INDIAN CENTRAL ARECANUT COMMITTEE

ANNUAL PROGRESS REPORT

OF

THE CENTRAL ARECANUT RESEARCH STATION, VITTAL, SOUTH KANARA DISTRICT, MYSORE STATE.

FOR THE PERIOD

1ST JULY 1963 TO 30TH JUNE 1964.

Office:

CALICUT, KERALA STATE

CONTENTS

		Page
A.	Introduction	1
B.	Summary of work done	2
C.	Seasonal Conditions	10
D.	Technical Programme for the year 1963-64	11
E.	Results:	
	(i) Botany	15
	(ii) Agronomy	33
	(iii) Statistics	56
	(iv) Pests and Diseases	57
F.	General	67
G.	Technical Programme for the year 1964-65	74
H.	Appendices	
	I. Rainfall data	81
	II. Experimental data (Tables I to XXVIII) ...	82
	III. Set up of the Central Arecanut Research Station, Vittal ...	109
I.	Location and Plan of the Central Arecanut Research Station, Vittal ...	111

Annual Progress Report of the Central Arecanut Research Station, Vittal, Mysore State for the period ending 30th June 1964.

A. Introduction

The Central Arecanut Research Station, Vittal was started by the Indian Central Arecanut Committee in April 1956 with the main object of carrying out fundamental and applied investigations on Botany, Physiology, Agronomy, Soil Chemistry and Pests and Diseases of arecanut crop in addition to solving the regional problems of its cultivation and production. The Station, which is the Central Research Institute for arecanut is also to plan and co-ordinate the work of the Regional Research Stations which are set up by the Committee in the major arecanut tracts of India*. The Station also renders advisory work on various aspects of the crop.

This is the eighth annual progress report of the Station, and covers the period from 1st July 1963 to 30th June 1964.

The Station is located in Vittal Village, Buntwal Taluk of South Kanara District of Mysore State, 41.8 km. (26 miles) from Mangalore Railway Station on the Mangalore-Vittal-Puttur highway, and 51.5 km. (32 miles) from Kasargod on the Kasaragode-Mangalore highway. It lies on 12° 15″ N. latitude and 75° 25″ E. longitude. The altitude of the station ranges from 73.00 to 91.44 m. (250 to 300 feet) above mean sea level.

The winding rivulet Vokkethur runs placidly along the north-eastern boundary and then through the middle of the Station, and is the main source of irrigation.

The soil at the Station is typically lateritic and is admixed with sand, alluvium and gravel, in varying proportions in different locations. It is generally acidic, with a mean pH of 5.25.

The total area of the Station is 48.37 ha. (119.08 acres) and is being utilised as detailed below:

1. Bulk garden for study of progeny behaviour of mother palms and conducting miscellaneous observations. 2.23 hectares.

*1) Hirehalli, Mysore; 2) Peechi, North Kerala; 3) Palode, South Kerala; 4) Mohitnagar, West Bengal; and 5) Kahikuchi, Assam.

2.	Exotic types and species collection.	0.40	hectares.
3.	Spacing experiment	0.88	,,
4.	Manurial experiment (N. P. K.)	2.03	,,
5.	Effect of organic and inorganic forms of N. P. K.	0.36	,,
6.	Method of aligning garden	0.24	,,
7.	Experiment with banana as intercrop.	1.22	,,
8.	Miscellaneous Botanic and Agronomic observations	0.62	,,
9.	Bulk and experimental nurseries	1.80	,,
10.	Miscellaneous crops like coconut, cashewnut etc.	12.51	,,
11.	Green manure crops and fallow	22.10	,,
12.	Buildings, road etc.	3.98	,,
	Total	48.37	,,

B. Summary of work done

The following is a summary of the work done at the Central and Regional Areacanut Research Stations:

1. Botany

At the Central Station, seedlings of the 17 exotic species and types introduced from eight foreign countries and planted in the main field during 1961-62 along with the local type were under detailed observation. Morphological data of the above plants recorded showed that the types introduced from Fiji, China, Saigon (1) and Singapore were more vigorous than the rest. Data gathered with a view to assess the initial productive potential of the different introductions showed that the type introduced from China produced the maximum number of female flowers per inflorescence. A study of these types and species with reference to their susceptibility to mite infection showed that the different types of *A triandra* and *A concinna* were relatively resistant to this pest. Detailed type and species description of these introductions covering 44 characters had commenced. Observations recorded on production of suckers showed that *A concinna* suckers more profusely than *A trindra*. During the year, twelve exotic types and species obtained from four foreign countries were transplanted to the main field. Seednuts of three more exotic types were introduced during the same period from Formosa and New Guinea.

Ten seedlings in each of the eight indigenous types planted during the previous year recorded satisfactory growth. Three more indigenous types, one each from Shrivardhan (Colaba District) and Dapoli (Ratnagir

District) of Maharashtra State and one from Thirthahalli of Mysore State were added to the existing collections. Similar collections of indigenous types and a few of the exotics were made at the Regional Stations also. Forty eight seedlings of two mother palms of the local type were planted at two fruit Research Stations of Coorg District of Mysore State, for study of their performance at higher altitudes.

A sampling technique worked out for the cultivar study showed that a twelve nut sample size was adequate for the survey. Studies on the floral biology were continued in the main garden of the Station. It was observed that at the Central Station the number of inflorescences produced in a tree ranged from nil to eleven, and the largest number of trees produced inflorescences ranging from four to eight. Studies on the month-wise variation in flowering showed that the percentage of inflorescences to leaves shed was more or less the same during the current as well as in the previous year. It was also observed that the maximum percentage of inflorescences was produced in the months of January to April. Similar studies on floral biology were continued at the Regional Research Stations and at the Regional Station, Thirthahalli. 100% overlapping of male and female phases within the same inflorescence as well as between different inflorescences of the same tree were observed in certain palms. A study of the yielding behaviour of the progenies of different mother palms showed that there was considerable variation in their yield which might probably be due to the differential transmitting ability of the different mother palms in respect to the character.

At the Central Station, germination studies of pollen grains of arecanut were continued during the year. A medium consisting of 0.5% sucrose and 0.1% agar was found to be ideal for pollen germination; and pollen in this medium gave significantly higher germination than in 0.5% sucrose alone. Pollen produced in the months of December to May gave higher germination than that produced in other months. Studies on pollen storage continued during the year showed that the maximum germination was obtained after seven days of storage and that a high viability was maintained even up to 21 days of storage. Studies on humidity in the storage chamber and pollen germination were initiated during the year. It was observed that the humidity inside the storage chamber comes to a constant level almost immediately after the commencement of the storage, maintaining the same at the level of 17 to 20%. Since no variation in humidity level inside the storage was observed, the variation in viability of pollen appeared to be not related to humidity. It was, however, observed that

even with constant humidity, maximum germination was obtained after seven days storage as reported earlier.

Studies on standardisation of crossing technique showed that tryophane bags reduced fruit set. Cloth bags were found to give sufficient protection against the entry of foreign pollen. It was also observed that spray application of pollen hastened the hybridisation work.

Selfing was taken up on South Kanara and Thirthahalli types for the production of homozygous lines. Selfed nuts obtained from exotic palms of Andaman and Indonesia were sown along with open pollinated nuts. Selfing was initiated in the Chinese type. Crosses effected between the selected palms of the local type showed that the extent of fruit set varies considerably between different palms and that there were wide reciprocal differences. Crosses were also effected between certain mother palms of outstanding performance of the local type as well as between the local and the Thirthahalli types for combining high yield and regular bearing habit. With the same objective, crosses were also effected between some exotic types and selected palms of the local type.

Preliminary studies on the progeny behaviour of mother palms were continued, and data gathered showed that there was an increase in the number of female flowers produced by the progenies of different mother palms as compared to the previous year. A fresh experiment designed to find out how far the selection of mother palms and seednuts influenced germination and turnover of quality seedlings as well as their performance in the main field was laid out. The germination data and morphological characters of the sprouts gathered from this experiment showed that seednut selection was effective but not mother palm selection.

Studies on leaf anatomy and cytology were initiated. Trial with assisted pollination repeated during the year showed that a higher fruit set was obtained when natural pollination was supplemented by spraying pollen. Trials with Gibberelic acid showed that fruit set could be considerably increased by spray application of this hormone at 1000 p. p. m.

A fresh batch of seednuts were irradiated with different doses of X-ray for inducing genetic variability. Treatment of sprouted nuts with colchicine was also continued. Pollen irradiated with different doses of X-ray was used for pollination.

Correlation studies were undertaken for finding out the correlation existing between the time of germination and morphological characters of

sprouts in the primary nursery. Suitability of Bartlett's index for comparing the germination pattern of seednuts in different lots or treatments and the correlation that existed between the Bartlett's indices of different lots with morphological characters of their sprouts and seedlings were also studied.

2. Agronomy

Experiments to standardise the nursery practices were continued during the year both at the Central and at the Regional Research Stations. Germination data gathered at one of the Regional Stations showed that seednuts collected from old palms gave higher percentage of germination. Seedlings raised from the second bunch of the palms of the same age group were also found to have more girth, height and number of leaves. Trials laid out in all the Stations did not show any significant difference in regard to germination percentage between seednuts possessing different floating habits. However, seedlings from vertically floating nuts recorded significantly higher height. The trial laid out at the Central Station did not show any significant difference in regard to germination percentage of seednuts of different maturities ranging from 9½ months to 10½ months. The results obtained at the Regional Arecanut Research Station, Mohitnagar were, however, slightly at variance with the above finding.

Studies on position-cum-depth of sowing seednuts carried out at Central Station showed that sowing seednuts in vertical or slanting positions at 0" and 1" depths gave higher percentage of germination. Results of similar trial laid out at Regional Station, Mohitnagar, did not show any significant difference in germination between different depths. Trials on the effect of different intensities of shade on seednut germination showed that nuts sown under partial shade and complete shade gave significantly higher percentage of germination than the nuts sown in open. The mortality percentage of sprouts was also significantly higher in open conditions. The death of seedlings under partial and complete shade was rather very low and did not differ much among themselves. Different pre-sowing treatments given to seednuts did not reveal any significant difference with regard to the morphological characters of the resulting seedlings.

In the trials on the use of different packing materials for arecanut seedlings intended for long distance transport, it was found that seedlings packed with alkathene film established better than seedlings packed with either dry grass or arecanut leaf-sheath. Trials on frequency of irrigation showed that increasing the interval between irrigations beyond two days significantly reduced germination. Among the different shade crops (other

than banana) tried for arecanut nurseries, *Coccinia indica* again proved to be the best during the second year of its trial at the Central Arecanut Research Station. In the trial to compare the effect of different media and methods of raising seed beds on germination of seednuts it was found that raised beds were equally good as trenches for sowing seednuts, thus indicating that the former method may be useful for places where the soil is heavy and ill drained.

In the spacing experiment planted in 1958 at the Central Station, studies on the influence of spacing on (i) sun-scorch of stems, (ii) production of spadices, (iii) number of female flowers produced and set, and (iv) yield, were made. It was observed that as the spacing increased, there was a progressive increase in the number of plants affected by sun-scorch and that the number of spadices per tree and the number of flowers per spadix increased with increase in spacing. Similar results in respect of sun-scorching were obtained in the case of the spacing trial laid out at the Regional Station, Peechi.

An experiment on inter and associate crops in arecanut gardens and another on cover and green manure crops suitable for growing in arecanut gardens were laid out at the Regional Station, Peechi. At the Central Station the different intercrops maintained in specimen plots for trial in arecanut gardens showed that the performance of all of them excepting tapioca is satisfactory. A fresh experiment to study the effect of growing banana in arecanut gardens for different durations covering an area of one ha. was planted in the main field on a 8 x 4 randomised replicated design.

Another trial to compare the usefulness of different locally available mulches for arecanut garden was also laid out. An observation trial to study the desirability of growing arecanut and coconut as mixed crops was also laid out.

Among the different cover crops tried, *Pueraria javanica* and *Calapogonium muconoides* continued to come up well under the conditions prevailing in arecanut gardens.

The second year dose of different manures was applied to the palms under N.P.K. experiment. The growth measurements of plants recorded in this experiment showed that plants manured with green leaf had significantly better height growth. In the same experiment laid out at the Regional Research Station, Peechi, nitrogen was found to have significently increased

the girth and number of leaves. Another experiment to find out the "effect of applying N.P.K. in organic and inorganic forms on palm performance" was laid out in a six year old garden of the Central Station.

In the trial to study the effect of depth of transplanting seedlings-cum-intervals of irrigation on growth and yield laid out at the Research Station, Peechi, it was observed that growth performance of seedlings planted at 23" and 36" depths was better than those at 12" depth. Similar experiment to determine the optimum intervals of irrigation and depths of planting was also planted at two other Regional Stations at Hirehalli and Kahikuchi.

In the harvesting trial taken up at the Central Station to study the quantity and quality of cured produce (*Biligottu*) as influenced by maturity of nuts showed that the output of '*Biligottu*' from the lower bunch (higher maturity) is significantly more than that from the higher bunch. The quality of the former also was found to be better.

At the Central Station, collection of yield data from marked palms for determining the shape and size of plots for field experimentation was continued. Statistical analysis of yield data for the year 1962-63 showed that 12 tree plots gave low coefficient of variation. Other main field observational trials initiated during the earlier years were in progress.

3. Pests and Diseases:

Investigations on the control of different pests and diseases of arecanut were continued both at the Central and the Regional Stations. Trials repeated at the Central Station with different miticides showed that Kelthane and Tedion were effective in the control of mite and in the subsequent re-establishment of the colonies. Similar results were obtained from trials laid out at the Regional Stations.

In the trials on the control of 'Koleroga', the comparative efficacy of the fungicides could not be evaluated due to non-incidence of disease. Trials with 'Intox-8' against white grubs were continued in private gardens. Investigations into the causes and methods of control of button shedding and tender nut fall were continued. The studies confirmed the association of fungi and insects. Large scale spraying trials taken up against button shedding and tender nut fall in private gardens showed that a combination spray of one per cent. Bordeaux mixture plus Endrex reduced the shedding, considerably. The same trial taken up at the Regional Station, Peechi gave

similar results. Field trials laid out to determine the effect of micro and macro-nutrients on some of the common diseases of arecanut palm were continued. Repeated trials both in the field and in the laboratory confirmed that Nickel Chloride was not effective against *Phytophthora arecae* which causes 'Koleroga'.

Trials indicated that MCO and MCOZ were quite effective in the control of the yellow leaf spot in arecanut seedlings. Heavy guage polythene films painted white with enamel paint afforded very good protection to arecanut stems when tied around. Trials to study the nature of incipient fungal infection in fruits were initiated. An on-the-spot study of a new fungus disease of arecanut seedlings in Kadur area was conducted. A species of *Gleosporium* was isolated from the diseased material and the same was found to be pathogenic in inoculation tests. Trials laid out by the Regional Station, Hirehalli, showed that the application of one percent, Bordeaux mixture at intervals of 25 days could effectively check the spread of the disease.

Investigations on the virus association and related studies with reference to yellow leaf disease of the arecanut palms were continued at the Regional Research Station, Palode Observations made on the seasonal influence on the incidence of spindle bug *Carvalhoia arecae* indicated that the pest population followed a six months' growth cycle, peak periods of population growth being August-September, and January-February. Field trials in the control of spindle bug revealed that the pest could be effectively controlled by monthly spraying either with Endrin (0.03 percent.) or Folidol (0.02 percent) or BHC 50% (0.2percent). Studies on plants in the exploratory demonstration plots which received a package treatment consisting of application of macro and micro-nutrients, indicated that the treated plants particularly those in the early stages of attack responded well to the treatments. Improvements in the colour of the foliage as well as reduction in the shedding of nuts were observed in the case of treated palms.

4. Farm management.

At the Central Station the total area under arecanut at the close of the year was 8.0 ha. (19.85 acres). All the gardens were given the normal cultural, manurial and plant protection treatments as per schedule. The first garden covering an area of 2.2 ha. planted in 1957 yielded its second year crop of 4,85,393 fruits valued at about Rs. 26,212 during the year. The

percentage of trees that came to bearing in this garden increased from 78.9 in 1962-63 to 82.6 during the year. A total of 61,641 arecanut seedlings was sold to the growers during the year. The nursery of the current year was sown with 75,000 seednuts. The resources of organic manure at the Station were augmented by planting cuttings of *Gliricidia* on the hillocks and other vacant corners of the farm and by utilising all the available organic refuses for making compost. An area of 190' x 130' was levelled for installing the meteorological equipments. One of the thatched sheds was improved by putting tiled roof and masonry for use as temporary godown. A small room with a plinth area of 132 sq. ft. was constructed near the laboratory building for accommodating the gas plant.

The major construction work at the Central Station undertaken by the Central P. W. D. was almost completed. The approach road connecting Vittal-Puttur highway with the laboratory building of the station and farm was blacktopped. An old well in the farm was improved for supply of water to the quarters and laboratory.

The officers and staff of the Central and Regional Research Stations were in intimate touch with the growers. The number of enquiries from the arecanut planters and the demand for spot-inspections for advisory work increased considerably. The Stations continued to be the centres for suggesting or finding out solutions to the numerous problems confronting the arecanut growers.

Results of research which are of practical utility to the cultivators.

