COCONUT ROOT (WILT) DISEASE

INTENSITY, PRODUCTION LOSS AND FUTURE STRATEGY

REPORT OF SURVEY

JOINTLY ORGANISED

by

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PREFACE

The coconut palm (**Cocos nucifera Linn.**) is one of the important sources of vegetable oil in the world. India ranks third in the world in production of coconuts and it is estimated that nearly 50% of coconuts in India are, consumed as such, while the remaining are converted to copra to obtain coconut oil for edible and industrial purposes. Coconut in India also enjoys a capital market. Kerala State accounts for nearly 60% of the country's production of about 6,000 million nuts annually and accounts for one-third of the agricultural income of the State.

The coconut root(wilt) disease, prevalent predominantly in Kerala is a serious malady affecting coconut production in the State. Though the disease has been reported after the floods of 1882 in the erstwhile State of Travancore, it has since then spread to eight districts of Kerala stretching from Trivandrum to Trichur. Isolated incidence has been reported from the other districts of the state and also from the neighbouring districts of Tamil Nadu. Palms of all age are susceptible to the disease and in a recent publication of CPCRI evidence gathered so far on the cause of the malady has been summarised [9]. According to an earlier report, 30 per cent of the area under the crop in Kerala comprising 15 million plams had been affected by the malady incurring an annual loss of 340 million nuts [4,5]. The data accrued from the earlier surveys may not be relevant at present in view of the time-lag of nearly a decade.

The advantage of roguing the diseased palms in areas of sporadic incidence, to contain the disease has been brought out by the Institute from its field trials. Experiments carried out during the past one decade also have added scientific rationale to indicate the concept of 'live with the disease under better management' for enhancing productivity of palms to a reasonable extent [1]. In the light of this some efforts to contain the disease in the border areas and to rejuvenate the diseased gardens in the heavily infected tracts had already been undertaken by the extension and developmental agencies in the past.

In this context, it was felt necessary to update the information on the extent of severity of the disease in both the pre-bearing and bearing palms and loss in production and productivity consequent to the development of coconut root (wilt) disease. This is an essential pre-requisite for formulating appropriate productin-oriented developmental programmes especially during the Seventh Five-Year Plan period at the State and National levels.

A combined meeting of the representatives of Central Plantation Crops Research Institute, Centre for Development Studies, Central Plant Protection Station, Coconut Development Board, Department of Agriculture, Government of Kerala, Department of Economics and Statistics, Kerala Agricultural University and Special Agricultural Development Unit was held on 29 May, 1984 at the CPCRI Regional Station, Kayangulam to examine in detail the methodology and other relevant aspects connected with the survey. Details of participants are furnished in Apendix - I. All the participants were unanimous in having a survey undertaken on a priority basis, so that the data could be made use of in formulating developmental programmes at the central and state levels. A Sub-Committee was constituted to prepare the detailed plan of work of the survey so as to find out the extent and intensity of root (wilt) disease and its impact on production loss.

A Control Room for the effective implementation and monitoring the survey programmes was set up at the CPCRI Regional Station, Kayangulam (Appendix - II). According to the schedule, the first round of survey was initiated on 20 August, 1984 and concluded on 25 August. The entire field staff for the survey was provided by the Department of Agriculture, Government of Kerala comprising 8 Principal Agricultural Officers and 21 each of Sub-Divisional Agricultural Officers and Subject Matter Specialists (PP), 142 Junior Agricultural Officers and 491 Agricultural Demonstrators in the respective areas

of operation. Nineteen scientists from the Institute worked in different sub-divisions providing the required guidance and support to the field staff. The results were tabulated and the "Preliminary Report on the Survey on Production loss due to Coconut Root (wilt) Disease" were presented to Shri.A.L Jacob, Hon'ble Minister for Agriculture, Government of Kerala on 24 October, 1984.

