# COCONUT CONVENTION

9th & 10th October, 1975

at

THE KERALA AGRICULTURAL UNIVERSITY



TECHNICAL REPORT

COCONUT CONVENTION

9th & 10th October, 1975

at the Kerala Agricultural University

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# TECHNICAL REPORT

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Nellicat says 600 mts is the maximum potential. I. natural requirements

COCONUT CONVENTION OCTOBER 9th & 10th KERALA AGRICULTURAL UNIVERSITY

## A. REVIEW OF RESEARCH WORK ALREADY DONE

### I. COCONUT RESEARCH STATION, NILESWAR.

### A. Agronomic Practices.

### 1. Planting

Optimum age of seedlings for planting.

Comparative study of performance of trees obtained by planting 1, 2 and 3 years old seedlings, revealed that one year old seedlings establish better and gave good performance. In aged seedlings there is a set back in growth, and delay in establishment. One year old seedlings are found to be the best planting material for planting in uplands and non inundated level lands.

Optimum depth of planting.

Out of the four treatments tried (1) surface planted (2) Planted in 1 ft. depth (3) Planted in 2 ft. depth and (4) planted in 3 ft. depth, it is observed that seedlings planted at (1') and (2') depth thrived better in early stages. But in later stages the treatment differences are evened out.

In order to avoid formation of surface roots in later stages, 3 feet depth is recorded as ideal. Observations on the performance of palms after its 50th year (declining phase) are in progress.

In the red sandy loam soil, planting in 3 feet depth was found significantly better than 2' and 1'. In the littoral sand of Nileswar III Station, planting in 3ft. depth was found better than planting in 6 ft. depth.

Optimum spacing.

Seedlings were planted at the rate of 100 trees, 80 trees, and 60 trees per acre respectively under triangular method. Trees under 100 trees per acre grow lanky and tall and flowering was considerably delayed. Incidence of disease was more in the crowded plantation. Yield in closely planted palms was significantly lower than the other two treatments. So a population of 60 to 80 trees per acre depending upon the soil condition and other environmental features is the best. For soil types of normal fertility status 25 ft. ($7\frac{1}{2}$ Meter) spacing under square method is ideal.

Lowering experiment:-

Trial conducted by lowering the surface planted trees after 3 years to a further depth of 2 feet, showed that it causes some set back in the plants. It is, therefore, not advisable to disturb the plants after transplanting. However, the palms are found to improve in subsequent years. When surface planted palms of 25 years of age were lowered, a set back was recorded for the next 3 years. However, the palms recorded better yields thereafter.

II. Soil Management.

Intercultural operations in Coconut Garden.

Ploughing with iron plough was compared with mammatti digging. No significant difference was noticed. Economics, convenience, and availability of the labour are the factors to be considered for choice of operation.

Regarding the number of ploughing tried, two ploughings a year was found benefitial and economical than one ploughing a year and 3 ploughings a year.

Regarding the depth of ploughing or digging trial no significant difference was noticed between 5" deep digging

and 4" and 6" deep ploughing.

2. Moisture conservation

Husk burrial

The practise of burrying husks at 15" depth in linear trenches in between rows of trees resulted in better performance of trees and it stands on par with the other manuring practices. The advantage is mainly due to the moisture conservation and prevention of leaching loss of nutrients. Increased yield is mainly by way of reducing button shedding. So it is a desirable practice provided the husk is available at reasonable cost.

In a comparative trial to study the effect of application of clay and burrial of coconut husk to improve the structure of sandy soil, it was recorded that husk burrial improved the production of nuts. Application of clay did not record any increase in yield.

Cover cropping:-

Cover corps namely Calapagonium muconoides, Peuraria Phaseoloides and Centrosema were tried. Of these calapagonium muconoides was found to give a dry in summer months and is found to be better than the other two.

Ploughing of alternate strips in alternate years added good green matter to the soil and at the same time retained the crop permanently as a self sown crop.

III. Manuring.

Method of application of manures and fertilizers.

Application of manures and fertilizers in (1) circular basins (2) Linear trenches of 2 ft. width in between rows and (3) by broadcasting in the entire area were tried. Application in circular basins and by broadcasting were found significantly better than the application in trenches.

Though broadcast application works out to be cheaper it can be adopted in pure plantation only; so application in circular basins is ideal.

Forms of Nitrogen.

Groundnut cake and Ammonium sulphate were used as organic and inorganic forms of nitrogen. They were applied on equal nitrogen basis and there was no significant difference on yield and performance. Comparison on unit value basis revealed that ammonium sulphate is the more economical form for use.

Forms of Potash.

Sulphate of Potash muriate of Potash and wood ash were tried as source of potash on equal $K_2O$ basis. It was found that muriate of potash and wood ash applied trees gave significantly better yield, than those which received sulphate of potash. The difference between the effect of wood ash and muriate of potash was not significant. But working out the unit value of potash, muriate of potash is found to be the cheapest form.

Levels of potash.

Among the levels of potash tried at the rate of 0, 1 and 2 lb. $K_2O$ per tree per year in the form of Muriate of Potash, 1 and 2 lb. levels gave beneficial results. But the yield difference between 1 and 2 lb. level were not significant. So muriate of potash at 1½ to 2 lb. per tree per annum is the optimum dose.

Effect of Nitrogen and Phosphrus on the performance and yield of Coconut.

An experiment was started during 1961 with an object to study the effect of phosphatic fertilizers and its interaction with nitrogenous fertilizer on the yield of coconut i.e. effect of $P_2O5$ with and without nitrogen over and above potash.

The data collected were analysed statistically. There was no significant difference due to the effect of treatments and hence the experiment was discontinued from 1970 onwards.

Green manuring.

Green manure crops namely cowgram, sunhemp, Cassia tora Cassia occidentals and Crotalaria striata were tried.

Cowgram and Crotakaria striata were found to give higher tonnage of green matter.

Regarding the time of sowing, sowing seeds in second fortnight of April was found to give better spreading growth of the crop.

Green Manure shurbs.

Glyricidia maculata, Indigofora teysmani, Adathoda visica, Tephrosia candida, Luecana glauca were tried as shrubs. Glyricidia is found to be a good hedge cum green manure shrub. While Tephrosia candida is an ideal shade cum-green manure crop in coconut garden.

IV. Irrigation.

Improvement by irrigation.

Irrigating bearing trees in sandy soil of Central Coconut Research Station, Nileshwar III has increased the yield from second year of commencement of irrigation. This is by way of reducing button shedding. Yield increase was observed by production of more number of bunches from 4th year onwards. On an average 30-60% increase in yield is recorded. Basin irrigation once in 10 days during November to May is found to give good results.

Differential response to irrigation.

Trees under medium yield groups respond well to irrigation while the improvement recorded in high yield group is not perceptable. Regarding the percentage increase in annual yield, the low and medium yield group

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of trees recorded the maximum yield increase.

Influence on nut characters.

In the irrigated trees a larger proportion of nuts come under medium size group.

Size of dehusked nut is also little reduced by irrigation.

No appreciable difference is noticed in the Kernel thickness.

Though the difference in out turn of copra per nut is not conspicous, total copra production per palm is significantly high because of the high yield.

Oil percentage on irrigated produce is comparatively lower than unirrigated. Proportion of oil cake to copra is more in the case of irrigated crop.

B. Crop improvement.

I. Improvement by selection.

Following nursery studies and performance studies of adult palms forward a key for fixation of selection criteria.

Month of harvest and germination.

The germination studies made on nuts harvested in different months have proved that nuts harvested in February gave the lowest percentage of germination and that harvested in March have the highest percentage of germination. The percentage of germination is maximum between 17th and 18th week after sowing and gradually decreases after 18th week. The most suitable season for collection of nuts and sowing has been standardised.

Rate of production of leaves.

The studies on the relationship between the rate of production of leaves and time taken for germination revealed that:

(i) The period between the production of Ist and 2nd

leaf was shorter in all cases and varied from 28 to 43 days.

(ii) The period between the production of 2nd and 3rd leaves was shorter in all cases and varied from 32 to 47 days.

(iii) The difference in period between the production of successful leaves was less in case of late germinated seedlings.

(iv) There is positive correlation between time taken for germination and rate of production of leaves.

(v) Early germinated seedlings are observed to flower early. // data??

Thickness of husk and germination.

Seednuts having very thick and thin husk had comparatively lower germination than nut having husk of medium thickness.

Root production and germination.

Early germinated nuts have more number of roots.

Number of roots and seedling vigour.

There is a positive correlation between the height and girth of seedlings and the number of roots produced.

High setting and early germination.

Early germination is observed in the case of nuts collected from trees which exhibit high setting percentage.

Number of nuts in the bunch and germination.

High germination percentage as well as early germination are noticed in heavy bunches.

Size of nut and germination.

Too big and too small sized nuts gave poor and late germination. Medium sized nuts are ideal.

Position of nuts in the bunch and germination.

Total germination percentage is poor in the case of seednuts from top and bottom portion of the bunch.

Performance of progenies of regular and irregular bearers.

The results are inconsistant and so it is not a distinictly transmittable character in the case of West Coast Tall variety.

Method of selection of seedlings and performance of trees.

Progenies from poor mother palms and poor seedling proved to be a failure.

II. Improvement by introduction.

Collections from all over the world were introduced at Coconut Research Station, Pilicode and their morphological characters and adaptability were studied in detail.

Exotic varieties.

The 22 varieties tried at the station were categorised as follows based on the economic and other characters of interest.

(a) Economic varieties fit for commercial growing.

(1) Laccadive Ordinary (2) Andaman Ordinary (3) Java (4) Philippines (5) Siam.

(b) Economic varieties noted for their size and tender nuts.

New Guinea and Cochin China.

(c) Fancy varieties.

(1) Laccadive Small (2) Laccadive Micro.

(3) Andaman Giant (4) Spikeless.

(d) Economic variety noted for ornamental value.

1. Strait settlement .. Apricot.

(e) Ornamental dwarf varieties.

(1) Andaman Dwarf (2) Laccadive Dwarf (3) Gon thembili.

(4) Nyor Gading (Kalpa gading)

(f) Dwarf varieties suitable as pollen palms in hybridisation work.

(1) Chowghat Green Dwarf (2) Gangabondam (Semi tall)
(3) Laccadive Dwarf (4) Chowghat Orange Dwarf.

(2) Indegenous varieties.

Collections from Bombay, Mysore, Bengal, Tanjor and Godavari were planted out for their performance study. The type from Bengal, Bombay and Mysore are found to be economic and promising varieties with good nut characters.

III. Improvement by breeding.

1. Study of self and natural progenies of West Coast Tall.

The selfed progenies of West Coast Tall variety was compared with the open pollinated progenies. It is recorded that open pollinated progenies showed significantly better performance than the selfed progenies which evidenced inbreeding depression.

2. Study of Tall x Dwarf Hybrids.

This is recognised as a most popular hybrid with the following economic characters.

a) TxD bears within $4\frac{1}{2}$ years.
b) It attains steady bearing within 3 years of first flowering.
c) Total annual yield of nuts ranges from 75-85 while that of Tall and Dwarf are 55-60 and 10 to 50 respectively.
d) Percentage of poor yielders are comparatively lower than that of Tall raised in identical environments.
e) The average copra content per nut is 187 gms. for TxD 171 gm. for west Coast Tall and 52 g. for Dwarf.
f) But the total annual copra production per palm is 12.45 kg. to 14.110 kg. for TxD 10.560 kg. for West Coast Tall and 2.340 to 2.700 kg. for Dwarf.
g) Alternate bearing of Dwarf is not inherited in TxD but irregular bearing is noticed to a small extent.

h) Detailed study on morphological characters has given hints to predict longivity almost alike the female parent West Coast Tall. TxD gives 25 to 50% increased yield over the local.

IV. Improvement of other economic features.

1. Button sheding in different varieties. Observations were made on 15 exotic varieties and west coast tall to find out the percentage sequance of shedding and the age of buttons so shed.

High shedding is recorded in Fiji and Andaman Ordinary varieties while the lowest is in Ceylon and Philippines.

Shedding is more after the stigmatic receptivity than in the earlier period.

2. Trials to prevent button shedding.

(a) Spraying Bordeaux mixture.

1% Bordeaux mixture was sprayed soon after the opening of spathe and after shedding of male flowers. No improvement was recorded.

(b) Spraying Planofix.

1% solution of the chemical was sprayed twice after opening of spathe and the treatment was not found to be effective.

(c) Thinning bunches.

Only one bunch was retained per tree and the others were removed, to see whether this process could improve setting percentage of bunch. But this practise provided to be a failure.

3. Toddy recovery from different varieties.

Seventeen varieties were tapped for 6 months a year to find out and quality of toddy obtained. Of those, Laccadive Ordinary, Andaman Ordinary, Laccadive Small, West Coast Tall and Cochin China are found to be promising, giving an average

yield of 243, 213, 133, 119 and 110 litres of toddy. Spikeless variety give no toddy. Toddy obtained from Siam, Bengal and Andaman Giant were very negligable such as 5,0.3 and 0.125 litres respectively.

Dwarf varieties also gave very little toddy ranging from 0.6 to 10.litres.

C.Farm Management.

I. Intercropping.

Following intercrops were tried various seasons.

a) Cereals & Millets. Paddy,Ragi, Samai, Vargu, Cumbu,Kudirai Vali & Maize were tried. Of these paddy Ragi and maize are found to be promising cereals that could be cultivated profitably in coconut garden.

b) Tuber crops.

Tapioca, Sweet potato, Colocasia, and Yam were tried. Tapioca and Sweet potato are the promising crops which could be raised profitably with adequate manuring.

c) Oil seeds.

Groundnut, Castor and gingelly were tried. Of these groundnut is a promising crop in all the three soils types giving an average yield of 1500-2500 lbs.per acre TMV.I is the most suitable strain.

d) Spice and condiments.

Ginger, Turmeric, Chilly were tried. Ginger is a promising crop in laterite soil & Chilly is profitable in sandy soil.

PESTS AND DISEASES.

1. Effect of lime and potash on control of bud rot disease.

Experiment was conducted to study whether the application of these nutrients will impart resistance to trees and form a preventive treatment against disease.

Potash application was found to impart some resistance adjudged by the low occurrance of disease in that group. In lime applied plots there were instances of fresh attacks and casualities.

2. Control of Rhinocrous beetles.

(a) Biological control of Rhinocerous beetles by green muscardin fungus. Observations does not show any significant effect in controlling the pest.

(b) Spraying insecticides in the breeding places.

Guesarol 550:1 lb. in 12 gallons were sprayed in the manure pits and breeding places on every 15 days. No appreciable reduction in the gurbs and multiplication of pest was observed.

3. Study of susceptibility of varieties for beetle attack.

Observations of instances of pest attack were made on all the exotic varieties through out the year. It is recorded that exotic varieties are more susceptible to beetle attack than the indigenous varieties.

2. Straint settlement and siam are the most suspectible varieties.

3. Andaman giant and Bengal varieties are not seen attacked by this pest.

4. Instances of beetle attack is more during summer months (March-June) and minimum during August-October.

Biological control of Nephantis Serinopa.

Nephantis Serinopa is a serious pest affecting the coconut palms. The caterpillar eats the entire foliage and when the pest is widespread the whole garden presents a burnt appearance resulting in reduction in production of nuts. The pest is effectively controlled by releasing parasites which are reared in the Laboratory. The most effective parasites liberated to control the pest are Periserola & tephantides

(Beythylid). Annually 15 lakhs of these parasites are reared and liberated to benefit an area of about 800 acres.

## COCONUT RESEARCH SUB STATION, KUMARAKOM

I. Manurial Experiment.

A manurial trial was conducted from 1952 to 1959 with the object of determining the manurial requirements of coconut in the tract with the following treatments.

| | N | P | K | |
|---|---|---|---|---|
| 1. | 0.25 lb. | 0.25 lb. | 0.5 lb. | per tree per year. |
| 2. | 0.25 ,, | 0.25 ,, | 1.0 ,, | per tree per year. |
| 3. | 0.5 ,, | 0.25 ,, | 1.0 ,, | per tree per year. |
| 4. | 0.5 ,, | 0.75 ,, | 1.0 ,, | per tree per year. |
| 5. | 0.5 ,, | 0.75 ,, | 1.0 ,, | per tree per year. |
| 6. | 0.5 ,, | 0.75 ,, | 1.5 ,, | per tree per year. |

The treatments were found significant and treatment No.4 viz., 0.5 lb. of N. 0.75 lb. of P and 1.0 lb. of K per tree per year was found superior giving 40 to 50% increase in yield over the control.

ii. Cultural trial:- A cultural trial with the following treatments were in progress from 1952 to 1961.