A few important results which are the outcome of research carried out at the Central and Regional Research Stations and are of practical utility to the arecanut growers were as follows.—

1. Nursery technique.

1) For obtaining high percentage of germination in primary nursery as well as for obtaining healthy growth of seedlings in the secondary nursery, shade has to be provided. Partial shade was found to be sufficient. Seedlings raised in open were subject to severe mortality.

2) In order to get high percentage of germination, seednuts should be sown soon after harvest without resorting to any pre-sowing treatments. The prevailing practice of sun-drying seednuts was found to reduce germination.

3) For long distance transport of arecanut seedlings they should be removed with a ball of earth of about six inches diameter and this ball of earth enclosing the roots packed in alkathene film of 400 gauge. Such seedlings could be kept for a period of nearly 15 days before they are transplanted.

4) **Control of premature nut fall:** Premature nut fall is a common feature in arecanut gardens of all the States. Trials carried out at the Central and Regional Stations brought out the specific advantage of spraying the bunches from the second month of flowering onwards with a combination spray consisting of one percent. Bordeaux mixture to which Endrex at 125 c.c. per 100 litres of the mixture was added. A total of 750 litres of spray liquid costing Rs. 25 was required for spraying an area of one hectare and one round of spray cost Rs. 75 in all. The spray had to be repeated at intervals of about 40 days. The treatment was found to reduce an estimated crop loss by about 25 per cent.

5) **Control of pests:** Spindle bug which is a major pest of arecanut, particularly on the West Coast, causes severe damage to the spindle (unopened leaf) and tender leaves by feeding on the green foliage. Spraying the palms with 0.3% Endrin or 0.02% Folidol, or 0.2% BHC. 50% W. P. effectively controls the pest. The cost of chemicals for spraying one hectare would be Rs. 96 if Endrin is used and Rs. 20 or Rs. 8 respectively if Folidol or BHC 50% W. P. is used.

C. Seasonal Conditions.

A total rainfall of 3028.4 mm. was received at the Station on 122 rainy days during the period, as against an average of 4402.90 mm. received in 137.7 rainy days during the last six years. Thus the total precipitation received was much less than the average. This was more so during the hot weather period. The total number of rainy days during the period from November to May and the total precipitation during the year were 7 and 126.2 mm. as against 22.7 and 470.40 mm. respectively for the last six years. The droughty condition which prevailed during the above period resulted in severe scarcity of water for irrigation. The attack of mites in the nurseries and on the young palms of experimental gardens was also very severe during the period, although the attack of 'Koleroga' in the gardens was very mild. The maximum temperature ranged between 29.8°C. and 38.0°C. and the minimum between 13.0°C. and 20.5°C.

The month-wise distribution of rainfall and temperature recorded is given in Appendix I.

D. Technical Programme for the Year 1963–'64

Item No. in the technical programme — *Name of the experiment*

BOTANY

Crop Improvement:

I. Breeding and genetics of areca.

1) Introduction and maintenance of indigenous and exotic species and types of *Areca* for selection and hybridisation.

2) Survey of arecanut gardens to select superior types and assessing genetic variation.

3) Floral biology of *areca*.

a, b) Study of the range of variation in flowering from tree to tree including month-wise variation in flowering in the same garden.

c) The frequency distribution of number of palms flowering per week during all weeks. The phenomenon of early flowering etc. to be correlated with fruit production.

d) Floral initiation.

e) Study of pollen.

4) Hybridisation and selection:—

a) Standardisation of crossing technique.

b) Production of inbred lines of distinct types.

c) Hybridisation between distinct types and selected palms to combine high yield and regular bearing, and study of progenies.

d) Hybridisation between exotic and indigenous types.

5) Preliminary studies on progeny behaviour of mother palms.

6) Effect of selection of seed nuts on germination and future performance.

II. Root studies:

a), i) Root studies at different ages and under different soil conditions in adult palms.

ii) Root studies in seedlings at different ages.

b) Root studies in plants showing symptoms similar to 'Band'.

III. Anatomical studies:

a) Structure and development of fruit in arecanut growing under high and low altitudes.

b) Study of the structure of roots in diseased and healthy plants.

c) Study of the anatomy of the leaf of the different ecotypes.

IV. Cytological studies:

a) Standardisation of cytological techniques.

b) Study of meiosis in different ecotypes of arecanut.

c) Karyomorphological studies in different types and specie of *Areca*.

V. Physiological studies:

1) Studies on fruit setting and shedding.

2) Inducing mutations in arecanut:

a) By irradiation of seednuts (thermal and pile neutrons, X-ray and Gamma rays.)

b) By chemical (Colchicine etc.)

c) By the use of irradiated pollen in pollination.

3) Effect of plant regulators on growth.

4) Role of micro-nutrients in arecanut.

AGRONOMY.

VI. A. Standardisation of nursery practices:

1) Criteria for seednut selection:

a) Concluded.

b) Concluded.

c) To determine the frequency of occurrence of nuts possessing different floating habits and factors influencing such habits.

d) Concluded.

2) Sowing experiments:

a) to d) Concluded.

e) Effect of different intensities of shade in seed bed and secondary nursery beds on growth performance of seedlings.
f) and g) Concluded.
h) Determination of optimum age of transplanting seedlings-cum-sowing *in situ vs.* transplanting of single, double and triple transplanted seedlings.

3) Concluded.
4) Standardisation of method of packing seedlings.

VI. B. Cultural experiments:

a) 1. Determination of optimum spacing in the main field.
2. Effect of depth of transplanting seedlings-cum-intervals of irrigation on growth and yield.
3. Effect of different methods of inter cultivations on the productivity of palms.
4. Study of inter crops in arecanut gardens.
5. Comparative studies of different green manure and cover crops for arecanut gardens.
6. Investigation on different types of areca under rainfed and irrigated conditions. (Postponed.)
7. Effect of growing banana in arecanut gardens for different durations.
8. Relative performance in the main field of plants of differnt ages at the time of planting and of single, double and triple transplanting of the above ages.
9. Drainage experiments in arecanut gardens.
10. Mixed garden of coconut and arecanut.
11. Relative performance of seedlings obtained from different bunches and different positions in the bunch of mother palms of different ages.
12. Studies on the performance of nuts gathered at different stages of maturity for seed purposes.

VI. C. Manurial experiments

1) Concluded.
2) Determination of optimum N. P. K. requirements in the main field.
3) Simple Manurial trials on arecanut in ryots' gardens.
4) Effect of applying N. P. K in organic and inorganic forms on palm performance.

5) Relative merits of different nitrogenous fertilizers.
6) Study of exhaustion of plant nutrients by adult bearing palms.

VI. D. Miscellaneous:

1) Uniformity trials—Collection of yield data of palms.
3) Project to find out the weight ratio of the raw and processed arecanuts.
4) Concluded.
2) & 5) Harvesting Trials:—
   a) Season-wise variation in quality of produce.
   b) Quality of produce as influenced by degree of maturity.

PESTS AND DISEASES:

VII. 2) Trials with different fungicides and insecticides to find out effective control measures for all diseases and pests:
1) Control of mites.
2) Control of white grub.
3) Trials on the control of 'Koleroga' or 'Mahali' with and without adhesives.
4) Trials to investigate causes and methods of control of button shedding and tender nut fall.
5) Control of yellow leaf spot of arecanut.
6) Postponed.
7) Study of collar-rot of seedlings and influence of soil micro-organisms.
8) Studies in the control of sun scorching of stem.
9) Postponed.
10) Concluded.
11) Studies on the retention of copper fungicides on sprayed fruits.
12) Susceptibility of arecanut to 'Koleroga' at different stages of maturity (development).
13) Observations on exploratory demonstration plots where package treatments are laid out.
14) Studies of organisms (other than *Phytophthora*) that cause rotting of fruits and impair keeping quality.
15) Combined with item (11)
16) Study of palms showing symptoms similar to 'Band' in the primary and secondary nursery and their behaviour in the main field.
17) Other problems evoked in the course of studies.

E. Results

BOTANY.

Crop Improvement:

I. Breeding and genetics of Areca:

1. Introduction and maintenance of indigenous and exotic species and types of areca for selection and hybridisation:

Exotic types collection—1957 planting:

The four palms introduced in 1957, viz., Indonesia I, Indonesia II, Nicobar and Andaman continued to flower during the year. Recording of leaf fall and production of spadices was continued. Annual morphological characters such as height, girth at permanent mark and last node, number of nodes, etc. were recorded. The internodal length in the case of the two Indonesian types, continued to be lesser than in the other two types, the range of measurement at the last node being 3.3 to 4.1 cm. in the former against 10.0 cm. for the Nicobar type and 5.3 cm. for the Andaman type.

1961-62 planting:

This collection consisted of 16 species and types introduced from eight foreign countries, i. e. Fiji, China, Ceylon, Mauritius, Indonesia, Saigon, Singapore and British Soloman Islands, and a local. The planting was done on a randomised block design with single tree plots. All the plants continued to record satisfactory growth excepting *A. concinna* from Ceylon, which had poor growth. The palms were manured and cultural operations were attended to as per schedule.

The annual morphological characters were recorded in respect of all the palms. From the mean data presented in Table I* it would be seen that the types introduced from Fiji, China, Saigon (1) and Singapore were more vigorous than the rest as judged by the number of leaves and nodes produced and girth.

Data recorded on the production of suckers showed that the rate of production in the different types of *A. triandra* ranged from 1.9 to 7.3 suckers per palm with an over all mean of 4.0, as against a mean of 7.2 in *A. concinna*.

Regular recording of leaf fall and production of spadices were taken up in all the palms. The number of trees flowered, inflorescences and

---

* All the tables refer to those in Appendix II.

flowers produced and fruit set obtained during the first year of flowering are furnished in Table II, with a view to assess the initial productive potential of the various introductions as compared with the local type. It may be seen from this table that, of the different types of *A. catechu* introduced, the type from China produced a mean maximum of 121 female flowers per inflorescence.

Floral biology studies taken up in some of the types showed that in the type introduced from China, there was complete overlapping of male and female phases in the same inflorescence.

Four palms in each of the 18 types and species maintained in the same collection block were selected at random for varietal/species description and permanent marks were made at 75 cms. from the root zone for recording height etc. Out of the 44 characters that are to be recorded in each of these palms observations on the following were recorded during the period:—

1. Height.
2. Girth at fixed mark and at collar.
3. Internodal distance at fixed mark and last node.
4. Total number of leaves.
5. Total number of inflorescences.
6. Angle of leaf to leaf-sheath.
7. No. of leaflets.
8. No. of mid-ribs.
9. Length and breadth of central leaflet.

In order to note the interval between leaf emergence and leaf fall, three spindles in each palm of length 5 to 10 cms. were ringed.

During the year there was severe incidence of mites and it was observed that the intensity of infection in the different types maintained in the collection block was different.

In order to get a preliminary idea of the differential bahaviour of these types to mite attack, a count of the number of palms infested was taken during the peak period of mite infestation. The data gathered are given in Table III, from which it would be seen that mite infection was comparatively low in the types Mauritius, Indonesia (1) and Indonesia (2). All these types belong to the species *Areca triandra*. Ceylon (3), (*A. concinna*) did not have mite infection. It, therefore, appears that *A. triandra* and

A. concinna are relatively resistant to mite infection. Among the types of *A. catechu*, Ceylon (2) (Rate puwak) had the least infestation.

1963-'64 planting

One plant of the type received from Aden was planted out in the field and got established.

Ten types of *A. catechu* and two species of *Areca* (*A. normanbyii* and *A. triandra*), received from Australia, Fiji, Saigon and Andaman were transplanted to the main field in June, 1964 on a randomised block design using single tree plots. The planting was done at a distance of 9' x 9' and the local type was included as the control. A total of 132 plants was planted in this collection block.

Seedlings of *Malayan - Wangi* introduced from the Agricultural Research Station, Taliparamba during the previous year were ready for transplanting.

1963-'64 introduction

During the year, fresh consignments of seednuts were received from Formosa and New Guinea. All the 20 nuts received from Formosa failed to germinate, but out of the 26 nuts received from New Guinea in the first consignment, 19 germinated. Germination is in progress in the second lot of 5 nuts received from the same country.

Indigenous types collection:

The eight ecotypes from 1) Khasi and Jayantia Hills, 2) Mohitnagar, 3) Mettupalayam, 4) Chickmagalur, 5) Hirehalli, 6) Thirthahalli, 7) Peechi and 8) South Kanara, planted out in the main field last year were growing well. Annual morphological features were recorded.

The indigenous types collected from Mahuva (Gujerat) and Hirehalli (dwarf) during the previous year and which were in the secondary nursery were ready for transplanting to the main field.

During the year three more indigenous types, one each from Shriwardhan (Colaba District) and Dapoli (Ratnagiri District) of Maharashtra State and one from Thirthahalli (with male and female phases running simultaneously) of Mysore State were added to the existing collections.

Fortyeight seedlings of two mother palms (CARS 605 and NGB 9) were planted at the Fruit Research Station, Chethahalli and Athur (3000 ft. above mean sea level) of Coorg for the study of their performance at higher

altitudes. Seednuts of CARS 605 palm have been sown previously at all the Regional Stations for studying the performance of this type under different ecological conditions.

2. Survey of arecanut gardens to assess genetic variation and to select superior types:

In order to work out a sampling technique for the above survey, nuts of different sample sizes were taken at this station and the length and breadth measurements recorded. The statistical analysis of the data showed that for a sample size of 12 nuts, the coefficient of variation was less than 3%. Further, the data on length and breadth measurements of fully ripe nuts of a sample size of 12 nuts from different bunches of three trees were recorded and the standard error of various sample sizes statistically analysed. Results of analysis are given in tables IV (a) and IV (b). It could be seen from the tables that the coefficient of variation was less than 3% in all the trees. It was thus inferred that a 12 nut sample size would be adequate for cultivar studies.

It was also observed that there was significant difference in fruit size between fruits produced in different bunches, fruits in the first bunch being smaller than the rest. Hence it is proposed to collect samples from the peak harvest so as to overcome the possible misclassification.

3. Floral biology of Areca

a, b. Study of range of variation in flowering from tree to tree including month-wise variation in flowering in the same garden.

The above study was undertaken in the bulk garden of the Station planted in 1957 where the palms were given uniform cultural and agronomic treatments. An abstract of the observations made on 200 palms is given below:—

Details	Number	Percentage	Yield (No. of fruits)	Percentage of yield to total
Palm which produced no spadices	9	4.5	nil	...
,, one spadix	3	1.5	nil	...
,, two spadices	8	4.0	96	0.2
,, three ,,	14	7.0	897	2.5
,, four ,,	26	13.0	2972	8.3
,, five ,,	31	15.5	5210	14.4

Palm which produced	six	22	11.0	5007	13.9
,,	seven ,,	43	21.5	9340	25.9
,,	eight ,,	23	11.5	6914	19.4
,,	nine ,,	16	8.0	4373	12.2
,,	ten ,,	4	2.0	771	2.1
,,	eleven ,,	1	0.5	396	1.1
	Total	200		35976	100.0

It will be seen from the above data that the number of inflorescences produced ranged from nil to eleven and that the majority of trees produced spadices ranging from four to eight.

Studies on the month-wise variation in flowering were also made in the same garden. An abstract of the observations made during the current as well as in the previous two years is given in Table V, indicating that the percentage of inflorescence to the leaves shed was more or less the same during the current year and previous year. It is also seen that a very high percentage of leaves shed in the months of January to March had inflorescences in their axil. Of the inflorescences produced in different months, the maximum percentage of the total production was observed during the months of January to April.

c) *The frequency distribution of number of palms flowering per week during all the weeks, and correlation of early flowering with fruit production.*

The yield data of the 2834 progenies of 41 mother palms grown under uniform agronomic conditions were classified with a view to study the progeny performance of these mother palms as well as for working out the correlation of the yield with early flowering. The results are summarised below:—

Range in the mean yield of progenies (in gms.)	Total No. of mother palms	Total No. of progenies in the mother palm
2001—3000	3	162
3001—4000	5	389
4001—5000	7	473
5001—6000	11	736
6001—7000	7	494
7001—8000	6	352
8001—9000	2	228
	41	2834

From the above it will be seen that in spite of the fact that all the mother palms have been selected based on the same criteria with reference to yield and other morphological characters the mean yield of progenies ranges from 2000 gms. to 9000 gms. This varied behaviour of the progenies with reference to yield is probably due to the differential transmitting ability of the different mother palms in respect of this character.

d) Floral initiation.

In order to find out the age of the different inflorescences located in different leaf axils of the primordia the interval between successive leaf productions and leaf falls is being recorded in four palms of the local type by ringing each of the spindles as they emerge.

e) Study of pollen:

i) Viability during different months of the year.