This was followed by a second round of yield enumeration which was done during February 20-25, 1985. The pooled data were analysed with the computer facilities available at the Centre for Development Studies, Trivandrum and the results were brought out as a preliminary combined report and circulated among the participants of the collaborating agencies. A final meeting of the agencies was also convened on 18 May, 1985 at the Centre for Development Studies, Trivandrum. The views of the participants have been given due consideration and incorporated in this report. An attempt has also been made to project the strategies that could be undertaken for the development of coconut in the state in the light of the results obtained from this survey.

In this context, I express my sincere thanks to the Department of Agriculture, Government of Kerala for having provided a massive support of personnel for the actual implementation of the survey, without which the endeavour would not have been possible in the scheduled manner. I thank all the other agencies for their effective participation in the programme.

I would like to make special mention of the contributions made by Shri. P. Suseelan, Director of Agriculture and Shri. R. Hali, Additional Director of Agriculutre, Shri. K. Balakrishnan Nair, Department of Economics and Statistics, Shri.P.K. Sivanandan, IAS, Director of SADU, Dr. P.C.S. Nair, Director of Research, KAU Shri. A. S. Pankajakshan, Coconut Development Board, Dr. K.N. Nair and Shri. D. Narayana, Centre for Development Studies, Shri.N. Krishnaswamy, C.P.PS. and my colleagues of the Institute Dr. N.P. Jayasankar,

M/s. M.V. George, TSS Rawther, Jose Abraham, Thomas Joseph G.B. Pillai, Dr. S. Robert Cecil and Dr. P. Rethinam for their participation and involvement in this survey.

The document contains information on the methodology, its implementation, field evaluation, enumeration of data and analysis. It is unique in having been initiated and completed in record time after a series of discussions and consultations among the participating agencies. It is hoped that the results of this survey will be useful in the formulation of appropriate development programmes for coconut as well as for initiating similar attempts in other maladies affecting coconut and even other perennial crops.

K.V. Ahamed Bavappa
DIRECTOR

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SUMMARY AND RECOMMENDATIONS

The century-old root(wilt) disease of coconut has been slowly but steadily spreading from its primary foci of occurrence in Kottayam district to both in southern and northern directions. The disease now occurs in eight out of fourteen districts of the Kerala State in intensities ranging from 1.52% in Trivandrum to 75.63% in Kottayam, the mean percentage of disease incidence being 32.31. In a survey conducted in 1976 the loss estimated due to the disease was 340 million nuts [4] while the present survey shows that the loss has increased to 968 million nuts. In addition, in the present survey efforts were made to estimate the loss in husk and copra yield, and leaf number and quality due to the disease. The total estimated monetary loss on all these counts, on the basis of 1984 price of coconut was of the order of about Rs.3,000 million.

Keeping in view the fact that coconut is not a crop of a few farmers but that of every landholder in Kerala, the attention that is to be given to remedy the malady requires very special consideration. It is possible to keep the disease under check and contain it within the present eight districts of its occurrence and one of the possibilities is to totally salvage an area of 0.13 million ha of coconut in Trichur and Trivandrum districts where the disease intensity is less than 5 per cent by total removal of all the diseased palms, irrespective of their age. The total number of such palms to be removed comes to ~~6.08~~ 0.64 million. A planned programme to undertake this massive operation is to be worked out so that the disease spread is restricted to six districts. The financial requirements involved and operational strategy to be followed are to be formulated taking into account the ongoing efforts in bringing down the damage due to root(wilt) disease, being implemented by different agencies.

In the remaining six districts where the disease intensity is rather high,removal of diseased yong palms in the pre-bearing age and older ones in advanced stages of the disease is worth undertaking,

since these palms are unlikely to respond to any treatment. If they are retained in the plantations it will only help in increased incidence of the disease and reduced productivity of the plantations. Removal of such palms numbering 12 millionand replanting with healthy seedlings, preferably hybrids, and protecting them against insect vectors till the replanted seedlings come to bearing is the other strategy to be immediately thought of.

While the efforts to identify varieties resistant to the disease are being intensified, there are no better methods right now than eliminating the focus of infection which can help to reduce the spread of the disease and to maintain the remaining palms at optimum levels of management so that the returns to the farmer from coconut are improved and the total production of coconut in the State goes up.

