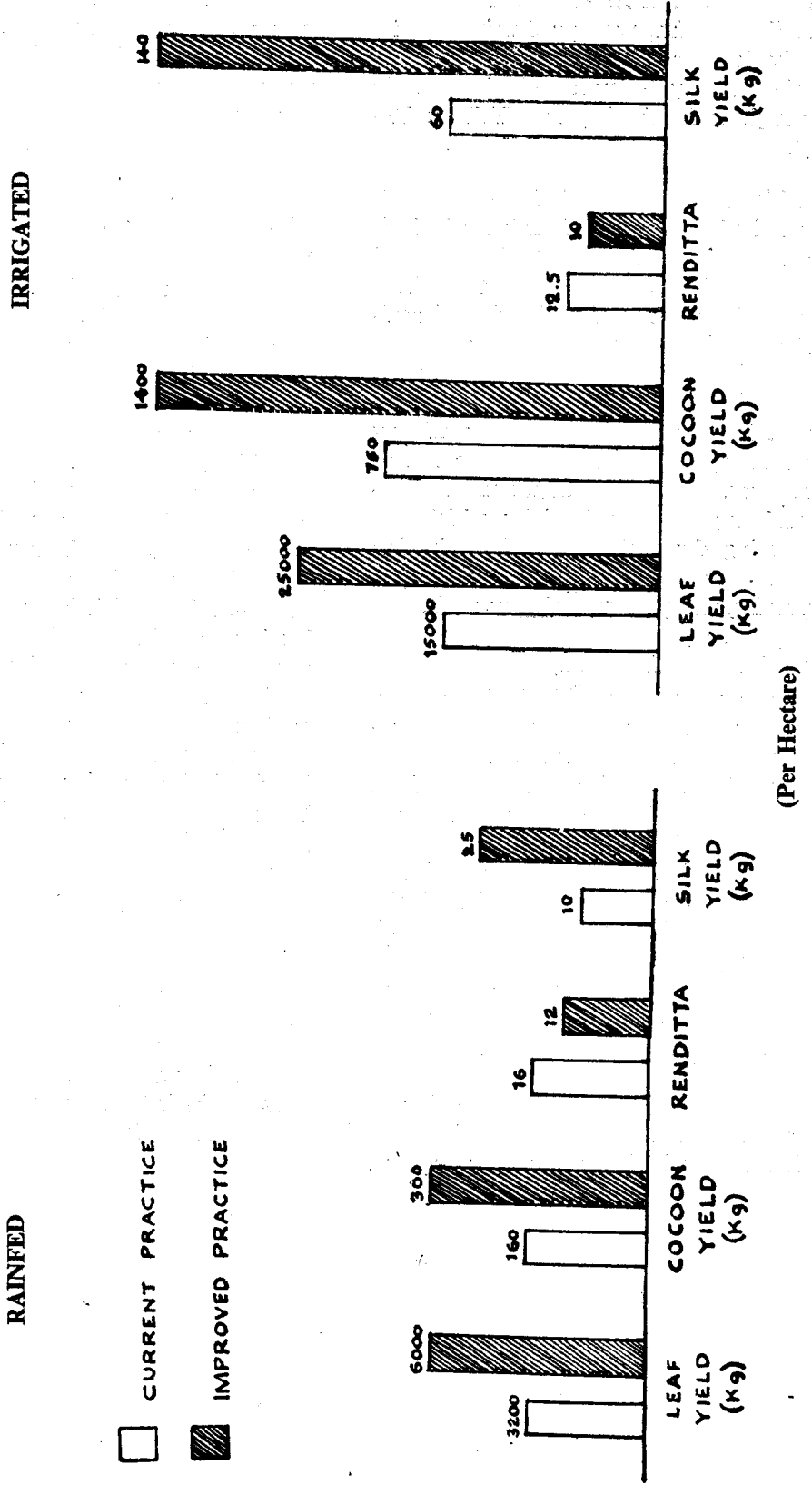
For the last two and a half years the Central Sericultural Research and Training Institute, Mysore has been seized of this major problem

and working seriously to improve the quality of production in Mysore State. The multi-voltine races of the tropical regions have limitations in regard to quality and, therefore, attempts were made to introduce bivoltine races which give highly improved and superior grade of raw silk. In the past it had not been possible to rear successfully the bivoltine silkworm races under the tropical conditions of Mysore and, therefore, quality production of raw silk was not possible. As a result of intensive research on the adaptation and handling of the bivoltine silkworm races through improved techniques of rearing it has been established that bivoltine race hybrids could be successfully reared even under the tropical conditions of Mysore. It has been shown conclusively that by rearing bivoltine hybrid races both the cocoon yield and the quality of the cocoons could be improved considerably. The yield per 100 disease free layings of the order of 40-50 kg which is almost double that for local race hybrids and the renditta (ratio of cocoon to raw silk) is brought down to the level of 8 to 10 for the bivoltine cocoons as against 16 to 20 for the local race hybrids. The quality of silk obtained from the bivoltine hybrids is far superior and reaches the level of 'A' grade of International standards. This grade of silk will have ready demand in the world markets and, therefore, India can build up a sustained export trade.

The above findings have been demonstrated on a large scale under actual field conditions of the sericulturists and thus proved beyond doubt that a new era of large scale production of bivoltin grade quality silk has just dawned. This marks indeed a great breakthrough in the history of Indian Sericulture Industry.

Fig. 1

Achievements of Research in Sericulture in Mysore





PLANTATION CROPS RESEARCH IN THE SEVENTIES

K. V. Ahamed Bavappa

*Director
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Born in 1930 Shri K. V. Ahamed Bavappa, Director, Central Plantation Crops Research Institute, Kasaragod has a very brilliant academic record. He secured the first rank for his B.Sc. (Ag.) from Madras University and had won a number of gold medals and prizes. He took his post-graduate degree also in I class from Madras University. Commencing his service as a Research worker with the Madras Agricultural Department in 1951 he joined the services of the Indian Central Arecanut Committee in 1956. Later he worked in the capacities of Agronomist, Botanist and Arecanut Specialist at the Central Arecanut Research Station, Vittal. In 1970 when the Central Plantation Crops Research Institute came into being with its headquarters at Kasaragod, Shri Bavappa became its first Director. He has worked on problems connected with rice, arecanut, cacao and plans and organises research work on coconut and other plantation crops like cashew, oil palm and spices. He was mainly responsible for the evolution of the new high yielding 'Mangala' variety of Arecanut. He was awarded a merit promotion for his outstanding work by the Indian Council of Agricultural Research. He has a large number of publications to his credit. He is a member of several scientific societies and the first President and Life Member of the Indian Society for Plantation Crops.

Barring Tea, Coffee and Rubber which have separate organisations to deal with the research, development and marketing of these crops including dissemination of the knowhow to the planting community, crops like coconut, arecanut, oil palm, cashew, cacao and spices have no

effective agency to deal with their overall improvement. Surprisingly, the foreign exchange earning from these crops is about 105 crores rupees every year. India has the virtual monopoly in many of the spices like cardamom, turmeric, etc. while about 80% of the world export

of cashew kernel is from India. As world requirement of these commodities is on the increase, there is considerable scope for increasing the area and production of these crops in India and enhancing the foreign exchange earning. The fact that the production of arecanut in our country has increased by 70% during the past one decade enabling us to wipe out the deficit in production and meet the internal demand in full, is a definite proof of the benefits of improved practices developed by research. However, in the case of crops like coconut, oil palm and cacao, imports worth about 5-6 crores of rupees are being effected annually to meet the country's requirements. In spite of the fact that these crops are important from the point of view of export earning and import substitution adequate attention has not so far been given for the improvement and development of most of them.

The Central Plantation Crops Research Institute is the centre for Plantation Crops Research and training in the country. Established in January, 1970 by amalgamating the Central Coconut Research Stations, Kasaragod (established 1916) and Kayangulam (established 1947) and the Central Arecanut Research Station, Vittal (established 1957) with its five Sub-Stations, the Institute is the youngest among the Institutes of the Indian Council of Agricultural Research. The expansion programme now on hand, mostly by way of additional staff and laboratory facilities is being implemented. The Institute, during its working from the inception of its constituent units has made important contributions in different disciplines pertaining to coconut and arecanut research. It has also been imparting training to both research and extension workers, working in the Departments of Agriculture of different States and Agricultural Universities and interested farmers. It has also been training scientists and extension workers from abroad deputed by various agencies such as FAO.