Study of the viablity of arecanut pollen *in vitro* initiated in 1961-62 was continued during the year. The data on germination of pollen obtained during different months are given in Table VI. From this table it will be seen that the germination percentage obtained during the months of December to May (excepting March) when dry bright weather prevailed, was higher than what was obtained in other humid months. These results are more or less in conformity with the results obtained during the last two years. It may, therefore, be concluded that humidity has an adverse effect on viability of pollen, which fact is also supported by the higher percentage of fruit-set obtained during the dry weather period.

ii) Storage of pollen

Freshly collected pollen was stored in a dessicator containing calcium chloride for study of viability and the germination percentage was tested at intervals of seven days in sucrose media of 0.5, 1.0, 2.0 and 5.0% concentration. The mean data obtained are tabulated below:

Storage life in days	Concentration of sucrose solution (%)				Mean
	0.5	1.0	2.0	5.0	
	Germination percentage				
Fresh	30.2	80.5	51.2	71.7	55.9
7	69.6	80.9	82.1	70.3	75.5
14	nil	58.0	75.0	41.3	43.3
21	nil	nil	87.2	54.8	35.5
28	nil	nil	15.3	nil	3.8

It will be seen that pollen grains give maximum germination after a period of seven days storage. There are also indications that high viability is maintained even upto 21 days of storage as evidenced by the 87.2% and 54.8% germination obtained in 2.0% and 5.0% sucrose solutions respectively. The results are in conformity with those obtained last year.

Trials were also initiated to find out the relationship between humidity in the storage chamber and germination. Male flowers were stored over calcium chloride in completely sealed dessicators and humidity inside recorded using a hair hygrometer. It was observed that humidity inside the storage chamber was more or less constant and ranged within very narrow limits of 17 to 20% only. It was also observed that even with constant humidity, maximum germination was obtained after seven days storage as reported earlier. Confirmatory trial were in progress.

iii) Evolving suitable media for pollen germination

With a view to find out a suitable media for pollen germination trials were conducted with the following six media:

1. 0.5% sucrose.
2. 0.5% sucrose + 0.1% Agar.
3. 0.5% sucrose + 0.25% Agar.
4. 0.5% glucose.
5. 0.5% glucose + 0.5% Agar.
6. 0.5% glucose + 0.1% Agar.

0.5% Sucrose + 0.1% Agar media gave a maximum mean germination of 82.5%. This was found to be significantly higher than the germination recorded by 0.5% sucrose alone.

Studies were also taken up to find out the influence of certain auxins and hormones on pollen germination. Results obtained are given below:—

Sl. No.	*Media*	*Mean pollen germination.*
1.	0.5% sucrose+0.1% Agar.	88.9
2.	Tr. 1+Gibberellic acid at 50 mg./litre	70.6
3.	Tr. 1+ do 100 mg /litre	82.0
4.	Tr. 1+Boric acid at 50 mg /litre.	88 8
5.	Tr. 1+ do 100 mg./litre.	84.2
6.	0.5% sucrose alone.	74.9

7.	Tr. 6+Gibberellic acid at 50 mg./litre.	21.6
8.	Tr. 6+ do 100 mg /litre.	17.8
9.	Tr. 6+Boric acid at 50 mg./litre.	76 8
10.	Tr. 6+ do 100 mg./litre.	80.0

From the above it can be seen that Gibberellic acid in combination with sucrose alone considerably reduced germination. In general it may be stated that neither Gibberellic acid nor Boric acid had improved germination over sucrose and agar media.

iv) Pollen viability in exotic types.

Viability of pollen of seven exotic types were tested in sucrose media of 0.5, 1.0, 2.0 and 5.0 percent concentrations. The mean germination obtained is given below:—

Type		*Mean germination percentage.*
China	...	29.96
Saigon (1)	...	3.70
Saigon (2)	...	10.75
Saigon (3)	...	41.10
Fiji	...	24.65
Singapore	...	8.20
Ceylon (1)	...	36.80

From the above it will be seen that the types introduced from Singapore and Saigon have very low pollen viability.

v) Morphology of pollen.

Studies on pollen morphology were initiated in the local type as well as in the type introduced from China. It was observed that in the case of the local type the pollen grains were slightly oval in shape and uneven in size as compared to that of China. The exine is deeply reticulate and the grains have a mean size of 30.57+5.81 μ . In the China type the pollen is more or less round and has a mean size of 30.30+3.62 μ . The exine is slightly reticulate.

4) Hybridization and selection:

a) Standardisation of crossing technique.

Preliminary trials taken up during the previous year showed that, for controlled pollination work, Trayophane transparent paper bags also could

be used. Large scale use of these bags during the current year indicated that these bags had depressing effect on fruit-set. Trials were, therefore, taken up with Trayophane bags of different gauges as well as cloth bag under two sets of conditions i e. under partial shade of leaves on the crown and under exposure to sun for finding out their relative influence on fruit set. The results obtained are given below:

Treatment	*Percentage set under partial shade*	*Percentage set under exposure to sun.*
1. Trayophane bags of 600 gauge.	19.3	nil.
2. Trayophane bags of 400 gauge.	9.0	2.0
3. Trayophane bags of 250 gauge.	12.0	nil.
4. Kora cloth bags.	32.6	8.6
5. Open pollination.	62.0	8.0

From the above it is seen that 'Trayophane' bags reduced fruit set under both conditions.

For ensuring that cloth bags gave sufficient protection against foreign pollen, three inflorescences were completely covered with cloth bag after removing all the male flowers. Since no fruit-set was obtained in any of the inflorescences, it could be inferred that cloth bags of close mesh give enough protection against the entry of pollen from outside.

With a view to find out whether the spray application of pollen could be used for hastening the process of hybridisation, pollen suspended in two types of media i. e., 0.5% sucrose alone and 0.5% sucrose + 0.1% agar were sprayed on 15 bunches, leaving equal portions for open pollination (control). The flowers were not, however, covered with bags. A fruit-set of 32% each was obtained in flowers sprayed with pollen suspended in the two media as against 36% fruit-set obtained in open pollination. However, spray application of pollen under field conditions appeared to be a quick method. Its performance under the cover of bags remained to be tested

b) Production of Inbred lines in distinct types—In local types

With a view to obtain homozygous lines in the different types selfing of few palms in each of the types initiated during the previous year was continued. Forty five selfed nuts of the local types were sown.

Selfing was done in three distinct types, i. e. South Kanara (big size),

Thirthahalli (small size) and 'Chandra Adike' (red kernel) types, and a fruit set of 39%, 9% and no set respectively was obtained.

In exotics

Seventy seedlings of Indonesia–I and 44 seedlings of Indonesia–II raised from selfed seednuts, were transplanted in the secondary nursery. The seedlings will be planted out in the main field during the current season.

A total of 239 selfed nuts along with 234 open pollinated ones for comparison were sown during the year for further studies. Selfing was also done in the Chinese type and repeated in Andaman and Indonesia—I types.

Distribution of selfed seeds of exotics.

Fifty-six selfed seednuts of Andaman were sent to different Regional Research Stations of the Committee. Six selfed seednuts of Nicobar were also sent to the Regional Research Station, Palode.

c) *Hybridisation between distinct types and selected palms to combine high yield and regular bearing and study of progeny.*

As a preliminary to the above, a project was started in 1961–62 with a set of four palms so as to find out whether there was any difference in the degree of compatibility between palms of the same type and different types, the existence of a high degree of which could be exploited to obtain high yield of nuts by interplanting such types. During the year the crosses were repeated with the addition of a few more trees. The data on the fruit-set recorded two months after pollination are given in Table VII, from which it will be seen that the extent of fruit-set varied considerably between different palms and that there were wide reciprocal differences in fruit-set in the case of certain sets of crosses. These observations are in conformity with the results obtained during the previous year. There are indications that male or female sterility or both or compatibility differences exist in certain palms. It is proposed to investigate this aspect during the ensuing season.

With a view to combine high yield and regular bearing habit, crosses were effected between selected mother palms of outstanding performance of the local type as well as between the local and Thirthahalli types. The results are given below:—

Name of type	*No. of crosses made*	*No. of female flowers pollinated*	*No.of fruits set*	*Percentage set.*
Selected mother palms of the local type	6	1333	297	22.2
Local x Thirthahalli	6	670	67	10.0

d) Hybridisation between exotic and indigenous types.

Crosses were also effected between some of the promising exotic types and selected palms of the local type for combining regular bearing habit and high yield. Fruit-set obtained in the following crosses are noted against each.

Female parent (local)	Percentage set		Open pollination.
	Male parents		
	Indonesia-I	Indonesia-II	
MGU. 14	35	36	66
MGU. 16	50	37	40
MGU. 13	54	4	90

The hybrid progenies will be compared with open pollinated and selfed ones.

5. Preliminary studies on progeny behaviour of mother palms

These studies initiated in 1960-61 in the progeny garden of the Station were intended to find out the extent to which the mother palm characters are inherited and how these characters differ among the progenies. For this, studies on the 200 progenies of the ten mother palms selected in the above garden were continued during the year. The rate of production and shedding of leaves and productive characters, such as number of female flowers produced and set etc., were recorded. Data gathered are given in Table VIII. There was considerable variation in the progenies of different mother palms as regards both the percentage of inflorescences produced to leaves shed and the number of female flowers produced. There was an increase in the number of female flowers produced as compared to the previous year when it ranged from 588 to 1021 as against 740 to 1364 of the current year. Progenies of KMJ. 2 which had produced the maximum

number of female flowers during the previous year produced the maximum number of female flowers during this year also.

The morphological characters and yield of the mother palms were also recorded during the year so as to correlate these with the progeny characters. It is proposed to continue further observations in respect of 300 progenies selected by using stratified sampling.

6. Effect of selection of seednuts on germination and future performance

This experiment was designed to find how far the selection of mother palm and seednut influences germination and turnover of quality seedlings in the primary and secondary nurseries as well as their performance in the main field. The experiment was laid out with the following treatments on a 4 x 6 randomised block design:

1. Unselected bulk nuts.
2. Selected bulk nuts.
3. Unselected nuts from mother palms.
4. Selected nuts from mother palms.

Fifty nuts were sown under each treatment after recording the weight of individual nuts. They were numbered serially and dates of germination noted for each. The sprouts when they were about six months old were transplanted to the secondary nursery on a 4 x 3 x 6 split plot design, after classifying them as vigorous, normal and rejected groups based on visual observations. The morphological characters of the sprouts were also recorded prior to tranplanting. The data were statistically analysed and the results are given in Table IX. From this table it will be seen that there is significant difference in respect of all the attributes studied except the percentage of rejected seedlings. With reference to germination, selection of nuts as well as selection of mother palms was found to be effective, nuts from unselected bulk giving significantly less germination than the rest. In the case of other characters studied, selected bulk nuts were found to be significantly better than unselected bulk nuts as well as selected and unselected nuts from mother palms. In general, selection of seed nuts was found to be effective but not mother palm selection. The performance of progenies from different mother palms was found to vary very widely as reported in an earlier section. The ineffectiveness of the mother palm selection now observed may probably be due to the mother palms involved in this experiment having poor progeny performance. The experiment is proposed to be repeated including mother palms with better progeny performance.

II. Root studies.

a) (*i*) *Root studies at different ages and under different soil conditions in adult palms.*

In order to gather comprehensive information on the rate of development and the pattern of growth of the root system of areca palms in different types of land and under different soil conditions, it was decided to plant arecanut seedlings in each of the following three types of land on which arecanut is planted in this tract, for study of the root development at periodical intervals:—

1) 'Bettu' or single crop paddy land.
2) Newly terraced hill side.
3) Low lying land subject to occasional water logging.

The 85 plants planted in 'Bettu' land during the previous year were maintained by giving timely cultural and manurial operations. The remaining plantings will be taken up as soon as the required land becomes available.

(*ii*) *Root studies in plants showing symptoms similar to 'Band'.*

Eight seedlings showing 'Band' symptoms transplanted in the main field along with equal number of normal seedlings were under observation during the period. Root study will be taken up during the coming year.

III. Anatomical Studies

a) Structure and development of fruit in arecanut, growing under high and low altitudes.

A preliminary survey of the higher altitudes of Coorg District was undertaken during the year with a view to find out the maximum altitudes up to which arecanut was grown in this district. Arecanut was found to be grown up to 3900 feet above mean sea level. Fruits from different altitudes will be collected for anatomical studies.

c) Study of the anatomy of leaf of different ecotypes

For working out a sampling technique for the study of the anatomy of the leaf of different ecotypes, leaf samples from different leaves of the local ecotype were fixed.

IV. Cytological studies.

a) Standardisation of cytological techniques:

In order to find out a suitable fixative for PMC studies, Cornoy's solutions having different proportions of alcohol, chloroform and acetic acid were tried. It was observed that Cornoy's solution having a proportion of 6:3:1 (alcohol : chloroform : acetic acid) gave better smears than the rest.

b) Study of meiosis in different ecotypes of arecanut.

Microsporogenesis in the exotic palm 'Nicobar' was studied in detail adopting the usual aceto-carmine smear technique. It was found to be normal. The chromosome number was also determined and found to be $2n = 32$.

V. Physiological Studies

1) Studies on fruit setting and shedding

a) Supplementing natural pollination by spray method to improve fruit set.

The above trial was initiated in 1961-'62 and repeated in 1962-'63 to find out if higher set of fruits could be obtained by supplementing natural pollination by spraying the inflorescence with pollen held in suspension in a liquid medium, namely, 0.5% solution of sucrose. The trials gave encouraging results. To verify the results, the trial was repeated in 1963-'64 with the same treatments as before, namely (1) open pollination plus pollination by the spray method, (2) open pollination plus spraying with 0.5% sucrose solution alone and (3) control—open pollination. The data on the number of flowers that were allotted for the different treatments and the extent of fruit set obtained are given in Table X. It will be seen from the table that when natural pollination was supplemented by spraying pollen on the female flowers, a higher percentage of fruit set was obtained in all the months, except in June and July. The poor set in June and July was probably due to the high rainfall which prevailed during these months when collection of pollen and spraying were rather difficult.

b) Growth regulators as aid to fruit-set.

Trials taken up with NAA during the previous year had shown that application of this hormone in lanolin medium at 10,000 p. p. m. had striking effect in increasing fruit-set. It was, however, found that the fruits so treated had different patterns of development, some growing normally and others lagging behind.

During the year Gibberellic acid at concentrations of 50, 250, 500 and 1000 ppm. were sprayed on four bunches in four palms, the same bunch getting all the treatments. The data collected are given below:—

Concentration	*Total No of flowers treated*	*No. of fruits set*	*Percentage set*
50 ppm.	130	32	25.
250 ppm.	131	43	33
500 ppm.	100	32	32
1000 ppm.	105	43	41
Control	100	15	15

From the above it will be seen that Gibberellic acid at all concentrations have given higher fruit-set, a concentration of 1000 ppm, having given the maximum set.

2) Inducing mutations.

With a view to increase genetic variability in the existing materials so as to get types with reduced height (dwarf) and types having less astringency and disease-resistance, particularly against Yellow leaf disease and 'Koleroga', the following treatments with mutagenic agents were initiated in 1960-61:—

(*a*) *By irradiation of seednuts with Thermal and Pile neutrons.*

Of the ninety eight seedlings obtained from seednuts irradiated with Thermal neutron in 1961 at the 'Apsara' reactor, Trombay and planted out along with control (un-treated) in June, 1963, on a randomised block design, all the seedlings excepting three got established. No visible effect of the treatments were observed.

Two seedlings obtained from seednuts irradiated with Thermal neutrons in 1960 at the same reactor were also planted in the field and established.

(*b*) *By irradiation of seednuts with X-ray*

Five seedlings obtained from nuts irradiated with X-ray at the Physics Laboratory of the Indian Institute of Science, Bangalore in 1962, were also transplanted to the main field. The plants were well established.

Fifty seednuts of Indonesia I and Indonesia II types were irradiated with different doses of X-ray at the Agricultural College & Research Institute, Coimbatore. The irradiated seednuts were sown at the Station.

(*c*) *By chemicals* (*Colchicine*).

Out of the 320 sprouts treated with colchicine in 1961-62, 67 seedlings which showed abnormalities like stunting and early splitting of leaves, were planted out in the main field, and 64 were established.

During 1962-63, 544 sprouts were treated, out of which 134 showed stunted growth, but later these were also found to revert to normal condition. These sprouts will, however, be planted in the secondary nursery for further observation.

During the current year, 250 sprouts were treated with 0.25%, 0.50% and 1.00% colchicine, the duration of treatment being limited to 48 hours. The sprouts were under observation.

d) *By use of irradiated pollen.*

Pollen grains irradiated with the following doses of X-ray at the Agricultural College & Research Institute, Coimbatore, were utilised for pollination on three palms at the Station:—

1. 30,000 r.
2. 50,000 r.
3. 70,000 r.
4. 1,20,000 r.
5. 2,00,000 r.
6. 2,00,000 r. (Perianth removed)

A total of 312 female flowers was pollinated.

The irradiated pollen was tested for viability after seven days of storage. Viability was found to range from 2.6% to 16.6%. Viability of pollen in the flowers treated with 2,00,000 r. after the removal of perianth was nil.

In addition to getting mutations it was also intended in the above programme to watch for haploids in the resulting seedlings. Haploids if obtained will be very useful both for the cytological studies as well as for getting completely homozygous plants by doubling the same. Since pollination with pollen of allied species etc. was also found to yield haploids, a total of 819 female flowers of *Areca catechu* was pollinated with pollen of 'Ramadikke' (*Actinorhytis calaparia*), and 14.6 percent fruit-set was obtained.

3) Effect of plant regulators on growth:

The effect of Gibberellic acid on development of fruits will be studied in respect of the nuts which were obtained in the spraying trial with different concentrations of this hormone as already reported in an earlier section.