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ABBREVIATIONS

C.D.B.	- Coconut Development Board, Ernakulam, Cochin - - 682 011, Kerala.
C.D.S	- Centre for Development Studies, Ulloor, Trivandrum - 695 011, Kerala
C.P.C.R.I.	- Central Plantation Crops Research Institute, Kasaragod - 670 124, Kerala.
C.P.C.R.I. R.S.	- Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram - 690 533, Kerala.
C.P.P.S.	- Central Plant Protection Station (Government of India), Cochin -682 011, Kerala
D.A.K.	- Directorate of Agriculture, Vikas Bhavan, Trivandrum 695 033, Kerala.
D.E.S.	- Directorate of Economics and Statistics, Vikas Bhavan, Trivandrum - 695 033, Kerala
K.A.U.	- Kerala Agricultural University, Vellanikkara, Trichur - 680 651, Kerala
S.A.D.U	- Special Agricultural Development Unit, Government of Kerala, Thamapanoor, Trivandrum - 695 001.
R.R.L	- Regional Research Laboratory, Industrial Estate, Trivandrum - 695 019
D.A.	- Diseased advanced
D.E.	- Diseased early
M.L.O	- Mycoplasma-like organism
P.P	- Plant Protection
R.W.F	- Root (wilt) Free

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1. INTRODUCTION

The coconut root(wilt) disease was first reported following the great floods of 1882 in three isolated pockets, about 50 km away from each other in the erstwhile State of Travancore. (11) It has since then spread from the original foci of infection and currently occupies a contiguous area, covering eight out of the fourteen districts of Kerala.

The diagnostic symptom of the disease is the characteristic bending of the leaflets termed 'flaccidity'; yellowing and necrosis are the other associated symptoms (7). It is certain that the coconut root(wilt) disease is pathogenic in nature as extensive investigations have excluded nutritional deficiency, hormonal imbalance and water stress as factors directly involved in symptom expression. Palms of all age are susceptible to the disease. The disease is only debilitating but not lethal. It occurs in all soil types in varying degrees of intensity. Various biotic agents such as fungi, bacteria and nematodes have been implicated with the malady as causative factors. But, the exact role of none of them has been conclusively proved. Reports on the viral etiology of coconut root(wilt) disease have also, once, emerged. But the subsequent studies have ruled out the association of any virus with the disease.

Under the circumstances, the detection of Mycoplasma-like organisms in ultrathin sections of developing leaves, unopened inflorescences, root tips and terminal bud tissues in disease affected palms and their absence in samples from the healthy palms is highly significant (9). Supporting evidence in favour of mycoplasmal etiology has also emerged from transmission trials using dodder and periwinkle. Indications on the nature of probable insects transmitting the pathogen are also encouraging (2).

The present survey has been conducted in two rounds, one in August, 1984 and the other in February, 1985. There are four sections in this report. In Section I, the objectives of the survey, methodology, field evaluation, compilation of data and analysis are discussed.

The extent of spread and intensity of incidence of the disease are analysed in Section II. Section III deals with the estimated production loss due to root(wilt) disease. Based on the existing information on the disease, a strategy for arresting the extent of spread and intensityof the disease and increasing the coconut production and overall productivity in the disease affected gardens are outlined in the last Section.

2. METHODOLOGY

2.1 *Objectives*

(i) To estimate the extent of spread and intensity of incidence of the disease in the disease-affected tracts.

(ii) To estimate the decline in yield of the disease-affected palms at early and advanced stages of the disease: reduction in quantity and quality of husk, copra, oil and leaves; and

(iii) To estimate the production loss due to the root(wilt) disease.

2.2 *Disease incidence and yield of nuts*

2.2.1 *Coverage*

The survey covered the entire diseased tract viz. Trivandrum, Quilon, Pathanamthitta, Alleppey, Kottayam, Idukki, Ernakulam and Trichur districts.