The research on Plantation Crops is organised under 11 disciplines viz. Genetics, Agronomy, Soil Chemistry, Physiology, Biochemistry, Microbiology, Pathology, Virology, Entomology,

Nematology and Extension and Training. The Institute which has its headquarters at Kasaragod, Cannanore District, Kerala, has two Regional Stations, one each at Kayangulam (Kerala) and Vittal (Mysore) and seven Sub Stations, one each at Kahikuchi (Assam), Mohitnagar (West Bengal), Hirehalli (Mysore), Sipighat (Andamans), Minicoy (Laccadive) and Peechi and Palode (both Kerala).

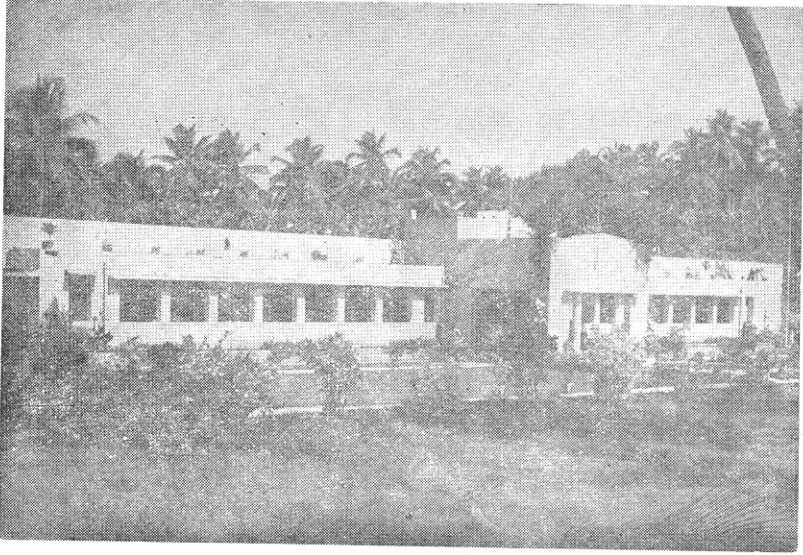
In organising research on plantation crops the following aspects have been kept in view by the Institute.

1. Socio-economic problems of plantation crop community

One of the major handicaps in bringing about a revolution in the time old practices adopted by cultivators is that the crops are mostly cultivated in small holdings, the average size being 0.2 ha with about 10 million cultivators directly connected with the production of these crops. The recent decision of the Kerala State Government to allot 10 cents of land to the landless which in most cases is coconut areas has added a new dimension to the situation. A correct understanding of the socio-economic problems of the plantation crop community especially of the small holding group should go a long way in planning the research programmes for meeting their needs.

2. Increased net return per unit area and time

Unlike the annuals, areas planted with crops such as coconut, arecanut, cashew etc., are permanently committed to these crops, probably for centuries. This will mean that the planning on these crops has to be very much different from those of annuals which can be changed from year to year and season to season. While aiming at increasing the economic return to the farmer by increasing the return per unit area, time and inputs, it is imperative that this should be achieved without detriment to the long term productivity of the main crop which continues to be in the field for years. This aspect has the highest relevance in the case of the plantation crops. The plantations offer tremendous scope for the successful operation of the tools of pro-



Central Plantation Crops Research Institute, Kasaragod



CPCRI, Regional Station, Kayangulam



CPCRI, Regional Station, Vittal

duction such as intercropping, mixed cropping and mixed farming.

3. Increasing the efficiency of farming

Reducing the cost of production has a vital role to play in the prosperity of the plantation crop industry or for that matter even in its survival in view of the export oriented nature of these crops. Other conditions being same, how far a commodity can compete in the international market will depend upon how cheap the commodity can be offered to the consumer. This will mean that a very high efficiency of farming by way of maximum returns from the investment on inputs such as fertilizer and water are to be planned and achieved.

4. Increasing employment potential

Crops like coconut, arecanut, cashew, spices etc. which are not exempted from the ceiling limit of holding as applicable to other plantation crops will continue to have limited holding size for years to come. In addition, in the State of Kerala, coastal Mysore and portions of West Bengal, where these crops are under large scale cultivation, the population intensity is already very high affording very limited scope for increasing the size of holding. This will mean that even with the best around knowhow, their income from the holding may not be adequate enough to maintain the family. Since these crops have a number of byproducts which can be processed at the level of the cultivator, a number of small scale industries can profitably be developed in the plantation areas to find employment and thus to increase the income of the family.

5. Dryland farming versus irrigated conditions

Excepting arecanut the other crops are, by and large, grown under rainfed conditions. At least in the case of coconut there is a sizable area available along the sea coast where irrigation facility is available, but not made use of now. Research work done so far on these crops has been for rainfed conditions where soil moisture becomes a limiting factor in production. Stability in production of these crops, which are subject to the vagaries of the climatic

parameters of the entire year, can only be achieved either by enhancing the soil moisture storage through conservation practices and improving soil physical properties or by resorting to irrigation. Working out requirements of the input as related to adequate moisture availability, easy methods of tapping the water sources available along the sea coast and possibility of irrigation using saline water are lines worth careful study.

6. Augmenting the food sources of the country

Coconut was hitherto considered to be an oil yielding crop and dealt with only keeping this as the main objective of its production. The coconut cake contains over 20% protein. In the every day increasing demand for food, particularly that of protein in this country every source will have to be tapped. Coconut, cacao and cashew are crops which are amenable to this in various ways. Thought is being given in using them as food sources.

7. Export quality standards

Unlike the normal food crops, plantation crops have to maintain a very high standard of quality at various levels of their production since most of them, though not all, are meant for foreign markets where keen competition exists today. It calls for not only an immediate adherence to quality standards but also an understanding of the likely demand of the foreign buyers in the next one decade to come in the light of the fact that improved processing technology is being developed in the competing countries. A very broad view of these problems and anticipatory action based on world trends will have to be taken and approaches developed for improving the quality standards.

8. Industrial outlook

Crops such as coconut, cashew, cacao etc. have tremendous potential for establishing industries, particularly agroindustries. No large scale agroindustries based on these crops exist in the country today. This has been mostly due to the fact that many products of these crops were being exported and a variety of finished products imported back to the country. For

example, in the case of cashewnut, the shell liquid is still exported to foreign countries and many of the manufactured products using this as the base imported. The work done so far on the industrial utilisation of the different raw materials of these crops have not been brought to the level of large scale exploitation. This situation requires looking into and adequate work organised to bridge the gaps in the production line.

9. Planning research efforts in relation to the national need

The specific targets of production for these crops are being worked out by the Development Councils dealing with these commodities, based on the various physical factors of production such as additional area to be brought under cultivation, enhanced production from the existing areas by package of practices etc. and keeping in view the internal consumption and the export requirements. Barriers in achieving these targets as well as special problems that limit the destruction of the barriers of production at national level are being looked into and research efforts planned in such a way as to enable the developmental agencies to achieve the national targets of production fixed for the crop.

10. Linking Research, Development, Extension and Cultivators through an Agricultural Polytechnic

Even though considerable knowhow has already been developed at the Research Institute, the desired results on production front have not been achieved, due to the gap existing in the chain of converting this knowhow into production. The situation will be much more serious if the higher inputs in research efforts and better results that will be coming out are not put into the production line in the years to come. The present agencies of production of these crops viz. Development Councils and Extension Directorate of the Ministry, Departments of Agriculture of different States, the Agricultural Universities and the cultivators will be linked through extension and training wing of the Institute in

the form of an Agricultural Polytechnic for the effective transmission of the results of research.

11. Building up of a scientific team

It is now well known that any substantial contribution in research front can be achieved if only scientists work as a team. By a proper training programme there is no reason why a scientist should not be moulded to fit himself into a team. This is being examined in greater depth and an effective training programme for team work, project leadership and scientific administration drawn up so that every scientist working in the Institute forms a fit and effective participant of a national team of scientists.

12. Participation in postgraduate teaching and research

The extensive laboratory, field and scientific manpower facilities available at the Institute can probably be utilised for improving the standard of education of the postgraduate students of Agricultural Sciences with special reference to plantation crops. A useful collaboration with the Agricultural University of Kerala and others of the southern States to involve the academically competent scientists of the Institute for teaching and research at postgraduate level should be mutually beneficial. Working arrangements for this programme will have to be formulated.

The role the Institute can play in the ensuing decade in solving the problems of plantation crops, improving the socio-economic conditions of the plantation community, enhancing the foreign exchange earning of the country and increasing the employment potential is of vital importance in the progress of the national economy. To achieve this, it is essential to build up a strong team of scientists whose dedicated and sincere efforts will not only produce research results but will also activate the entire chain of the production machinery. Towards attaining these set goals, the concerted efforts and attention of the Institute will be focussed during seventies.