1. Forming mounds in August and levelling in December.
2. Shallow digging with local mammatty.
3. Deep digging with kunthali.
4. No cultivation

The treatments gave no significant results at all.

iii) Studies on the residual effects of fertilizers.

The experiment was started in 1959-60 to determine how long the residual effects of continuous application of fertilisers remain in the soil under local conditions. The results showed that the residual effects persist in the soil even after five years but there was a general tendency of

decline in the yield and increase in the yellowing of leaves. As it would be detrimental to the palms to keep them unmanured the experiment was discontinued in 1965.

iv) Cultural trial II.

This trial was laid out in 1962 with the following four treatments replicated six time.

1. Intercultivation; two digging in a year.
2. Clean surface removal of grass.
3. Perennial cover of Pueraria javanica.
4. Perennial cover of grass.

The results of the pooled analysis of the yield data for the years 1965 to 1969 showed significant difference due to treatments. It was found that the treatment clean surface removal of grass was significantly superior to the treatments perennial cover of leguminous crop and perennial cover of grass. The treatment intercultivation was at par with clean surface removal of grass. The results show the need for intercultivation and removal of weeds in coconut gardens.

v) Manik Compound trial:- An experiment was conducted from 1964 to 1969 using Manik compound over a dose of major nutrients to assess its effect on yield and disease condition of coconut palms.

The following were the treatments.

1. Control; NPK; 7 lbs. of 8:8:16 mixture per tree per year.
2. Control + 2 kg. Manik applied to the soil per tree per year.
3. Control + 2 kg. Manik as spray in 4 spraying and
4. Control + 1 kg. Manik applied basally and 1 kg. as spray in two sprayings.

The experiment did not give any significant result in any of the years and therefore discontinued.

vi) Potash trial:-

As observational trial was conducted from 1964 to 1970 to study the effect of higher doses of potash on the yield of coconut palms. It was found that the application of potash above 900 gm. without a corresponding increase in the levels of Nitrogen and Phosphoric acid has a depressing effect on the yield.

vii) Carbide ash experiment: This experiment was started in 1968 to study the effect of carbide ash as liming material and to compare its effect with that of dolomite on the growth and yield of coconuts. No significant results have been obtained.

viii. Manurial cum micronutrient trial on adult palms.

The object of the experiment is to assess the effect of application of fertilizers with andwithout a dose of trace elements on the yield and disease condition of coconut palms. A randomised replicated trial with the following 9 treatments with 4 replications is in progress since 1962-63.

1. NPK alone.
2. N1 P1 K1 alone.
3. NPK + Boron (200 g. Borox)
4. NPK + Manganese (200 g. of manganese sulphate)
5. NPK + Copper (200 g. of copper sulphate)
6. NPK + Zinc (200 g. of Zinc sulphate)
7. NPK + Molybdenum (2 g. of ammonium molybdate)
8. NPK + All the above 5 trace elements at the above dose.

| | | | |
|---|---|---|---|
| N = 250 g. | P = 350g. | K = 700 g. | per tree per year. |
| N1 = 500 g. | P1 = 700g. | K1=1400 g. | per tree per year. |

The trace elements are applied basally. In addition each palm received 20 kg. of glyricidia leaves and 20 kg.of cattle manure per year. Yield data for the years 1965 to '71 were analysed. Significant results were obtained only in one year. T2 and T7 were found superior to other treatments.

T6 (NPK+Zinc) has recorded constantly better results in other years also. Observations recorded on the yellowing of palms have revealed that yellowing was on the increase and the basal application of the above 5 trace elements is not effective in making any improvement in the disease condition of the palms.

## COCONUT RESEARCH SUB STATION, BALARAMAPURAM

I. Review of work:-

(1) One manurial and cultural experiment was laid out during the period from 1951 to 1959 the results of which are as follows:-

a) The best treatment combination for coconut in red loam soil is an N.P.K. mixture containing 0.50 lbs. of N, 0.25 lb. of $P_2O_5$ and 1.00 lb. of $K_2O$ per tree per year under ordinary soil conditions.

b) There was no statistically significant difference between taking basins around the tree alone and ploughing the entire area without taking basins.

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B. TECHNOLOGICAL PROBLEMS IN COCONUT CULTIVATION.

The Coconut palm which has the unique distinction of being styled as 'Kalpa Vriksha' continues to dominate the tropical countries of the world. India is the second largest producer of Coconut in the world. Kerala State accounts for 70% of the total area under coconut in the Indian Union. The total area under coconut in Kerala State is 80.00 lakh hectares contributing to 24% of the cultivated area. However, a careful analysis of the production trend in coconut has revealed that the productivity of coconut is declining. As against 6430 nuts obtained for an hectare of coconut during 1960-61, an yield of 5536 nuts per hectare alone was recorded in 1970-71 which works out to 14% reduction in yield per unit area. Though 44% increase in the area under coconut was recorded during the ten year period the proportionate increase in the overall yield was only marginal because of the 14% reduction in yield per unit area.

While it is extremely difficult to provide a comprehensive list of contributory factors responsible for this declining trend in yield, an attempt is made to enumerate the most important technological problems in coconut cultivation facing the growers.

I. Rootwilt disease on coconut.

This is the most dreaded disease of Coconut crippling the coconut cultivation in south and central Kerala causing an annual loss of about Rs.28 crores. Out of the total area of 80 lakh hectare under coconuts, 3 lakh hectares are affected by rootwilt and about 80 lakh disease affected coconut palms have been cut and destroyed. The disease is debilitating in nature and spreads slowly but steadily. The rapid spread and high intensity of the disease in light soils subject to inundation are also important features of this baffling disease. The etiology of the disease continues to be intriguing in spite of the concerned efforts of the Plant Pathologists

at C.P.C.R.I., Kayamkulam.

However the possibilities of rehabilitating the disease affected coconut tract by systematic adoption of agronomic practices resulting in increased production and replacement of uneconomic palms with high yielding hybrids are being studied by the C.P.C.R.I. and Kerala Agricultural University. Trials are in progress to screen the different exotic and indigenious types against rootwilt disease at Regional Coconut Research Station, Kumarakom.

II. Damages caused by rats.

It is estimated that about 50 to 60 crores of coconuts accounting for about 5 to 10% of the total production of coconuts are being damaged by rats. An integrated approach for rat control is to be formulated and adopted.

III. Planting coconuts in unsuitable areas.

Extensive hard laterite areas have been chosen for planting coconuts. Such areas have only a few inches of top soil. In the initial stages, the seedlings exhibit satisfactory growth, but later they give only less than 10 nuts per palm. Such unsuitable areas could be allotted to cashew or jack or to polyembryonic mango varieties.

IV. Low yield of copra from types grown in India.

Nearly 7000 nuts are required to make a tonne of copra in India while the figures for Shri Lanka and Philippines are only 4500 and 4000 nuts. As a consequence, India will remain backward inthe development of coconut based industries due to the high production cost.

This could be got over by systematic selection of seedlings from nuts of palms giving high copra yield, since it has been established from heritability studies that weight of husked nuts as a higher heritability value than the number of nuts. Similarly, some of the introduced varieties like

Laccadive Ordinary, Phylippines, Cochin China and the indegenious types 'Kappadam' which give higher copra out turn could be multiplied and distributed to growers for obtaining economic yields.

V. Providing irrigation to Coconut Plantation.

Increased yield upto 60 to 100% has been obtained by irrigating coconut gardens at Coconut Research Station, Nileshwar. Since soil moisture is the greatest limiting factor for the successful growth of coconut where rainfall is meagre and ill-distributed, adequate soil moisture should be ensured by irrigation to obtain satisfactory growth and yield. Even sea water could be used for irrigation. Productivity of palms has been extremely poor in the coastal areas due to drought conditions prevailing from December to May.

VI. Rehabilitation of unproductive palms.

The proportion of unthrifty palms is usually large in the gardens of small holders because of closer planting. Further more, closer planted palms are prone to disease and pests. From experiments conducted at Coconut Research Station, Pilicode it is seen that a population of 80 trees and above per acre is deleterious to crop yields.

It is, therefore, absolutely essential that thinning is to be carried out in closely planted gardens.

Similarly all palms which are very old and unproductive should be removed and replaced with seedlings raised from prepotent palms.

VII. Manuring of Coconut palms.

About 60% of the palms are not being manured systematically. The importance of manuring in enhancing production has been clearly brought about by experiments conducted at the Research Stations as well as on private gardens.

VIII. Lack of correct apprisal of management practices.

The poor productivity of most of the coconut plantation is due to faulty and improper or inadequate soil management. A fuller appreciation of this fact and a systematic adoption of improved practices will help to step up production. The important soil management practices are tillage, drainage, mulching, cover cropping, husk berrial, use of soil amendments and soil ameleorants.

IX. Defective intercropping.

Coconut is raised as a mixed plantation with tall growing fruit crops like jack, and mango with the result, that the yield from coconut is too low to be economical.

X. Lack of correct apprasial of the pests and diseases affecting coconuts and method of their control is yet another cause of the low productivity in coconut.

XI. Loss due to frequent fluctuations on prices.

It is estimated that there is an annual loss of Rs.160/- crores by the fall in prices of coconuts. Consequent to fall in prices, the growers are unable to manure their palms on account of the high cost of inputs like fertilisers, green leaves and other organic manures.

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## C. DISCUSSION ON RESEARCH WORK IN PROGRESS AT NILESHWAR

### A. Botany:-

(i) Germ plasm collection and study of performance.

Object:- To study in detail the performance and adaptability of exotic varieties and to multiply the promising varieties.

Results of studies undertaken.

Introduction and study of exotic and indigeneous types and their performance under West Coast conditions was first made in this country at Coconut Research Station, Pilicode in the year 1924. A total number of 32 exotic and indigeneous types have been introduced so far. Detailed studies regarding the yield and copra content have been made in respect of 25 types. The results of studies relating to six of the more promising types are tabulated below:-

| Name of variety | No. of palms available. | Average No. of nuts. | Average copra out-turn per nut. | Av. copra output per palm year. | Av. annual production of female flr. | % of set |
|---|---|---|---|---|---|---|
| | | | gm. | kg. | | |
| 1. Laccadive Ordinary | 16 | 87 | 180 | 15.66 | 400 | 21.7 |
| 2. Philippines | 21 | 61 | 224 | 13.66 | 277 | 22.0 |
| 3. Java | 18 | 54 | 246 | 13.28 | 200 | 27.0 |
| 4. Cochin China | 14 | 50 | 234 | 11.70 | 233 | 21.4 |
| 5. New guinea | 7 | 46 | 231 | 10.62 | 247 | 18.6 |
| 6. Laccadive Micro | 2 | 140 | 81 | 11.34 | 700 | 20.0 |
| 7. West Coast Tall | 10 | 52 | 171 | 8.89 | 224 | 23.2 |

From the tabulated statement shown above Laccadive Ordinary is by far the best type giving an yield of 15.66kg. copra per palm as against 8.8 kg. recorded by West Coast Tall. The other promising varieties are Philippines, Java, Cochin China,

New Guinea and Laccadive Micro.

(ii) Study of second generation selves and sibmatic progenies in Coconut.

Object:- To evolve inbred lines in Coconut and to find out whether hybrid vigour is met within the crosses between the first generation selves.

Treatments

Main Plot:- Progenies of 6 grand parent family group.

Sub Plot:- (1) $S_2$ generation. (Second generation selves)
(2) Sibmated progenies of $S_1$ progenies.

Year of planting: 1961

Lavout:- Split plot in compact family blocks.

Spacing:- 6.6 metres. Square planting.

Results of studies are tabulated below.

| Grand parent. | | 1968 | 1969 | 1970 | 1971 | '72 | '73 | '74 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1/109 A. | self | .. | .. | .. | 11.0 | 20.0 | 20.8 | 13.0 | 65.6 |
| | Sib | .. | .. | 13.3 | 22.1 | 23.4 | 32.8 | 22.5 | 114.1 |
| 1/109 B. | self | 21 | 10.2 | 14.7 | 27.4 | 29.3 | 29.0 | 28.0 | 159.0 |
| | Sib | 4.4 | 12.6 | 11.1 | 26.7 | 23.7 | 33.6 | 20.3 | 132.5 |
| 1/174 | self | 2.0 | 6.2 | 12.7 | 25.4 | 35.7 | 39.1 | 38.4 | 159.5 |
| | Sib | .. | 15.3 | 17.5 | 30.0 | 51.8 | 49.6 | 58.1 | 222.3 |
| 6/4 | self | 1.0 | 6.0 | 6.7 | 14.0 | 28.1 | 19,5 | 18.1 | 93.4 |
| | Sib | .. | 4.8 | 10.0 | 22.8 | 26.1 | 28.1 | 20,6 | 101.3 |
| 1/129 | self | .. | 1.5 | 9.7 | 17.0 | 24.9 | 17.0 | 17,8 | 87.9 |
| | Sib | 2.0 | 6.0 | 15.7 | 32.3 | 34.3 | 46.8 | 43.2 | 180.3 |
| 8/127 | self | .. | 2.8 | 7.8 | 9.8 | 20.5 | 20.5 | 23.4 | 88.6 |
| | Sib | 3.3 | 15.5 | 10.4 | 20.4 | 33.6 | 24.3 | 37.0 | 144.5 |

It would be interesting to observe that while most of the progenies exhibited quite a marked depression in yield on selfing, the progeny of 1/109 B, did not record any reduction. This material would be reasonably uniform in yield and other

desirable characters, since it is known that about 2/3rd of the deleterious recessives get eliminated by two selfings.

(iii) Study of Tall x Gangabandam Crosses.

Object:- To study the performance of hybrid progenies obtained by crossing promising exotic varieties and West Coast Tall with semi tall type 'Gangabondam' as the male parent.

Treatments

(1) Laccadive Ordinary x Gangabondam.
(2) Laccadive Small x Gangabondam.
(3) Andaman Ordinary x Gangabondam.
(4) Cochin China x Gangabondam.
(5) West Coast Tall x Gangabondam.
(6) Java x Gangabondam.

Year of planting: 1949

Layout Progeny rows

Results of studies.

The observations recorded so far are tabulated below:

| Hybrid Female x Male | Mean yield per tree. | Copra content per nut | Copra out turn per tree per year. |
|---|---|---|---|
| | | gm. | kg. |
| 1. L.O. x G. | 110.8 | 182.3 | 20.20 |
| 2. A.O. x G. | 78.4 | 216.0 | 16.9 |
| 3. C.C. x G. | 57.9 | 273.6 | 15.8 |
| 4. T x G. | 75.4 | 201.0 | 15.1 |
| 5. L.S. x G. | 86.5 | 158.0 | 13.7 |
| 6. J x G. | 54.7 | 175.6 | 9.6 |

All the six types of tall forms used as female parent when crossed with Gangabondam exhibited hybrid vigour. Among the 6 group of hybrids, Laccadive Ordinary x Gangabondam continued to be superior to other progenies in respect of annual yield, and out turn of copra per tree. Copra content per nut

is more in Cochin China x Gangabondam followed by Angaman Ordinary x Gangabondam.

(iv) Introduction of Spicata character in the local "Tall" variety.

In the variety spicata described by Jacon (1041), the character of masculnity was seen to be least expressed. This variety is reported to have not more than 50 male flowers as against the mean number of about 5000 met within ordinary varieties. It would be useful to breed this character into the local tall variety, so as to build up a tree in which the inflorescences are branched, as in the ordinary tall variety, but the flowers borne on it are largely female.

Object:- To find out whether the high female flower production of Spicata could be introduced into Typica (West Coast Tall) to improve the yield potential of Typica.

Treatments

T1 ... Typica x Spicata

T2 ... Spicata x Typica

Layout ... Replicated Progeny rows.

Results of studies.

A total number of 45 Typica x Spicata and 27 Spicata x Typica hybrids were planted in 1960 to find out whether the high female flower production of Spicata could be introduced into Typica variety to improve the yield potential of the latter. Out of these 3 typica x Spicata hybrids died and 42 are surviving.

Among the 42 Typica x Spicata hybrids 29 plants have shown Typica characters (69%) and 13 have shown Spicata characters (31%) while in the 27 Spicata x Typica hybrids 16 have shown Typica characters (59.2%) and 11 Spicata characters (40.8%).

In respect of yield Typica x Spicata and their reciprocals have given almost the same yield. While the mean annual production of nuts in Typica x Spicata is 40 nuts per palm that

of Spicata x Typica is 42 nuts per palm.