VI. Miscellaneous:

1. Poly-embryony:

The 19 twin-seedlings which were separated and planted in the main field got established. Since it is likely that one of the members of the poly-embryony plants might have haploid, the plants are being studied with this point in view, in addition to their general performance.

2. Correlation and index studies:

Studies were undertaken for finding out the correlation existing between time of germination and morphological characters of sprouts in the primary nursery, suitability of Bartlett's indices for comparing the germination of seednuts in different lots, or treatments and the correlation that exists between Bartlett's indices of different lots with morphological characters of their sprouts in the primary nursery and seedlings in the secondary nursery.

a) Time of germination and vigour of sprouts

Date of germination of individual nuts of six different lots (mother palms) were recorded as and when they germinated. The data were classified according to the number of days taken for germination and the mean morphological characters (girth, height and number of leaves) of these sprouts germinated on the same dates were calculated. Correlations were worked out between the number of days taken for germination and each of the morphological characters recorded six months after germination. The results are given below:—

Correlation coefficients between number of days taken for germination and

1. Girth at collar (—) 0.48*
2. Height (—) 0.73*
3. Number of leaves (—) 0.75*

*Significant at 5% level.

From the correlation coefficients obtained, it may be observed that all the characters are having negative significant correlation coefficients with the number of days taken for germination.

b) Bartlett's index:

Weekly germination data recorded in respect of nuts collected from different mother palms and sown bunch-wise were made use of for the study. Since the germination of nuts in any lot starts after an initial period of four or five weeks after sowing, due allowance had to be made for this varying factor, while working out the Bartlett's index. This initial period is referred to as x and the germinations taking place after this initial period viz., $x + 1$, $x + 2$, ... $x + n$ weeks as y_1, y_2, ... y_n. Bartlett's index of germination (B) was calculated by using the formula

$$B = \frac{ny_1 + (n - 1)\, y_2 + \ldots\ldots 1.yn}{n.Y}$$

where $Y = y_1 + y_2 + \ldots\ldots y_n$ (total number germinated)

Bartlett's index using the above formula was worked out in respect of about 40 lots and results pertaining to 10 of them are presented in Table XI. From this table it will be seen that the indices vary from 0.377 to 0.945 depending upon whether the lots are very late or very early.

c) Bartlett's index and vigour of sprouts and seedlings

Correlations were worked out between Bartlett's index of certain lots and the mean morphological data of the sprouts in primary nursery in one set and Bartlett's index and morphological data of the seedlings in the secondary nursery in another set. The results are given below:—

Bartlett's index of the lots and the mean morphological data of sprouts.

Bartlett's index	Girth (in cm.)	Height (in cm.)	No. of leaves
0.72	1.0	32.2	1.9
0.73	1.1	34.4	2.1
0.78	1.1	32.6	1.9
0.79	1.1	35.3	2.1
0.80	1.0	34.2	2.5

0.82	1.1	35.1	2.1
0.85	1.1	35.4	2.2
0.87	1.1	35.7	2.7
Correlation coefficient of Bartlett's index.	0.55	0.75*	0.69*

* Significant at 5% level.

From the above it will be seen that there is a significant positive correlation between Bartlett's index and height and number of leaves of sprouts. The girth, even though not significant, has got a sufficiently high value.

Bartlett's index of lots and the mean morphological data of seedlings

Bartlett's index	Girth (in cm.)	Height (in cm.)	No. of leaves
0.77	3.2	91.5	5.1
0.82	2.5	78.0	4.9
0 84	3.2	104.7	5.2
0.85	2.9	96.9	5.4
0.86	3.2	109.9	5.0
0.87	3.6	109.9	5.2
0 87	3.0	93.5	5.2
0 92	3.5	114.4	5.1
Correlation coefficient of Bartlett's index.	0.94*	0.78*	0.25

*Significant at 5% level.

It will be seen from the above that the Bartlett's index is positively and significantly correlated with girth and height but with number of leaves it has given only a low value.

AGRONOMY

VI. A. Standardisation of nursery practices:

1. Criteria for seednut selection:

c) To determine the frequency of occurrence of nuts possessing different floating habits, factors influencing such floating habits and their relative merits on seednuts:

Fresh seed arecanuts when allowed to float in water show different floating habits such as, vertical, slanting and horizontal. The common

belief is that the fruits that float vertically are superior as seed material to others. This experiment was laid out to study the influence of such floating habits on seednut performance with the following three treatments replicated eight times in a randomised block design:

Seednuts floating
1) vertically,
2) slantingly, and
3) horizontally.

The trial was first laid out in 1959-60 and was repeated during the succeeding three years. The germination data in respect of the trial carried out in 1962-63 was analysed and are presented in Table XII(a). It will be seen from this table that there is no appreciable difference between the treatments. These results are in conformity with the observations made in connection with the earlier set of trials.

The morphological data of the seedlings in respect of the 1962-63 trial were also statistically analysed. The results are given in Table XII(b). Out of the three characters studied, there is significant difference between the different treatments in respect of height of seedlings only. Seedlings from vertically floating nuts have recorded the maximum height followed by those from slantingly floating and horizontally floating nuts.

The data in respect of all the three years were pooled and analysed. The results in respect of the characters that were under study are as follows:

Height of seedlings: The test of analysis of variance was found to be not valid and hence weighted means were calculated. The following values were seen for the height of seedlings:—

Treatment:	
1) Vertically floating nuts	55.53
2) Slantingly „	51.14
3) Horizontally „	46.87
Average C. D.	3.44

Germination percentage of seednuts, girth and number of leaves of seedlings. The means pooled over three years are given below:

Treatment	*Germination*	*Girth*	*No. of leaves*
1. Vertically floating nuts	95.7	1 76	3.97
2. Slantingly „	95.5	1·68	3.85
3. Horizontally „	94.4	1.58	3.73

It will be seen from the above analysis that only in respect of height of seedlings there is significant difference. However, in respect of other characters studied even though the difference is not significant, the trend is in favour of vertically floating nuts. The experiment has been concluded.

d) Studies on the performance of nuts gathered at different stages of maturity for seed purposes.

This experiment was taken up to study the extent of germination of nuts at different stages of maturity and the performance of the seedlings resulting from them in order to arrive at the optimum period for collection of seednuts.

The experiment was initiated in 1958-59 and repeated in 1960-61 and 1961-62.

During 1958-59, seednuts of six maturity levels ranging from eight months to ten-and-a-half months were under study. During 1960-61 and 1961-62, seednuts of four maturity levels ranging from nine months to ten-and-a-half months only were included.

The germination data in respect of 1958-59 trial showed that the performance of eight months old seednuts was significantly poor. The data in respect of 1960-61 trial and 1961-62 trial did not show any significant difference in respect of germination between different treatments.

The morphological data in respect of the 1958-59 trial when subjected to analysis showed that the treatments did not have significantly varying effects on any of the characters studied, whereas similar analysis in respect of the 1960-61 data showed the significant superiority of seedlings obtained from ten months old seed nuts.

The morphological data analysed in respect of 1961-62 trial are presented in Table XIII. It will be seen that there is no significant difference between the treatments in any of the characters studied.

Maturity studies: Field trials

In the experiment "studies on the performance of nuts gathered at different stages of maturity for seed purposes", no appreciable difference was found in the germination percentages of nuts gathered at $9\frac{1}{2}$ to $10\frac{1}{2}$ months maturity. It was, therefore, felt that, while collecting seednuts for sowing, the third bunch may be harvested at the same time as second, thereby avoiding a second visit to the garden for collection of seed material from the

same tree. In order to confirm if this could be done, regular trials were initiated in 1960–'61 and repeated in 1962-'63.

The germination data in respect of the first set of trial conducted in 1960–'61 did not show any significant difference between the treatments, whereas the morphological data revealed that the seedlings obtained from fully ripe nuts (lower 2nd bunch) is superior to seedlings from nuts of upper bunch in respect of the number of leaves produced.

The analysis of the germination data in respect of 1962–'63 trial is given in Table XIV, from which it will be seen that the percentage of germination of seednuts from the lower bunch is significantly more than the percentage of germination of nuts from the upper bunch.

2) Sowing experiments:

a, b) Study of different positions-cum-depth of sowing seednuts.

This experiment intended to find out the ideal position for sowing seednuts as well as the optimum depth at which the seednuts have to be sown, in order to obtain a high percentage of and early germination, was carried out in 1959-'60 and repeated in 1960–'61 and 1961–'62. Three positions of sowing viz., vertical, slanting and horizontal and four depths of sowing, viz. 0", 1", 2" and 3" were compared. In all the three years it was found that sowing seednuts in vertical or slanting positions at 0" and 1" depths gave higher percentage of germination than the other treatments.

The data gathered separately in the three sets of trials were pooled and analysed. The results of analysis are given in Tables XV(a) and XV(b). Sowing seednuts vertically or slantingly is significantly better than sowing horizontally.

By fitting a quadratic curve to the vertical components of means the following curve can be got:—

$Y = 4.34\ x^2 + 11.12\ x + 89.93$ where Y is the germination percentage and x the depth of sowing.

From the above curve it is seen that the optimum depth of sowing is 0.5 inches.

c, f) Effect of different spacing-cum-efficacy of sowing unsprouted and sprouted seeds on seedling performance:

This experiment is intended to find out the effect of sowing seed arecanuts directly in the secondary nursery as against transplanting the

sprouts after germination on seedling growth and the optimum spacing to be given in the nursery when these methods are adopted. The experiment was first laid out in 1959–'60 and repeated in 1960–'61 and 1961–'62. In each year, the trial was laid out on a 8 x 4 randomised block design with the following treatments:

Nature of the seed arecanut:

1) Unsprouted;
2) Sprouted,

(in both cases the sowing was done on the same day)
Spacing given:

1) 9" x 9"
2) 12" x 12"
3) 15" x 15", and
4) 18" x 18"

The 1959-60 set of trial showed that in general, seedlings obtained from pre-germinated seeds made better growth than the seedlings obtained from sowing made directly. The 1960-61 set of trial indicated that seedlings raised by transplanting sprouts as well as planting at spacing of 18" x 18" and 15" x 15" were better than the other treatments.

The data of the 1961-62 set of trial analysed are given in Table XVI. It will be seen that sowing unsprouted seednuts directly in the secondary nursery give seedlings with significantly better height and girth growths. As regards different spacing there is no significant difference between the treatments.

The data in respect of the three years will be pooled and analysed.

e) *Effect of different intensities of shade in seed bed and secondary nursery beds on growth performance of seedlings.*

This experiment is a modification on the trial, "Effect of different intensities of shade in the seed bed and in the secondary nursery on the growth performance" conducted in earlier years. The three treatments viz., no shade, partial shade, and complete shade, given to the nuts in the primary nursery of the original trial were continued, but in the secondary nursery, the following treatments were given:—

	Primary nursery		*Secondary nursery*
1.	No shade in the primary nursery	&	No shade in the Secondary nursery.
2.	do	&	Partial shade do
3.	do	&	Complete shade do
4.	Partial shade do	&	No shade do
5.	do	&	Partial shade do
6.	do	&	Complete shade do
7.	Complete shade do	&	No shade do
8.	do	&	Partial shade do
9.	do	&	Complete shade do

The above modified trial was initiated in 1962-63 and repeated in 1963-64.

The germination data recorded in 1962-63 were analysed and the results are presented in Table XVII(a). It will be seen that there is no significant difference in germination percentage between the treatments. But from the mean values it can be seen that nuts sown under partial shade and complete shade had given higher percentages and of germination.

The sprouts were transplanted in the secondary nursery on a 9 x 4 randomised block design. The morphological data are being gathered.

The germination data recorded in 1963-64 were also analysed and the results are presented in Table XVII(b). Nuts sown under partial shade and complete shade have given significantly higher percentage of germination than in the open.

Establishment capacity of seedlings, raised under different intensities of shade, in the main field.

In order to further see whether the seedlings raised under different intensities of shade in the secondary nursery show any set-back when transplanted to the main field, an observational trial with the seedlings obtained from the nursery trial initiated in 1961-62 was transplanted. Eight seedlings from each of the three treatment plots (open, partial shade and complete shade) were planted in the main field. The rates of mortality and establishment of seedlings were recorded from time to time. From the observations made for a period of six months after planting, it was observed that the treatments (shade) provided in the secondary nursery had no influence on the establishment capacity of seedlings in the main field.

Mortality of sprouts in the primary nursery.

Data on the number of casualties in the different treatments in the primary nursery collected during the years 1961, 1962 and 1963 were statistically analysed. The results are given in Table XVII(c). It will be seen from this table that in all the three years there was significantly higher percentage of mortality in the open. The death of seedlings under partial shade and complete shade was rather very low and did not differ much among themselves.

d) Standardisation of media and method for sprouting seed arecanuts.

To find out a suitable medium or a method for sprouting seed arecanuts, an experiment was first laid out during 1959-60 and repeated during the subsequent two years. A 5 x 6 randomised block design was adopted with the following treatments which included some of the local practices also:—

1. Sowing seed arecanuts in soil medium.
2. Sowing seed arecanuts in sand medium.
3. Arranging the seed arecanuts in country baskets with a layer of straw as cover.
4. Tying the seed arecanuts in straw bundles.
5. Heaping the seed arecanuts under shade.

Analysis of the pooled germination data for the three years was done and the results are given in Table XVIII. Nuts sown in soil and sand medium (treatments 1 and 2) had given significantly better germination than nuts sown under treatments 4 and 5. For getting maximum germination. sowing seed arecanuts either in soil or sand medium may, therefore, be done with advantage

g) Influence of pre-sowing treatments and period of sowing on seednut performance.

It is a common practice in this tract to give varied treatments to seednuts prior to sowing with the object of improving the germination of seednuts and vigour of seedlings. An experiment was initiated during 1959-60 with a view to determine the merits of the different practices. The experiment was laid out with the following twelve treatments replicated six times on a randomised block design.

1. Harvesting and immediate sowing.
2. Treating in cow dung slurry and immediate sowing.

3. Treating in cow dung slurry and air drying for three days and sowing.
4. Treating in cow dung slurry and air drying for six days and sowing.
5. Treating in cow dung slurry and air drying for nine days and sowing.
6. Sun drying for two days and sowing.
7. Sun drying for four days and sowing.
8. Sun drying for six days and sowing.
9. Air drying for three days and sowing.
10. Air drying for six days and sowing,
11. Air drying for nine days and sowing.
12. Soaking in water for three days and sowing.

The trial was repeated in 1960–61 and 1961–62. The results of first year trial showed that sun drying of nuts for different number of days and sowing, as well as air drying for longer periods after treating with cow dung slurry give significantly lower germination than harvesting and immediate sowing. Results obtained during the subsequent two years did not show any significant difference between treatments with reference to germination. The morphological data of seedlings collected after one year in the secondary nursery also did not reveal any significant difference during the first two years of trial. The morphological data of the seedlings collected in the third year (1961-62) of the trial were statistically analysed. The results are given in Table XIX. It will be seen from the data that the various treatments did not have significantly varying effect on any of the morphological characters.

h) Determination of optimum age of transplanting seedlings: Sowing in situ vs. transplanting of single, double and treble transplanted seedlings in the nursery.

This experiment was intended to study the relative performance of plants obtained from the seednuts which were sown *in situ,* of seedlings planted in the main field at different ages and seedlings of the above ages which had been transplanted once, twice or thrice in the nursery prior to field planting. An observation trial was laid out during 1961 with the following eight treatments:

1. Directly sowing the seednuts in the main field.
2. Transplanting one-year-old seedlings.

3. Transplanting two-year-old seedlings.
4. Transplanting three-year-old seedlings.
5. Transplanting four-year-old seedlings.
6. Transplanting two-year-old seedlings which had been transplanted once in the nursery
7. Transplanting three-year-old seedlings which had been transplanted twice in the nursery.
8. Transplanting four-year-old seedlings which had been transplanted thrice in the nursery.

The nuts for treatment 1 were sown *in situ* in pits of three feet cube at a spacing of 9′ x 9′. The seednuts under the other treatments were sown in the nursery beds The germination of nuts was satisfactory and the plants were in healthy condition. From the nursery, the seedlings relating to treatments 2 were planted in 1962 and 3 and 6 in July, 1963 to the main field. The seedlings pertaining to treatment 8 were again transplanted in the tertiary nursery during the year under report. The seedlings of treatments 4 and 7 will be planted in the main field during the month of July, 1964.

The morphological data, viz , girth, height and number of leaves of all seedlings of different treatments were recorded during the year. The mean data are given below:

Treatment	Circumference at the collar (cm)	Height (cm)	No. of leaves
1	37.6	238.3	6
2	34.1	221.1	6
3	30.7	216.6	5
4	30.2	193.5	5
5	29.6	180.7	5
6	27.1	191.5	5
7	15.3	111.3	4
8	15.2	125.2	4

From the above it will be seen that plants raised out of seednuts which were sown *in situ* and the one-year-old seedlings which were transplanted in the main field from the nursery (treatments 1 and 2) had better girth, height and number of leaves than seedlings in the other treatments. Seedlings which had been transplanted twice in the nursery (treatments 7

and 8) have produced lesser girth, height and number of leaves. Trans planting seedlings in the secondary nursery is thus seen to induce stunting of their growth.