THE RUBBER RESEARCH INSTITUTE OF INDIA A RESUME OF ITS ACTIVITIES

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Natural Rubber is one of the major plantation crops of India planted in an area of about two lakhs hectares. This plantation crop is comparatively a recent introduction into this country and hence has several special problems. For attending to the needs of the new plantation industry, Rubber Research Institute was established in 1954 under the Rubber Board, constituted by an Act of the Parliament. The main object of the Institute is carrying out scientific research on different aspects of rubber cultivation and processing for the allround advancement of the Industry. To enable this, the Institute conducts a comprehensive research programme on the rubber plant and its improvement, planting management, nutrition, control of pests and diseases, harvesting and the processing of the crop into forms in which raw rubber is required by the consumers.

Since its inception the Institute has made valuable contribution to the improvement of the Rubber Plantation Industry. As a first

step, the Institute sorted out the planting, soil management, plant protection, exploitation and crop processing methods suitable to the conditions obtaining in the rubber growing areas in India based on the scientific knowledge accumulated as a result of the work carried out in other countries and on the results of scientific methods of rubber production followed in some of the progressive rubber plantations in the country. These methods which were all geared for increasing the per hectare production of rubber were then popularised among the rubber growers in the country. Having attended to the primary need of the rubber growers in the country detailed research programmes were then drawn up in the various fields and investigations were initiated. Although the majority of these investigations initiated by the Institute must necessarily take many years to obtain conclusive results, the data so far collected from them helped to make advances in the selection of planting materials suited to Indian conditions, manuring, cover crop establishment, culti-

vation methods, plant protection practices and processing methods.

The Rubber Research Institute has at present four Research Divisions, viz. Agronomy, Botany Pathology and Chemistry/Rubber Technology, besides, a Statistics section and a Central Experiment Station for carrying out field experiments.

Based on the results of the exhaustive field experiments conducted by the Agronomy Division in six different locations situated in the main rubber growing tract in the country during these seasons a more specific and scientific recommendation for manuring rubber seedling nurseries has been recommended. This revised recommendation will help overcome the problems usually encountered by growers like retarded growth due to imbalanced nutrition, incidence of magnesium and zinc deficiencies etc. A study of the results of soil and leaf samples collected from the different agroclimatic regions in South India indicated the need for discrimination in recommending magnesium containing fertiliser to rubber particularly in the mature phase. Accordingly, the necessary modifications have been made in the recommended fertiliser mixture for the mature rubber.

Discriminatory fertiliser recommendations based on soil and leaf analyses are being given to some plantations which resulted in improvement of the per hectare yield and in the reduction of the cost of production per unit quantity of rubber in these plantations. In achieving economic fertiliser usage by the rubber plantation industry in India, the Division is proposing to undertake on a very large scale, soil and leaf analysis work for discriminatory fertiliser recommendations.

Experiments with different contact and hormone weedicides have given satisfactory results in controlling grassy and broad leaved weeds in rubber areas.

Botany Division has succeeded in evolving a few promising clones named RR II 100 series, the small scale trials of which have indicated a possible yield of 4000 kg per hectare.

Large scale trials of these materials have been initiated. Nucleus quantities of budwood materials of these promising clones are distributed for experimental planting also. In the plantings of foreign clones imported from Malaysia such as RRIM 600 series and 500 series tapping has commenced. Their initial performance is satisfactory. Measures are now being taken for exchange of improved planting materials between the different Natural Rubber Producing countries with a view to increasing the available variability and to utilising the promising cultures for further selection and hybridisation.

The Rubber Research Institute of India's efforts in establishing Polyclone gardens in different plantations of Kanyakumari District, with desirable parents to obtain improved seed materials for planting have received good response. The Gardens established since 1964 have commenced production. Polyploid plants have been developed by colchicine treatment and the evaluation of their growth performance, anatomy etc. are in progress. Mutation breeding with ionizing irradiation has been initiated. Data on evaluation of commercial yield of different planting materials under different planting regions are being collected and tabulated for a meaningful assessment of their performance under different agroclimatic conditions.

The incidence of several destructive diseases and pests is a limiting factor in the optimum growth and yield of rubber plants in the country. The annual recurring occurrence of the abnormal leaf fall disease necessitates adoption of costly control operation every year. For the control of the disease the modern technique of low volume spraying was introduced into rubber by the Institute as early as 1958. This method of spraying, using oil based copper fungicides dispersed in diluent mineral oils employing low volume micron sprayers from the ground or with helicopters from the air, is very efficient, time saving, more convenient and highly economical in comparison to the conventional high volume spraying using Bordeaux mixture. Investigation on the different forms of copper oxychloride in the powder form is more economic than the oil based copper paste, which was



View of Rubber Estate

previously recommended. Spray trials carried out by the Institute also showed that 35% copper gives adequate protection to the rubber plants in place of 40% copper which was originally recommended for the purpose, which also will result in substantial saving on spraying costs.

The diluent mineral oil having U.S.R. value, 92% and above, used for rubber spraying was being imported in previous years, at a very high cost. The foreign exchange requirement in this regard was also substantial. Investigations carried out by the Institute have revealed that diluent mineral oils with low U.S.R. value could be used on rubber under our climatic conditions and the recommendation of indigenously processed diluent mineral oil with 72% U.S.R. value has resulted in a saving of about Rs. 10 lakhs to the industry in a season. The saving on foreign exchange in this regard is also considerable in addition to ensuring timely availability of this essential material for the plantation industry.

A method for screening the different clones to assess their susceptibility to abnormal leaf fall disease by artificial inoculation was developed in the Institute. This method in conjunction with field observations has enabled, the Institute to select three clones, comprising of imported and local selections, which are somewhat resistant to abnormal leaf fall disease. These clones are being used for crown budding on other high yielding clones in field experiments. This method is also being used to evaluate the reaction of new clones to abnormal leaf fall disease, that are being produced or imported into the country.

Work on testing and development of suitable machinery for plant protection in rubber has resulted in the introduction of a very efficient duster cum micron sprayer, for large scale use in rubber plantations. This machine is being manufactured entirely with indigenously available components.

The control of pink disease of rubber with copper fungicides required repeated application of the fungicide in addition to the disadvantage of copper contamination of latex and high cost

involved for the treatment. The studies carried out in the Institute have shown that better disease control could be obtained at a cheaper cost by treating the affected plants with Tetra-methyl thiuram disulphide at a concentration of 0.2% incorporated in a petroleum product. This treatment is being recommended.

Investigations on other diseases affecting the rubber plants, like brown root disease, dry rot, canker, bark rot were also carried out by the Institute and suitable treatments were recommended which are being widely practised in large plantations and small holdings.

Diseases of rubber leaves caused by *Corynespora cassiicola* and *Pellicularia filamentosa* were investigated and first reported by the Institute. Field trials were carried out on different panel protection compounds and suitable products were recommended for large scale use in rubber plantations.

Investigations on the pathogens causing abnormal leaf fall disease have revealed that more than one species of *Phytophthora* are responsible for the incidence of this disease for rubber in this country. Sexual reproduction of the pathogen is noticed in nature as well as in culture. Germination of the oospores both found in nature as well as in culture is another very significant finding in the study on the physiology of the pathogen. During the investigations on host parasite relationship it was found that the pathogen enters through the stomata of the host.

During the study on alternative hosts of *Phytophthora*, several plants of economic importance were found to be infected by this pathogen. In this connection, the Institute has worked out in detail and reported the leaf rot and fruit rot diseases of cardamom.

While working on the epidemiology of the pathogen it was found that the sporangia of *Phytophthora* were caught on the slides exposed in locally made spore traps. From this culture of the pathogen was developed and pathogenicity studies carried out.

During investigations on the physiology of the pathogen, *Corticium salmonicolor*, causing pink disease of rubber, it was observed for the first time that the pathogen produces asexual spores on artificial culture medium.

Screening of various insecticides showed that dieldrin is the most effective for the control of white ants attacking rubber. Similarly studies on the toxicity of insecticides and molluscicides on slugs and snails attacking rubber have given valuable information. For the control of rodents causing damage to rubber, a new bait preparation has been evolved based on zinc phosphide with vaseline in collapsible tubes. This bait was found to be very effective in comparison to conventional baits.

Studies on the rhizosphere flora in rubber estate were carried out and antagonistic actinomycetes against pathogens causing rubber diseases were selected for further investigations. Regional isolates of root nodule bacteria were made and their efficiency in nitrogen fixation in their respective host is being tested.