It is also of interest to note that the palms which show Spicata characters and Typica characters in the Typica x Spicata hybrids have given the same yield i.e. 40 nuts per palm. But in the case of Spicata x Typica crosses while the palms which show Typica characters have yielded 36 nuts per palm the palms which show spicata characters have given 49 nuts.

Indications are that the high female flower production character of Spicata and the high setting percentage character of typica could not be combined in the hybrids produced by crossing them.

Detailed studies on the setting percentage, female flower production, nut production, bearing behaviour, copra out turn etc. will be conducted for a few more years before arriving at a final conclusion.

(v) Studies on the inheritance of Spicata characters.

Object:- To study the inheritance of Spicata characters in pure bred progenies of Spicata and Crosses with Dwarf (Typica) and reciprocals.

Treatments.

T1 .. Pure bred Spicata

T2 .. Spicata x Dwarf

T3 .. Dwarf x Spicata

Spacing:- 6.6 m. square planting.

Results of Studies:

9 plants in each of Spicata x Spicata and Spicata x Dwarf crosses were planted in 1963 to study the pattern of inheritance of parental characters. Of the 9 Spicata x Spicata, one plant died and 8 are surviving. There is wide difference in the number of years taken for flowering between plants and it ranged from 5 to 12 in both the crosses. With regard to the expression of parental characters 6 out of 8 plants in the Spicata x Spicata showed spicata characters while the other 2 showed typica

characters. In the case of Spicata x Dwarf crosses 5 have shown Spicata characters 2 dwarf characters and one typica characater. One plant has not flowered. Since most of the plants have only just started bearing yield data will not give a correct assessment of their yield potential.

Cytological and genetic studies on these corsses will be taken up in due course.

(vi) Comparative study of open pollinated progenies of TxD hybrids and back cross progenies.

Object:- 1. To study the performance of open pollinated progenies of TxD with their back cross with tall and Dwarf.
2. To compare the yield and nut characters of open pollinated progenies of TxD with their back crosses with Tall and Dwarf.

Results of Studies.

24 Natural progenies of TxD, 24 progenies obtained by back crossing TxD with tall parent and 12 obtained by back crossing TxD with dwarf parent were utilised for a comparative study of their performance. Of these 23 natural progenies, 20 (TxD) x T and 11 (TxD) x D are surviving. Ten years mean yield of nuts per palm under different treatments are furnished below:

| | | |
|---|---|---|
| F2 Naturals | .. | 67.30 |
| (TxD) x T | .. | 55.30 |
| (Txd) x D | .. | 55.50 |

The F2 naturals have given more yield than their back cross progenies. Oil percentage and copra of the 3 groups will be studied.

(vi) Study of F2 open pollinated progenies of Tall x Dwarf.

Object:- To find out whether the open pollinated progenies of TxD hybrid can be used for raising commercial plantation with rigorous selection in the nursery.

140 progenies obtained from 10 parent palms of TxD planted at Coconut Research Station, Nileshwar were utilised

for the study. The performance of the progenies so obtained are tabulated below. Of the 140 progenies, 29 progenies died during the course of 25 years.

| Parent Tree No. | No. of progenies in each family. | Mean yield of parent trees. | Mean yield of progenies. | Copra prodn. per nut |
|---|---|---|---|---|
| | | | | gm. |
| VIII/26 | 11 | 50.9 | 50.7 | 168 |
| VIII/32 | 28 | 65.9 | 56.5 | 181 |
| VIII/33 | 9 | 51.8 | 76.6 | 164 |
| VIII/40 | 11 | 47.7 | 69.2 | 182 |
| VIII/48 | 3 | 49.3 | 74.5 | 164 |
| VIII/54 | 12 | 60.9 | 84.6 | 182 |
| VII /109 | 9 | 46.0 | 73.4 | 193 |
| VII /111 | 19 | 76.6 | 82.8 | 167 |
| VII /114 | 4 | 63.3 | 62.8 | 202 |
| VII /115 | 5 | 70.0 | 92.1 | 130 |

The data tabulated above indicates the possibility of raising an economical plantation with open pollinated progenies of TxD provided rigorous roguing out of the Dwarfs which would be easily identified by their growth characters in the nursery. However, it is to be mentioned that precaucity which is usually manifested in TxD is not recorded in the TxD selections planted. In respect of copra content, all the progenies of the 9 parents recorded high percentage of copra production.

(viii) Comparative study of N.C.D. with true progenies of dwarf yellow and dwarf green.

Object:- To compare the performance of vigorous types of seedlings in Dwarf nursery (NCD) with that of green dwarf and yellow dwarf in respect of precaucity, yield potential, bearing habit and nut characters.

| | | |
|---|---|---|
| Treatments | ... | 3 |
| T1 | ... | N.C.D. |
| T2 | ... | Dwarf Green. |
| T3 | ... | Dwarf yellow. |

Details of studies and results.

10 Dwarf yellow, 10 dwarf green and 5 natural cross obtained from dwarf yellow were planted in block N.VIII in 1954 for a comparative study of their performance. Of these 8 dwarf yellow, 8 dwarf green and 5 natural cross dwarf are surviving. Their mean annual yield of nuts per palm and copra out turn are furnished below.

| | Mean yield of nuts | Copra out turn per palm |
|---|---|---|
| Dwarf Yellow | 46.4 | 5.61 kg. |
| Dwarf Green | 55.9 | 5.86 kg. |
| Natural Cross Dwarf | 76.8 | 15.79 kg. |

Natural cross dwarf palms recorded very high yield of nuts and maximum out turn of copra.

(ix) Exploitation of Hybrid Vigour.

Object:- To study the performance of different hybrids involving 15 parental combinations and to compare them with that of West Coast Tall.

The experiment was laid out during the year 1973. Morphological characters such as total number of leaves produced, number of functioning leaves, length of leaf etc. are being recorded. Data on the age of commencement of bearing, female flower production and the yield will be recorded and results interpretted.

(x) Study of off types of different dwarf varieties.

Object:- To find out the performance of off type seedlings of six dwarf types viz. Laccadive Dwarf, Andaman Dwarf, strait settlement, Nyior Gading, Green Dwarf and Orange Dwarf..

Data on the age of commencement of bearing, annual

production of leaves, female flowers etc. will be recorded. The study has commenced only in 1973 and no results have been obtained.

## COCONUT RESEARCH STATION II, NILESHWAR

(xi) Study of inheritance of yield potential in the cross, self and natural progenies of West Coast Tall palms of six yield Groups.

Object:- With a view to fix criteria for the selection of seedlings for planting, seedlings obtained by self, natural and controlled cross pollination from parent trees at Kasaragod Station belonging to 6 yield groups viz., below 40 nuts, between 41 and 60, 61 and 80, 81 and 100, 101 and 120 and above 120 nuts per tree were planted at Coconut Research Station, Nileshwar II in the year 1941 in a randomised replicated layout with 5 replications over an area of 4-05 hectares with six experimental trees per plot.

Observations on the yield of nuts recorded for the past 6 years (1969-74) are furnished below:

| Treatment | Av. Annual yield per tree 1969 | '70 | '71 | '72 | '73 | '74 | Average for 6 years. |
|---|---|---|---|---|---|---|---|
| 1. 120 and above Natural. | 33.5 | 30.1 | 42.4 | 49.4 | 48.9 | 42.9 | 41.2 |
| 2. -do- Cross | 33.3 | 24.8 | 44.4 | 56.7 | 51.0 | 39.0 | 41.5 |
| 3. -do- Self | 34.8 | 21.6 | 41.0 | 49.0 | 42.7 | 42.2 | 38.5 |
| 4. 101 to 120 Natural | 30.5 | 28.7 | 38.0 | 48.0 | 51.0 | 36.4 | 38.7 |
| 5. -do- Cross | 32.8 | 31.3 | 47.0 | 50.0 | 57.0 | 42.8 | 43.5 |
| 6. -do- Self | 20.4 | 23.0 | 28.0 | 38.3 | 33.5 | 32.4 | 29.5 |
| 7. 81 to 100 Natural | 21.7 | 22.6 | 33.1 | 41.5 | 31.5 | 32.8 | 31.3 |
| 8. -do- Cross | 30.9 | 23.3 | 40.2 | 39.9 | 42.2 | 34.4 | 35.1 |
| 9. -do- Self | 25.7 | 17.3 | 25.5 | 35.7 | 25.3 | 28.2 | 26.3 |
| 10. 61 to 80 Natural | 21.7 | 20.6 | 23.5 | 34.4 | 25.1 | 25.2 | 25.1 |
| 11. -do- Cross | 27.2 | 20.5 | 30.9 | 41.1 | 35.9 | 32.8 | 31.4 |
| 12. -do- Self | 23.3 | 19.1 | 30.2 | 32.4 | 28.2 | 26.9 | 26.6 |
| 13. 41 to 60 Natural | 25.8 | 20.0 | 27.7 | 34.6 | 32.4 | 32.2 | 28.8 |
| 14. -do- Cross | 22.2 | 22.2 | 39.3 | 39.0 | 47.7 | 36.3 | 38.4 |
| 15. -do- Self | 15.5 | 10.8 | 20.7 | 20.7 | 25.8 | 15.7 | 18.2 |
| 16. 40 and below N, | 23.9 | 17.3 | 22.9 | 26.8 | 35.3 | 26.5 | 25.6 |
| 17. -do- Cross | 25.7 | 23.9 | 38.1 | 41.5 | 42.4 | 32.6 | 35.7 |
| 18. -do- Self | 17.2 | 13.9 | 20.1 | 26.9 | 26.3 | 22.5 | 21.9 |

It is observed that in all 6 yield groups progenies obtained by controlled cross pollination gave the maximum yield.

(xii) Comparative study of TxD hybrid with the parental types. (C.R.S. II, Nileshwar)

Object:- To study the growth, yield and adaptability of hybrid progeny of Tall and dwarf and assessment of hybrid vigour of the palm.

Layout:- Progeny rows (Single replication)

Treatments:-

1. TxD hybrids
2. Progenies of Female parents - W.C.T.
3. Progenies of male parent - Green Dwarf.

The experiment was started during the year 1936.

The study so far revealed that the early bearing characters of dwarf parent is inherited in Tx.D. It attains study bearing stage much earlier than the tall types. Total annual yield is more in TxD than its parental types. Though, alternate bearing exhibited by certain combinations, the lean harvests are compensated by the very high yields in subsequent years. Alternate bears are common in tall variety also.

The observations recorded on TxD and Dwarf are furnished below:-

(1) Morphological characters for 35 years.

| | TxD | Tall | Dwarf |
|---|---|---|---|
| Height of palms | 618 cm. | 621.6 cm. | 360 cm. |
| Girth | 65.9 cm. | 64.6 cm. | 55 cm. |
| Total No.of leaves produced | 395.7 | 349.3 cm. | 415 |
| No.of functioning leaves | 28.5 | 29.6 | 22 |
| Rate of lead production | 13.5 | 12.0 | 13.6 |

(2) Yield characters.

| | | | |
|---|---|---|---|
| Average number of nuts per annum | 75.3 | 54.0 | 11.3 |
| Average weight of a nut | 1.16 kg. | 1.188 kg. | 0.400 kg. |
| Weight of nut without husk | 0.900 kg. | 0.600 kg. | 0.100 kg. |
| Weight of shell | 0.091 | 0.135 | 0.027 |
| Weight of Kerrel | 0.237 | 0.220 | 0.052 |
| Weight of Copra | 0.187 | 0.171 | 0.038 |
| Oil percentage | 70.1% | 71.7% | 65.6% |

Due to the undefined nature of the tall parent, the progenies of TxD crosses have exhibited a wide variation in the yield of nuts and copra content. Therefore, in hybridisation work, care is to be taken to choose female and male parents whose transmitting power is well established with high copra content and heavy yield.

(xiii) Prepotency studies in West Coast Tall.

Object:- To study the possibility of choosing prepotent parents in West Coast Tall for seed nut collection and to work out standards for selection of such prepotent parents and of progenies.

Details of the experiment:- Progenies of 15 mother palms selected as best transmitter at Kuttiadi centre were utilised for the study. The experiment was started in the year 1961.

20 selected seedlings from each of these 15 palms were planted.

Design:- Randomised block design with 15 plots per block; each plot consisting of single row of 5 plants.

Replication ..... 4

Data on the yield of nuts recorded for the past 6 years are tabulated below:-

| Treatment | Parent tree No. at Kuttiadi. | No. of progenies planted. | Yield of nuts | | | | | | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1969 | '70 | '71 | '72 | '73 | '74 | | |
| 1. | 5 | 20 | 18 | 47 | 73 | 262 | 272 | 264 | 936 | 46.8 |
| 2. | 19 | 20 | 44 | 117 | 223 | 427 | 479 | 376 | 1666 | 83.3 |
| 3. | 30 | 20 | 15 | 28 | 60 | 200 | 267 | 242 | 812 | 40.6 |
| 4. | 34 | 20 | 133 | 48 | 135 | 263 | 315 | 299 | 1193 | 59.6 |
| 5. | 36 | 20 | 76 | 147 | 220 | 478 | 479 | 389 | 1789 | 89.45 |
| 6. | 50 | 20 | 71 | 65 | 138 | 425 | 379 | 316 | 1394 | 69.7 |
| 7. | 54 | 20 | 108 | 213 | 256 | 549 | 526 | 448 | 2100 | 105.0 |
| 8. | 55 | 20 | 23 | 112 | 215 | 416 | 356 | 290 | 1412 | 70.6 |
| 9. | 65 | 20 | 17 | 32 | 61 | 257 | 328 | 277 | 972 | 48.6 |
| 10. | 75 | 20 | 6 | 28 | 52 | 201 | 270 | 154 | 711 | 35.5 |
| 11. | 78 | 20 | 116 | 181 | 249 | 433 | 388 | 522 | 1889 | 94.4 |
| 12. | 81 | 20 | .. | 18 | 41 | 224 | 301 | 208 | 792 | 39.6 |
| 13. | 84 | 20 | 65 | 61 | 156 | 285 | 326 | 252 | 1145 | 57.25 |
| 14. | 14 | 20 | 99 | 137 | 199 | 459 | 456 | 445 | 1793 | 86.6 |
| 15. | 100 | 20 | 44 | 61 | 113 | 321 | 330 | 332 | 1201 | 60.25 |

Family group numbers 54 and 78 have recorded the maximum yield. Morphological characters and flowering details are being collected. Studies will be continued.

(xvi) Study of cross progenies of exotic tall varieties x Indegenous varieties - Production of new cross combinations.

This item is proposed for exploiting genetic diversity which often manifests itself in greater vigour in inter varietal and inter racial crosses.

Treatments .. 21.

1. Java x Tall.
2. Tall x Java
3. Java
4. Siam x Tall
5. Tall x Siam
6. Siam
7. A.O. x T.
8. T x A.O.
9. A.O.
10. Phi x Tall
11. Tall x Phi.
12. Phi x Dwarf
13. Philippines
14. L.S. x Tall
15. Tall x L.S.
16. L.S. x Dwarf
17. L.S.
18. C.C. x Tall
19. Tall x C.C.
20. C.C. x Dwarf
21. Cochin China.

Note:- In the case of Java, A.O. and Siam crosses with dwarf were not available.

Layout:- Progeny rows.

Spacing .. 9 m.

The experiment was started during the year 1967 and the morphological as well as flowering characters are being recorded.

(xv) Evaluation of Tall x different dwarfs.

To study the comparative performance of different TxD hybrid with DxT natural, DxT and W.C.T.

Treatments .. 9

1. West Coast Tall x Gangabondam
2. West Coast Tall x Green Dwarf
3. West Coast Tall x Laccadive Dwarf
4. West Coast Tall x Orange Dwarf
5. West Coast Tall x Malayan Dwarf
6. West Coast Tall x Andaman Dwarf.
7. N.C.D.
8. Yellow dwarf x Tall
9. West Coast Tall.

Replication .. 3

The seedlings were planted during 1972 and the morphological characters are being recorded.

**********

Micronutrient leads
to specific roots
to better
to see whether such nutrients
are absorbed.

## COCONUT RESEARCH STATION, PILICODE

B.Agronomy:-

(i) Varietal response to varying levels of potash with and without Mg.

Object of the experiment is to find out the effect of potash in the presence and absence of Mg. on the yield of 10 varieties of Coconut. The experiment was started in 1967. The details of the experiment are as follows:-

Treatments:-

Main plot .. 10 varieties.
N.G., C.C., Java, A.O., L.O., L.S., Philippines.
S.S.(A), S.S. (G), and Fiji.