2.2.2 *Sampling Design*

A two-stage cluster sampling design with taluk as the stratum was adopted for enumerating the coconut palms. Fifty per cent of the revenue villages in each of the taluks in the districts specified were selected, at random, as the first stage units. However, in Trichur district, only 25 per cent of the villages were selected in three taluks.

From each of these villages six clusters of five survey sub-divisions were selected, at random, as the second stage units. All the palms in these survey sub-divisions were counted and categorised according to disease status, age, bearing and non-bearing stages.

In each cluster a key plot, i.e., a survey sub-division with at least six bearing palms, was identified for enumeration of yield. Two palms each from three groups viz. root(wilt) free, diseased early diseased advanced, were selected at random starting from the keyplot.

2.2.3 Concepts and definitions

For identifying the palms, the following concepts were used:

Root(wilt) free

A palm which is not affected by root(wilt) disease is defined as Root(wilt) free (RWF), irrespective of the fact that the palm is affected by other diseases or pests.

Diseased early

A plam having disease intensity up to and including 50 index points based on symptoms such as flaccidity, yellowing and necrosis is categorised as diseased early (DE) [3].

Diseased advanced

A palm manifesting disease intensity above 50 index points is categorised as diseased advanced (DA).

Bearing palm

A palm which has borne fruit once is treated as bearing.

Non-bearing Palm

A palm which has never borne fruit.

Key plot

One plot having at least six bearing palms in a given cluster is designated as key plot.

2.2.4 Mode of observation

In the selected cluster all the coconut palms were first classified into bearing and non-bearing and each category again into three different groups namely Root(wilt) Free (RWF), Diseased Early (DE) and Diseased Advanced (DA). The owners of the plot were contacted and information regarding irrigation, cultural practices and cropping pattern ascertained. Observations were recorded using the prescribed proformae (Appendix - V). The palms selected for yield observation were given bands with paint for future identification. Number of nuts in bunches, wich are five months and above in maturity, was counted and recorded by climbing on to the crown. The youngest bunch so counted was also tagged for future observations.

The observations were recorded in two rounds. During the first round all the information noted above were collected. But in the second round, carried out after six months, only the yield data of the selected palms were recorded.

2.2.5 Training

Systematic and exhaustive training was imparted to the personnel in stages. Initially the Sub-Divisional Agricultural Officers and the Subject Matter Specialists (PP) of the survey area were exposed to the theoretical aspects, followed by adequate training on the field operations and the survey methods at CPCRI, Regional Station, Kayangulam. They were also trained to prepare action plans for the survey. Training was also imparted to the Agricultural Demonstrators of the Department, who were the field enumerators. Classes were conducted in the different Agricultural Sub-Divisions during the fortnightly training sessions by the Subject Matter Specialists and the Junior Agricultural officers, who had already undergone the training at CPCRI. Special field level training camps were organised and experts from the participating agencies were present in all the camps to observe and guide the programmes. In all, four rounds

of training were imparted to the Agricultural Demonstrators and the entire "Training and Visit" contingent of the Agricultural Extension Workers was mobilised and trained in the exact identification of the diseased palms so as to enable them to provide sufficient information to the farmers on the current concept of coconut culture and the root(wilt) disease. Revenue officials of Karthikapally Taluk gave necessary guidance in selecting the plots based on revenue records.

2.3 Impact of the disease on quality of leaves and nuts

A survey was carried out in five villages viz. Karthikappally, Mavelikkara, Karunagappally, Mannar and Nooranad representing five different soil types. From each village three locations were identified at random with a spacing of about 3 Km between locations. From each location 20 palms each of healthy, diseased early and diseased advanced having mature nuts were selected. Four mature nuts from each palm were collected for studying the nut qualities. In the case of diseased advanced palms the sampling was limited to the available number of mature nuts at the time of sampling. The total number of leaves, the proportion of plaitable to non-plaitable leaves among the lowest five leaves on the crown of each palm were also recorded. Simultaneously, leaf quality, weight of whole nut, dehusked nut and husk were determined. The copra was prepared under uniform drying conditions at RRL, Trivandrum using the copra driers and the copra weight was recorded. The oil content in the copra was estimated by the Soxhlet extraction method. The free fatty acid content of the extracted oil was also estimated.