On the processing side as an initial step research efforts were mainly directed to the improvement of the conventional processing methods and assessing the technological properties of the conventionally processed rubbers particularly rubber produced by the small holders. Smoke houses were designed to cater to the needs of small holders. The Division has

worked in close collaboration with I.S.I. for formulating I.S.I. specifications for the different grades of rubber and rubber products made in the country. Investigations on oil extension of natural rubber, carbon black masterbatch, relationship of PRI and copper content, search for different preservatives for NR latex, biochemical changes of preserved latex, economic usage of rubber seed oil etc. were under progress.

Now in view of the fact that radical changes have taken place in the processing of rubber for the market and its specification in the international scene, the chemistry and technology division is confronting with the task of reorienting its research activities to give more emphasis to studies connected with the introduction of modern methods of processing into solid block forms, technical specification of rubber and problems of the consumers of rubber in addition to the current research activities.

With the above things in view, the Institute is contemplating to start a Pilot Plant using indigenous machineries for perfecting a process that is suitable under our conditions and economic circumstances. This would also facilitate the Institute to carry out experiments on incorporation of chemicals such as carbon black, oil, synthetic rubber etc. with natural rubber with a view to developing tailor cut raw rubber which would eliminate some mixing process in consuming factories thereby reducing their cost of production.

CENTRAL COFFEE RESEARCH INSTITUTE—IN RETROSPECT

G. I. D'Souza

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The Institution saw its birth as a small Coffee Experimental Station at Balehonnur, Chikmagalur District (Mysore State) in 1925-26 primarily for devising suitable control measures against coffee leaf-rust (*Hemileia vastatrix* B. & Br.). The Institution was under the control of the Department of Agriculture, Government of Mysore till 1946, when its administration was handed over to the Coffee Board.

The Research Department of the Coffee Board maintains two research stations—the Central Coffee Research Institute at Balehonnur, Mysore State and Coffee Research Substation, Chethalli, Coorg District, Mysore State and also a full fledged Soil Testing Laboratory in Mysore City.

The extension wing of the Research Department comprises of 16 liaison centres with six Coffee Demonstration Centres under a Deputy Director of Extension with Headquarters at Chethalli. The Extension Wing is responsible for developmental aids to small farmers and advisory and technical assistance to large growers. A world wide collection of various varieties and species of coffee is being maintained at Central Coffee Research Institute and Coffee Research SubStation.

The main emphasis is on breeding of rust resistant varieties. Nutritional and plant protection aspects of crop-improvement are also given due attention. Training of management personnel is also an important activity.

The following are the significant achievements of the Central Coffee Research Institute since its inception in 1926 up to 1972.

- 1926-27 — The first NPK manurial experiment in coffee laid out.
- 1932 — Phenomenon of race specialisation in coffee rust fungus reported.
- 1933-35 — Bordeaux mixture spraying introduced into coffee plantations.
- 1936 — Isolation of Mayne's races I, II, III & IV of leaf-rust.
- 1946 — The Coffee Experimental Station at Balehonnur was taken up by the Coffee Board.
- 1950 — Extension wing of the Coffee Board Research Department came into existence.
- 1952-53 — Disease-tolerant selections (S. 795) released for general cultivation.
- 1958 — Soil Testing Laboratory organised to rationalise fertilizer practices and recommendations on the basis of soil tests and foliar analysis.
- 1959-60 — Foliar nutrition technique with NPK and micronutrients (Zinc) standardized.

1964-69 — Nematode problem of arabica coffee solved by grafting arabica scions on nematode tolerant robusta stock.

S. 1934, another disease-tolerant variety of arabica coffee with lesser triage content than S. 795 released.

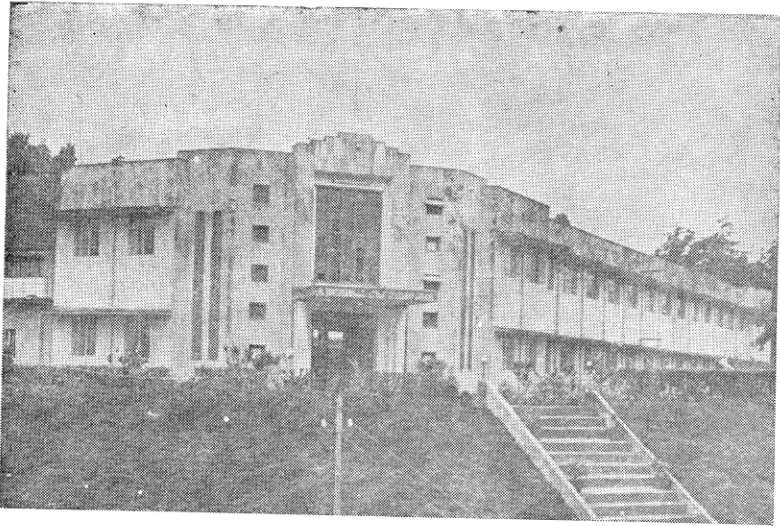
New malady die-back diagnosed as a predominantly exposure problem.

1970-72 — Liaison Wing reorganised and expanded to adequately accommodate increased production.

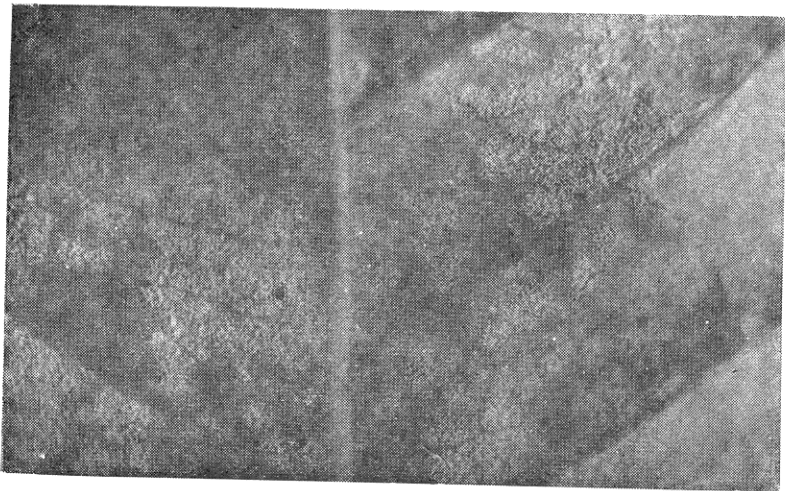
At present the major problems are:—

- 1) Maintenance and improvement of quality of Indian Coffee.
- 2) Reducing cost of production of coffee without lowering production.
- 3) Regulation of Annual yields of coffee.
- 4) Effective control of pests and diseases with minimum environmental disturbances.

As a result of continuous research and extension effort production of coffee has increased from an average of 30,000 tons during the 1950's to 75,000 tons during the 1970's and a record crop of 1,09,000 tons was harvested during 1970-71.



Central Coffee Research Institute, Balehonnur, Chikmagalur Dist., Mysore State



Coffee Leaf Rust (*Hemileia vastatrix* .B & Br.) Pustules on the leaf



ARECANUT AND SPICES

T. T. Paulose

*Director
Directorate of Arecanut and
Spices Development, Calicut*

Born in August, 1916 Shri T.T. Paulose had his college education in Ernakulam and Bombay. He joined service in 1939 in the Indian Central Cotton Committee and he was in the services of that Committee for over 25 years. In June, 1964 he was appointed Secretary of the Indian Central Arecanut Committee in charge of both research and development work on arecanut in India. On the dissolution of Commodity Committees, Shri Paulose became Deputy Director in charge of the Regional Office for Arecanut and Spices Development and was subsequently appointed as Director, in the Directorate of Arecanut and Spices Development. In this capacity, Shri Paulose is member-Secretary of the Indian Arecanut Development Council and Chairman of the Indian Spices Development Council. Shri Paulose is also a member of various scientific committees.

Arecanut and Spices are very important commercial crops. While the former is essentially a commodity for domestic consumption, spices are very important exportable commodities earning large amounts of foreign exchange. These commercial crops play a very vital role in the economy of our country. India produces about 1.41 lakh tonnes of arecanut worth about Rs. 850 millions. Nearly four million people in India are directly or indirectly engaged in the

cultivation of arecanut and its processing and trade earning their livelihood from this crop.

India produces almost all spices, ranging from pepper, the "king of spices", to cardamom, ginger, turmeric, chillies, cloves, nutmeg, cinnamon, cumin, coriander, vanilla etc. in all about 37 different items including saffron which is probably the world's most costly spice. It was the trade in spices which in the 15th

century introduced India to the world outside and Vasco de Gama and other daring explorers suffered untold hardship to reach India in search of its costly spices.