Sub plot:- 6 Manurial treatments.

T1 = K0 + M0
T2 = K1 + Mo
T3 = K2 + Mo
T4 = Ko + M1
T5 = K1 + M1
T6 = K2 + M1

Ko = No potash.
K1 = 0.678 kg. $K_2O$ per tree per year.
K2 = 1.356 kg. $K_2O$ per tree per year.
Mo = No Magnesium
M1 = 0.5 kg. Magnesium Sulphate per tree per year.

All trees received uniform dose of N@.0.339 kg. and $P_2O_5$ @ 0.226 kg. per tree per years.

Layout:- Split plot experiment.

Replication:- Single.

The yield data for six years (1968-73) have been analysed statistically using the pretreatment yield data for six years as concomittant variete. The treatment differences and their interaction effects are not significant.

(ii) Effect of plant density and split application of fertilizer on performance and yield of Coconut.

The experiment was started in the year 1968 with the object to study the effect of split application of fertilizers on yield and bearing habits of coconut planted under different spacing. The experimental details are as follows.

Treatments:-

Main Plot: - 3 plant density.

1. 100 trees per acre.
2. 80 trees per acre.
3. 60 trees per acre.

Sub Plot:- 4 frequency of application.

To .. Control - No fertilizer.

| | | N | $P_2O_5$ | $K_2O$ | kg/tree/year |
|---|---|---|---|---|---|
| T1 | .. | 0.339 | 0.226 | 0.678 | applied in single dose (Aug.Sept.) |
| T2 | .. | 0.339 | 0.226 | 0.678 | applied in 2 equal split doses (May, June and Aug.Sept.) |
| T3 | .. | 0.339 | 0.226 | 0.678 | applied in 3 equal split doses (May-June, Aug.Sept. and Oct.Nov.) |

Layout:- Split plot experiment.

Replication .. 3

The yield of coconuts for six years (1968-73) have been satistically analysed. The treatment differences and their introduction effects are not significant.

(iii) NPK Requirement of Coconut with and without additional dose of Mg.

The experiment was started in the year 1971 with the object to study the response of NPK and NPK + Mg. on the yield of coconut and to work out the optimum requirement of NPK with and without Mg. for coconut in laterite soil. Thedetails of requirement are as follows:-

Treatments

Main plot :- Factorial combinations of 3 levels of NPK - 27.
Nutrient levels kg/tree/year.

| | | | |
|---|---|---|---|
| N | 0.50 | 1.00 | 1.50 |
| $P_2O_5$ | 0.25 | 0.50 | 0.75 |
| $K_2O$ | 0.75 | 1.25 | 1.75 |

Sub plot:- Levels of MgO - 2.
0 and 0.170 kg/tree/year.

Layout:- Split plot in confounded factorial experiment confounding NPK in replication I and NPK in replication II.

The yield data for the two years (1972-73) have statistically analysed. The treatments and their interaction effects are not significant.

(iv) Effect of raising Cocoa as an intercrop in adult coconut Plantation.

The experiment was started in the year 1970 with the following objects:

1. To find out the effect of raising Cocoa as intercrop on yield and bearing habit of Coconut.
2. To study the performance of Cocoa in different systems of planting.

Treatments:- 3 systems of planting.

T1 ... Single row of cocoa
T2 ... Doubel rows of cocoa.
T3 ... No Cocoa.

Layout:- RBD

Replication .. 8

Spacing 3.65 M. between plants.

Result:- Preliminary results show that Cocoa can be successfully cultivated in coconut gardens. Between the two method of planting tried i.e. single row and double tow in between two rows of coconut trees, double row planting has given the maximum number of pods two years after planting. As against 621 pods obtained from double row planted plants only 250 pods were obtained from single row plantings. Yield when the

plants come to full bearing will be studied in detail.

With regard to the effect of cocoa on the yield of coconut the mean pre-treatment yield from 1966 to 1969 and the post treatment yield from 1971 to 1974 are given below:

| | Pre-treatment yield | Post treatment yield. |
|---|---|---|
| Control .. | 61.6 nuts | 61.6 nuts. |
| Single row | 57.8 nuts | 69.1 nuts. |
| Double row | 63.1 nuts | 63.8 nuts. |

It is evident that there is no reduction in yield of coconuts as a result of interplanting cocoa 4 years after planting. The studies will be continued.

(v) Intercropping trials with various annual crops.

Object:- To find out the most suitable annual crop to grow as intercrop in Coconut gardens and to study their effect on the yield of coconut.

The experiment was started during the year 1967 and the following crops were tried.

1. Paddy
2. Ragi.
3. Tapioca.
4. Colocasia.
5. Sweet potato.

Performance of intercrops and their effect on Coconut have been studied in detail taking into account the pre and post treatment yield of nuts.

Result:- The results show that none of the crops under trial had any adverse effect on the coconut. Actually all intercropped trees have shown increased yield of nuts over the pre-treatment yield. The maximum increase in yield of 30.3 per cent was shown by the trees intercropped with colocasia while ragi and paddy intercropped trees have shown 20.4 and 18.2 per cent increase respectively.

With regard to net profit realised from the intercrops tapioca has given the maximum amount of Rs.1503/= per hectare followed by Colocasia with Rs.975/= and paddy with Rs.855/=.

The trials clearly show that intercropping coconut garden with annual crops like tapioca, ragi, paddy and colocasia is very profitable both in respect of increased production of nuts and nut return from the intercrops.

## COCONUT RESEARCH STATION, NILESHWAR.

(vi) Effect of NPK levels and frequency of application on the yield and bearing habits of TxD hybrids.

Object:- To study whether the yield potential of TxD can be increased further and the alternate bearing tendency can be reduced by heavy dose and split application of fertilisers.

Experiment was started during 1970.

Treatments .. 4.

| | | N | P | K | |
|---|---|---|---|---|---|
| T1 | Levels of -do- | 1 kg. | 0.640 | 2.4 | single dose. |
| T2 | .. -do- | 1 kg. | 0.640 | 2.4 | 2 split dose. |
| T3 | .. -do- | 0.5kg. | 0.32 kg. | 1.2 | Single dose. |
| T4 | .. -do- | 0.5kg. | 0.32kg. | 1.2 | 2 split dose. |

Layout .. R.B.D.

Replication .. 5

Number of trees per plot .. 2

Results of studies so far made are given below:-

| Treatment | Mean number of nuts | |
|---|---|---|
| | Pre treatment data for 4 years 1966 - 1969 | Post treatment data for 2 years. 1973 and 1974. |
| T1 | 55.11 | 43.55 |
| T2 | 53.78 | 64.60 |
| T3 | 50.21 | 54.25 |
| T4 | 52.89 | 58.89 |

An increasing trend is seen in nut production in the case of split application of fertilisers (T2 and T4). High rate of fertilizers in split application is found to be better than single dose. Studies will be continued.

7. Response of Tx D hybrid to high rates of NPK fertilizers.

Object:- To study the effect of heavy doses of NPK fertilizers on the bearing habit yield and nut character of TxD hybird and to work out optimum fertilizers required for TxD hybrids.

Year of commencement .. 1972.

Layout : $3^3$ confounded factorial experiment.

Treatments 27 combinations.

NPK at 3 levels.

| | | |
|---|---|---|
| No. | .. | 0 |
| N1 | .. | 0.35 kg/tree/year |
| N2 | .. | 0.70 ,, ,, |
| P0 | .. | 0 |
| P1 | .. | 0.175 ,, ,, |
| P2 | .. | 0.350 ,, ,, |
| K0 | .. | 0 |
| K1 | .. | 0.70 ,, ,, |
| K2 | .. | 1.40 ,, ,, |

Replication : - 4.

Single tree per plot: Observation on the yield characters are being recorded. It is too early to draw any conclusion.

## DISCUSSION OF RESEARCH WORK IN PROGRESS AT KUMARAKOM

### 1. Investigations on the dose, frequency and method of application of Fertilisers.

This experiment was started in 1966 to determine the most economic dose, frequency and method of application of manures for coconut in the tract. There are 27 treatments replicated 3 times.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | M1 | E | C1 | 2.M1 | E | C2 | 3.M1 | E | C3 | 4.M1 | A1 | C1 |
| 5. | M1 | A1 | C2 | 6.M1 | A1 | C3 | 7.M1 | A2 | C1 | 8.M1 | A2 | C2 |
| 9. | M1 | A2 | C3 | 10.M2 | E | C1 | 11.M2 | E | C2 | 12.M2 | E | C3 |
| 13. | M2 | A1 | C1 | 14.M2 | A1 | C2 | 15.M2 | A1 | C3 | 16.M2 | A2 | C1 |
| 14. | M2 | A2 | C2 | 18.M2 | A2 | C3 | 19.M3 | E | C1 | 20.M3 | E | C2 |
| 21. | M3 | E | C3 | 22.M3 | A1 | C1 | 23.M3 | A1 | C2 | 24.M3 | A1 | C3 |
| 25. | M3 | A2 | C1 | 26.M3 | A2 | C2 | 27.M3 | A2 | C3 | | | |

M1 = N0 P0 K0 = 250 g. N+ 350g. P2 05 + 750 g. K2 0
M2 = N1 P1 K1 = 375 g. N + 475g. P2 05 + 875 g. K2 0
M3 = N2 P2 K2 = 500 g. N + 600g. P2 05 + 1000g. K2 0

E = Manuring every year.
A1 = Manuring in alternate years starting with the first year.
A2 = Manuring in alternate years starting with the second year.

C1 = Applying fertilizers in basins.
C2 = Applying fertilizers in linear trenches.
C3 = Applying fertilizers by broadcast.

Statistical analysis of the yield data has shown that there is significant difference in the yield of nuts due to frequency of application. Manuring every year being the best, manuring in alternate years starting with the first year and manuring in alternate years starting with the second year ranking second and third. The treatment N2 E C1 has been found to give consistently higher yield in all the years from 1969. Applying the fertilizers in basins was found to be better than the other method of application.

ii) Manurial trial on coconut seedlings

The object of the experiment is to find out the manurial requirement of coconut seedlings planted on mounds raised in channels. The experiment was started in 1965 with the following 8 treatments replicated 12 times.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | N1 | P 1 | K1 | 2. | N1 | P1 | K2 |
| 3. | N1 | P2 | K1 | 4. | N1 | P2 | K2 |
| 5. | N2 | P1 | K1 | 6. | N2 | P1 | K2 |
| 7. | N2 | P2 | K1 | 8. | N2 | P2 | K2 |

N1 = 250 g. Nitrogen, P1 = 250g. P2 05 K1 = 500g. K2 0
N2 = 500 g. Nitrogen, P2 = 500g. P2 05 K2 = 1000 g. K2 0

Manurial doses for the seedlings in grams per year.

| | N1 | P1 | K1 | N2 | P2 | K2 |
|---|---|---|---|---|---|---|
| 2nd year | 50 | 50 | 100 | 100 | 100 | 200 |
| 3rd year | 75 | 75 | 150 | 150 | 150 | 300 |
| 4th year | 125 | 125 | 250 | 250 | 250 | 500 |
| 5th year | 175 | 175 | 350 | 350 | 350 | 700 |
| 6th year | 250 | 250 | 500 | 500 | 500 | 1000 |

Observations recorded on the growth measurements of seedlings show that increased dose of Nitrogen promote the vegitative growth of coconut seedlings. Combined analysis of the data of growth measurements from 1966 to 1970 has not revealed any significant difference in respect of height of seedlings and increase in girth due to the effects of treatments. There is significant difference in the mean number of leaves produced. It is also seen that the mean number of leaves produced, increase in girth and height vary significantly with the years.

iii) Split application of fertilizers on coconut seedlings.

This experiment is aimed at finding out the effect of foliar and soil application of fertilizers in split doses on coconut seedlings.

Started in 1966 the trial consists of 11 treatments with 12 replications.

1. Single application of 200g. N+150g. P2 05 +250g. K2 0/seedling/.
2. Single application of 400g. N+300g. P2 05 + 500g. K2 0/seedling.
3. Two equal split application of T1 dose.
4. Two equal split application of T2 dose.
5. Three equal split application of T1 dose.
6. Three equal basal application of T2 dose.
7. 3/4 T1 dose basally and 1/4 T1 dose through foliage in 2 times.
8. 3/4 T1 dose basally and 1/4 T1 dose through foliage in 3 times.
9. 3/4 T1 dose basally and 1/4 T1 dose through foliage in 4 times.
10. 1/2 T1 dose through foliage on in 6 times.
11. Control. No manure.

Observations so far recorded on the growth of seedlings show that basal application of fertilizers in split doses is better than foliar application in promoting the vegetative growth of coconut seedlings. Early flowering and maximum female flower production are noticed when the fertilizers are applied in split doses basally. Statistical analysis of the growth measurements recorded from 1966 to 1970 did not show any significant difference in height of seedlings and girth. But there is significant difference in the mean number of leaves produced. Growth of seedlings was found to vary significantly with the years.

iv) Collection of coconut hybrids and varieties to assess their resistance to root wilt disease.

Twenty four coconut hybrids and varieties were planted in August 1971 to study their disease resistance potentialities with regard to root wilt disease. Observations on the growth performance and disease incidence are recorded. It is too early to draw any conclusions.

v) Study of disease tolerance of coconut varieties.

This experiment was laid out in a completely randomised design in November 1972. There are 9 coconut varieties under study.

The planting materials for this experiment was supplied by the Central Plantation Crops Research Institute, Kasaragod. Observations on the girth, height and leaf production are recorded.

vi) Study of disease tolerance of hybrid coconut seedlings.

This experiment consists of only two hybrid progenies, T x D and T x G planted during 1973.

vii) Study of disease tolerance of hybrids of experimental crosses.

The material for the experiment was supplied from the Coconut Research Station, Nileshwar and three experiments were laid out during 1974.

RESEARCH WORK IN PROGRESS AT BALARAMAPURAM.

The following are the experiments laid out in the present site i.e. Kattachalkuzhi - Balaramapuram.

A) NPK fertilizer experiment starting from young seedlings (fresh planting - 1 year. Old seedlings - date of planting: 17.6.1964).

B) Spacing-cum-manurial experiment (fresh planting - 1 year old seedlings. Date of planting: 18.6.1964)

C) Method of application of NPK fertilizer experiment (Old adult palms of the acquired land. Expt. laid in 1965)

D) NPK fertilizer experiment on adult palms was laid out in 1967.

E) Progeny row trial with T x D and T x GD seedlings laid out on 14.10.1970.

F) Experiment for the comparison of West Coast Tall and other exotic dwarf varieties was laid out on 10.10.1973.

G) One observation trial to get first hand information on the effect of normal and enhanced doses of nutrients in single and split application. Date of planting: 17.6.1964.

A) NPK fertilizer experiment starting from young seedlings:-

(i) Layout:- $3^3$ factorial, confounded design in 9 plot block; replicated twice, confounding $NPK^2$ in replication I and $NP^2K^2$ in replication II.

(ii) Treatments:- All possible combinations of N.P. and K. each at 3 levels - 27 treatment combinations.

(iii) Levels of Nutrients:- per/tree/year

N0 = No Nitrogen
P0 = No Phosphorus
K0 = No Potash.

N1 = 340 gms. of N, P1 = 225 gms. of $P_2O_5$ K1 = 450 gms. of $K_2O$
N2 = 680 " P2 = 450 " K2 = 900 "

(iv) Plot size:- Net plot size - 15 Mx 15 M containing 4 trees with a border row.

(v) Spacing:- $7\frac{1}{2}$ M x $7\frac{1}{2}$M.

(vi) Total No. of trees: 563

vii) Experimental trees: 216

Boarder row trees are given average dose of adjascent plots.

viii) Cultural operations:- Uniform cultural practices i.e., digging with spade, taking basins etc. before the monsoon.

ix) Observations recorded:

1. Girth at collar.
2. No. of functioning leaves.
3. Frequency of production of leaves.
4. Length of leaf.
5. No. of leaflets on one side.
6. Nature of foliage.

When palms commence to bearing stage the following observations are also taken:

1. No. of good nuts.
2. No. of barren nuts.
3. Nature of leaf axil.
4. Setting percentage.
5. No. of female flowers produced.

Out of 216 trees only 102 trees have come to bearing stage. Inference regarding the observations are given below:-

(1) Girth at Collar:- The effect of N1 P1 K1 are significant N1 P1 K1 are superior to N0 P0 K0 respectively. There is no significant difference between the higher and lower levels of N.P. and K.