3. RESULTS

3.1 Incidence of the disease

In the contiguously disease-affected tract stretching from Trivandrum in the South to Trichur in the north, the estimated palm population is 59.2 million bearing and 32.4 million non-bearing palms (Table 1). Trivandrum district contains maximum number of bearing

(10.3 million) and non-bearing palms (6.4 million) closely followed by Quilon district (8.9 million and 6.3 million palms, respectively). It was observed that the incidence and intensity of the disease varied considerably between the districts (Table 2). The extent of incidence of the disease in both bearing and non-bearing categories of palms together was the highest in Kottayam district (75.6%) followed by Alleppey (70.7%), Pathanamthitta (38.2%), Ernakulam (34.5%), Idukki (34.2%) and Quilon (28.6%). In Trichur district the disease incidence was 2.6 per cent. The lowest incidence of 1.5 per cent was in Trivandrum district. The distributions of bearing and non-bearing palms in relation to disease incidence (Taluk-wise) is given in Annexure-I and the percentage distribution in Annexture - II.

In Trichur district the disease was observed mainly in Mukundapuram (7.7%) and Kodungallur (3.2%) taluks and was practically negligible in Thalappally taluk, while Chavakkad taluk was totally free of the disease. In Trivandrum district where the disease incidence is the lowest, Nedumangad taluk had 5.5 per cent incidence, while in the remaining taluks the incidence was less than one per cent. In the earlier survey conducted in 1976 only bearing palms were considered for evaluating the incidence of disease while in the present survey all the palms irrespective of their age were considered. A significant observation is that young palms which are infected with the disease before flowering suffer more. The flowering is delayed considerably in such palms which also give very poor yield. In this context, it is observed that most of the coconut growers continue to retain even those non-bearing palms which are in advanced stage of the disease. Out of the estimated population of 32.4 million non-bearing palms, 16.8% were affected by the disease. Of these, 13.5 per cent were in the early stage and 3.3 percent in the advanced stage of disease. The incidence in non-bearing palms was as high as 46.8 per cent in Kottayam and 40.4 per cent in Alleppey districts and it was comparatively very low in Trivandrum (0.31%) and Trichur (0.58%) districts (Table 2). The distribution pattern of disease among

non-bearing palms in other districts viz. Quilon, Pathanamthitta, Idukki and Ernakulam was 17.0, 18.7, 5.1 and 21.4 per cent, respectively. In the earlier survey, conducted by George et al (1979), the estimated incidence of root(wilt) disease was maximum in Alleppey district (55%) followed by Kottayam (50%) [5]. The disease incidence was considerably low towards the northern and southern parts of the heavily infected central tracts. The present survey also indicated more or less the same trend. However, the intensity has increased considerably in most of the districts.

Palm density, cropping pattern, cultivation practices etc. in the different agroclimatic zones are presented in Annexure-IV. The palm density was found to be high in the low 'lands but' it was observed to be irregular and scattered in 'high lands'. Distribution of palms according to age group and disease incidence is given in Annexure -V. It is interesting to note that Kottayam district has the maximum number of senile and un-economic palms. Out of the 1.9 million senile (above 50 index points) diseased advanced bearing palms more than 0.89 million were from Kottayam district. The number of such senile, unproductive diseased palms in Alleppey, Ernakulam and Pathanamthitta were 0.34, 0.21, 0.12 million, respectively.