The position regarding the development of these crops is briefly dealt with below.

Arecanut

Work on development of arecanut started with the partition of India in 1947. India lost nearly 50% of its area under arecanut in East Bengal as a result of the partition. The reduced supplies available from the rest of the country were not sufficient to meet its requirements with the result that we were compelled to import large quantities of arecanut from Sri Lanka, Malaysia etc. However, as a result of the developmental activities undertaken for increasing production which gained added momentum with the constitution of the erstwhile Indian Central Arecanut Committee, the area and production of arecanut in the country increased steadily and the imports were proportionally reduced. Since 1968-69 the imports were completely stopped with a view to providing adequate incentive to the growers of arecanut in India. This enabled the cultivators to get better prices for their produce and arecanut became probably the most paying agricultural commodity. The following figures of area, production, imports and annual average prices would clarify this position.

Meghalaya). These three states together produce more than 90% of the total crop in India. The erstwhile Indian Central Arecanut Committee had, besides the developmental activities undertaken by them, laid considerable stress on research work. They established a Central Arecanut Research Station at Vittal in South Kanara District of Mysore State and Regional Stations in Kerala, Mysore, Assam and West Bengal. These Research Stations carried out very useful work and, apart from standardising nursery practices, developed remedial measures for the pests and diseases affecting the crop and laid down suitable manurial schedule for obtaining maximum production. The fine quality seedlings produced and distributed from these Stations and the work done by them on control of pests and diseases and adoption of the scientific methods of cultivation were largely responsible for the rapid development of the crop. During the II and III Plan periods the area and production of arecanut exceeded the targets. Since the dissolution of the committees in 1965, the research work is being continued by the Indian Council of Agricultural Research, through the Central Plantation Crops Research Institute, Kasaragod, and the development work attended to by the Directorate of Arecanut and Spices Development which is a subordinate office under the Ministry of Agriculture, Government of India. The Government of India have also constituted an Indian Arecanut Development Coun-

Year	Area	Production	Import	Average annual prices per qtl. (Rs.)
1960-61	113.00	95.46	11,170	498
1961-62	115.87	97.11	10,041	569
1962-63	118.28	99.00	8,979	581
1963-64	123.13	98.46	2,810	555
1964-65	125.93	107.51	3,275	572
1965-66	138.10	119.90	3,323	651
1966-67	142.10	130.10	597	688
1967-68	147.40	135.40	136	741
1968-69	157.00	139.70	..	755
1969-70	160.70	137.70	..	773
1970-71	167.30	141.00	..	802

Kerala has the largest area under arecanut in India followed by Mysore and Assam (including

cil with officials from the Central and State Governments and representatives of growers,

traders, parliament members and various other interests to advise government on the lines on which the development of the crop should be carried out. The Council has a non-official grower of arecanut as its Chairman.

In view of the fact that the primary objective of developmental work on arecanut was to make India self sufficient in the commodity and realising the danger involved in indiscriminate expansion of cultivation of arecanut and consequent surplus production for which there is no export potential, the erstwhile Indian Central Arecanut Committee and the Indian Arecanut Development Council had repeatedly stressed the need for avoiding further expansion of the area and concentrating work only in existing gardens. Since the unit yield of arecanut in Kerala, which has the larger area under the crop, is only about 50% of the yield in Mysore, it was felt that all the additional production needed could be obtained by taking measures for improving the unit yield in this state as also in Assam which is another major arecanut growing state.

At present the total area under arecanut is 167.3 thousand hectares producing 1,41,000 tonnes. As we near self-sufficiency in the commodity, it is only natural that the market prices which were very high when we were short of the required quantity, would gradually come down and maintain a normal level. However, recently there has been a very sharp fall in arecanut prices which has adversely affected the growers. Whilst the exact causes which led to the fall in prices are not known, it is felt that unsatisfactory marketing arrangement has been a major contributing factor. Since arecanut is mainly a holder's crop, the cultivators often fall a prey to commission agents and other itinerant merchants to whom they part with the produce at throwaway prices with a view to securing immediate ready cash. It is necessary to develop co-operative marketing agencies on a large scale and to strengthen such agencies with adequate monetary support so that they will be able to come to the rescue of the growers by granting them produce loans and arranging to sell their produce at up-country consuming centres at

advantageous prices. Realising the fact that at present arecanut has no export potential and there are no ways and means of absorbing the surplus production, if any, the cultivators will also be well advised to increase their income from arecanut garden, by intercropping with cacao, pepper, banana, yam and other crops. Work done at the Arecanut Research Stations which now come under the Central Plantation Crops Research Institute has shown that considerable additional income can accrue to cultivators by adopting such intercropping. By adopting the recommendations made by the Research Stations the cultivators can also increase their unit yields so that the loss in income due to fall in prices can, to a certain extent, be set off against the income obtained from increased yields.

Spices

Unlike arecanut, spices earn considerable foreign exchange to the nation. During 1970-71, India exported 47,000 tonnes of different spices earning foreign exchange of the value of Rs. 39 crores. Nearly 50% of this is from pepper alone which is the most important spice crop. Organised work on development of spices started with the constitution of the Indian Spices and Cashewnut Committee in 1961. However, the committee was dissolved in 1965 and the research part of the work handed over to the Indian Council of Agricultural Research which has since initiated an all India Co-ordinated Project for research on all spices. Developmental work on Spices is looked after by the Directorate of Arecanut and Spices Development. Government of India have also constituted an Indian Spices Development Council with representatives of Central and State Governments, parliament members, growers, traders and various other interests to advise government on the measures to be taken for development of the different spice crops.

Although India is famous for its pepper and, at one time, held a near monopoly in trade in pepper, our production and exports have remained more or less static or declined over the past decade as shown overleaf.

Year	Production (‘000 Tonnes)	Export (‘000 Tonnes)
1962-63	26.0	20.9
1963-64	24.0	18.9
1964-65	24.0	17.4
1965-66	23.0	26.3
1966-67	27.0	21.8
1967-68	26.0	25.1
1968-69	26.0	19.0
1969-70	25.0	22.3
1970-71	26.0	18.0
1971-72	26.0	19.2

The main drawback has been our low unit yields when compared to the yields obtained in other producing countries. Efforts are, therefore, being concentrated on increasing the yield per vine by adoption of improved planting materials and plant protection measures. Research work done in Kerala has brought out a high yielding hybrid variety of pepper called ‘Panniyur-I’. The yield from this variety compares with one of the popular local variety as under:—

Panniyur-I is also early bearing when compared to other varieties. In view of these advant-

ages steps have already been taken for the rapid multiplication and distribution of planting materials of this variety. A central nursery for this purpose has already started functioning in Kerala and at present over one lakh of rooted cuttings are produced and distributed annually. It is proposed to expand this nursery so as to produce 25-30 lakhs rooted cuttings annually for distribution in Kerala and potential pepper growing areas in other states like Mysore, Tamil Nadu, Andhra Pradesh etc. Demonstration plots to highlight the advantages of this hybrid pepper have also been established in these states for making it popular. It is expected that use of this high yielder will considerably enhance our unit yields.

Pests and diseases also account for large scale fall in production which, in certain years, is as much as 30%. Demonstrations for control of pests and diseases are, therefore, being conducted in cultivators’ fields and it is proposed to grant subsidies on plant protection chemicals and equipments so as to avoid such crop losses. The combined effect of using the high yielding hybrid planting material and control of pests

	Panniyur-I	Kalluvally-local popular variety.
Maximum yield obtained per vine	10.5 kg (green)	5.59 kg (green)
Minimum yield obtained per vine	5.325 kg (green)	0.931 kg (green)
Mean yield obtained per vine	7.331 kg (green)	1.751 kg (green)
Mean length of spike	16.2 cm	10.8 cm
Mean number of berries per spike	98	65
Weight of 100 green berries	16.8 g	12.4 g
Percentage of drriage	32.8	31.4

Panniyur-I is also qualitatively superior as will be seen from the following analytical data.

	Panniyur-I	Malabar Black pepper (garbled)	Tellicherry black pepper (garbled)
Volatile ether extract	1.85 %	2.32 %	1.02 %
Nonvolatile ether extract	13.52 %	8.53 %	7.00 %
Alcohol extract	13.38 %	9.88 %	8.28 %
Total Ash	4.45 %	4.83 %	4.35 %
Acid insoluble ash	0.11 %	0.03 %	0.07 %

and diseases will definitely push up our productivity and make it easier for us to compete in foreign markets with other producers.