(2) No. of leaflets one one side:- The effect of NPK are significant. The middle and higher levels are significantly superior to the lower levels of the same.

(3) No. of functioning leaves: The effect of N P and K and interaction of P & K are found to be significant. There is significant difference between lower and higher levels of P and K.

Out of the 216 experimental trees only 102 trees have come to bearing stage. In treatments with 112, 122, 211, 212, 221 and 222 all the trees have flowered. Among these 6 treatment combinations, treatments with 211 and 212 early flowering have been noticed, i.e. after $6\frac{1}{2}$ years from the date of planting. In treatments with 000, 010, 020, 100 and 200 no plants have flowered till date.

(B) Spacing-cum-manurial experiment

(i) Layout:- RBD with 3 replications.

(ii) Treatments:- All possible combinations of 3 levels of manures and 3 different spacings with 3 replications - 9 treatment combinations.

(iii) Levels of nutrients:-

M0, M1 and M2 in factorial experiment.

(iv) Plot size:- 30 M x 30 M.

(v) Spacing:- 5 M x 5 M - 25 trees.
$7\frac{1}{2}$ M x $7\frac{1}{2}$ M - 9 trees.
10 M x 10 M - 4 trees

One border row of trees kept in between plots with a spacing of $7\frac{1}{2}$ M x $7\frac{1}{2}$ M.

(vi) Total No. of trees .. 601.

(vii) Experimental trees .. 342

(viii) Cultural operations: As in factorial experiment.

(ix) Observations:- As in other experiments.

Out of 342 experimental trees 221 trees have come to bearing stage.

(1) Girth at collars- There is significant difference between fertilizer treatment but spacing has no effect. M1 and M2 are superior over M0, but no difference between M1 and M2.

(2) No. of functioning leaves:- M1 & M2 are superior over M0 but spacing has no difference.

(3) Frequency of production of leaves:- M2 is superior to M1 and M2 & M1 are superior over M0.

(4) Length of leaves:- M1 and M2 are superior over M0 but no difference in length of leaves with regard to different spacings.

(5) No. of leaflets on one side:- M1 & M2 are superior over M0. There is no difference regarding to different spacings.

Out of 342 experimental trees 221 trees have come to bearing stage. In treatments M2, S2, M2 S1, M1 S2, M1 S1 all the trees have flowered. Early flowering has been noticed after 4 years 8 months in treatment M1 S2 and after $5\frac{1}{2}$ years in M1 S1 In treatment No.S2 none of the trees flowered so far.

(c) Method of application of NPK fertilizer on Adult palms:-

(i) Layout:- 8 palms in each plot were selected and replicated twice. Trees selected are from the trees that were standing at the time of acquiring the site. Trees having desirable characters are selected and they are single tree plots.

(ii) Treatments:-

| | N | P | K |
|---|---|---|---|
| | gms. of N/tree/year | gms. of P/tree/year | gms. of K/tree/year. |
| Normal dose | 340 | 225 | 450 |
| Enhanced dose | 680 | 450 | 900 |

Enhanced dose is applied in 2 split doses i e., 1st dose in June and the 2nd dose in October.

(iii) Cultural Practices:- Regular cultural operations as in the case of other experiments.

(iv) Observations recorded:-

1. No. of good nuts.
2. No. of barren nuts.

All the trees in the experiment are adult palms of full bearing stage. Average yield of trees in two different treatments is as follows for 8 years.

Normal dose - 48 nuts/tree/year.

Enhanced dose - 53.7 nuts/tree/year.

Enhanced dose of fertiliser was found to be superior over normal dose of fertiliser.

(D) Progeny row trial with T x D and T x GB Seedlings.

a) To make comparison in performance and yield between T x D and T x GB

b) To make comparison in performance and yield between the progenies within T x D and T x GB.

(i) Lay out:- Compact family block design. The progenies of T x D and T x GB seedlings are planted side by side in a block. The seedlings are planted by randomising within the rows. Replication-5.

(ii) Treatments:- 5 progenies of T x D and T x GB seedlings.

(iii) Spacing:- $7\frac{1}{2}$ M x $7\frac{1}{2}$ M.

(iv) Plot size: $37\frac{1}{2}$M x $22\frac{1}{2}$ M holding 5 progenies each of T x D and T x GB seedlings.

(v) Total No. of plants:- 50

(vi) Manure schedule:-

| | N per tree/year in 2nd split doses | P per tree/year in 2 split doses | K per tree/year in 2 split doses. |
|---|---|---|---|
| Ist year | 113 gms | 75 gms | 150 gms. |
| 2nd year | 227 gms | 150 gms | 300 gms. |
| 3rd year | 350 gms | 225 gms. | 450 gms. |

Fourth year onwards full dose of 350 gms. of Nitrogen 225 gms, of $P_2O_5$ and 450 gms. of $K_2O$ in single application.

(vii) Cultural operations:- Common as in other experiments.

(viii) Observations:- As in the case of other experiments from seedlings stage.

Out of 50 experimental trees 8 trees have flowered so far. Among these 8 trees 6 trees of T x D and 2 of the variety T x GB. First flowering in 4 numbers of T x D plants were noticed in November 1974 i.e. after 4 years of planting. In 2 Nos. of T x GB flowering noticed on April 1975 and May 1975 i.e. after 4 years 6 months of planting.

(F) Experiment for the comparison of West Coast Tall and other exotic dwarf varieties:-

Seedlings in this experiment were planted only on 10.10.1973.

Observations and other details are same as those of other experiments starting from seedlings stage.

(G) To study the effect of Normal and Enhanced dose in single and split doses of manuring on the growth of young seedlings and to see the earliness in bearing can be induced by the same.

(i) Layout:- 4 plots consisting of 15 plants in each. Normal and Enhanced doses are applied in single and split doses.

(ii) Treatments:-

1. Normal dose of manure applied in full at a time.

2. Normal dose of manure applied in two split doses i.e. ½ in August and remaining ½ in February during the year.

3. Enhanced dose of manure applied in full at a time.

4. Enhanced dose of manure applied in two split doses i.e. ½ in August and the remaining ½ in February during the year.

(iii) Doses of fertilizer:

| | N gms/tree/year | P gms/tree/year | K gms/tree/year |
|---|---|---|---|
| Normal .. | 340 | 225 | 450 |
| Enhanced .. | 680 | 450 | 900 |

(iv) Spacing:- 7½ M x 7½ M.

(v) Observations:-

1. No. of good nuts.

2. No. of barren nuts.

Out of 60 trees 42 trees have flowered so far, i.e. 4 trees out of 15 trees in Normal full application at a time, 12 trees out of 15 trees in Normal split application, 12 trees out of 15 in Enhanced dose full at a time and 14 trees out of 15 trees in Enhanced dose split application.

Average Nuts/year is as given below:-

| | No. of nuts | No. of trees |
|---|---|---|
| 1. Normal dose full application | 6 | 4 |
| 2. Normal dose split application | 49 | 12 |
| 3. Enhanced dose full application | 69 | 12 |
| 4. Enhanced dose split application | 167 | 14 |

From this it is seen that enhanced dose in split application shows superiority over all other treatments. Since the cultural operations are same for all the treatments. The only difference in cost of

labour is for the 2nd application of fertilizer in split doses. Considering this fact normal split application is economical and gives better yield. It is also observed that split application induces earliness in flowering.

| Treatment | No. of trees flowered in July 1972 |
|---|---|
| 1. Normal dose full at a time | Nil |
| 2. Normal dose split application | 1 |
| 3. Enhanced dose full at a time | 1 |
| 4. Enhanced dose split application | 8 |

A. Factorial experiment starting from young seedlings:

No conclusive result is available since all the trees have not come to bearing stage.

As the coconut crop is a perennial one with very long duration and the full bearing stage from the experimental trees can be expected only after 20-25 year after these trees established, i.e, after 1984. This experiment will have to be continued upto 1994 to get a conclusive result. After reaching the full bearing stage usually the yield of coconut trees remain steady for about 40-50 years.

The soil of this farm is red loan which is acedic. The water table is very low. i.e, 30 metres.

B. Spacing-cum-manurial experiment:-

Due to the above reasons this experiment will have to be continued upto 1994 by altering the present closer spacing only. That is by cutting and removing all the alternate trees from the layout having a spacing of 5 metres. So that their spacing will be 10 metres.

At present coconut palms planted by the cultivators are not having proper spacing. They believe that 100 trees can be planted in an acre of land. The ill effects of closer spacing can be seen from this experiment. If coconut trees are to bear well, they should get plenty of sunlight. When trees are over crowded there is a tendency to grow tall and lanky in their struggle to get sunlight and consider-

able energy is used up in producing a tall trunk at the expenses of the yield.

C. To secure preliminary information about the response of old palm to the normal and enhanced dose of manuring:-

Enhanced dose of fertilizer was found to be superior over normal dose.

This experiment need not be continued further since conclusive result can be obtained by analysing statistically the yield data recorded so far.

NPK Fertilizer experiment on adult palms:

In this experiment the yield of trees of different treatments are not statistically significant. But basin method and trench method are found to be superior over broad-casting method of fertiliser application. In broadcasting method there was too much weed growth in the plot. In the yield there was no much difference between the trench method and basin method.

Progeny Row Trial with T x D and T x G Seedlings.

This experiment will have to be continued indefinitely to study the performance of the different progenies in the re-loam soils of Kerala.

F. Experiment for the comparison of West Coast Tall and other Exotic dwarf Varieties:-

This experiment is started only during the year 1973.

Observational trial to get first hand information on the effect of normal and enhanced doses of nutrients in single and split application.

This experiment will have to be continued upto 1994, i.e., to study the yield difference at the economic bearing stage of the coconut trees.

D. FUTURE LINE OF RESEARCH WORK

1. Germplasm collection

a) Varieties introduced from a number of coconut growing countries are currently under study at Pilicode and Kasaragod. Very valuable information has already been collected in as much as a wide variation in the yield of nuts, copra content, per centage of female flowers and their setting per centage has been found between varieties. There is scope for further intensification of effort in this regard by introducing all the promising types from all over the world and evaluating them.

This could be attempted at the main campus of Kerala Agricultural University or at Kasaragod.

b) At present only very few plants of each of the exotic varieties have been raised at the Research Station. This number is not adequate to get a true idea of the economic characteristics of the varieties, nor can they be purposefully utilised for supplying their seednuts of at least those varieties which have been found to be promising in preliminary observations, so that replicated progeny row tests can be carried out with them. Isolated blocks of each promising type could also be raised and planted so that seednuts could be collected by the process of sibbing for further propagation.

This work could be taken up at the main campus at Mannuthy.

2. Evolution of inbred lines and making single lines.

A number of inbred lines and sibs evolved as a result of the work initiated at Pilicode are available. Cyclic crosses between all lines could be made and a progeny row test laidout for selecting the lines which have the highest combining ability.

3. Study of Tall forms x Gangabondam.

The promising hybrids of exotic tall with Gangabondam could be made and distributed to disease affected areas to screen them for disease resistance.

These crosses could also be utilised in making 3 way and double

crosses with pre-potent Talls. The hybrid material so obtained from 3 way crosses and double crosses could be planted in a replicated progeny row test for assessing their performance.

4. Study of F2 open pollinated progenies of Tall x Dwarf.

The results of studies conducted at Pilicode on the performance of open pollinated progenies of T x D have defenitely indicated that it would be economical to raise a plantation of such progenies provided rigorous selection is made in the nursery. Selection indices are to be worked out and finalised.

5. Study of crosses between exotic and indigenous varieties using selected 'tall' mother palms.

This item of work is proposed for exploiting the "genetic diversity" which often manifests itself in greater vigour in intervarietal crosses. For success of the project, it is necessary that only palms of the prepotent tall variety are used for hybridisation. The crosses are to be made reciprocally and progeny row tests laid out with hybrid nuts for valid comparison of their yield and other economic characters.

6. Improvement through paired crossing in selected talls.

After good male and female transmitters have been identified, they could be used for crossing in pairs to give more uniformly high yielding off spring that could be attained by any other breeding method. The particular advantage of this method is that the eliminating rate of seedlings in the nursery is considerably reduced as the paired crosses are bound to give a high percentage of good seedlings. The method has thus immense possibilities, though it is more time consuming than other methods.

## A G R O N O M Y

1. The Nutritional requirementsof high yielding Coconut varieties and hybrids (T x D, L.O. and T x D).

It was suggested at the 2nd workshop to take up a fertilizer

experiment on high yielding varieties (T x D, L.O. and T x G) at the main campus of the University at Mannuthy. The details are given below:

Treatments:

Varieties, Laccadive Ordinary, T x D and T x G.

Fertilizers:- All combinations of three levels of N, P and K. with two levels of Ca plus Mg.

Levels of nutrients (Per palm, per year)

| N | $P_2O_5$ | $K_2O$ |
|---|---|---|
| 1. 1.0 kg. | 0.50 kg. | 1.25 kg. |
| 2. 1.5 kg. | 0.75 kg. | 1.75 kg. |
| 3. 2.0 kg. | 1.00 kg. | 2.25 kg. |

| CaO | | MgO |
|---|---|---|
| 1. 0.15 kg. | + | 0.15 kg. |
| 2. 0.30 kg. | + | 0.30 kg. |

Design:- $3^3$ x 2 factorial design with higher order interactions confounded.

Replication: One replication for each variety.

Plot size: Six palms per plot.

Planting materials: One year old seedlings of Laccadive ordinary T x D and T x G will be planted.

Fertilizer application, schedule of operations and observations:-

The first dose of fertilizers consisting of 1/10th the above dosage may be applied about three months after planting. The young palms will receive 1/3 of the above dosage during the first year and 2/3 in the second year. From the third year onwards the full dose of fertilizers will be given.

The annual dose of fertilizers will be applied in two splits, 1/3 before the commencement of the monsoon (April-May) adequate soil moisture should be available at the time of application and 2/3 in August-September after the heavy rains have subsided. Adjustment in the time of application should be made to suit local conditions.

II. Fertilizer and water requirement of palms to be utilised for tapping and the effect of tapping on production of nuts.

It is proposed to take up this trial at Nileshwar II.

Treatments:- The treatments will consist of 3 levels of NPK mixtures and 3 intervals between irrigation as follows:-

Fertilizer mixtures.

| | $M_1$ | $M_2$ | $M_3$ | |
|---|---|---|---|---|
| N | 1.0 kg. | 1.5 kg. | 2.0 kg. | Per palm per year. |
| | + | + | + | |
| $P_2O_5$ | 0.5 kg. | 0.75 kg. | 1.0 kg. | |
| | + | + | + | |
| $K_2O$ | 1.25 kg. | 1.75 kg. | 2.25 kg. | |

Irrigation intervals.

1. Once in three days.
2. Once in six days and
3. Once in nine days.

Design:- Split plot design with irrigation intervals in main plots and fertilizer levels in sub plots.

Replication:- Three

Plot size: Two palms per sub plot.

Material: Adult palms of uniform age, and growth habits of the tall variety.

1. Medium yield groups.
2. Poor yield groups.

Fertilizer and irrigation schedule:- Measured quantity of water 100 litres per irrigation - will be applied in circular shallow basins 1.8 meters in radious around the base of the palms. The fertilizers will be applied in four equal splits in February, May, August and November, each year in the basins.

Observations: Yield of toddy per palm, per day will be recorded in addition to the details required. Tapping is to be done for the entire year.

A Research Project for Coconut improvement in back water areas of Kuttanad has been sent to I.C.A.R. in order to carry out intensive research programme on Coconut Improvement under the Agro climatic conditions prevailing in Kuttanad.

Details of the project are furnished below:-

Kuttanad is a distinct coconut zone, comprising an area of about one lakh hectares, lying in the back water areas of Vembanad lake with peculiar agro-climatic problems like bund cultivation, flooding of coconut gardens during monsoon, salinity during summer and therefore research findings applicable to other tracts may not be suitable for this tract.

Though intensive research on agronomic problems and disease and pests of coconut is being carried out at C.P.C.R.I. Kasaragod and Kayamkulam, the problems relating to the back water areas with regard to agronomic requirements and pest control of coconut has not been attempted so far. Hence a research Project has to be started exclusively for the back water areas of Kuttanad tract giving emphasis on agronomic and plant protection aspects of coconut cultivation.

Object of the scheme:-

To carry out intensive research programme on the coconut improvement under the agro-climatic conditions of the back water areas of Kuttanad tract.

(a) Agronomy:-

(1) Studies on macro and micro-nutrient status of the soil of Kuttanad.