3.2 Production Loss

3.2.1 Average yield per palm and decline in yield due to the disease

Estimated average yield per palm in relation to their disease intensity is given in Table 3. (Taluk-wise figures are given in Annexure-III). The highest overall yield of 77 nuts per palm was observed in Trivandrum district where the disease incidence was lowest (2.46%) and the lowest yield of 35 nuts was observed in Kottayam district with the highest disease incidence (85%). Highest average yield of 86 nuts per palm was observed among the RWF palms in Alleppey which is heavily infected (80%). The average yield of RWF palms

in Trivandrum, Ernakulam and Pathanamthitta districts was 78, 80 and 78 nuts respectively. Among the diseased early palms in Alleppey district the average yield was also high with 48 nuts per palm. However, the highest yield among this category of palms is observed in Pathanamthitta (52 nuts) followed by Trichur district. With respect to the yield of diseased advanced catetgory of palms the highest yield of 31 nuts per palm was in Trichur followed by 27 nuts in Pathanamthitta and 22 nuts in Alleppey.

An analysis of the taluk-wise data on yield (Annexure - III) shows that the average yield among the diseased early palms varied from 11 nuts in Trivandrum taluk to 72 nuts in Mallappally taluk. The yield in the DE category of palm in Mallappally (72 nuts), Devicolum (70 nuts) and Kuttanad (66 nuts) were found very high and exceeded the average yield of RWF palms in several taluks viz., Kunnathur (51), Kottarakkara (61), Pathanapuram (59), Meenachil (46), Trichur (61), Thalappally (51) and Chavakkad (45).

The yield data of root (wilt) affected palms is normally reduced with the incidence and increase in the intensity of the disease. The overall analysis of the data in different districts indicates that the extent of decline in yield was 43 per cent in the DE palms and 74 per cent in theDA palms, over the RWF palms. The difference in yield between RWF and DA palms was 88 per cent in Trivandrum District while in Trichur district the diffeence was only 51 per cent. In Alleppey district where the RWF palms gave highest yield of 86 nuts, the yield difference between RWF and DA was around 74 per cent. In the early stage of disease the reduction in yield varied from 13 to 44 nuts per palm between districts. The reduction in yield between RWF and DA palms varied from 32 to 69 nuts between districts.

3.2.2 Estimated production loss

The production loss consequent on the development of root-(wilt) disease is estimated on the assumption that the decrease in

mean yield of diseased palms over the root(wilt) free palms is the loss caused by the disease. The average loss in yield per palm for the diseased early and diseased advanced groups in each taluk has been obtained by deriving the difference in the mean yield of palms in each of these categories compared to the yield of root(wilt) free palms. The average loss so derived is multiplied by the estimated population of bearing palms in the respective categories in different taluks. These figures have been added up to arrive at the production loss in each district and the overall loss due to the disease. For the purpose, the yield data recorded in both the rounds of the survey were computed. The results are presented in Table 4.

It is observed that the estimated loss in 1984-85 is of the order of 968 million nuts, which is a little more than one-fourth of the expected production for the year. Highest loss is reecorded in Alleppey district (271 million nuts), followed by Kottayam (254 million nuts) and the lowest in Trivandrum district (11 million nuts).

3.3. Loss in quality of leaves and nuts

It is necessary to account the loss in husk and copra/oil and to consider the adverse effects of root(wilt) disease on the leaves of the palms with an overall perspective for arriving at the total loss consequent on disease development. It is, therefore, estimated that the loss in husk per nut of diseased palm is around 25.8 per cent and that of copra/oil per nut is 9.0/11.3 per cent. The loss in yield/revenue of leaves per palm will be to the tune of 60 per cent.

The reduction in the quality of leaves was worked out after estimating the average number of plaitable and non-plaitable leaves of the palms based on the observations recorded on the lowest five leaves on the crown: for the three categories of palms viz., root(wilt free, diseased early and diseased advanced. (Table 5).

Table 5

Plaitable (P) and non-plaitable (NP) leaves of healthy and diseased palms

Category	RWF			DE			DA ±±		
	P	NP	Total	P	NP	Total	P	NP	Total
Mean number of leaves/palm	29.3	2.3	31.6	7.9	20.9	28.8	0.1	24.2	24.3
Percentage	92.7	7.3	100	27.4	72.6	100	0.4	99.6	100

While 92.7 per cent of the leaves in the root(wilt) free palms are plaitable only 27.4 per cent and 0.4 per cent are plaitable for diseased early and diseased advanced palms respectively.