With a view to avoiding unhealthy competition in pepper trade between the different countries and to effect regional co-operation in all aspects concerning production and marketing of the crop, a Pepper Community has been established with India, Indonesia and Malaysia as members. The inaugural meeting of this Community was held recently in Bangkok. The Community is expected to carry out research and developmental activities in the common interests of the participating countries with its own finance as well as grants from various U. N. Organisations.

Work connected with development of cardamom is looked after by the Cardamom Board functioning under the Ministry of Foreign Trade. The Board is also well represented by officials of the central and state governments, parliamentarians, growers, traders etc. The Board is undertaking various measures for the development of the crop with particular emphasis on controlling the 'Katte' disease in cardamom which accounts for considerable damages to the crop. Indian cardamom (Alleppey green, Coorg green etc.) are well-known in foreign countries. India exports annually about 2000 tonnes of cardamom valued at Rs. 100 million against a production of about 3000 tonnes.

Ginger, turmeric and chillies are the other major spices. However, the bulk of these crops is for domestic consumption. The following statistics will show the area, production and export of these spices during the past ten years.

No organised research has so far been done in respect of these crops. However, this aspect of the work is now receiving attention by the Indian Council of Agricultural Research under their co-ordinated research project administered by the Central Plantation Crops Research Institute, Kasaragod. It is necessary for us to improve the quality of these spices by research as to enable us to enhance the exports. At present, Calicut and Cochin ginger, Alleppey turmeric etc., are wellknown in foreign countries. Still further improvement in quality is needed to produce less fibrous ginger and better quality turmeric for foreign markets. In the case of chillies also, different countries require different degree of pungency etc. and we will have to produce different varieties to cater to these markets.

Cinnamon, clove and nutmeg, known as tree spices, are also very important. At present India is depending on imports of these to meet our requirements. Increased production of these crops in India as a measure of import substitution is an urgent necessity. Efforts are, therefore, being made to initiate work on developments of these spices.

Year	Ginger			Turmeric			Chillies		
	Area ('000 ha)	Production ('000 tonnes)	Export ('000 tonnes)	Area ('000 ha)	Production ('000 tonnes)	Export ('000 tonnes)	Area ('000 ha)	Production ('000 tonnes)	Export ('000 tonnes)
1962-63	21	20	6.1	55	105	3.0	637	425	4.9
1963-64	23	21	4.9	59	116	3.2	748	490	12.1
1964-65	22	21	3.6	70	148	9.5	717	469	11.9
1965-66	22	22	4.0	67	128	10.4	652	383	9.5
1966-67	23	21	5.0	58	111	9.5	721	418	6.2
1967-68	21	20	3.9	54	109	6.0	788	501	7.2
1968-69	20	18	1.7	60	104	5.4	663	399	9.2
1969-70	21	21	1.2	69	134	7.0	682	395	2.0
1970-71	22	30	3.2	75	144	11.1	714	413	2.1
1971-72	23	34	6.7	N.A.	N.A.	14.2	N.A.	N.A.	4.5

N.A.: Not available.



PROBLEMS POSED FOR RESEARCH IN COCONUT

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In a perennial crop like coconut, *Cocos nucifera L.*, there is considerable time lag for the research activities to yield results. Research in any field of coconut improvement—whether it be in genetics, agronomy or plant protection—has to continue for a very long period for getting conclusive results. In India, organised attempts for the systematic development of coconut research were initiated with the establishment of the Indian Central Coconut Committee in the year 1945 and, since then, commendable progress has been made in tackling various problems of coconut improvement. Very useful findings of economic importance became available to the growers, and coconut research in India gained international recognition and reputation. However, the problems required to be handled are so innumerable and exhaustive that many problems of economic value and utility still remain to be explored. It is in this context that the following problems, which have a bearing on the economics of coconut industry as a whole in the country, are posed for immediate research.

1. Yield increases in terms of copra output

In coconut, high yield must ultimately mean higher outturn of copra. For all practical purposes, including the development of coconut-based industries, the yield output in terms of copra per unit area is the most important factor. In India, though the average yield in terms of number of nuts per ha compares favourably with that in other major coconut producing countries, the average yield in terms of copra output is the poorest. Nearly 7000 nuts are required to make a tonne of copra in India, while the figures for Sri Lanka and the Philippines are only 4500 and 4000 nuts respectively. As long as this disparity continues, India will remain backward in the development of coconutbased industries, especially desiccated coconut and milling industry, for the cost of production will be prohibitive compared to that in Sri Lanka and the Philippines and can never aspire to compete in the international markets even after achieving a surplus in the total availability of coconuts in the country. The logical approach to the problem is to analyse the factors responsible for the

comparative low yield of copra in the country and to initiate breeding programmes aiming at increasing copra output per unit area. The low yield of copra may be due to climatic factors peculiar to the country. Even in the West Coast, there is a dry spell of about 4 to 5 months in a year which is not considered suitable for high yield. Still it is a known fact that some of the introduced varieties and also indigenous types like "Kappadam" give comparatively higher copra outturn under the same climatic conditions. Some of the experimental results also show that use of such types as pollen parents contributes to a higher copra yield of the resulting progenies. Indications are also available to the effect that progenies resulting from mixed planting of exotic and indigenous types with high copra yield and the ordinary West Coast Tall are likely to give increased copra yield. Another possible reason for the present poor copra yield may be due to the emphasis we give for the number of nuts rather than the annual copra yield per palm in the process of mother palm selection. Studies on this aspect have shown that number of nuts, weight of unhusked nuts and weight of husked nuts are all positively correlated with the outturn of copra. However, there is no conclusive evidence to prove that trees producing large number of small sized nuts yield more copra than those producing lesser number of medium sized nuts. Further, heritability studies have shown that weight of husked nuts has a higher heritability value than the number of nuts. In view of these observations, copra yield of a palm assumes considerable importance among the standards laid out for the selection of mother palms for maintaining a higher copra yield of the progenies. All these possibilities are to be studied properly and our efforts oriented towards achieving a higher copra output per palm per year.

2. Disease resistance studies

The root (wilt) disease has affected extensive coconut growing areas in the State of Kerala. The disease is considered to be of virus origin predisposed by certain agronomic factors, particularly the ground water regime and the calcium-magnesium status of the soil. Coupled with agronomic improvements, another line of

approach adopted now is testing of exotic and indigenous types including hybrids for disease tolerance or resistance. In this context, the findings of the recent survey conducted by the Central Plantation Crops Research Institute on the comparative degree of tolerance of the $T \times D$ and $D \times T$ hybrids and the indigenous types assume considerable importance. The survey results give encouraging indications that the $T \times D$ and $D \times T$ hybrids possess a very high degree of tolerance to the root (wilt) disease and that the performance of the $D \times T$ hybrids is slightly better than that of $T \times D$. Based on these findings new projects are being envisaged for a phased programme of rejuvenation of diseased areas by the adoption of a systematic replanting and underplanting programme with the hybrids, especially with $D \times T$. Though the natural cross hybrids of the dwarf have been found to be superior to the West Coast tall in all economic characters, including disease tolerance, no reliable data are available about the performance of $D \times T$ hybrids as a group under similar conditions. Studies on the genetics of dwarfs and the phenomenon of the occurrence of natural cross hybrids of dwarfs, have shown that even with selfing in dwarfs, seedlings similar to natural cross hybrids occur among the progenies. Similarly, controlled pollination for the production of $D \times T$ hybrids also results in the production of a small percentage of pure dwarfs. The results of selfing and the occurrence of dwarfs in controlled pollination suggest the possibility that the natural cross hybrids might be heterozygous segregates with imposed hybridity. If this is so, there is a possibility that the $D \times T$ hybrids that are produced in hybrid seed gardens may consist of two distinct groups, i.e. a smaller percentage of heterozygous segregates of dwarfs with imposed hybridity and the $D \times T$ hybrids. In that case, the performance of the two groups of progenies need not be the same with respect to disease tolerance and other economic characters. This aspect requires a detailed and critical study on a priority basis.

In the breeding programme for disease resistance, the apparently tolerant palms found in large numbers in the highly diseased tracts may prove to be useful breeding material. These

palms do possess a comparatively higher degree of tolerance to the disease. But whether this character is transmitted to the progenies is not known now. However, these palms can be utilised for *inter se* crossing and for controlled pollination with selected mother palms.