(2) Role of Magnisium and Calcium in increasing the yield of coconut.

(3) Role of organic manures in maintaining the yield of coconuts.

(4) Trial on different cultural practices on adult coconut palms.

(5) Spacing trial of coconut on double bunds and narrow bunds.

(b) Soil survey of coconut growing Panchayats in Kuttanad tract.

Soil classification is an important and integral part of Agricultural planning and development. The survey will enable to:-

(1) Classify the soils of the region on a scientific basis.

(2) Prepare the soil map of the region.

(3) Assessment of the inherent fertility status of the different places in the region.

(c) Trials in Farmer's gardens:

To conduct manurial-cum-plant protection trials in coconut gardens of progressive farmers the entire panchayats of Kuttanad tract will be included in the scheme.

B. PEST CONTROL:

(1) Survey of pests of coconuts and the extent of damage made by them.

(2) Breeding of parasites and releasing in the pest attacked areas as a biological control measure.

(3) Conducting experiments on the different insecticides for the control of different pests.

(4) Studies on different pests of coconuts in the laboratory.

COCONUT CONVENTION OCTOBER 9TH & 10TH KERALA AGRICULTURAL UNIVERSITY.

REPORT FROM THE C.P.C.R.I

## I. Review of work done in Agronomy and Soil Science on Coconut:

### 1. Nutritional requirement:

In the NPK factorial experiment at CPCRI, Kasaragod the response in terms of yield of nuts was obtained in the third year for application of N, in the fifth year for K and in the nineth year for P. Although a 13.7% increase in the yield of nuts was obtained to N application, there was only slight increase in the out-turn of copra per palm, due to its adverse effect on the nut characters. Potash had very beneficial effect both on the yield of nuts and out-turn of copra per palm which increased by 19.8 per cent. The optimum dose of fertilisers for the ordinary tall variety palms, in sandy loam soil, was found to be 500 g N + 320 g $P_2O_5$ + 1200 g $K_2O$ per palm, per year. Mg had little effect on the yield of nuts. Application of 0.15 kg CaO per palm, per year, combined with N P K fertilisers had beneficial effect on the yield and nut characters while at higher doses effect was adverse. As a measure to conserve soil moisture it was found that common salt has to be applied at such high levels that Na taxicity in soil will arise. Superphosphate (ordinary) gave higher response than rock phosphate or bonemeal. Application of the annual dose of fertiliser in two splits resulted in the increased yield of nuts (8.4%) and copra out-turn (11.7%) over single application. Rapid vegetative growth of young palms was obtained when bimonthly split application of the annual dose of fertilisers was carried out.

Fertiliser requirement of high yielding palms like D x T, T x D, etc. was found to be much higher than that of the ordinary Tall. It was also seen that D x T is the most efficient user of applied nutrients, as measured by the growth characters. However, under 'no fertiliser' treatment, there was high incidence of shoot-rot in D x T palms.

Highly significant response to the application of green leaf was obtained in littoral sandy soil, emphasising the necessity to improve the

organic matter status of such soils to ensure satisfactory yield of nuts.

The study of the foliar nutrient levels showed that the N-content is higher during the dry months as compared to that during the rainy season. Foliar content of P and K was higher during rainy season. Soil application of fertilisers increased the foliar level of N while that of P remained nearly static. Marked increase in the K-content of the leaves was obtained. There was evidence of K-Mg antagonism which was more pronounced than K-Ca antagonism.

In the soil increased availability of N through application of N fertilisers was found to last only for about 3 months indicating the need for frequent application of fertilisers. The organic carbon content of the soil remained unaffected. There was considerable build up of available P and K.

The effective root zone of an adult bearing palm is confined to 2 m laterally and 30-120 cm vartically.

The cation exchange capacity of coconut roots was determined. Maximum CEC was noticed in the 5 cm length from the root-tip. The CEC of the rootlets of the lateral roots was found to be 6.16 me/100 g while the CEC for rootlets of the vertical roots was only 3.75. The matting roots showed low CEC.

The deficiency symptoms of major nutrient elements in coconut seedlings have been established by pot-culture experiments. Foliar yellowing of the coconut palm in sandy soil was found to be due to nitrogen and magnesium deficiency. Lower calcium and high potash contents were also noticed in chlorotic leaves. Appreciable quantities of nutrients were found to be leached from the leaves by the rains.

Water requirement:

A long spell of dry weather causes a severe setback in the growth of the palm and consequent reduction in yield. Ameliorative measures like application of clay, silt, organic matter, etc. failed to improve the condition of palms growing in deep sands. But irrigation during the dry months

resulted in marked increase in the yield. In sandy and sandy loam soils Sea water was found as effective as fresh water for irrigation and there was no residual harmful effect. Application of 0.3 $m^3$ of red earth and 150 dry husks of coconut in 2 alternating layers in planting pits was found to improve soil moisture retention in littoral sandy soil and young palms showed the best growth, when combined with irrigation at 45 ltires of water, once in 4 days. Burying dry husks and leaves of coconut in trenches 40 cm deep and 180 cm broad, in between rows of palms, at 1000 husks per palm, helped to reduce the crop losses due to drought.

Cultural practices:

Clean cultivation was found to benefit the coconut, even in the absence of manuring. Ploughing twice a year effectively checked weed growth, and resulted in a mean annual yield of over 30 nuts per palm, as compared to 15 nuts in the 'neglected' plot. A mean yield of 62 nuts per palm was obtained in the regularly cultivated and manured plot. Inter-cultivation was found to have beneficial effects on the physico-chemical properties of the soil.

Preliminary trials indicated that Bihedenol, Dalapon, Tafapon and Tributon are effective in the control of nut grass. Planotox and Spontox are effective against dicot weeds.

Inter and mixed cropping trials:

Study of the rooting pattern of the coconut in well drained loamy sand, receiving regular cultivation and manuring, showed that few roots were present in the upper 20 cm layer of soil and that 90 per cent of the roots are confined to the 20-150 cm layer. Laterally, 72 per cent of the roots originating from the bole did not extend beyond 2 meters. Less than 6 per cent of the roots were found to extend beyond 3.5 meters from the bole. The accommodate the large canopy the recommended spacing for coconut palm is 50 $m^2$. The effective root zone is confined to an area of 12.5 $m^2$ only, leaving about 75% land area not effectively utilised.

Intercropping studies have shown that annuals like tapioca, sweet potato, dry paddy, ground nut, elephant yam, etc. and summer and winter

vegetables can be profitably grown during the early years of the plantation. In adult plantations, the main crop and the intercrop gave higher yields when both were adequately and separately manured. There was a 22% increased yield of the main crop - coconut.

Shade-loving perennials like cocao, nutmeg, cinnamon, and clove were also found to perform well in the interspaces of the coconut. Cocao plants (Forestero variety) made excellent growth and flowered within 10 months of planting. Experiments in progress at Kayangulam showed that mixed farming viz. raising fodder grass - legume mixture, under irrigated condition, and maintaining milch cows is not only remunerative (net profot of Rs.2,200/- per ha from dairy alone) but also provides alternate employment to the cultivator.

With a view to harvesting the solar energy at different vertical intervals and the soil resources at varying layers, a 4 crop combination of coconut, pepper, cocao/cinnamon and pineapple, designated as multi-storeyed cropping, was successfully raised. Mixed cropping with cocao favoured a higher activity of beneficial microbes like nitrogen fixers, P solubilizers, and hormone synthesisers.

Nursery studies:

Investigations on the nursery technique have shown that horizontal sowing of seed nuts results in slightly higher germination and more vigorous seedlings. Seednuts of the tall variety require about two months' rest period. Nuts older than 11 months can be used for seed purpose. Seednuts that float in vertical position give rise to more vigorous seedlings. One year old seedlings uprooted from the nursery and kept packed for 4 weeks, established satisfactorily, when planted.

Although seednuts harvested in March-April and sown in May-June germinated early and produced more vigorous seedlings, seednuts harvested during other months were also suitable for raising nursery. Fertiliser application to the nursery resulted in significantly increased N and total chlorophyll (from 1.74 to 2.34 mg/g) content of leaves.

Soil Chemistry:

Detailed soil survey of Cannanore and part of Kozhikode districts was carried out and six distinct soil groups were identified. The distribution of area under coconut was found to be laterite (65%), lowland valley soil (17%), river alluvium (6%), coastal sandy (5%), red sandy loam (5%) and reclaimed marshy (2%). The lime requirement of the major soil types was worked out at 1.65, 1.8, 1.5 and 4.36 tons of $CaCO_3$ per acre for laterite, midland laterite, red sandy loam and reclaimed marshy soils, respectively.

Mobility and availability of applied K and P in laterite soils were investigated. Availability of K and P increased with fertilizer application. There was considerable downward movement of K but that of P was restricted. The phosphorus fixing capacities of laterite and sandy soils were estimated at 500 - 1375 mg/100 g and 25 - 112.5 mg/100 g of soil, respectively.

Dwarf and T x D seedlings were found to be more tolerant to water-logged condition than the Tall variety. In pot-culture studies with river sand, coconut palms produced plenty of roots and flowered under water logged condition. But with sandy loam soil, however, they died and showed root decay.

Soils associated with diseases:

An intensive study on the nutritional aspects of the disease has been completed at the Central Plantation Crops Research Institute. Soil and tissue samples collected from healthy and diseased tracts of Kerala, covering all the major soil groups were analysed. The salient findings were:

(1) Lower status of sodium, sulphur, manganese, iron and zinc was observed in the soils from diseased tracts;

(2) Magnesium, sulphur, aluminium, manganese, iron, zinc, boron and molybdenum were low in the tissues of palms of the diseased tracts;

(3) Deficiency of major nutrients were not found to be directly related to disease incidence. But imbalance

of nutrient ratios in the leaf tissues was evident. Considering the nutrients in relation to essential and sufficiency (critical) levels, it was found that zinc and molybdenum were the limiting factors. A field trial has been formulated in a severely disease affected area at the CPCRI Regional Station, Kayamkulam to confirm the above inference.

II. RESEARCH WORK IN PROGRESS

1. a) NPK fertiliser experiments on young palms to determine the optimum NPK requirements of the Tall variety in different agroclimatic regions.
   b) Fertiliser experiments to determine the needs of high yielding genotypes like D x T, T x D, Laccadives etc.
   c) Fertiliser experiment on neglected palms to work out the schedule of fertilisers in the first few years.

2. a) Irrigation cum fertiliser experiment to find out the optimum depth and frequency of irrigation and the fertiliser requirement of palms growing under irrigated conditions.

   b) Efficiency of different moisture conservation measures under rainfed conditions in sandy loam soil.

3. a) Spacing cum system of planting experiment on Tall variety to find out the optimum palm density and the efficiency of different planting systems.
   b) Permanent observation plots to study the long term effect of neglect, cultivation alone, herbicides and manuring on the soil properties and productivity of palms.
   c) Establishment and management in deep sands.

4. Intercropping trials with annuals, mixed cropping with cacao, coffee, tree species, and multistoreyed cropping.
5. Agrostology - mixed farming in coconut garden - raising fodder grass and maintaining milch cows. a) in root (wilt) affected area and b) economics and optimum size of holding in healthy area.

6. Crop weather studies in mixed cropping experiment.
7. Studies on the phosphorus nutrition of coconut.
8. Studies on micro-nutrient status of soil and tissues.
9. Role of Ca, Mg and S in the incidence of foliar yellowing and rubbery kernel.
10. Choice of a reflect for analysis in coconut palm for macro and micronutrients.

III. Future line of work

1. Nutritional requirement of the ordinary Tall and high yielding hybrids and varieties under different agroclimatic regions and crop combinations.
2. Crop logging and efficacy of slow release N fertilisers.
3. Water management including use of saline/sea water for irrigation and evaluation of different methods of irrigation.
4. Maximising production per unit area, time and input through multistoreyed cropping and developing suitable crop combinations under different systems of planting and palm densities.
5. Screening intercrops in relation to light availability in coconut plantations.
6. Nonsymbotic N fixing and other nutrient mobilising microflora of soil in intensive cropping systems.
7. Dynamics of available nutrients in different layers of root zone of coconut and inter and mixed crops using specification electrodes.
8. Working out the economics and cost accounting of all agrononic practices including remunerations for varying situations viz. limited availability of fertilisers, capital, irrigation etc.
9. Preparing cropping programmes/farm plans for coconut farmers with varying holding size, resources, etc.
10. Recycling of organic matter wastes with a view to improving the productivity of the land and supplementing the inorganic sources.
11. Microclimatic studies with reference to growth and yield of coconut and mixed crops.

GENETICS

Introduction of promising exotic and indigenous materials in coconut was in progress at this Institute, since 1947. The germplams bank now consists of 59 exotic collections and 32 indigenous collections. Among the introductions fiji and Laccadives have a uniformly high setting percentage while Philippines, Strait Settlements, and F.M.S. produce large number of female flowers. These are being used in hybridization work. In the yield trials Laccadive Ordinary, Laccadive Micro, Andaman Ordinary, Fiji, Java, SS Green, San Ramon and Philippines outyielded the local cultivar. The copra out-turn of SS Green, San Ramon, Laccadive micro, Laccadive Ordinary and Kappadam is 60 to 100% more than that of West Coast Tall.

The hybrids between West Coast Tall and Chowghat Dwarf Orange (T x D and D x T) have been found to be early bearing, high yielding and tolerant to the root (wilt) disease. Chowghat Dwarf Orange is a better parent than Chowghat Dwarf Green. The hybrid D x T gives 25 kg. copra/palm/year as against 13 kg. yield of West Coast Tall. D x T hybrids can be produced by emasculation and open pollination of dwarfs. The hybrids using Laccadive Ordinary or West Coast Tall as mother palms and Gangabondam (a dwarf cultivar from Andhra Pradesh) as male parent have also been found to be promising.

Based on the performance of progenies a few prepotent palms could be identified. Studies on the selected Vs unselected seedlings have shown that selection is a must at the seedling stage. Selection standards for mother palms and seedlings have been standardised. $D^2$ analysis indicated that phenotypic uniformity can cover up considerable genetic diversity. The estimates of relative magintude of additive and non-additive genetic variance for yield in six yield groups and three sets of crosses of West Coast Tall varieties indicated that there is substantial additive genetic variance for selection for yield and associated characters in coconut and the ge neral combining ability for high yield group is large for number of bunches, number of female flowers and yield of nuts. The instability in production of nuts is due to seasonal differences within each year. The number of spikes with one female flower and total number of

spike is found to contribute to greater stability of production than other characters. Nut setting, female flower production, length of leaf, number of leaf scar/metre, number of functional leaves and height contributed maximum towards total divergence.

Observations on Chowghat Dwarf Orange and Tall cultivars like West Coast Tall, Philippines and Laccadive Ordinary indicated that Dwarf showed high selfing intensity (47%). Intraspadix overlapping was the major component responsible for selfing in Dwarf Orange while interspadix overlapping played a major role in the selfing of Talls. Palms homozygous for colour could be identified in the Tall variety. Selfed progenies of Chowghat Dwarf Green showed less variation than those of Chowghat Dwarf Orange indicating higher heterozygosity in the later cultivar.

It has been confirmed that the initiation of inflorescence commences from the 10th leaf axil. It has been brought to light that barrenness begins to develop at the 4th or 5th month of growth after fertilisation. The seasonal specificity of barren nuts helps to identify the bunches producing barren nuts at a very early stage. In the type of barrenness where there is shell development the bunches may either be tapped for toddy or harvested early as tender nuts. But in the rudimentary and pigmy types tapping is the only feasible proposition.

Present work

The breeding programmes on hand mainly attempts at refinements of techniques of introduction, selection and hybridisation. A few fundamental studies to aid the breeding programmes are also attempted.

1. Introduction: Intensification of collection in terms of number of collection as well as palms per collection is now undertaken. Inter se crossing is done to minimise the variation within a cultivar to the possible extent. Cataloguing of the genetic material available in India is being done.

2. Selection: Additional characters are being identified to improve the mother palm selection. Trials have been initiated to locate morphological, physiological and biochemical markers to identify D x T seed-

lings from open pollinated progenies of Chowghat Dwarf Orange.

3. Optimum parental combination: As wide differences are observed within the same inter-varietal hybrids when different palms are used, it is essential to test the optimum palmwise combinations for deriving maximum benefit. Location of specific resistance to root (wilt) disease is also attempted.

4. Multilocation trials: Performance of promising cultivars and hybrids under six different agroclimatic conditions are being assessed in comparison with the locally grown cultivar of each region.