4. Standardisation of method of packing seedlings.

This experiment was laid out first during 1961–62 with a view to evolve the best method of packing arecanut seedlings for long distance transport and the maximum period for which the seedlings thus packed can be retained unplanted without their capacity to establish being impaired. The experiment was repeated in 196 -'63 aud 1963-'64 adopting a 4 x 3 x 4 split plot design with the following treatments: –

Main treatments: Planting intervals (four)– No. of days.

1) Five,
2) Ten,
3) Fifteen, and
4) Twenty.

Sub treatments: Material for packing (three)

1) Dry grass (Muli)
2) Areca leaf-sheath, and
3) Alkathene film.

Ten seedlings were used per treatment. The seedlings for all the treatments were lifted with 6" ball of earth. They were then packed in three types of packing materials as given above. In both the sets of trials conducted in 1961-'62 and 1962-'63 it was found that (1) seedlings planted five days after lifting gave significantly higher percentage of establishment than the other treatments, (2) as the intervals between lifting and planting increases the mortality of the seedlings also increases, and that (3) among the three different packing materials viz, 'muli', arecanut leaf sheath and alkathene film, alkathene film gave significantly higher establishment capacity.

The data on establishment of the seedlings in respect of the third year trial (1963-64) were analysed statistically. The results are presented in Table XX. It will be seen from this table that planting seedlings five days after lifting is significantly better than later plantings. Seedlings packed in alkathene film gave significantly better capacity for establishment than seedlings packed in dry grass (muli.) Even though packing in alkathene film was not significantly better than packing seedlings in areca leaf sheath,

the trend was highly in favour of alkathene film packing. These observations are in conformity with the previous two years' results. It was also observed that packing seedlings in alkathene film was easier and required considerably less labour and time than the other two treatments. Alkathene film packing was also found to withstand long distance transport much better than the other two packings. Observations recorded at the time of planting after retaining the packed seedlings for the different periods showed that wilting and yellowing of the seedlings were considerably less in the case of those which were packed in alkathene film. The experiment has since been discontinued.

Other Studies

a) *Determination of the optimum intervals of irrigation for germinating seed arecanuts.*

This trial initiated during 1960-'61 was intended to determine the optimum intervals at which irrigations are to be given to obtain maximum germination and optimum growth of seedlings in the primary nursery. The trial was repeated during the succeeding two seasons in a slightly modified form with the following treatments:

Watering the seed beds once
1) daily.
2) in two days.
3) in three days.
4) in four days.
5) in five days.

The trial was laid out on a 5 x 6 randomised block design with thirty seed arecanuts sown under each treatment beds. At the scheduled intervals, seven litres of water was applied for each treatment bed with rose can. The germination data were recorded daily. The data pertaining to the year 1962-'63 were analysed and the results are given in Table XXI (a). The treatments had significantly varying effect on germination. Increasing the intervals between the irrigations beyond three days reduced the germination considerably These results are in conformity with earlier years' findings.

The germination data for all the three years of the trial were pooled and analysed. For this purpose the first treatment adopted during the year 1960-'61 (watering twice daily) and the fifth treatment of the years 1961-'62 and 1962-'63 (watering once in five days) were deleted from the analysis so as to have a uniform set of treatments during all the three years. The following were the treatments that were considered for analysis:—

Watering once 1) daily.
2) in two days.
3) in three days.
4) in four days.

The results of the analysis are given in Table XXI (b). From this table it will be seen that the treatments differed significantly. Watering daily and once in two days gave significantly higher germination than watering once in four days. Primary nursery beds may, therefore, be watered once in two days.

c) *Study of different shade crops, other than banana, for arecanut nursery.*

This experiment was laid out during July, 1962 in order to find out the suitability of the following crops as shade for the arecanut seedlings in the secondary nursery:—

1) *Crotalaria anagyroides.*
2) *Coccinia indica.*
3) *Cyamopsis psoraloides* (cluster beans)
4) *Tripsa-cum laxum* (Gautemala grass)
5) No shade crop (control)

A 5 x 5 latin square design was adopted for the trial.

The morphological data of the seedlings taken after one year of their growth in the secondary nursery were analysed. The results are given in Table XXII, which show that among the seedlings under shade, those provided with shade of *Coccinna indica* and *Cyamopsis psoraloides* recorded better growth than those under other shade crops. Seedlings under the shade of *Crotalaria* were significantly poor in growth. Though the seedlings under no shade recorded a good growth, this treament was not fit for recommendation in view of the high death of seedlings that took place under no shade conditions as is evident from the following data:—

Treatment	Mortality %
1	9
2	18
3	23
4	38
5	41

The experiment was repeated during the year under report for

verification of the results and for working out the economics of the different shade crops.

d) Effect of different media and method of raising seed beds on germination of seednuts and subsequent establishment of seedlings in the secondary nursery.

The object of the trial was to select the best medium not only for the germination of seed arecanuts but also for providing the optimum conditions for the development of roots of young sprouts for enabling them to withstand the shock while lifting from the seed bed so that they will establish better in the secondary nursery after transplantation. The trial was also meant to find out the best method of forming seed beds. The trial consists of the following treatments, replicated four times adopting a randomised block design:—

Treatments:

Media of sowing—(four)

1. Soil.
2. Sand
3. Soil + sand (50:50).
4. Burnt earth.

Methods of forming seed bed—(two).

1. raised bed.
2. trenches

Fifty seed arecanuts were sown under each of the above treatments. Germination counts of the seednuts were recorded periodically. The data were analysed and the results are given in Table XXIII. It will be seen from this table that there is no significant difference between the different treatments with regard to percentage of germination and period taken to complete the same as indicated by the Bartlett's index. However, it was observed that the sprouts raised in the burnt earth medium were more greenish than from rest of the media. It was also observed that there was minimum damage to roots of sprouts lifted from raised beds. The sprouts were transplanted in the secondary nursery for further observations.

VI. B. Cultural Experiments.

a) 1) Determination of optimum spacing in the main field.

The experiment was intended to determine the spacing to be given to the arecanut palms in the main field to obtain optimum yield, and was

planted in November, 1958. A randomised replicated design was adopted with six replications. A uniform plot size of 36'x72' (5.96 cents) was adopted for all the treatments. The trees have commenced flowering in 1962–63.

The data on morphological characters, viz, girth at the permanent mark, girth at the last exposed node, number of nodes above the permanent mark, and the number of leaves on the crown were recorded. The data were statistically analysed. The results are presented in table XXIV (a) which show that there is no significant difference between the different treatments in respect of any of the morphological characters. However, the mean data in respect of all the characters excepting height, show that as the spacing increases the vigour of the plants also get increased up to certain limits.

Studies on the following aspects were also made in the experimental garden:—

Influence of spacing on
1) Sun-scorch of stems.
2) production of spadices,
3) quantum of female flowers produced and set and
4) yield.

i) Influence of spacing on sun-scorch.

In the experimental plots a number of palms were found to be affected by sun-scorch. The number of plants thus affected was found to be different in different treatments, and, therefore, counts of the number of palms thus affected were made in order to see the effect of spacing on the extent of sun-scorching. The data gathered are given below:—

Spacing	Percentage of palms affected due to sun-scorch	
	Border	Experimental
6' x 6'	11.90	0.54
6' x 9'	8.10	1.80
6' x 12'	25.00	28.20
9' x 9'	25.80	10.50
9' x 12'	45.90	60.70
12' x 12'	52.80	85.00

It will be seen from the above that as the spacing increases the percentage of palms affected by sun-scorch also gets increased.

ii) Influence of spacing on production of spadices

Observations were made on the rate of production of spadices in the different treatment plots. The data gathered are summarised in Table XXIV (b), from which it will be seen that the percentage of trees flowered as well as the mean number of spadices produced per tree in the different treatment plots increase with the spacing.

iii) Influence of spacing on number of female flowers produced and set

The above study was initiated with a view to find out whether spacing (density of trees) has any influence on the number of female flowers produced per spadix (i. e. size of spadix) and the percentage of female flowers set. Recording of observations commenced from January, 1964 and was confined to five trees in each treatment in each of the six replications. The data gathered are summarised in Table XXIV (c), which shows that spacing has some definite influence on the size of spadix and the flowers set. The size of spadix (number of female flowers per spadix) increases with increase in spacing, whereas the percentage of fruit set tends to become low at the closest and widest spacings.

iv) Influence of spacing on yield

The first crop of the garden was harvested during the year. Data on yield of individual palms were maintained. The information gathered is summarised and given in Table XXIV (d). Regarding the influence of spacing on yield it is too early to draw any conclusions since it is the first year yield of the garden that is reported in the table. However, it will be observed that a spacing of 12′ x 12′ appears to be rather uneconomical.

4) Study of inter crops in arecanut gardens.

This experiment is intended to find out whether growing of certain inter crops in the arecanut gardens has any adverse effect on the performance of the palms. The crops proposed for the trial are banana, pineapple, ginger, pepper and guinea grass.

It is proposed to lay out the experiment in a garden to be raised for the purpose. But for want of land the garden could not be planted. However, specimen plots consisting of banana, pineapple, ginger, tapioca, arrow root and guinea grass were planted for studying their performance under the shade of arecanut palms preliminary to laying out the trials. All the above crops except tapioca have performed satisfactorily.

5) **Relative performance of different green manure-cum-cover crops in arecanut gardens.**

The experiment is intended to find out the effect of growing some of the common green manure and cover crops in arecanut garden on palm performance. Since the garden proposed for this trial was yet to be established specimen plots of the following crops were continued to be maintained during the year:

1. *Pueraria javanica.*
2. *Calopogonium muconoides.*
3. *Centrosema pubescens*
4. *Tephrosia candida.*
5. *Crotalaria anagyroides.*
6. *Crotalaria striata.*
7. *Sesbania speciosa.*
8. *Crotalaria walkeri.*
9. *Mimosa invisa var inermis.*
10. *Stylosanthes gracilis.*

Observations carried out in the collection plot have shown that *Pueraria javanica* and *Calopogonium muconoides* were the most promising. *Stylosanthes gracilis* had also recorded good growth These observations were in conformity with the previous findings.

7) **Effect of growing banana in arecanut gardens for different durations.**

Banana is the most common intercrop grown in arecanut gardens of almost all the arecanut growing tracts. It is a food crop which gives an income of nearly Rs. 200 to 300 per acre per annum when grown as an inter crop. In addition, the crop is also believed to benefit the arecanut crop by providing microclimatic and soil conditions optimum for the growth of the arecanut palms The trials are intended to find out the effect of growing banana as an inter crop in arecanut gardens

The planting of the experiment was taken up in September-October, 1963, on a 8 x 4 randomised block design with the following treatments:

1. No banana throughout the period of the experiment (i. e. pure plantation of arecanut).
2. Banana as inter crop throughout the period of experiment at full level.
3. Banana upto the end of 3rd year at full level and no banana thereafter.
4. Banana upto the end of 3rd year at full level and at reduced level for the rest of the period of the experiment.
5. Banana upto the end of 3rd year at full level and at reduced level till the end of 6th year and then no banana for the rest of the period.

6. Banana upto end of 6th year at full level and no banana thereafter.
7. Banana upto end of 6th year at full level and at reduced level thereafter for the rest of the period.
8. Banana upto the end of 6th year at full level and at reduced level upto the end of 10th year and then no banana.

The arecanut seedlings were planted at a spacing of 9′ x 9′ adopting 20 plant plot per treatment with border row all round. The number of banana plants per plot at full level was 17 and at half level 10. Mysore Poovan variety of banana was planted. Both the crops were given the cultural and manurial operations as per schedule and the plants established well.

10) Mixed garden of arecanut and coconut.

Arecanut and coconut are found grown as mixed plantations in certain areas. The object of the trial is to find out the desirability of such a practice as against raising them as pure crops. An observational trial with two treatments viz. (1) arecanut and coconut as mixed crops and (2) arecanut as pure crop replicated twice was laid out during the year. Eight coconut seedlings were planted in the trial plot. The arecanut seedlings will be planted in 1964-65.

11) Relative performance of seedlings obtained from different bunches and different positions in the bunch of mother palms of different ages.

This is one of the trials initiated as a follow-up of the nursery trial "effect of age of trees, order of bunches and position of seednuts in bunch on seednut performance." The trial aimed at determing the performance in the mainfield of stock derived from seeds collected from palms of different ages (young—10 to 15 years, middle aged—30 to 35 years, and old palms—above 50 years). Thirty six seedlings derived from two palms (18 seedlings per palm) for each of the above three age groups were planted out in the mainfield in 1962-63 at a spacing of 9′ x 9′. Each group of 18 seedlings were in turn from nuts collected from three bunches of the palm at the rate of six nuts each. These six seedlings were in turn from nuts selected from the bottom, middle and top portions of the concerned bunch at the rate of two each. There were thus 108 seedlings planted for the trial.

All the 108 seedlings established themselves.

12) Studies on the performance of nuts gathered at different stages of maturity for seed purposes.

With a view to find out the performance in the main field of palms derived from nuts collected at different stages of maturity, such as nine, nine-and-a-half, ten, ten-and-a-half months an observational main field trial was laid out during 1962-63. Fifteen seedlings were planted under each treatment. The planting material for the above trial was obtained from a corresponding nursery trial conducted earlier and thus this is a follow-up of the nursery trial. The palms were given uniform cultural and manurial treatments during the year and they recorded satisfactory growth.

Other studies

1) Effect of different spacings and methods of lay out on the incidence of sun scorch on arecanut palm.

Arecanut palms are highly susceptible to sun scorch, particularly in situations where the plantations are exposed to the south-western sun. This is more so in South Kanara and North Kerala regions. In advanced stages of scorching the stem breaks off and the tree dies. There is a belief among the growers that aligning the trees in north-south direction reduces such damage due to the protection that each successive tree in the row gives to the next tree. This experiment was initiated to find out to what extent this belief is true, and was laid out in November, 1960. The plants were spaced at 8'x8'x9'x9' and 12 ft. quincunx, and one set of such trees was aligned in north-south direction and another set at an inclination of 20° to north-south direction.

The plants have not attained the height required to give protection to the neighbouring palms.

2) Mulching trial—Comparison of different mulches in arecanut gardens.

A trial to compare the utility of different mulching materials for arecanut gardens was laid out in the bulk garden (block III) of the station adopting a complete randomised design with four plots per treatment. The following treatments were imposed:

1. Mulching with chopped arecanut leaves.
2. Mulching with Guatemala grass.
3. Mulching with arecanut husk.
4. Mulching with dry leaves collected from the forest.
5. No mulch (control).

The effect of the different mulches on the performance of arecanut palms and soil moisture in the summer of 1964-65 will be studied.

VI. C. Manurial Experiments

1. Response of seedlings of varied time of germination to different levels of manuring.

The object of this experiment is to study the growth of seedlings obtained from the seednuts which germinated at the different periods from sowing, to three levels of manuring, and was initiated in 1960-61 and repeated in the years 1961-62 and 1962-63. The experiment in all the three years was laid out on a 9 x 4 randomised block design with the following treatments:

Period of germination:

1) Early (germinated within 50 days of sowing)
2) Late (germinated within 50 to 58 days of sowing)
3) Very late (germinated after 58 days of sowing)

Manurial doses:

	N	$P_2 0_5$	$K_2 0$	
1) No manuring	0	0	0	lbs. per acre
2) Moderate manuring	75	25	75	
3) Heavy manuring	150	50	150	

The morphological data of the seedlings in respect of the trial laid out in 1962-63 were tabulated and analysed statistically. The results are presented in Table XXV. It will be seen from this table that manuring has resulted in significant increase in girth of seedlings over no manuring. However, there was no significant difference between moderate and heavy manuring. As regards height and number of leaves, even though there is no significant difference between the different manurial treatments the trend was in favour of manuring. The effect of time of germination of nuts was not found to be significant. These results are more or less in conformity with the earlier observations.

The experiment was concluded with the above observations.

2) Determination of optimum N. P. K. requirements in the main field.

This main field experiment was intended to determine the optimum manurial requirements of arecanut palms for producing vigorous, early bearing and heavy yielding palms. The experiment was laid out in 1961 on

34 confounded factorial design as a single replicate in nine plot blocks with 20 seedlings per treatment.

The following were the treatments:

Nutrients or manure	Levels			
Nitrogen	0	50	100	Pounds per 500 palms (full dose)
$P_2 0_5$	0	40	80	
$K_2 0$	0	75	150	
Green leaf	0	7500	15000	

Application of the second year dose (2/5 of the full dose) of different manures was taken up in October, 1963 as per schedule. The morphological characters viz., girth at last exposed node, number of functining leaves and height of the plants in the plots were recorded prior to application of the manures. The data were tabulated and analysed. The results are presented in Tables XXVI (a) and XXVI (b). From these tables it will be seen that none of the two factor inter actions are significant. The palms receiving green leaf recorded significantly better height growth, the difference between the two levels of green leaf, however, being not significant.

3) Simple Manurial Trials on arecanut in ryots' gardens.

All the 12 units of Simple Manurial Trials laid out around the Central Station in the growers' gardens in 1960-61 were continued. Scheduled doses of manures were applied to the palms. The morphological data of the palms were recorded in December, 1963. The yield data were collected during the harvesting season from November, 1963 to March, 1964. The relevant data were tabulated and sent to the Indian Central Arecanut Committee, Kozhikode, for analysis.

4) Effect of applying N. P. K. in organic and inorganic forms on palm performance.