The mean weight of whole nut, dehusked nut, husk, copra oil content and free fatty acids are presented in Table 6.

Table 6

Nut quality characters, oil content and free fatty acid content in healthy and diseased palms

Category	mean weight (g)				Oil content(%)	Free fatty acid %
	Whole nut	Dehusked nut	Husk nut	Copra nut		
RWF	1845	676	1169	187.6	69.7	0.96
DE	1522	616	906	175.8	68.3	1.41
DA	1424	596	828	165.7	67.5	1.16

The results show that there is significant reduction in the weight of wholenut and the weight of husk per nut when the palms get diseased, while the weights of dehusked nut and copra per nut do not differ much. However, a consistent decline is visible in all the three characters. The oil content of the nuts from the diseased palm is lower whereas the free fatty acids are higher in the diseased, compared to the healthy. The mean values with respect to the two stages of disease for weight of whole nut, dehusked nut, husk per nut, copra

per nut and oil content show a decline of 20.2, 10.4, 25.8, 9.0 and 11.3 per cent respectively.

4. Future Strategy

4.1 Available scientific information

The magnitude of the damage caused by the coconut root(wilt) disease in the contiguously disease affected tract has been brought out by this survey. In order to formulate a suitable strategy to combat the disease in the light of the data generated in the present survey it will be worthwhile to evaluate some relevant scientific attainments.

The cause of the malady reported nearly a century ago has now been elucidated to be Mycoplasma Like Organisms (MLO) through its consistent presence in different tissues of the root(wilt) affected palms under the electron microscope and its conspicuous absence in the disease free palms. Additional information in favour of a mycoplasmal etiology has also been obtained through successful transmission studies employing dodder parasitising on young diseased coconut palms. MLOs have been transmitted through dodder not only from coconut to periwinkle (a mycoplasmal indicator plant) but also from periwinkle to periwinkle. MLOs are susceptible to the tetracycline group of antibiotics. The weightage is currently in favour of the lace wing bug Stephanitis typica as the possible insect vector involved in transmission of the disease. In addition to the preponderence of the lace bug in the root(wilt) affected tracts MLOs have been detected inthe brain and salivary glands of the insect. While efforts to confirm the etiology are in progress, certain definite leads have emerged from other investigations undertaken by the CPCRI on the management aspects of the disease.

Encouraging results have been obtained both in the farmers' gardens as well as at the Research Institute farm in support of the concept of "living with the coconut root(wilt) disease" [1]. Being a debilitating disease, different package of practices suited to different

growers' situations consisting of balanced fertilizers, weed control, recycling of organic matter, multiple cropping, mixed farming and irrigation were observed to improve the health and yield of disease affected palms. In general, apparently healthy and diseased palms in early stages of infection responded to such management practices. In a mixed farming experiment initiated in 1970 at Kayangulam with fodder crops grown in the inter-spaces of the coconut and maintaining milch cows with this grass and recycling of the cattle manure an increase in nut yield of 26.1 per cent was obtained over a period of five years. (10) Cultivation of tuber crops like tapioca, elephant foot yam, and yam for a period of three years similarly increased the nut yield by 4.5%, 15.57% and 8.07% , respectively. (6)

In an experiment laid out in farmers' fields at Krishnapuram near the CPCRI, Regional Station, Kayangulam, the annual yield of coconut increased from an average of 17 nuts to 46 nuts per plam under irrigated and fertilised coconut-cacao mixed cropping system. (1)

Efforts to contain the disease within the present region of incidence have also yielded useful results. In areas north of Karuvannur river in Trichur district all disease affected palms were eradicated, the roots and boles burnt in situ and a surveillance maintained on the recurrence of the disease. Observations have indicated that out of the 156 root(wilt) affected gardens, 151 remained free of the disease (Table 7). Similar observations on the effect of eradication of disease affected palms in areas farther away from the belt region with sparse incidence were also similarly encouraging.