5. Production of new cross combinations: Hybrids between various cultivars identified for one desirable character or the other are being produced and tested.

6. Testing against disease resistance: All the available cultivars and hybrids are being tested in a phased programme for resistance to pests and diseases with special reference to root (wilt) disease. $M_2$ progenies have also been planted in the disease affected area for screening.

7. Genetical Investigations: Detailed studies are under way to work out the genetic parameters. Two sets of diallel crosses involving 36 and 53 hybrids respectively are under trial. Investigations on the genetics of certain important characters are also in progress.

8. Large scale multiplication of hybrids: Elite seed gardens, planted with parents in alternate rows, have been established for production of promising hybrids on a larger scale.

Future programme

1. Maternal effect: Comparative performance of T x D and D x T using specific combinations.
2. Studies on selfed generations: for evaluating performance of crosses vis selfs, potentiality of $F_1$s, and inbreeding depression.
3. Studies on advanced generations: Inter se mating of hybrids and assessment of progeny performance to examine the feasibility of using the hybrids as mother palms and to find out whether selection

in the $F_1$ will enable realisation of a stable $F_2$ population with higher yield.

4. Multiple crosses: Four-way and higher order crosses using the F1s are produced under the full diallel cross.
5. Efficiency Estimation of new breeding programme: Evaluation of the efficiency of the programme initiated using selfed dwarfs and selected talls in a two stage hybridisation programme.
6. Ideal plant type: Defining the ideotype based on crown habit, number and total area of leaves, inflorescence characteristics, yield, yield attributes and related physiologic parameters.
7. Refinement of seedling selection of hybrids: through/flourescence banding pattern of chromosomes and electrophoretic movement of protein fractions.
8. Production of haploids through anther culture for cytogenetic studies and evolution of homozygous palms.

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## DISEASES OF THE COCONUT PALM

a) Root (wilt) disease of coconut:

Distribution and spread.

Root (wilt) disease of coconut, located in isolated pockets in Central Kerala as early as in 1882, is now prevalent in 2.5 out of 7 lakh hectares of coconut plantations in the State between Trichur District in the north and Trivandrum District in the South. The disease occurs in all types of soils from the foothills to the banks of rivers and canals in the low lying areas. Sporadic occurrence of the disease in interior gardens in the healthy area, far away from the diseased belt and existence of healthy palms within the diseased gardens add to the complexity of the problem. The spread of the disease, although slow, is faster in sandy and sandyloam soils than that in laterite soils. Recently the disease has also been observed in the Kanyakumari District of Tamil Nadu at Kulasekharam and Vallon villages.

Symptons.

A critical assessment of the disease syndrome showed that flaccidity or ribbing of leaflets is the diagnostic sympton, with foliar yellowing and necrosis appearing at later stages. Root rot is a major sympton. Recent studies suggest that internal damage to the root system - namely vascular discolouration and disorganization occur prior to the manifestation of foliar symptons.

Aetiology.

The spreading nature of the disease suggests the involvement of a biological agent with the disease. The disease symptons were reproduced under field conditions and controlled conditions by sap transmission from diseased palms as well as by incorporation of roots of diseased palms in the soil substrate. However, soil factors also seem to play an important role. Salient findings of the various aspects can be summarised as follows:-

1. Soil fungi like *Rhizoctonia solani* and *R. bataticola* are found to be associated with the root damage.

2. A strain of tobacco mosaic virus was isolated from diseased coconut tissues and also from healthy material from Kasaragod. Tubular particles were also detected in developing tissues of both healthy and diseased palms. A soil-borne and sap transmissible pathogen which could also be transmitted through an insect vector Stephanitis typicus Dist. was observed in earlier trials.

3. A bacterium identified as Pseudomonas sp. was found to be associated with the rotted roots.

4. Plant parasitic nematodes belonging to 23 genera occur in the root zone of coconut. This includes species of Xiphinema, Longidorus and Trichodorus, all known virus vectors. Role of Longidorus sp. in the transmission of the disease is under study. Large population of Radopholus similis, the burrowing nematode has been observed in the roots of the diseased palms causing severe rotting of roots. The role of R. similis as a primary pathogen or as a disease incitant is under investigation. Thirty species of plants have so far been recorded as hosts of this nematode which include arecanut and banana.

5. Earlier investigations on soil and nutritional factors suggested possible role of calcium and magnesium deficiency in soils in predisposing the palms to the disease. However, critical studies conducted later failed to substantiate this observation. Detailed survey conducted recently indicate the status of zinc in the soil and leaf of the disease affected tract was only half that in the healthy tract. The leaf status of iron, manganese and molybdenum was lower than that of the leaves in the healthy areas. Field experiments have been initiated to study the absorption pattern, optimum dose and plant response of these elements.

6. Physiological studies revealed an internal imbalance in the water economy of the palm, deranged permeability of the root tissue, enhanced rate of respiration, breakdown in translocation system and aberations in nitrogen metabolism. Nutritional studies indicate that foliar yellowing associated with the disease is caused by induced deficiency of megnesium and could be controlled by application of megnesium sulphate.

7. Studies on control of the disease -

(a) Agronomic practices - Series of field experiments conducted so far with major and minor nutrients did not yield any encouraging results in controlling the disease, although improved management tended to increase yield of palms.

(b) Varietal resistance - Attempts initiated from 1950 to locate disease resistant planting material from indigenous and exotic stock have not proved successful. However, a recent survey conducted in the disease affected tract suggest better performance of the hybrids - tall x dwarf and dwarf x tall. In the light of this observation a large number of demonstration plots with hybrids, involving indigenous and exotic germ plasm, have been laid in different soil types.

(c) Chemical control.

Earlier trials with hydrated lime and fungicide pentachloronitrobenezene proved to be effective in controlling the disease in secondary hosts. Further limited trials on coconut seedlings indicate remission of symptoms when treated with fungicides PCNB and Benlate. Broad spectrum antibiotics had no effect. Nematicidal trials have been initiated.

(d) Intercropping.

Intercropping with fodder crops under irrigated conditions reduced foliar yellowing of diseased palms. However, other symptoms of disease namely flaccidity and necrosis showed progressive increase. Yield of the palms increased to the extent of 26.0%.

b) Leaf rot disease of coconut

Leaf rot disease of coconut generally occur super-imposed on the root (wilt) disease affected palms. Nearly 16 to 40 per cent of the palms in different localities in the wilt affected area also have leaf rot disease. Random occurrence of rotting of leaves similar to the leaf rot disease, in a very mild form was observed in north Kerala which is free from the incidence of root (wilt) disease. In both the cases Helminthosporium halodes (Bipolaris halodes) was found to be the associated organism. Inoculation experiments conducted with the two isolates of B. halodes

showed that the root (wilt) affected palms are more susceptible to the fungal infection as compared to apparently healthy palms in the wilt affected area. The healthy palms in the wilt-free area remained free of infection in spite of the inoculation. The disease is most virulent during periods of high atmospheric humidity.

Control.

Fungicidal trials conducted to study the efficacy of copper fungicides in comparison with organic preparations indicated that the two formulations of Dithiocarbamates - Dithane M-22 and M-45 (0.3%) were as effective as Bordeaux Mixture (1.0%) in controlling the disease. The data further revealed that all the preparations retained their potency for less than three months.

Manuring and spraying trials.

The beneficial effect of regular manuring with NPK fertilizers coupled with fungicidal spraying was confirmed. Experiments conducted in different soil types revealed that manuring at the rate of 340 g N + 340 g $P_{205}$ + 680 g $K_{20}$ per palm per year alone reduced the disease incidence upto 6 per cent while in conjunction with fungicidal spraying four times an year the beneficial effect was observed to the extent of 12 per cent. In untreated control palms 4 to 9 per cent disease increase was recorded. Yield of the experimental palms also showed an increasing trend whereas reduction in yield of the controls was noticed.

Effect of Boron.

A field trial was conducted to study the effect of Boron on the incidence of the disease by the application of 0.2 per cent aqueous solution of Boron as foliar spray 1.5 l. per palm at bimonthly intervals and soil application of 227 g and 454 g of Borax per palm per year in split dodes. Data collected after a period of 20 months revealed no significant effect of boron. The average percentage of leaf rot incidence varied from 64.7 to 73.6 in boron treatments and 64.2 in untreated controls.

Future line of work: Root (wilt) disease

1. Assessment of the role of the suspected pathogens, fungi, bacteria and nematodes individually and in association with each other in the development of disease.
2. Evaluation of the effect of application of zinc in checking the disease.
3. Efficacy of systemic chemicals as prophylactic and control measure.
4. Screening for disease resistance.
5. Studies on intercrops, crop rotation and crop management.
6. Physiological and biochemical factors involved in the disease complex.
7. Integrated plantation management - phytosanitary measures - eradication of diseased palms, use of disease tolerant planting material, agronomic practices, general plant protection measures.

Leaf rot.

1. Studies on the factors associated with the incidence of the disease.
2. Efficacy of systemic fungicides in controlling the disease.

## PESTS OF COCONUT

1. Rhinoceros beetle, Oryctes rhinoceros L. is the most ubiquitous pest of coconut palm. An exact assessment of the loss of crop due to Oryctes infestation is only under study. However an increase in yield of 5-6 nuts per palm per year was recorded as a result of controlling the beetle in heavily infested tracts which may give an approximate idea for the damage done. Characteristic cuts on newly opened leaves and holes on unopened spathes and chewed up fibre extruding through holes in the spindle and spathe indicate the attack of the beetle. The pest is seen to breed in manure pits, compost heaps and other decaying organic debris.

Maintenance of plant and field sanitation by proper disposal of all decaying organic materials including coconut palm refuses is an

essential prerequisite which can be profitably practised without much difficulty.

The mechanical method of control by extracting beetles from the innermost leaf axils on the crowns of palms using a beetle hook is seen to be effective. This can be combined with the periodical harvest to reduce the operational cost and can be done during the peak period of pest incidence viz. July-August. Treatment of the breeding sites of the beetle where the early and vulnerable stages of the pest are present is quite essential. BHC 50% wettable powder at the rate of 350 g per 3 $M^3$ in the breeding material is quite effective in suppressing the population. 0.01% Aldrin/Carbaryl also effect successful control of grubs. Breeding material should be raked well so that the insecticide suspension in water is thoroughly mixed with it.

The prophylactic method involves filling the innermost 2 or 3 leaf axils using 5% BHC/Chlordane dust mixed with sand in equal proportion. This is to be done thrice a year in April-May, September-October and December-January.

Biological control methods using the indigenous predators Agrypnus sp., Scarites sp., Santalus parallelus and the exotic Platymeris laevicollis exert considerable check on the pest population by their feeding on the different stages of the host. The nematode DD-136 (Neoaplectana carpocapsae) together with the associated bacterium Achromobacter nematophilus has been proved effective against the various larval stages of the pest. The pathogenic green muscardine fungus Metarrhizium anisopliae also effect control of the pest. Studies with the pathogen Rhabdionvirus oryctes is in progress.

Ecological manocuvring is proved useful in control of this pest. Cattle-dung with a moisture content of 40-60% and having a temperature 20-40°c is found congenial for the breeding of the beetle. But too dry cowdung with moisture 5-10% or too wet 80-100% and temperature above 40°c is not conducive to multiplication. Thus by regulating the moisture content of the breeding medium a check in the breeding can be effected without any

additional expenditure.

The efficacy of the above methods of rhinoceros beetle control has been proved in separate experiments. Now they are to be tested in an integrated manner under an adaptive research programme to be implemented by the Kerala State Department of Agriculture in several Districts. CPCRI is to collaborate by passing on the technical know-how.

2. Red Palm Weevil, Rhynchophorus ferrugineus F. is the enemy that strikes to kill the palm. Grub is the harmful stage. It is found serious in India particularly Kerala, Tamil Nadu and Karnataka. The damage by the pest if left untreated results in eventual death of the palm. Nearly 5% of the total palms in Kerala are found infested by this pest. Infestation occurs mostly on palms between 5-20 years. In the early stages of the infestation symptoms are not quite apparent while as it progresses the infested trees manifest small holes on the stem and leaf base from where chewed fibres protrude and a brown fluid ooze out. Leaves including the heart leaf wilt and dry up. Longitudinal splitting of petioles and gnowing sound of feeding are other sure symptoms that help in identifying infestation. The damage done by Oryctes often paves way for weevil entry. The pest being a tissue borer identification of pest attack at an early stage is an essential prerequisite for adopting suitable control measures.

Injection of Pyrethrins-piperonyl-butoxide (Pyrocon-E) is an effective curative treatment. Carbaryl is also effective and cheaper. 10-15 ml of Pyrocon-E $\frac{2}{20}$ or 20-30 g of Carbaryl (Sevin)50% W.P. suspended in 1000-1500 ml water is required for curing an infested palm. This is to be administered through the red palm weevil injector(funnel).

Filling of all leaf-axils of young palms with a mixture of 5% BHC/Chlordane dust and sand in equal proportion thrice a year is a good prophylactic method of control. Mechanical-cum-sanitational methods are also essential, which involves cutting and burning very badly infested palms beyond recovery. Treatment of injured portions such as cut end of leaf stalks, holes and injuries on stem, rotting tender leaves and bud with BHC prevents entry of the pest. Leaves, if necessary, are to be cut at

a distance of 120 cm or more away from the base. By providing traps, using tender coconut stems treated with fresh toddy, the weevil can be attracted and killed. Prevention of injury to palm is also a pre-requisite for checkmating the spread of the pest.

The exotic predator Platymeris laevicollis is found to feed on various stages of the pest in cages and on adults in the field and the earwig Chelisoches moris feed on the eggs.

3. The leaf eating caterpillar Nephantis serinopa M. prevalent along the coastal States in India is found to feed on leaflets from underneath. They live in galleries and defoliate the palm.

Mechanical, chemical and biological methods must be adopted in a phased programme depending on the intensity of attack. Mechanical method of cutting and burning the very badly affected leaves of the outer whorl prior to spraying helps in control of the population. Similarly in trees where the pest appear new and in a mild form cutting and burning helps. Biological method by the release of laboratory bred indigenous and exotic parasites has also proved to be effective. Field experiments conducted at Badagara (Calicut District) during 1970 with integration of mechanical and biological methods reduced the pest population from 2-3 pest per leaflet to 2-3 pest per palm.

In severe epidemic outbreaks chemical method may be resorted to for immediate relief. BHC 0.2% or malathion 0.05% is quite effective in the control of the pest. Spraying the insecticide suspension on the lower surface of the leaf is to be done three or four times a year, before and after rains, depending on the intensity of attack. Parasites may be liberated 3-4 weeks after insecticidal application. Liberation of the exotic parasite Spoggosia bezziana Bar. in endemic tracts can improve the scope of biological control.

4. The Cockchafer beetle, Leucopholis coneophora and allied species attack roots of coconut and intercultivated crops. Grubs are the harmful stage. They are found mostly in sandyloam soil. The worst damage is done just after the premonsoon showers.

Tilling and deep plouthing of the soil expose the grubs to dessication and to predacious natural enemies. Application of 5% BHC/Aldrin or 30% heptachlor @ 120 kg/ha twice a year in April and August proved effective in reducing pest population. Endrin granules @ 7.5 g of active ingredient, applied twice a year for 50 $M^2$ plot gave maximum reduction of the pest.

5. Among the minor pests the slug caterpillar Contheyla rotunda H. has been observed as a serious pest of coconut. In cases of epidemic out breaks they denude the tree attacking even green spathe, petioles and tender nuts. Severe defoliation causes heavy reduction in yield. Out breaks are controlled by spraying BHC/0.1% or Carbaryl 0.05%. They are attacked in nature by parasites and fungal and baceerial diseases, which are found to play a considerable role in suppression of the pest.

Other pests of importance are a slug caterpillar Macroplectra nararia, a very serious pest in Andhra Pradesh, butter fly caterpillars Gangara thyrsis and Suastus gremius poests in coconut nurseries, Stephanitis typicus (suspected to be a vector of the root (wilt) of coconut), Aspidiotus ddstructor, Pseudococcus longispenus, Odontotermus obesus, locusts etc. The Coreid Paradasynus sp. is a new pest in India. Nymphs and adults feed on buttons and immature nuts and cause shedding.

Among the mammalian pests rats and bats are important. Rats attack seedlings and tender nuts and bats feed on immature nuts of all ages. The control methods proved effective at CPCRI include using poisoned baits (Zinc, phosphide and Coumarin compounds), trapping, Cyanogas fumigation in burrows and erection of physical barriers on individual palms.