3. Economics of fertilizer use

A large number of experiments to study the response of coconut palms of different age groups to fertilizer inputs have been done in the country under different agroclimatic conditions. Based on the findings of these experiments, fertilizer recommendations are available to the growers for a given set of conditions. New fertilizer experiments are also in progress in the different research centres in the country as part of the coordinated programme of the Indian Council of Agricultural Research for coconut improvement. It is a known fact that, in agriculture, decisions of farmers in favour of the adoption of a recommended technology, are basically economic. In the use of fertilizer inputs, the farmers are interested not in the theoretical optimum levels but in the economy in the adoption of recommended doses. A coconut grower may be interested to know the most economic levels of fertilization that will ensure him the maximum net income from his holding. It is doubtful whether such information is available to him now.

The economics in the use of fertilizers and manures on coconut require to be studied in

detail so that recommendations on the most economic level of fertilizer use could be evolved and passed on to the growers for reaping the maximum benefit.

4. Cropping pattern for coconut holding

Coconut is essentially a small holder's crop in India. The average size of the holdings is as small as 0.20 ha and more than 90 per cent of the holdings are under one ha. The income from such small holdings will be hardly sufficient to maintain an average family. A recent study conducted by the Reserve Bank of India in a few selected villages in Kerala, revealed that the average annual income of a coconut grower from a 0.4 ha holding is around Rs. 680/-. If he grows other crops along with coconut the income is just Rs. 744/-. This indicates that majority of coconut growers as a class lead a submarginal level of living. The problem highlights the importance of devising suitable cropping pattern for each agroclimatic region for maximising the total income from a unit coconut holding. Pasture cultivation and dairying will be a profitable proposition in some regions, whereas intercropping with cacao, tree spices, fruit trees and even suitable seasonal crops may be feasible and advantageous in other regions. Agronomic research designed to evolve measures for yield increases in coconut should also give equal emphasis to the problem of scientific and profitable utilisation of coconut holdings for increased total returns from a unit area



DISEASES OF PLANTATION CROPS

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Born in the year 1926 Dr. (Mrs.) K. Radha began her career as a Research Scholar of the erstwhile Cochin State. In the year 1953 she joined the Central Coconut Research Station, Kayangulam and became Plant Pathologist in the year 1968. She has been working on the fungal diseases of plants; of this for about twenty years she has been working on coconut and six years on cotton. She has a large number of publications to her credit. Since May 1971, Dr. Radha is the Joint Director of the Central Plantation Crops Research Institute, Regional Station, Kayangulam.

The root (wilt) disease of coconut, the yellow leaf disease of arecanut, root rot or wilt (Anabe roga) of coconut and arecanut, wilt of pepper and 'Katte' of cardamom are some of the important diseases that attract the attention of both the researchers and cultivators alike. In view of the economic importance of the crops and the extensive crop losses these diseases assume national importance.

The dreaded root (wilt) disease of coconut which is crippling the coconut cultivation in South and Central Kerala is estimated to cause an annual loss of about Rs. 150 million. The disease is debilitating in nature and spreads slowly but steadily. As the name signifies the

characteristic symptoms of the disease are rotting of roots and wilting of foliage. Internal damage to the roots appears to set in even before the expression of external symptoms. Presence of rod shaped virus particles identified as Tobacco Mosaic Virus in partially purified preparations of root and leaf tissues of diseased palms is an important step in the progress of the investigations on this complex disease. Yet, the existence of the same virus in healthy samples from disease free area necessitates intensive study on the role of this virus in the incidence of disease. The possibility of a mycoplasma origin to this disease is gaining ground recently. Direct evidence by electron microscopy and indirect proof by antibiotic (tetra-

ycline) treatments for confirmation of this suggestion are being gathered. Two species of *Rhizoctonia* viz. *solani* and *bataticola* associated with the disease are capable of causing root rot. The possible part played by a bacterium, *Pseudomonas* sp. observed in the affected palm and that of nematodes—species of *Xiphinema*, *Longidorus* and *Radopholus* occurring in coconut soils are yet to be established. Significance of nutrient deficiencies, particularly that of calcium and magnesium and the associated nutritional imbalance as predisposing factors for the activity of pathogenic organisms needs confirmation. The rapid spread and high intensity of the disease in light soils subject to inundation are also important features of this baffling problem. Indeed, while the etiology of this disease remains intriguing, the possibility of rehabilitating the disease affected coconut tract by (1) systematic adoption of agronomic practices which yields positive response by way of increased production and (2) replacement of the uneconomic palms with the high yielding hybrids—Tall x Dwarf or Dwarf x Tall which are observed to be less susceptible to the disease is a practical solution.

Leaf rot disease of coconut due to *Bipolaris halodes* which superimposes nearly 20 per cent of the root (wilt) affected palms paves the way for its rapid decline. Although systematic fungicidal treatments can control this secondary malady, practical difficulties encountered in its adoption warrants a concerted effort to tackle this problem by the use of modern techniques and machinery like low volume spray and aerial spraying.

The yellow leaf disease of arecanut prevalent in Kerala is also a disease of unknown etiology having similarity to the root (wilt) disease of coconut. The disease is more frequent in soils of poor fertility and high water table and the affected palms have a low nutrient content. Investigations on the same as in the case of root (wilt) disease of coconut are expected to

throw light on the etiology of the disease.

A disease common to both coconut and arecanut is the root rot/wilt caused by *Ganoderma lucidum* known as "Anabe roga" in Mysore. The extensive root system of these crops provides favourable situation for this root inhabiting fungus. Neither field sanitation, nor eradication of diseased palms, nor application of sulphur, copper or mercurial fungicides have so far proved to be of any avail in controlling this disease. Early diagnosis of the disease prior to the manifestation of visual symptoms by "remote sensing" (aerial infrared photography) or fluorescent antibody technique, critical assessment of pathogenesis and use of systemic fungicides from the very early stage of infection might solve this problem.

The 'wilt' of pepper, both the slow wilt caused by a *Fusarium*—nematode complex and the quick wilt due to *Phytophthora*, are reported to respond to fungicidal treatments. However, the former needs a reevaluation of the role of the fungus and the nematode so as to improve the plant protection measure by a combination of fungicide—nematicide formulation. For the control of 'quick wilt' emphasis should be laid on prophylactic methods during pre-monsoon months coupled with soil water management since *Phytophthora* is highly specific in its environmental requirements.

'Katte' or 'mosaic' of cardamom considered to be a virus disease transmitted by the banana aphid, *Pentalonia nigronervosa* has no successful method of control. However, eradication of affected clumps, avoidance of banana crop in and around cardamom plantations and use of systemic insecticides are currently recommended. Effectiveness of mineral oil sprays in preventing transmissibility of the virus through the vector as in the case of aphid borne cucumber mosaic virus and potato virus Y is worth exploration as the spread of the virus can be checked without removing infective material.



CASHEW—A DOLLAR EARNING CROP

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Shri M. C. Nambiar, born in 1925 began his career as a Research worker with the Government of Madras in August 1947. In 1951 he joined the Cyto-Anatomy section of the Central Coconut Research Station, Kasaragod and he was the Cyto-Anatomist till August 1967, when he took over as Director of the Station. He was holding that post till 1970, when the Central Plantation Crops Research Institute came into existence, when he became the Joint Director. For about a year from May 1970, he was the Geneticist of the Institute. In July 1971 he was appointed as the Project Coordinator of the All India Coordinated Spices and Cashewnut Improvement Project. Shri Nambiar is a member of several scientific societies and has a large number of publications to his credit.

Cashew is a native of Tropical Central and South America and the West Indies. It was introduced into India by the Portuguese settlers in the 15th century. As in many other tropical countries the crop has become naturalised in India also. It is an important export oriented commercial crop and India has been and is still holding a dominant position in respect of the world trade of processed cashew kernels. India even today meets nearly 80% of the world demand for cashew kernel and it is still the second biggest dollar earning commodity. At present our export of processed cashew kernels per year is over 60,000 tonnes, earning a foreign exchange of about 60 crores of rupees. An-

other 1.28 crores is earned by the export of Cashewnut Shell Liquid. Though a comprehensive review on this important crop is not contemplated, an attempt is made to indicate the prospects as well as the problems which need immediate attention of the research workers. The technological aspects of the crop assume special significance in view of the export component involved in the economy of cashew cultivation.