There is a common belief among growers that application of inorganic manures continuously exhausts the palm and shortens their economic life. There is also a belief that if a garden which has been receiving fertilizers is changed over to organic manures, the tree refuses to respond. This experiment was programmed to determine how far the above notions were correct.

A six year old standing garden was selected to accomodate the trial consisting of four treatments replicated five times. Each treatment plot had

six experimental palms with a common border row. The following were the treatments:—

i) N. P. K. in the form of organic manures from the end of the sixth year till the end of 15th year.

ii) N. P. K. in the form of inorganic manure from the end of sixth year till the end of 15th year.

iii) N. P. K. in the form of organic manures till the end of the 10th year and then inorganic manure till the end of 15th year.

iv) N. P. K. in the form of organic manure till the end of 10th year and then organic manure till the end of 15th year.

The above treatments were superimposed over a uniform basic dose of green leaf and cattle manure (or compost) at 12 kg. each per palm.

Doses of manures:

N — 25 kg.
P_2O_5 — 25 kg. } per 500 palms
K_2O — 40 kg.

Form:

Inorganics: Ammonuim sulphate, Super phosphate and Muriate of potash.

Organics: Fish meal and wood ash. The application of first year dose of manures was taken up.

Before manuring, soil samples of different plots representing three depths 0"—6", 6"—18" and 11"—36" were collected for analysis. The morphological data, viz. girth at permanent mark, girth at last node, number of nodes above the mark, height from the mark to the last node and number of functioning leaves were recorded. The yield data of the individual palms were also recorded.

VI. D. Miscellaneous

1) Uniformity trials: Collection of yield data of palms.

a) *In private gardens.*

This study was initiated in 1958–'59 in a private garden to determine the optimum number of trees required for the experimental plots and the shape of such plots. For this purpose, five hundred and seventy palms of uniform age and of more or less uniform growth were selected. The palms

were being given uniform manurial and cultural treatments from the beginning.

Data on the yield of these palms were regularly collected from 1958–'59 onwards and the data for the years 1961–'62 and 1962–'63 were analysed statistically.

1961–'62 data

For the purpose of analysis a compact block comprising of 12 rows x 12 columns (144 palms) where four trees formed a 8½ ft. square was taken as a sample. The results of analysis are given in Table XXVII (a). It will be seen from this table that increasing the number of trees per plot from 12 did not give an appreciable gain in precision. It was also seen that long, narrow plots were less efficient.

These results are in conformity with those obtained in earlier years as well as with the results of analysis of a different sample of trees taken from the same group of 570 trees, four trees in each case forming parallelogram of 12′ x 6′.

1962–'63 data

Here again for the purpose of analysis, square plots were taken. The results are given in Table XXVII (b). The results are in conformity with that of the previous year, though there is a slight increase in the coefficient of variation.

b) In the bulk garden of the Research Station.

With a view to find out whether the observed plot size of 12 trees is required in the case of selected materials as those used for the various experiments at the Research Stations, the above studies were taken up in the progeny garden (Block II) of the Research Station. A compact block of 144 palms (progenies of six known mother palms) was marked out for the purpose of recording the yield for analysis.

3) Project to find out the weight ratio of the raw and processed arecanuts

This project was intended to find out the weight ratio between raw or fresh arecanut and the final produce and was initiated during 1960-61 and repeated in 1961-62 and 1962-63 in two representative centres where 'Chali' or 'Biligotu' was prepared, viz., Iritty in Cannanore District of Kerala State and Vittal of Mysore State. In each centre the data were collected in the yards of one progressive cultivator who undertook curing by

himself and one curer who processed the fresh fruits purchased from growers.

During the year under report the study was taken up in a private garden near the Station. The palms of this garden which had reached the full bearing stage were about 12 years old and were well maintained. Fruits harvested from 75 trees selected at random from a group of 570 palms were harvested and cured for the purpose of the above studies. The data gathered are summarised below:

i)	Total number of fruits harvested	13,274
ii)	Wet weight of fruits harvested.	479.8 kg.
iii)	Dry weight of the fruits	176.2 ,,
iv)	weight of kernel (produce)	112.2 ,,
v)	Outturn of kernel to whole fruits (wet) by weight	23.4%
vi)	Weight of 1000 dry kernels	8.4 kg.

2 and 5) **Harvesting trials:**

a) Season-wise variation in quality of produce

This study was initiated with a view to find out the influence of season on the quality of produce and was taken up with the ripe nuts harvested from the main garden (Block II) of the Research Station planted in 1957, which was in the second year of bearing. Fully ripe fruits harvested during the different months were dried separately in the open sun for about forty days. The dry fruits were husked and the kernel was graded as 'Biligotu' and 'Koka' the former which forms the bulk of the produce being of superior quality and the latter of inferior quality. The data gathered are summarised below:

Month of harvest	Dry weight of 1000 whole fruits (kg)	Weight of 1000 kernel (kg.)	Percentage of koka to total kernel (by weight)	Remarks
July to September	11.35	7.75	30.8	Monsoon crop
October	12.71	7.33	14.2	
November	13.12	8.27	12.5	
December	13.94	8.21	12.9	
January	14.27	8.05	6.4	
February	13.97	8.39	3.8	
March	13.46	7.94	4.7	
April and May	14.16	7.22	...	Last stray crop.
Mean	13.58	8.07	13.03	

From the above it will be seen that the weight of kernel from fruits harvested both at the commencement and end of the harvesting season is slightly less than those from the harvests made in the middle of the season. It is also seen that the percentage of 'Koka' (inferior quality) is more in the case of the fruits harvested during the monsoon period.

b) Quality of produce as influenced by the degree of maturity.

It is not unusual to see two successive bunches being harvested at one and the same time by the growers when they attend to the harvest of ripe bunches. These two bunches would necessarily be of different maturity levels, the lower one being of higher maturity than the upper in the same tree. With a view to find out if there is any considerable difference as regards the quality and output of 'Biligotu' or cured produce obtained from the fruits thus harvested from two bunches, a drying trial was undertaken.

The trial was taken up during the year with 20 pairs of bunches harvested from 20 trees. From each bunch, 50 fruits were selected at random for drying. The fruits were husked after 40 days of drying in the open. The data collected with regard to the output and quality of produce "Biligotu" are given in Table XXVIII. The output of 'Biligotu' in the two sets of bunches differ significantly, nuts from the lower bunch (higher maturity) giving higher percentage of the produce. With regard to quality also it will be seen that the produce from the lower bunches is superior to those from the upper (less mature) bunches.

STATISTICS

Statistical analysis and interpretation of the results in respect of all the experiments conducted at Central Arecanut Research Station and certain of the Regional Research Stations were taken up during the year. Statistical lay outs were suggested for all the experiments which were to be initiated at different Research Stations. Preliminary investigations on correlation in respect of the following characters were initiated:

1. Yield with
   a) Number of leaves.
   b) Girth at permanent mark (75cm. from the collar)
   c) Girth at last node.
   d) Number of nodes.
   e) Height.
   f) Mean internodal distance.
2. Number of nuts with size of nut.

3. Collar girth and girth at 10 cm. below the last leaf axil.
4. Time of germination and vigour of sprouts and seedlings.

An index for the study of the pattern of germination of seednuts in different lots on treatments was also worked out. Preliminary studies were also initiated to replace the girth at collar measurement by any other suitable measurement which could be more easily recorded.

PESTS AND DISEASES

VII 2) Trial with proprietary fungicides and insecticides to find out effective control measures for all diseases and pests.

I) Control of mites on arecanut:

Trials in the control of mites (white mite - *Paratetranychus indicus;* red mite – *Raoiella indica*) were initiated in 1959-60 and it was proposed to continue these trials for confirmation of results on hand as well as to find out the efficacy of a few new preparations. Experiments conducted during the previous years indicated that Chlorocide - Malathion liquid and Akar-338 were ovicides while the others namely Sayfos (pp 175), Trithion and Sultaf were toxic to the pest only at the adult stage.

During the year under report the trial was laid out in the main field with the following seven treatments allotting eight plants per treatment:

Treatments	Dose
PP 175 (ICI)	100 p. p. m.
Trithion (Mico)	126 cc./100 l.
Kelthane (Rohm and Hass)	186 cc./100 l.
Tedion (Mico)	2 kg./1000 l.
Chlorocide (M) Boots.	156 cc. 100 l.
Mitex (Hexamar)	1 cc./litre.

Observations taken 24 hours after the spray was applied showed that all the chemicals had given an immediate kill of the active mites. Post treatment observations were recorded in the plots 20 days after the first round of spraying. Reinfestation of the leaves with fresh mite populations as well as fresh infestations were noted. The observations recorded are summarised below:

Treatment:	No. of plants showing reinfestation	
	Mild	Severe
PP 175	7	1
Trithion	3	...

Mitex	5	...
Kelthane	1	...
Tedion	1	...
Chlorocide-Malathion liquid	5	...
Control	...	8

It will be seen from the above that Kelthane and Tedion were found to be quite effective in cheking the reinfestation for a long period.

The trial was repeated again with 14 plants per treatment with the addition of Sulkol, Akar-338 and Wettable Sulphur as per the undermentioned doses:

Sulkol.	3 cc./litre.
Akar-338.	1 cc./litre.
Wettable Sulphur	625 gms./litre.

A summary of the post-treatment observations recorded 20 days after the first round of spraying is given below:—

Treatment	*No of plants showing reinfestation.*	
	Mild	*Severe*
PP 175	5	2
Trithion	5	–
Mitex	7	4
Kelthane	–	–
Tedion	6	–
Chlorocide 'M'	5	2
Akar — 338.	2	4
Sulkol	6	5
Wettable sulphur	7	5
Control	–	14

Kelthane, Trithion and Tedion are found to be effective in checking the reinfestation.

2) Control of white grub

The white grub of a Cockchafer beetle (*Lepidiota sp.*) was found to feed on the roots of arecanut palms causing severe damage to the root system. An examination indicated a fairly high incidence of this pest in two package plan plots. As a control measure, the palms coming under the treatment

were treated with 'intox-8' liquid at 50 cc. in 100 litres of water. The basins of individual palms were dug out and closed after application and incorporation of the required dose of the pesticidal fluid. Observations on the effectiveness of the chemical were being recorded.

In addition to the above, a large scale application of the same chemical was given to 50 palms infested by the pest in one of the above units. During the previous year, trials with Intox-8 liquid and Heptachlor were laid out in two private gardens and the treatments were found to be quite effective in checking the incidence of the pest. Further studies were in progress.

3) Trials in the control of Koleroga or Mahali.

'Koleroga' or 'Mahali' caused by the fungus *Phytophthora arecae* is one of the major diseases of the arecanut palm and accounts for enormous losses of crops in most of the arecanut growing tracts. Trials in the control of the disease were continued during the year under report.

During the monsoon of 1963, the field trial to study the comparative efficacy of different proprietory copper oxychlorides with Bordeaux Mixture was laid out in the main garden of the farm on a 8 x 4 randomised block design with the following 8 treatments. Four palms were allotted for each treatment.—

1. Control
2. Fytolan
3. Coppesan — 1 kg. in 100 litres of water.
4. Blitox
5. Fytolan
6. Coppesan — 1 kg. in 200 litres of water.
7. Blitox
8. Bordeaux mixture —one percent.

The spray applications were given twice i. e. once before the onset of monsoon and a second time forty days later.

Since there was no incidence of the disease during the season, the efficacy of the various chemicals could not be evaluated.

Another trial was also laid out side by side in the main garden of the farm to study the effect of adding an adhesive to the various copper

oxychlorides so as to improve their adhesive property. Twelve palms were allotted to each of the following treatments:

1. Control.
2. Fytolan
3. Coppesan — 1 kg. in 200 litres of water.
4. Blitox
5. Fytolan
6. Coppesan — 1 kg. in 200 litres + shell tenac added in each case at half the quantity of the fungicide powder by weight.
7. Blitox
8. Bordeaux mixture.

No disease appeared in the plot and hence the efficacy of the treatments could not be evaluated.

During the previous year's trials it had been observed that fruits receiving copper oxychloride treatments showed copper injury to varying extents, the injury being in the form of greenish brown sunken spots of varied sizes which assumed, later, a deep colour. The injured fruits turned yellow prematurely or cracked and were then shed. In the trials conducted during the period under report the same phenomenon was observed. Copper injury was noticed in the case of fruits receiving copper oxychloride treatments of both high and low concentrations. Younger fruits were less affected, while fairly developed fruits suffered due to greater injury. The injury was found to be not confined to any particular surface of the fruit.

The field trial was again laid out in the main garden of the station on a 6 x 2 x 4 split plot design with the following main and sub treatments. Five palms were allotted for each treatment.

Main treatments:

Sl. No.	*Treatment*	*Dose*
1	Fytolan	one kg. in 200 litres of water
2	Blitox	do
3	Coppesan	do
4	Microcop	do
5	Bordeaux mixture one pecent	
6	Control. No spraying	

Sub treatments:

1. With adhesive.
   "Sandovit" adhesive at 66 cc. per 100 litres of spray liquid.
2. Without adhesive.

The first round of spray was given in June, 1964.

Observation trials were also laid out to test the efficacy of the following new chemicals against Mahali. Ten palms were allotted per each treatment.

	Chemical	*Active ingredient*	*Dose*
1.	Du Ter	Triphenyl Tin hydroxide	One kg. 800 litres of water
2.	Brestan	Triphenyl acetate of zinc	do
3.	Manol	Manganese dithiocarbamate	one litre in 108 litres of water
4	New Manol	Copper oxychloride + Carbamate	do

Chemicals 1 and 2 were applied in the usual high volume, whereas 3 and 4 were applied in medium volume at 60 gallons (270 litres) per 600 palm using a low volume nozzle.

Observations were being continued.

4) Trials to investigate causes and methods of control of button shedding and tendernut fall.

Two middle-aged palms in a private garden and three young palms in the main garden of the Station were marked for making preliminiary studies on the seasonal variations in the intensity of shedding.

To study the effects of assisted pollination in the control of shedding, female flowers were sprayed with a pollen suspension in 0.5 per cent sucrose solution, the suspension being directed on the stigmatic surface. It was observed that assisted pollination gave a set of 91 per cent. as against 78 per cent in the unsprayed control.

Bunches on four selected young palms were sprayed with each of the following hormones and fungicide. One half of the bunch was sprayed with the chemical just where the female flowers opened the other half being left as control.

IAA.	20 p.p.m. in water.
2, 4–D	20 p.p.m. in coconut water.
IBA	20 p.p.m. in water.
Flit 406	1 kg per 500 l. of water.

The spray treatments were repeated at fortnightly intervals. Final observations indicated that none of the hormones are effective in checking

the shedding. A laboratory examination of the freshly shed buttons revealed in most of the cases the presence of the fungus *Gleosporium,* which was found to infect the tip of the female flowers preventing their natural opening. The same fungus was also seen to infect the basal portion of the flowers bringing about embryo set. In one case the stigmatic surface of the majority of female flowers was found to have been completely damaged by an insect.

The extent of retention of female flowers in the bunch in the absence of pollination was studied by removing the male rachillae before the female flowers opened and bagging the female rachillae in separate cellophane bags. Shedding of the female flowers started from the 9th day following their opening and by 26th day all the flowers had shed, indicating that in the absence of pollination the flowers may be retained on the inflorescence to a maximum period of 25 days.

Besides the above experiments a large scale spraying trial against button shedding and tender nut fall was initiated in a private garden with a view to study the effect of combination sprays. The following treatments were imposed with 10 palms per treatment:—

1. One percent Bordeaux mixture plus Endrex @ 10 cc. in 8 litres.
2. Half percent Bordeaux mixture plus Endrex @ 10 cc. in 8 litres.
3. One percent Bordeaux mixture plus 50 percent BHC @ one kg. in 200 litres.
4. Half percent Bordeaux mixture plus 50 percent BHC @ one kg. in 200 litres.
5. One percent Bordeaux mixture.
6. Control.

The shed buttons and tender nuts were collected at regular intervals, starting from March. The total numbers shed in each treatment are given below:—

Treatment No	*Total No. of buttons*	*No. of tender nuts shed*
1	1702	193
2	2364	168
3	2502	257
4	2249	231
5	2304	163
6	2677	217

From the above it will be seen that a combination spray consisting of one percent Bordeaux mixture plus Endrex has considerably reduced the shedding of the buttons and tendernuts.

5. Control of yellow leaf spot of arecanut.

The yellow leaf spot caused by *Curvularia* occurs every year in the nursery as well as on newly planted plants in the main field. The leaves of the affected plants are disfigured and the growth becomes stunted.

A field trial to assess the efficacy of different fungicides in the control of the disease was laid out in the bulk nursery. 500 seedlings were allotted for each of the following treatments:—

Treatments	*Dosage rate*
Du Ter	One kg./800 l. of water.
Brestan	do
Dithane Z-78	115 gms./100 l. of water.
Urea	One kg./200 l. of water.
Mercurised copper oxychloride	do
Mercurised copper oxychloride plus zinc	One kg./100 l. of water.
Control	Unsprayed.