Programme of work:

Investigations on rginoceros beetle Oryctes rhinoceros L.

1. Chemical control.

i) Lab. studies - bioassay using granular insecticides.

ii) Field studies a) Studies with attractants.

b) Adaptive Research programme of Agriculture Department, Kerala (Collaboration).

2. Biological control.

i) Parasites - Nematode DD-136*

ii) Predators - Platymeris laevicollis (Reduviid)

iii) Pathogens - a) Metarrhizium anisopliae.

b) Rhabdionvirus Oryctes.

3. Pesticide residue analysis (work to start after commissioning of biochemistry wing)

Investigations on leaf eating caterpillar Nephantis serinopa M.

1. Chemical control - effect of insecticides on beneficial parasites.

2. Biological control a) Laboratory breeding of parasites.

b) Studies on Spoggosia

c) Norm fixation

3. Integrated control - spraying insecticides and liberating parasites after an interval.

Investigations on the red palm weevil Rhynchophorus ferrugineus F.

1. Chemical control (a) bioassay singly and in combination of various insecticides.

(b) Field tests using nevinphos, phostoxin.

2. Integrated control using all the conventional proved methods of control.

3. Sterile male release method for the control of red palm weevil (collaboration with BARC Trombay)

4. Pesticide residue analysis (work to start after commissioning of biochemistry wing)

Studies on Minor pests.

1. Studies on mites.

2. Control of rats.

3. Studies on new pests.

Studies on the Coreid bug Paradasynus sp./any other new pest or existing insects appearing in pest form.

Estimation of crop losses due to pests.

Future lines of research work (IVth Session)

Taking into consideration the temporary nature of the results achieved by the conventional method of control particularly chemical and the harmful side effects of using large dozes of toxic chemicals at frequent intervals, though the results achieved are at times convincing the latest trend among plant protection workers is to adopt an integrated method.

1. Rhinoceros beetle - Attempts are being made to integrate ecological manoeuvring, sanitational-cum-mechanical, chemical and biological methods and evolve suitable pest control schedules. The use of pathogens will be an essential item.

2. Leaf eating caterpillar - Use of exotic parasites and the pathogen Bacillus thuringiensis to increase the scope of the integrated method.

3. Red Weevil - We have a project on autocidal method of control in collaboration with Trombay. If we are able to do it on a large scale and are convinced of the efficacy we will incorporate the same into an integrated programme for control of this deadly enemy of coconut.

4. Use of Chemosterilants - Though the present studies are confined to rats we are to extend the same to a few major pests, if technically possible and economically feasible.

5. Studies on the use of pheomones as an attractant can also be attempted in the case of Nephantis and Contheyla

COCONUT CONVENTION OCTOBER 9TH & 10TH KERALA AGRICULTURAL UNIVERSITY

## REPORT FROM THE COCONUT DIRECTORATE

Note for discussion at the convention of workers engaged in Research and Developmental Activities of Coconut.

Majority of coconut growers in Kerala, who form the back bone of the rural economy, are small farmers and lead a sub-marginal level of living. The uncertain price behaviour and frequent fluctuations in the prices of coconut products make their lives gloomy. The coconut oil extracted from milling copra, the monopoly product of Kerala, has lost its unique position as an industrial raw material due to technological developments and availability of other cheaper substitutes. The price of coconut oil has crashed in recent months and the chances of revival to its original level is rather remote. Therefore it is high time to recommend appropriate technology to the growers which would help in augmenting the farm level income. Much in this regard could be done by unifying the activities of various State and Central agencies engaged in coconut research and development. The following problems assume prime importance in this context.

1. Proper utilisation of Research findings for fostering economic growth and development.

Very useful research findings of economic importance are available, but are not utilised for the formulation of policies, decisions and courses of action.

Some of the exotic cultivars introduced as long back as 1924 and 1951 at Nilwshwar Research Station, based on the performance of direct introductions and performance of open pollinated progenies at Kasaragod, have proved beyond doubt to be superior to west coast tall both in copra output and yield of nuts. This result combined with the findings on the influence of pollen parents on copra output, published from Kasaragod could profitably be used in the propagation of the most prominent types among our cultivators.

We have not so far recognised the importance of such findings

in revolutionising coconut culture. The yield of nuts, copra output, fibre and shell weight etc. are poor in India compared to those in other major coconut growing countries. Had we established seed gardens with imported cultivars of identified supremacy for multiplication and large scale distribution to the growers, the impact on our coconut industry would have been felt by this time.

Therefore it is essential to screen all the results obtained so far and pick up those with commercial feasibility and ensure speedly implementation of programme based on the findings.

2. Mixed farming and intercropping in coconut gardens.

The research has already identified crops suitable for intercropping in coconut gardens. Sufficient knowledge regarding mixed farming is also available. Adequate data based on experience on the comparative merits and demerits of mixed farming when implemented on compact area basis and also on scattered unplanned coverage basis are also available. The cultivators are also practising these to some extent in isolated localities. What is needed is systematic intensive approach to identify crops and activities suitable for each taluks of the State and implement or help the cultivators to implement the programme. The individual farmers need not always be the best judges in these aspects as identification of crops and activities are to be based on agroclimatic conditions and also on market facilities for easy and profitable disposal of the end products. The crops may cover tapioca, ginger, sweet potato, yam, pineapple, forage, cocoa, tree spices etc. and activities may include dairying, sheep rearing, poultry, bee keeping, fish culture etc. A planned approach, with emphasis on food items is very much needed in this field.

3. Coconut development in the disease affected areas.

The devastating root wilt disease has already shaken the edifice of our coconut industry. The disease has been prevalent here for the last 90 years. It has now spread to over 30 per cent of the

coconut area. It is prudent to accept the reality that research though could enrich our knowledge on the various aspects of the disease is not likely to yield conclusive results very quickly because of the complexity of the problem. The situation in other coconut growing countries is also the same as far as disease of unknown aetiology are concerned. Hence from the development angle the most immediate objective should be to exploit the present know-how in order to alleviate the distress of the coconut growers and to improve the coconut based rural economy. The only feasible way of accomplishing this objective is by implementing such programmes as could ensure productivity increases of coconut. The following action oriented programmes are suggested to ensure productivity in the diseased areas.

(a) Special Package Programme

This involves the following package of practices.

i) Provision of drainage, both surface and underground according to the requirement in the operational unit.

ii) Application of calcium and Magnesium in the form of dolomite.

iii) Application of silt and organic manures to build up enough organic matter and proper soil structure.

iv) Regular and systematic underplanting and also replanting where the palms have reached the irredeemable stage of infection with D x T hybrids. In the absence of adequate D x T planting material T x D hybrids and West Coast Talls could be used.

v) Regular plant protection to check leaf rot and other infectious diseases.

b) Integrated area approach for mixed farming and intercropping

The mixed farming and intercropping programmes may be implemented in small operational units which are endowed with the basic

facilities necessary for the successful implementation. The programme should be well conceived, properly organised and effectively coordinated.

(c) Alternate cropping.

A slow introduction of alternate cropping like oil palm in the disease affected areas is another approach with a long range perspective. This programme could be taken up confidently and the existing processing facilities available in the Anchal plantations could be made use of until optimum acreage is built up in the growers holding. For this purpose a major scheme could be formulated providing adequate financial assistance.

4. Organisation of model farms in every Panchayat.

The technological skill and knowledge possessed by the graduates in agricultural sciences or persons well experienced in agriculture have to be utilised for raising farm outputs. They can be helped to start model farms of about 5 hectares in each village/taluk and maintain them as mixed farms which will act as demonstration farms to others in the area. Through such people, the modernisation of agriculture in the area could be brought out by making arrangements for proper coordination with other cultivators and authorities concerned.

COCONUT CONVENTION OCTOBER 9TH & 10TH KERALA AGRICULTURAL UNIVERSITY.

REPORT FROM THE DIRECTORATE OF AGRICULTURE

TECHNICAL PROBLEMS IN COCONUT CULTIVATION AND SUGGESTION FOR RESEARCH

I. (a) The present day strategy to increase yield per unit area consists in the scientific cultivation of high yielding varieties of crops and in multiple cropping. Multiple cropping includes cultivation of annuals more than once in the same area during a year or intensive intercropping in perennial plantations. The most important perennial plant cultivated in the state is coconut. The area under coconut invariably possesses an adequate space for intercropping. Therefore, the utilisation of the interspace in coconut gareens will determine, to a great extent, the possibility of intensifying agricultural production in the State. For this purpose, it is necessary to have a planned programme both in the choice of crops to be used for intercropping in coconut gardens as wellas in the plant type in coconut. It is not uncommon to see coconut trees with very long leaves, yet with low yielding ability. This type of plants does not help the farmer either in the production of coconuts or in his intercropping programme. By plant type in coconut it is meant that the plant should have compact, umbrella shaped crown with leaves possessing short stout petioles, so that the whole plant system occupies only a reasonable space and makes it possible to utilise the solar energy in photosynthetic activities in the most efficient way possible. A knowledge of the optimum number of functional leaves in a tree is also important in determining the desirable type of crown a plant should have. If a plant type possessing the above desirable characters could be evolved or selected, the interspace which may be available for intercropping will be much more than at present that is, even if the same number of coconut plants as before are maintained per unit area. Incidentally, this may also help in accommodating more number of plants per unit area. When planting is done in such a way that the distance between rows in greater and within rows shorter with this plant type, the interspace available can be profitably utilised for intercropping. In fact in the large population of the crop we come across, such plant types are not rare. But coconut being a highly heterozygous plant, it is really a difficult problem to get the same characters reproduced in the progenies to the same extent. Possibly hybridisation followed by

selection procedures which may be drawn for the purpose may help in getting at progenies of the same type to an appreciable extent. The possibility of eveolving such a plant type for the best production of coconuts coupled with the possibility of offering chances for better intercropping in coconut gardens may be discussed.

b) It is a common practice to cut and remove the older leaves of coconut in summer months. There is a belief that removal of such leaves favours the production of more nuts. It may be confirmed by experiment whether this practice is worth following or deterimental in coconut cultivation.

II. Selection of seedlings in the Nursery:

It is well known that younger the seedlings, better the chances for early establishment in the main field. But the system now followed is the selection of seedlings in the Nursery when they are about 9-12 months old. This is based upon the fact that selection of seedlings would be easier at this stage. But by this time the roots of the seedlings would have established fairly well in the soil. The apple inside the nut also would have been used up by the plant to a large extent. Hence a seedling removed at this stage takes a very long time to get itself established in the main field, i.e. for the production of new roots and for putting forth new leaves. It is a common practice to observe that the seedlings so planted takes about 1 to 1½ years to recover from the shock that has been sustained by the removal from the Nursery. It is not due to any careless way in which the seedlings have been lifted from the Nursery, but it is due to the fact that the seedling cannot establish in a better way and pick up growth during the period of about one year in the absence of adequate reserve food in it and well established root system. These seedlings often present a weak and lanky appearance with their outer leaves dried up, however much care is bestowed on them. If selection criteria could be evolved for early selection and removal of seedlings from the Nursery before the seedlings have actually putforth a large number of roots and have fixed themselves in the soil (4-5 months after germination), this situation can be avoided and

will go a long way in getting them established better in the main field. This procedure would result in better and vigorous growth of seedlings during the first year itself eventually leading to early bearing of the plants.

III. Reclamation of clayey and sandy soils for coconut cultivation:

In as much as the fertile lands available at hand are being utilised by the cultivators for the cultivation of coconut, wherever possible, the possibility of extending coconut cultivation in the state lies in the reclamation of backwater areas and the long sandy stretch of land along the west coast for coconut cultivation. But standardised techniques to utilise these areas have not been evolved. For instance, in backwater areas coconut seedlings are planted on mounds. Certain people heap up mud, put some sand at the top and plant the seedlings. Others use coconut husk also in making the heaps. No standard procedure has been advocated so far for undertaking planting in such areas, so much so, we find large extents of land planted to coconut remaining unyielding even to the 10th or 12th year. If certain standard practices can be evolved and popularised it must be possible to get the yield from such plantations quite early.

In sandy soils it is a common practice to bury the coconut husks and then plant the seedlings on the same or to line the pits with coconut husks. This operation of lining pits with coconut husks with concave surface up can be done with varying number of husks. But no standard is available to make sure whether the pit should be lined with a specific number of husks in a particular sandy tract. This leads to either wastage of husks or insufficiency of husks for the proper growth of the seedlings.

Depth of planting in sandy tracts also possess equally important problem in coconut cultivation - whether it should be at 2', 3', 4' or 5' and so on to obtain an optimum growth for the plant. In fact the whole package or practices for growing coconuts in reclaimed areas of clayey soils and sandy soils has to be provided for boosting up production of coconut in the State.

The coconut trees suffer from the effects of severe drought from December-March, especially in the northern districts of the state where North East monsoon is quite megre. Irrigation of the coconut plantation situated in lateritic soils of this area is also impractical. Methods to conserve moisture in coconut gardens of this area have to be evolved.

IV. Utilisation of coir dust as a mulch:

A large quantity of coir dust formed in the prccess of local coir manufacture is being wasted. This organic substance is likely to bring about very important beneficial effects when applied at the right time in correct doses, i.e. for the retentivity of moisture and for improvement of soil conditions. In fact any organic matter, no matter how hard it is, will be converted in due course of time into humus by the micro-organisms in the soil. Therefore, it is quite important that methods have to be evolved for the best utilisation of this waste product for the good cultivation of coconuts in coastal areas, where procurement of green manure is a problem for the cultivators in manuring the coconut plants.

V. Irrigation:

Only very few studies have been made with respect to the water requirements of coconut. It is essential to have precise information on the water requirements of coconut in the various types of soil. This problem is all the more important in the context of providing artificial irrigation to coconut plantations either from command areas of major irrigation works or from local water resources. An intimate knowledge on this aspect will throw light on the quantity of water required by the plant in each soil type which will eventually help in working out the best utilisation of the available water.

VI. Undesirable characters noticed in hybrid population:

In TxD progenies it is a common occurrence that the plants show bunch buckling and less tolerance to drought resulting in dropping of leaves and shedding of buttons. Irregular bearing or alternate bearing

in TxD progenies is also not uncommon. In certain cases the hybrids having given initial good yields have failed to maintain the same standard. Most probaly these characters are transmitted by the green dwarfs in their combination with the tall. In green dwarfs these characters are pronounced. The occurrence of the above undesirable characters in TxD progenies makes cultivators feel diffident sometime about the usefulness of planting TxD seedlings, especially in large numbers. A remedy has to be found out for eliminating these undesirable characters in TxD progenies. Perhaps the solution lies in the selection of suitable male parents and utilising them alon e in crosses. Indiscriminate use of an apparently suitable male parent in a cross is likely to lead to difficulties of this sort in future. For, parents which are apparently good need not give progenies of the same or better standard when they 'nick' together, especially in the case of heterozygous parents. The solution of the problem perhaps may be found by studying the combining ability of parents and by the application of rigorous selection procedures in nursery, making use of selection indices.

VII. Intercropping coconut gardens with fodder crops:

The possibility of growing fodder grass as an intercrop in coconut plantations has been studied to some extent by C.P.C.R.I. But this field requires more investigation, though it is possible to replenish the depleted soils to a considerable extent with the cowdung that is obtainable from a cow, which has been maintained on the grass produced by intercropping in a specified coconut area. However, grass being a plant, that exhausts the soil of the nutrients in the long run, it is essential to find out whether such intercroppings could be substituted with leguminous plants which would enrich the soil and at the same time afford fodder for the cattle. If this idea is agreed to the best leguminous plants suitable for the various soil types in Kerala have to be picked up. Investigations in this line may be undertaken.

VIII. Perhaps the most dreadful disease of the coconut palm is root wilt. No specific remedy has been found out so far to save the crop from the disease. Coconut cultivators in Trivandrum, Quilon, Alleppey, Kottayam

Ernakulam, Idikki and parts of Trichur are actually scared of this disease. The real success in coconut cultivation in such disease affected areas lies in finding out suitable remedial measures to combat the disease since it is also known that leaf rot is linked with root wilt in the crop.

IX. Although studies on the relationship between the incidence of root wilt of coconut and deficiency of micro nutrients have been programmed for certain specific areas, an exhaustive investigation of the problem for the different tracts of Kerala with various soil types has not been planned so far. The question of use of micro-nutrients in the cultivation of coconuts assumes more importance when the package of practices involving higher doses of N.P.K. are advocated. An exhaustive study in this line may, therefore, be undertaken to know the impact of the use of the micro-nutrients in the production of coconuts.

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