Table 7

Effect of eradication of diseased palms on recurrence of disease in Karuvannur belt in Trichur district in five years.

Village	Disease incidence			
	1979		1984	
	No. of gardens	affected palms	No. of gardens	affected palms
Varanderapalli	78	175	5	8
Amballur	43	66	-	-
Kallur	5	9	-	-
Aattupuzha	2	9	-	-
Urakam	4	6	-	-
Inchamudi	2	3	-	-
Kurumbilavu	5	8	-	-
Keezhppullikkara	17	24	-	-
Total	156	300	5	8

In the light of the above technological informations it is necessary to develop strategies for containing the disease as well as for the better maintenance of the disease affected areas. Before doing so it is essential that the role coconut plays in the economy of farmers in Kerala is well understood. it may be more reasonable to use the term ' coconut grower' than the term 'coconut farmer' since everyone in Kerala owning even a very small piece of land grows a few coconut trees. Hence, the entire development programme contemplated in future for coconut including the containing of the disease and rejuvenation efforts must be viewed and planned accepting the above fact of covering all categories of coconut growers irrespective of their involvement in coconut cultivation, full time or part time. The following approaches are suggested.

4.2.1 Strategy for the mildy affected areas

The incidence of coconut root(wilt) disease in Trivandrum and Trichur districts is only 1.52 and 2.6 per cent respectively while its occurrence is sporadic in the districts of Palghat, Malappuram, Kozhikode, Wynad and Cannanaore and the neighbouring state of Tamil Nadu. Eradication of root(wilt) affected palms from areas of isolated occurrence as well as in the border undertaken by CPCRI since 1971 has shown that recurrence of disease can be checked if the focus of infection is eliminated. It is thus possible to contain the disease and keep the sparsely affected areas free of the malady. The removal of diseased palms and surveillance is already in progress in all the districts north of Trichur enabling the area to be free of root(wilt) disease. This necessitates a process of eradication of all diseased palms including the non-bearing young ones combined with phytosanitary measures and active surveillance.

4.2.2 Strategy for the contiguously disease affected areas

It has been brought out by the Institute on the basis of scientific investigations that young palms that have taken up the disease before the onset of flowering may not flower at all or will have delayed flowering as well as low productivity [8]. Under the circumstances the primary requirement is the eradication of such palms that have contracted the disease before bearing . Among the bearing palms the process of eradication shall receive priority for those which are in the advanced stage of the disease. The replanted seedlings shall receive a prophylactic spray against the possible insect vector till flowering. The programme of eradication shall commence in a simultaneous manner from north to south and south to north.

4.2.3 Enhancing the productivity of disease affected palms

Returning to the remaining stock of palms in the heavily infected areas the strategy would be to enhance productivity with an increase in income from unit area. In order to achieve this, it

is important to formulate several production models comprising of balanced fertilization, plant protection, irrigation, cultural practices and crop combinations to suit the needs of the farmers and agro-climatic conditions. For transplanting these models into actual farm conditions, a comprehensive programme for coconut development has to be drawn up and implemented.

4.2.4 Conclusion

In conclusion it is emphasised that for the programme to be successful and effective, two Field Stations, one in the border of Quilon and Trivandrum and the other in the border of Ernakulam and Trichur districts, are to be established for continued monitoring of the movement of planting material and surveillance work. It has to be ensured that no coconut planting material is taken out of the diseased tracts to healthy localities. Equally important is the need to build up seed gardens so that quality seedlings are available for implementing the programme. The success of such a massive project can only be ensured if there is full and willing co-operation of the coconut growers who have to be ensured of a minimum reasonable price for coconut.

The fact that coconut oil is a very important edible oil of the country and that it contributes about 8% to the edible oil pool, are points in favour of including coconut as an oil seed crop. Unlike annual oil seed crops whose area can have wide annual fluctuations and consequent variation in production, coconut, being a perennial, can assure a steady availability of oil. It is, therefore, appropriate to include coconut also in the list of oil seed crops so that there is accelerated development.

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