Field counts on the intensity of the disease were made using Mc-Kinney's scale and the infection index was calculated for each treatment using the following formula:

$$\frac{\text{Category numbers}}{\text{No. of plants} \times 4} \times 100 = \text{Infection index.}$$

Infection indices obtained just before and 15 days after the treatments are given below:—

Treatments	*Infection indices*	
	Before treatment	*After treatment*
Control	23.05	25.00
Urea	22.50	23.50
Dithane	23.25	23.30
Du Ter	22.50	22.50
Brestan	21.40	21.55
Mercurised copper oxychloride	20.50	20.50
Mercurised copper oxychloride plus zinc	20.75	20.75

From the above it will be seen that Du Ter, Mercurised copper oxychloride and Mercurised copper oxychloride plus zinc have been very effective in checking the further spread of leaf spot incidence.

Large scale spraying trials with the two chemicals confirmed the above observations.

8. Studies in the control of sun-scorching of stem.

Damage to the stems of arecanut palms caused by sun scorch on the south-western side of the palms, accounts for huge losses of trees annually in arecannt gardens all over the country. Collection and tying of arecanut leaves and leaf sheaths, jute stems of jungle leaves, as are in vogue, are laborious and costly. In order to find a suitable alternate material for protecting the stems, some trials with transparent heavy gauge (400 guage-1' x 10' 20') polythene films rendered opaque by painting with white enamel paint were initiated in November, 1963. Observations made indicated that this material gave adequate protection to the stems against sun scorch. The films when removed in June were found to be fit for further use, during the ensuing season.

13. Observations on exploratory demonstration plots where package treatments were laid out.

Periodical observations in the six package plan units started in 1961-62 in four growers' gardens where the general health condition of trees was poor and the yield sub-normal, were continued to be recorded. Application of the first split dose of micronutrients was taken up in the units. It was observed that in a majority of gardens, water-logging appeared to be a main problem which pre-disposed the palms to the attack of the white grub pest. Suitable measures of control against this, such as providing deep drainage channels and treating the basins of palms with pesticides were included in the schedule of treatments in addition to the application of the following micro and macro-nutrients.

Micro-nutrients:	*Dosage per palm per year.*
1. Ferrous sulphate	56.700 gm.
2. Sodium borate	2.268 „
3. Manganese sulphate	68.04 „
4. Copper sulphate	22.68 „
5. Zinc sulphate	22.68 „
6. Sodium molybdate	2.268 „

Macro-nutrients:

1.	Lime (Where soil is acidic)	454 gm.
2.	Green leaf	12 ,,
3.	Ammonium sulphate	142 ,,
4.	Sulper phosphate	227 ,,
5.	Muriate of potash	114 ,,

Out of the six units of package plan trials, complete improvement in the health of the palms could be obtained in two units at Balnad by the application of micro-nutrients coupled with improving the drainage conditions. It was observed that lack of drainage was the main reason for the set-back of the palms observed. The two units were discontinued.

14. Studies of organisms other than phytophthora that cause rotting of fruits and impair their keeping quality.

This experiment was initiated with a view to study the nature of incipient infection of the arecanut fruit due to certain fungal organisms which might have entered the fruit at a very early stage of their growth. Six palms were allotted for each treatment. Inflorescences were sprayed just when the female flowers opened. The following treatments were imposed:

1.	Blitox	1 kg. per 200 litres of water.
2.	Dithane Z-78.	1 kg. per 2000 ,,
3.	Flit 406	1 kg. per 500 ,,
4.	Control	No spraying.

Further observations were in progress.

16 Studies of palms showing symptoms similar to 'Band' in the primary and secondary nurseries and their behaviour in the main field.

During 1962 an observation trial was laid out in the farm with 14 one-year-old sprouts showing symptoms like curling and twisting of leaves similar to those produced by 'Band'-affected palms. The sprouts were set out in the main field along with an equal number of normal sprouts after recording their morphological characters. During the period under report the plot was weeded, irrigated, and manured as per schedule.

Further observations were in progress.

17. Other problems evoked in the course of studies.

a) Gleosporium inoculations:

During September-October, 1963, arecanut plants in certain gardens of Chickmanglur-Kadur area were reported to be affected by a fungus disease causing considerable damage to plants. An on-the-spot study of the disease showed that it was characterised by the appearance of dark brown lesions on the tender shoots and unopen leaves coalescing to form patches. Mid-ribs, petioles, and leaf sheaths were mostly affected. In severe cases the affected palms were killed due to the infection of the bud.

A fungus identified as *Gleosporium* was isolated from the diseased tissues. Four 2½ year old arecanut seedlings were inoculated on their petioles and laminae with a pure culture of the above fungus. Two seedlings were kept in the open while the other two were kept inside polythene humid tents. Those under cover developed characteristic dark brown lesions on the petioles in 5-6 days.

The trials were being continued.

b) Trials with Nickel Chloride.

During 1962, trials in the field and laboratory were conducted to study whether Nickel Chloride reported to be a very good eradicant fungicide in tea is effective in arecanut also with reference to Koleroga. It had been observed that the chemical is ineffective in eradicating the fungus.

The above trials were repeated during the monsoon of 1963. Tender fruits were sprayed with Nickel Chloride solutions ranging from 500 to 3000 ppm. No toxic effects were seen on the fruits except slight cracking at the higher concentrations. Fruits in the early stages of attack of the disease were steeped overnight in a 3000 ppm. solution of Nickel Chloride. The fruits developed the disease symptoms later showing that the chemical was not able to eradicate the fungus.

c) Identification of pests on arecanut.

A spotted grass-hopper pest reported to be doing great damage in certain areas by feeding upon the foliage was got identified at the Commonwealth Institute of Entomology, Kew, as *Aularchis miliaris*. Further specimens of banana scaring beetles collected from Assam were identified by the same Institute as *Nodostoma Viridipermis* Motsch.

F. General

A. Farm Management and Development.

a) Arecanut Gardens:

i) **Bulk garden** (1957): This garden which comprises of an area of 2.23 hectares (5.5. acres) was planted in 1957 with seedlings derived from 41 mother palms. The routine maintenance operations, such as cleaning the main and sub-drains during the monsoon, protecting the stems from sun scorch by tying arecanut leaf sheath around the stems, repairing irrigation channels and irrigating the garden at regular intervals were attended to according to the schedule. The grass and other weeds in the garden were scythed twice during the year in the months of August and February. All the palms were manured with 12.5 kg. of green leaf, 15.0 kg. of compost, 200 gm. of calcium ammonium nitrate, 250 gm. of super phosphate and 150 gm. of Muriate of potash applied per palm. Application of fresh soil brought from outside so as to fill up the old drains which had widened was taken up over an area of one acre.

The third crop of the garden was harvested during the year and 4,85,393 ripe nuts were obtained. These nuts when dried and husked gave 4,308.10 kg. 'Chali' (dried kernel) valued at about Rs. 26,212/-

Forty-two gaps which occurred in the main garden due to the death of palms were filled with fresh seedlings of known mother palms. Out of 3,215 palms in the garden 2,655 or 82.6 per cent. yielded fruits during the year as against 78.9 per cent. during the last year and 54.0 per cent during the year previous to that. The average number of bunches in a bearing palm worked out to 2.5.

ii) **Experimental gardens:** The experimental gardens consisting of spacing trial, N. P. K. trial, effect of growing banana in arecanut garden, method of layout and other miscellaneous observational trials were maintained in good condition by giving timely cultural and manurial operations.

b) Arecanut nurseries:

i) **Arecanut Nursery 1961-63:** This is the 7th nursery of the Station. The distribution of seedlings which commenced during the month of March, 1963 was continued upto April, 1964. Seedlings numbering 59,599 were distributed from this nursery. The percentage of quality seedlings obtained from this nursery to the number of seednuts sown worked out to 60.0. The cost of production of seedlings worked out to Rs. 0.15 per seedling.

ii) **Arecanut nursery 1962-64.** A total of 85,091 sprouts was transplanted in the secondary nursery beds. Mulching the nursery beds with green leaf at the rate of 25,000 kg. per hectare was taken up immediately after the planting. Banana suckers were planted in the nursery as a shade crop prior to the transplanting of sprouts. A second mulching with green leaf was taken up during the month of August. The plots were regularly weeded. Seeds of *crotalaria anagyroides* were also sown along the southern and western borders of the nursery beds in August.

The nursery was irrigated beginning from the month of November. Adequate irrigations as required could not be given towards the end of the season due to the scarcity of water in the river. Artificial shade was provided wherever found necessary.

The nursery was twice top-dressed with nitrogenous fertilizers. There was severe mite attack due to the hot and prolonged summer. Timely sprayings were given against this pest as well as diseases such as yellow spot.

Distribution of seedlings was commenced in May, 1964, and 14,600 seedlings were sold.

iii) **Arecanut nursery 1963-65.** Procurement of seednuts from the premarked mother palms for this nursery commenced in December and 75,000 nuts were sown in the primary nursery. The nuts recorded 96.8% germination.

Preparations of the secondary nursery beds were completed and planting of the shade crop of banana and arecanut sprouts commenced in June, 1964.

iv) **Selection of mother palms and procurement of seednuts**

All the 993 mother palms marked during earlier years were examined for their regularity in bearing, high yield and other characters. Mother palms numbering 75 were selected afresh, the total number of mother palms selected and marked during the year being 623.

During the year a total of 99,989 seed arecanuts were procured as detailed below:

Central Research Station nursery	75,000
,, experiments	9,459
Regional Stations and other purposes	15,530
Total	99,989

c) Green manure and cover crops and shade trees

In order to augment the green leaf manure supply in the farm, *Gliricidia maculata* cuttings numbering 3,366 were planted in the hillocks during the month of July and August. The plantings of the previous years were coming up well.

Other shade crops such as *Eucalyptus grandis, Grevillea robusta* planted during the previous year had recorded fairly good growth. Proper cultural operations and pruning and training were given to these plants.

d) Subsidiary crops

All the coconut seedlings and palms were given the routine cultural and manurial operations. The crowns of the palms were treated with a mixture consisting of equal quantities of BHC 5% and sand against Rhinoceros beetle. Coconut seedlings numbering 90 were planted. A total number of 9,219 coconuts were harvested during the period from 233 yielding palms, average number of nuts per tree being 39.5.

Economic plants such as jack, lime, sapota, gooseberry and miscellaneous shade trees numbering 378 were planted at the Station during the period under report.

e) Plant protection work.

The incidence of mites particularly the red ones, was very severe in the farm. Wettable sulphur was regularly used to check the pest. Large scale sprayings were also taken up against red mite attack with new proprietary miticides like Trithion, Tedion, Akar 338, Mitex and Chlorocide Malathion liquid.

Inflorescences in the bulk garden and spacing trial were sprayed with 50% BHC against red ants and with Endrex against the caterpillar pest (*Tirathaba mundella*). Mild coccid and mealy bug infestation noted on the plants in the experimental main field was controlled with Folidol spray. Crowns of palms showing bud rot were given surgical treatment and were cleaned and drenched with 0.1% Ceresan wet or bordeaux paste. Bunches in the main garden were also given a combination spray of Bordaeux mixture plus BHC against dieback and subsequent infection. Axils of coconut palms were filled with 50% BHC plus sand against rhinoceros beetle attack. Yellow leaf spot disease in the nursery was checked by spraying the seedling with a combination spray of Urea plus Dithane Z 78, Mercurised copper oxychloride and Mercurised copper oxychloride plus zinc.

Citrus and mango grafts were sprayed with a combination spray of Bordeaux mixture plus Endrex.

f) *Permanent improvements.*

Construction of gas house. Construction of a gas house having a plinth area of 132 sq. ft. was completed.

Temporary godown. A temporary godown having a plinth area of 530 sq. ft. with tiled roof was constructed during the period.

Site for the installation of meteorological instruments. An area of 190' x 130' was cut and levelled in the hillock near the laboratory building for setting up the meteorological observatory.

Mud wall fencing. A total length of 421 metres along the boundary wall of the new area of the farm was provided with mud wall fence with a live hedge top of agave and 'kali'.

Major constructions. The construction of laboratory-cum-administrative building, Guest House and residential quarters (11 Nos.) was completed.

B. Extension Work.

i) **Exhibiton.** The Station participated in a number of exhibitions organised by the National Extension Service and other State organisations, at a number of places around Vittal. It also participated at the All India Industrial & Agricultural Exhibition held at Mangalore.

ii) **Advisory work.** The officers and staff of the Station were in intimate touch with the arecanut growers with a view to know their problems and to suggest or find solutions for them. They visited a large number of gardens in South Kanara as well as neighbouring districts of Mysore State and Cannanore and Kozhikode of Kerala State to render advice to the growers on the laying out of new gardens, rejuvenating existing old gardens, raising of nurseries, planting, manuring and plant protection practices.

The Arecanut Specialist visited a number of gardens in Mohitnagar (West Bangal) and advised the growers on scientific cultivation. The Agronomist visited some gardens in Thirthahalli and Koppa of Mysore State and some plots in Cannanore, Kottayam and Kozhikode Districts. The Botanist visited some gardens in Coorg District with a view to study the possibilities of growing arecanut under high altitudes and to study the condition of existing plantations. He also visited arecanut gardens in Ratnagiri and Colaba districts of Maharashtra State to study the incidence

of 'Band' disease and for collection of types. He also undertook a joint tour along with the Assistant Plant Pathologist, Kayamgulam with a view to make an on-the-spot study of the new fungus disease of the arecanut palm in Chikmagalur District of Mysore State. He addressed arecanut growers at an Agricultural Seminar held at Bovikana.

The number of enquiries received from arecanut growers officials and non-officials and State Departments as regards the various aspects of arecanut cultivation was on the increase, and these were attended to promptly.

A large number of arecanut growers and other interested parties who visited the Station were taken round the farm and the various items of work in progress explained to them.

iii) **Training**. Shri M. Mahalingam, Assistant Horticulturist (Arecanut Development Scheme), Madras State, was given training on different aspects of arecanut cultivation for a period of10 days.

C. Miscellaneous

i) **Library**. During the period under report, 11 books and 114 periodicals were added to the library

ii) **Laboratorv equipments**. Some of the important laboratory equipments, such as pH meter, Hellige comparator shaking machine, digestion units etc. and a gas plant and accessories were purchased for the laboratory during the year.

iii) **Publications**. The following scientific and general papers were written and sent for publication during the year under report:—

1. Impressions of a tour of the arecanut gardens of South Kerala and some suggestions for improving the gardens—K. Shama Bhat.
2. Spot lights on arecaeut cultivation in Maharashtra State—K. V. Ahamed Bavappa.
3. Grow this multipurpose grass and improve your land and crops—Indian Farming—E. Velappan.
4. Correlation studies in A. **catechu Linn**—I. Time of Germination, Bartlett's index and vigour of sprouts seedling—K. V. A. Bavappa, P. R. Ramachander, and E. Velappan.

In addition, the Central Arecanut Research Station contributed materials for the ' Questions and Answers" and "Technical News item" sections of the Arecanut Journal. Reports of the progress of work at the

Station were published regularly in the quarterly journal "Agricultural Research," issued by the Indian Council of Agricultural Research, New Delhi.

Three pamphlets on different aspects of arecanut cultivation published earlier by the Indian Central Arecanut Committe were revised to bring them in line with the latest findings. Two new pamphlets on "Control of spindle bug" and "Yellow leaf disease of areca palm in Kerala State" were written up for release. A new poster on "Control of spindle bug" was also prepared.

iv) **Arecanut drier:** The mechanical drier fabricated by the Central Food Technological Research Institute, Mysore and installed at the Station during the previous year was worked for drying the off-season crop harvested during the monsoon months. The drier worked satisfactorily and was much appreciated by the growers.

v) **Tours:** The Arecanut Specialist inspected the Regional Arecanut Research Stations, Palode and Peechi and the Madras State Arecanut Nurseries located at Pattukottai. He also visited the yellow leaf disease affected areas of Trichur District. Besides, he attended the meeting of the Heads of Central Research Institutes held at New Delhi and the meeting of the IVth Plan Working Group held at Madras.

The Botanist, the Agronomist and the other members of the technical staff also undertook tours for spot inspection and advisory work.

vi) **Visitors:** The Station had a very large number of visitors during the year. These included visitors from other States of Maharashtra, Goa, Andhra Pradesh, Kerala and Madras and a number of batches of students from the Agricultural Colleges at Bapatla (Andra Predhesh) and Hebbal (Bangalore). Among the important visitors to the Station were, Shri Narayana Gowda, Minister for Agriculture, Government of Mysore, Mrs. Arnovici and Mr. V. S. Arnovici, Acting Director and Dr. K. C. Naik, Technical Advisor of the Far Eastern Regional Research Office of the American Embassy, New Delhi, members of the Mysore State Estimates Committee, Shri A. Bhima Bhat, Vice-President, Indian Central Arecanut Committee and Shri M. Janardhanan Nair, Director of Agriculture, Kerala State.

vii) **Administration.** Shri M. Mohan Rao, Arecanut Specialist continued to be in charge of the Station till 31st March, 1964. Consequent to his reversion to his parent Department Shri K. V. Ahamed Bavappa, Botanist, took over charge of the station with effect from 1st April, 1964.

Shri K. V. Ahamed Bavappa, Agronomist, was appointed to the post of Botanist with effect from 18—9—1963. Shri K. Shama Bhat, Farm Superintendent was appointed to officiate as Agronomist with effect from 23—11—1963. Shri P. R. Ramachander joined duty as Statistical Officer on 20—12—1963. Dr. A. R. Kalbande, reported for duty as Soil Chemist with effect from 15—6—1964.