India, Mozambique, Tanzania, Kenya and Brazil are the important cashew producing countries in the world and together they produce nearly 4,30,000 tonnes of raw nuts annual-

ly. In India, Kerala, Tamil Nadu, Andhra Pradesh, Mysore, Maharashtra, Orissa and Goa are the important cashew growing regions. Efforts made by the Central and State Governments during the past two decades have resulted in considerable expansion of the area and the total production of raw nuts is reported to have gone up to 1,45,000 tonnes in 1970. But the increase in production has not made much impact on the proportion of indigenous raw nuts that go for processing. The local supply of raw cashewnut to the processing units has, however, remained more or less stagnant at about 65-80 thousand tonnes a year during the last decade. It is, therefore, quite evident that the present indigenous production of raw-cashewnuts is far short of our requirements and the cashewnut industry still depends heavily on the imports of raw cashewnuts to cater to the needs of processing factories numbering about 320. Nearly 65 per cent of our requirement of raw cashewnut valued at about Rs. 80 crores is imported annually from East African countries. Till recently only in India raw cashewnut was collected and processed for marketing and obviously India enjoyed complete monopoly in the world trade for the supply of cashew kernel. The situation is fast changing. India's relative importance in the world trade for the supply of cashew kernel has fallen from 95% in 1966 to 78% in 1968. The countries from which we import raw nuts have started setting up their own processing factories and there is an imminent threat from the exporting countries to reduce or completely stop the supply of raw nuts to India and, therefore, India is faced with the challenging task of building up her own indigenous production in the shortest time possible. India has the physical facilities and knowhow to meet this serious situation. The reported 400 kg/ha yield of raw nuts can easily be increased to two to three fold by planting genetically superior planting materials and adopting proper package of practices and plant protection methods. We have, therefore, every reason to feel confident that it is possible to increase our indigenous production to meet the requirements of our industry from the existing area of over 3.3 lakh ha by proper planning and

adoption of scientific methods of cultivation based on results of research.

The research on cashew received attention only very recently and can be considered to have commenced with the sanction of an *ad hoc* scheme by the Indian Council of Agricultural Research from 1951 onwards, in the three states of erstwhile Travancore, Madras and Bombay. Later, the scheme was extended to Andhra Pradesh and Assam also.

Introduction, maintenance and evaluation of germplasm are the basic requirements for any research on crop improvement. Under the ICAR scheme at Bapatla, Vridhachalam, Vengurla and Anakkayam, nearly 650 collections have been built up which include both indigenous and exotic varieties from countries like Sri Lanka, Brazil, Tanganyika, Tanzania, Malaysia and Northern Nigeria, etc. Wide variability in yield and associated characters is observed in the collections available at different centres. From an initial evaluation of these collections, over 70 types have been selected as potential high yielders. These promising selections are being studied in detail. One of the selections at Vengurla was found to possess a short flowering phase. The entire harvest on the tree was completed within three weeks as against the protracted flowering and prolonged harvest period noticed in other trees of the same block.

Hybridization work at different centres initiated in the early thirties has yielded good results. A number of hybrids evolved at Bapatla, Anakkayam and Vengurla are being evaluated and a few of them are found to be high yielders producing good quality nuts. Promising selections and hybrids are being put under comparative yield trials with a view to assessing their adaptability and yield potential under different agroclimatic conditions.

Cashew is highly cross-pollinated and as might be expected from heterogeneous seedling population, the yield and quality of nuts vary widely from tree to tree. In Tanzania it is reported that less than 1% of the trees in a

population is worthy of selection as parents on the basis of high yield and quality of nuts. Performance of similar plantations of mixed and unselected origins in India also cannot be expected to be better. Reports from Bapatla and other Research Stations, however, show a slightly higher percentage of high yielders probably because of the selection pressure already exercised in the selection of planting material. Performance of open pollinated as well as a few selfed and hybrid progenies of selected parents of the Research Station shows that some of the parents are probably better transmitters of yield. Though detailed information on nature and magnitude of genetic variation for yield and associated characters is not available, it appears to be safe to assume that by adopting proper selection procedures, it should be possible to isolate lines which give high yield with superior quality of nuts. A comprehensive scheme has been drawn up to establish a seed orchard for simultaneous evaluation and multiplication of high yielding types. The promising lines identified at different Cashew Research Stations in the country will be planted at the proposed seed orchard adopting a statistical lay out.

Attempts have been made to standardise various methods of vegetative propagation. Of the various methods of propagation possible, only approach grafting and layering have been subjected to detailed study. A comparative study of the performance of layers, approach grafts and seedlings at different centres showed that airlayers produced higher yield than seedlings and grafts. Compared to other methods, layers are less expensive though for commercial exploitation, the method may still prove too costly. Budding and grafting techniques have been found successful at Vengurla, where July–August is the best season for veneer grafting and September–October for budding. Large scale field trials on budding and side grafting have been initiated at this centre. Budding being the most economic method of grafting in terms of both labour and amount of graft wood needed, intensive work on budding and side grafting has been initiated in all the coordinating centres with a view to stand-

ardising the technique suitable for different agroclimatic conditions.

Manurial trial conducted at different centres have given indications that cashew responds well to balanced fertilization. Preliminary investigations conducted on fruit drop show that high percentage of fruit drop at the early stages of development is due to imbalanced nutrition and incidence of pests and diseases. A detailed investigation on foliar application of nutrients in combination with pesticides has been planned.

High fluctuation in cashew production in our country is mainly because of the severe losses due to pests and diseases. The most destructive insect enemy is the stem borer *Plocaederus ferrugineus*, the grubs of which tunnel into the trunk and root zones and kill the tree outright. This can be controlled by injecting 1% carbaryl (Sevin) or by application of 10 g Phorate (Thimet) granules to the tunnels in the tree trunk. The Tea mosquito, another serious pest which causes heavy loss in yield of cashew, can be controlled by spraying Malathion or Phosphamidon at the appropriate time. 'Inflorescence blight' is the most important disease which can be controlled by combination sprays with Malathion and Aureofungin Sol/Endosulfan and Dithane Z-78/Phosphamidon and Dithane Z-78/Fenitrothion and Dithane Z-78. 'Die-back' disease can be controlled by pruning and burning of the affected portion and by application of Bordeaux mixture 1% over the wounds during the pre and post monsoon periods. Integrated control schedules against the important pests and diseases are to be worked out.

Every part of cashew from root to shoot is used in one way or the other. Cashew fruit and cashewnut are highly nutritious and contain protein, fat, minerals, carbohydrates and vitamins. Comparable both in quality and quantity with any other fruit (Table 1) cashew kernel contains over 21% protein with all the essential amino acids and in addition they are a rich source of vitamins. The kernel also contains good amounts of organic iron, calcium and

NUTRITIVE VALUE OF SOME INDIAN FOODS

Sl. No.	Commodity	Per 100 g of edible portion							Vitamins per 100 g edible portion				
		Mois- ture g	Protein g	Fat g	Mine- rals g	Fibre g	Other carbo- hydrates g	Calories	Vit. A (I.U.)	Thia- mine mg	Ribo- flavin mg	Nicotinic acid mg	Vit. C mg
1.	Almond	5.2	20.8	58.9	2.9	1.7	10.5	655	0	0.24	0.15	2.5	0
2.	Cashewnut	5.9	21.2	46.9	2.4	1.3	22.3	596	100	0.63	0.19	2.1	0
3.	Coconut (dry)	4.3	6.8	62.3	1.6	6.6	18.4	662	0	0.08	0.06	0.6	7
4.	Groundnut	7.9	26.7	40.1	1.9	3.1	20.3	549	630	0.90	0.30	14.1	0
5.	Cashew apple	86.2	0.8	0.6	0.4	0.9	11.1	53	39	0.02	0.05	0.4	180
6.	Mango (Alphonso)	81.6	0.4	0.9	0.5	0.4	16.2	75	11420	0.07	0.10	1.6	37
7.	Orange (Loose jacket)	86.2	0.9	0.3	0.6	0.4	11.6	53	326	0.12	0.06	0.3	68
8.	Guava	81.7	0.9	0.3	0.7	5.2	11.2	51	0	0.12	0.03	0.2	2

(Source: Aykroyd, W.R., 1966)

phosphorus and very high proportion of vitamin C. Processes have been standardised for making juice, syrup and canned products and ready to drink carbonated beverages from cashew apple after effectively toning the astringency. Techniques have also been developed for making dessert wine and brandy from cashew apple.

From the Cashewnut Shell Liquid a cation exchange resin for softening water for boilers and air conditioners can be produced, as revealed from the work of the National Chemical

Laboratory, Poona. Work done on the utilization of cashew shell liquid at the Industrial Research Laboratory, Hyderabad has shown that various types of varnishes and lacquers can be formulated from this. Cardanol is the main constituent of cashewnut shell liquid. Finishes for timber and metals as insulating varnishes can be made out of this. Other economic products developed from cashewnut shell liquid are resins with rubber, elastoplastic sealant for cracks and joints of buildings expansion joint filler using CNSL and coconut pith and water and weather proof resins.