Shri K. S. Nagaraja Rao, on his reversion from the post of Research Officer, Regional Arecanut Research Station, Palode, joined duty as Pathology Assistant on 2—12—1963.

Sarvashree K. S. Nagaraja Rao and P. Muddappa, Research Assistants were promoted as Senior Research Assistants with effect from 7th May, 1964.

Remarks of the Scientific Committee on the previous report and action taken thereon.

	Remarks	*Action taken*
1.	Dr. Swaminathan of I. A. R. I. might be consulted for the programme of work contemplated on breeding and genetics of Areca.	Dr. Swaminathan intimated that the items of work programmed under breeding and genetics of areca were in order.
2.	In cases where natural pollination is supplemented and higher yield is obtained, a higher dose of fertilizers will have to be given as the trees might get exhausted by the increased fruit-set. Further the effect of higher fruit-set on the production of female flowers in the succeeding years might be studied.	Action was taken to apply higher doses of fertilizer to such of the trees which gave increaesd fruit-set due to assisted pollination. Effect of higher fruit-set on female flower production was being studied.

K. V. AHAMED BAVAPPA,
Botanist.

G. Technical Programme for 1964–'65.

Item No. in the technical programme	Name of the experiment	Year of commencement and completion
(1)	(2)	(3)
BOTANY		
Crop Improvement:		
I. Breeding and genetics of Areca		
1.	Introduction and maintenance of indigenous and exotic species and types of Areca for selection and hybridisation.	1958-'59 To be continued,
2.	Survey of arecanut gardens to select superior types and assessing genetic variation.	do
3.	Floral biology of areca:—	
a, b)	Study of the range of variation in flowering from tree to tree including month-wise variation in flowering in the same garden.	1960-'61 To be continued for 5 years.
c)	The frequency distribution of number of palms flowering per week during all the weeks. The phenomenon of early flowering etc. to be correlated with fruit production.	1961-'62 To be continued for 5 years.
d)	Floral initiation.	1960-'61 To be continued for 5 years.
e)	Study of pollen.	do
4.	Hybridisation and selection:	
a)	Standardisation of crossing technique.	1958-'59 1964-'65
b)	Production of inbred lines of distinct types.	1960-'61 To be continued.
c)	Hybridisation between distinct types and selected palms to combine high yield and regular bearing, and study of progenies.	1960-'61 To be continued.
d)	Hybridisation between exotic and indigenous types.	1962-'63 To be continued.

(1)	(2)	(3)
5.	Preliminary studies on progeny behaviour of mother palms.	1960-'61 To be continued.
6.	Effect of selection of seednuts on germination and future performance.	1963-'64 To be continued.
II.	**Root studies:**	
a) (i)	Root studies at different ages and under different soil conditions in adult palms.	1962-63 To be continued for 5 years
(ii)	Root studies in seedlings at different ages	1963-64 To be continued for 3 years
b)	Root studies in plants showing symptoms similar to 'Band'.	1963-64 To be continued for 5 years
III.	**Anatomical studies:**	
a)	Structure and development of fruit in arecanut growing under high and low altitudes.	1962-63 To be continued for 5 years
b)	Study of the structure of roots in diseased and healthy plants.	— do —
c)	Study of the anatomy of the leaf of the different ecotypes.	1963-64 To be continued for 5 years
IV.	**Cytological Studies:**	
a)	Standardisation of cytological techniques.	1963-64 1964-65
b)	Study of meiosis in different ecotypes of arecanut.	1963-64 1965-66
c)	Karyomorphological studies in different types and species of areca.	1963-64 To be continued
V.	**Physiological Studies:**	
1)	Studies on fruit setting and shedding.	1959-60 To be continued for 5 years

(1)	(2)	(3)
	2) Inducing mutations in arecanut:	
a)	By irradiation of seednuts (Thermal and Pile neutrons, X-rays and Gamma rays.)	1960-61 To be continued
b)	By chemicals (Colchicine &c.)	1961-62 To be continued
c)	By the use of irradiated pollen in germination.	1963-64 To be continued
	3) Effect of plant regulators on growth.	1961-62 To be continued for 5 years
	4) Role of micro-nutrients in arecanut.	— do —
	AGRONOMY	
	VI. A. 2. Sowing experiments:	
(e)	Effect of different intensities of shade in seed bed and secondary nursery beds on growth performance of seedlings.	1962-63 1964-65
(h)	Determination of optimum age of transplanting seedlings-cum-sowing *in situ* vs. transplanting of single, double and treble transplanted seedlings.	1958-59 To be continued
4.	Standardisation of method of packing seedlings.	1960-61 1963-64
	B. Cultural experiments:	
a 1)	Determination of optimum spacing in the main field.	1958-59 To be continued for 15 years in the first instance
2)	Effect of depth of transplanting seedlings-cum-intervals of irrigation on growth and yield.	1964-65 To be continued
3)	Effect of different methods of inter-cultivations on the productivity of palms.	— do —
4)	Study of intercrops in arecanut gardens.	1960-61 To be continued
5)	Comparative studies of different green manure and cover crops for arecanut gardens.	— do —

(1)	(2)	(3)
6)	Investigations on different types of areca under rainfed and irrigated conditions.	Postponed
7)	Effect of growing banana in arecanut gardens for different durations.	1963-64
8)	Postponed.	
9)	Drainage experiments in arecanut garden.	1964-65 To be continued
10)	Mixed garden of arecanut and coconut.	1962-63 To be continued
11)	Relative performance of seedlings obtained from different bunches and different positions in the bunch of mother palms of different ages.	do
12)	Studies on the performance of nuts gathered at different ages of maturity.	do
13)	Effect of different spacings and method of layout on the incidence of sun scorch on arecanut palms.	1960-61
14)	Mulching trial—a comparison of different mulches in arecanut gardens.	1963-64 To be continued
VI. C.	**Manurial experiments:**	
1.	N. P. K. Manurial experiment.	1961-62 To be continued
4.	Effect of applying fertilizers, to supply N. P. K. in organic and inorganic forms on palm performance.	1963-64 To be continued
5.	Relative merits of different nitrogenous fertilizers.	1964-65
6.	Study of exhaustion of nutrients by adult bearing palms.	1964-65
VI. D.	**Miscellaneous**	
1.	Uniformity trials—collection of yield data of palm.	1958-59 1967-68
3.	Project to find out the weight ratio of raw and processed arecanuts and cost of processing nuts.	1961-62 1963-64

(1)	(2)	(3)
2 & 5.	Harvesting trials:—	
	a) Season-wise variation in quality of produce.	1963-64 1965-66
	b) Quality of produce as influenced by degree of maturity.	do
6.	Simple Manurial Trials on arecanut in ryots' gardens.	1960-61 1965-66
VI. E.	Crop weather study.	1959-60

Note:

Items VI A 1 (a) to (d); 2 (a) to (d), (f) and (g); 3; VI C 1 and VI D 4 have been concluded. For results vide earlier reports.

Items VI B 2, 3, 4, 5 & 9 & VI C 5 will be taken up when the lands proposed for acquisition come to possession.

STATISTICS

a)	Planning, analysis and interpretation of experiments.	1963-64 To be continued.
b)	Refinement of experimental technique.	do
c)	Biometrical studies on arecanut (in collaboration with Botany Division):—	
	1) Correlation and heritability studies.	do
	2) Selection index and discriminant function.	do

SOIL CHEMISTRY

1.	Analysis of soil samples	1964-65 To be continued.
2.	Preliminary studies with soils from important arecanut growing areas of different States.	do
3.	Tissue testing	do

(1)	(2)	(3)
4.	Plant analysis for the purpose of (a) nutrient exhaustion study, (b) correlation with crop response at various doses of fertilizers that are being supplied, and (c) finding out the critical nutritional status of the palm.	do
5.	Analysis of cured products	do
6.	Analysis of irrigation water.	1964-55 To be continued
7.	Pot culture studies.	do
8.	Permanent observational plot to study the composition changes in soil and plant.	do
PESTS AND DISEASES		
VII. (2)	Trials with different fungicides and insecticides to find out effective control measures for all diseases and pests:—	
1)	Control of mites.	1959-60 1964-65
2)	Control of white grub.	do
3)	Trials on the control of 'Koleroga' or 'Mahali' with and without adhesives.	do
4)	Trials to investigate causes and methods of control of button shedding and tender nut fall.	do
5)	Control of yellow leaf spot of arecanut.	do
6)	Postponed.	
7)	Study of collar rot of seedlings and influence of soil micro-organisms.	1960-61 1965-66
8)	Studies in the control of sun scorching of stem.	1960-61 1964-65
9)	Postponed.	
10)	Concluded.	
11)	Studies on the retention of copper fungicides on sprayed fruits.	1960-61 1964-55
12)	Susceptibility of arecanut to 'Koleroga' at different stages of maturity (development).	1961-62 1964-65
13)	Observations on exploratory demonstration plots where package treatments are laid out.	do

(1)	(2)	(3)	
14)	Studies of organisms (other than *Phytophthora*) that cause rotting of fruits and impair keeping quality.	1962-63	1965-66
15)	Combined with item (11)		
16)	Study of palms showing symptoms similar to 'Band' in the primary and secondary nurseries and their behaviour in the mainfield.	1960-61	1969-70
17)	Studies on the biology of *Ganoderma lucidum* and trials on the control of 'Anabe' disease.	1964-65	1966-67
18)	Other problems evoked in the course of studies.		

APPENDIX I

Rainfall and Temperature Data 1963–'64

Months	No. of rainy days 1963–64	Average No. of rainy days during the last six years	Rainfall in mm. during 1963–64	Average rainfall (mm.) during the last six years	Average temperature (°C) 1963—'64	
					Maximum	Minimum
July	31	30.00	692.7	1354.7	31.50	20.0
August	31	27.8	1072.9	909.87	29.8	20.5
September	15	19.5	144.5	460.2	32·5	20.3
October	12	13.5	327.3	263.03	33.0	20.0
November	3	4.8	32.4	85.38	35.0	17.5
December	2	1.5	24.6	21.32	34.8	15.0
January	—	—	—	—	35.0	13.0
February	—	—	—	—	36.6	14.5
March	—	0.3	—	3.68	38.0	17.0
April	2	3.8	69.2	31.92	36·5	19.0
May	—	12.3	—	328.10	35.7	19.0
June	26	24.2	664.8	944·7	35.0	19.8
Total	122	137.7	3028.4	4402.9		

APPENDIX II

TABLE I

Mean morphological characters of the exotic types

Date of planting: June, 1961. Date of observation: Oct., 1963

Name of type	No. of plants	Mean measurements (in cm.) Height.	Girth at collar	Girth at crown	No. of nodes	No. of leaves
1. Fiji	5	80.18	53.13	34.63	10.50	8.0
2. Mauritius (*A. triandra*)	18	20.21	31.86	34.58	3.27	5.7
3. China.	6	56.61	51.61	31.83	10.16	8.2
4. Ceylon (1)	18	81.49	48.84	31.97	9.16	6.1
5. Ceylon (2)	24	32 93	37 02	31.09	5.88	6.2
6. Ceylon (3) (*A. concinna*)	18	—	12.13	—	nil.	4.0
7. Indonesia (1)	6	40.40	22.83	16.30	5.83	5.8
8. Indonesia (2) (*A. triandra*)	18	43 46	32.18	26.13	6.11	6.3
9. Indonesia (4)	4	78.37	44.37	36.67	10.00	6.7
10. Indonesia (6)	6	81.71	48.85	35.68	8.00	6.8
11. Saigon (1)	24	109.78	57.12	30.97	12.21	8.6
12. Saigon (2)	24	87.18	44.34	29.16	9.66	7.9
13. Saigon (3)	24	99.80	53.79	31.53	10.92	7.8
14. Singapore	6	85 20	55.45	34.35	9.83	8.3
15. B. S. Islands (1)	6	13.33	39.65	28.99	2.50	5.8
16. B. S. Islands (2)	6	23.45	44.15	30.15	4.33	5.3
17. B. S. Islands (3)	6	21.48	39.15	29.60	3.16	6.1
18. Local.	15	50.67	53.44	33.52	5.25	7.4

TABLE II

Flower production and fruit-set in different exotic types.

S. No.	Type	Total No. of palms	Total No. flowered	Condition of inflorescence produced.			Total No. of female flowers	Total No. set recorded after 2 months	Percentage set
				Aborted or with out female flower	Good	Total			
1.	Fiji	5	5	15	9	24	554	nil	nil
2.	Mauritius	18	6	9	nil	9	nil	—	—
3.	China	6	4	3	9	12	1449	193	13.4
4.	Ceylon (1)	18	6	5	6	11	485	25	5.1
5.	Ceylon (2)	24	1	2	nil	2	nil	—	—
6.	Ceylon (3)	18	nil	nil	nil	nil	nil	—	—
7.	Indonesia (1)	6	4	4	2	6	172	nil	nil
8.	Indonesia (2)	18	9	6	3	9	2246	nil	nil
9.	Indonesia (4)	4	2	6	nil	6	nil	—	—
10.	Indonesia (6)	6	1	nil	1	1	195	50	25.6
11.	Singapore	6	2	2	4	6	430	115	26.7
12.	Saigon (1)	18	8	10	17	27	1304	127	9.7
13.	Saigon (2)	18	2	2	4	6	568	98	17.2
14.	Saigon (3)	18	4	7	9	6	649	41	6.3
15.	B. S. Islands (1)	6	nil	—	—	—	—	—	—
16.	,, (2)	6	nil	—	—	—	—	—	—
17.	,, (3)	6	nil	—	—	—	—	—	—
18.	Local	15	1	2	—	2	—	—	—

TABLE III

Susceptibility of different exotic types to mite infection.

S. No.	Name of type	Total No. of palms in the block	Total No. infested with mites	Percentage of palms attacked.
1.	Fiji	5	2	40.0
2.	Mauritius	18	3	16.6
3.	China	6	5	83.3
4.	Ceylon (1)	18	9	50.0
5.	Ceylon (2)	24	6	25.0
6.	Ceylon (3)	18	nil	nil.
7.	Indonesia (1)	6	nil	nil
8.	Indonesia (2)	18	2	11.1
9.	Indonesia (4)	4	3	75.0
10.	Indonesia (6)	6	3	50.0
11.	Saigon (1)	18	10	55.5
12.	Saigon (2)	18	8	44.4
13.	Saigon (3)	18	15	83.3
14.	Singapore	6	4	66.6
15.	British Solomon Islands (1)	6	3	50.0
16.	,, (2)	6	3	50.0
17.	,, (3)	6	2	33.3
18.	Local	15	5	33.3

TABLE IV (a)

Cultivar Survey—Expected Standard Error for sample size of 12 nuts

Tree No.	Bunch No.	Population mean		Expected S. E. for sample size 12	
		l (cms.)	*b* (cms.)	*l*	*b*
2752	I	4.49	3.33	0.0894	0.1082
	III	4.98	4.21	0.0583	0.0616
1221	I	4.61	3.66	0.1105	0.0900
	II	5.07	3.91	0.1059	0.0906
	III	4.88	4.02	0.0632	0.0592
531	I	5.14	3.76	0.1010	0.0888
	II	5.44	3.84	0.0656	0.0548

TABLE IV (b)

Cultivar Survey—Stan'ard error of various sample sizes

Sample size	Expected standard error for sample size							
	Bunch No. 1		Bunch No. 2		Bunch No. 3		Bunch No. 4	
	l	*b*	*l*	*b*	*l*	*b*	*l*	*b*
8	·1095	.1345	.1404	.1207	.1301	.1204	.1319	.1102
10	.0948	.1109	.1207	.1102	.1205	.1010	.1170	.0995
12	.0894	.1082	.1105	.1020	.1104	.1000	.1059	.0906
15	.0774	.0959	.1024	.0900	.1010	.0888	.0938	.0794
20	.0632	.0812	.0871	.0768	.0806	.0761	.0794	.0678
Population mean	4.49	3.93	4.61	3.66	5.146	3.767	5.07	3.91

TABLE V

Month-wise variation in flowering

Month	Percentage of inflorescences produced to leaves shed			Percentage of monthly production of inflorescences to the total		
	1961-62	1962-63	1963-64	1961-62	1962-63	1963-64
July	11.20	45.35	65.90	2.7	4.7	7.3
August	21.80	52.45	50.1	5.6	5.9	5.6
September	35.80	71.96	55 8	6.2	5.0	6.3
October	54.00	74.80	64.0	9.5	6.9	7.2
November	61.97	84.64	74.9	9.5	8.8	8.4
December	76.19	84.76	82.4	13.8	7.9	9.2
January	89.03	90.64	87.9	8.2	10.3	9.9
February	87.45	94.06	93.7	10.5	11.9	10.5
March	58.13	90.00	88.3	12.0	11.6	9.9
April	69.68	83.81	84.8	10.7	11.8	9.4
May	37.47	67.60	66.0	5.0	7.2	7.4
June	35.26	79.20	76.8	5.4	8.0	8.6
Mean	48.40	77.35	74.22	...	...	...

TABLE VI

Pollen Variability during different months

Month	Germination percentage. Concentration of sucrose solution %				Mean.
	0.5	1.0	2.0	5.0	
July.	39.0	29.0	13.8	14.7	24.20
August.	21.5	13.1	22.0	4.3	15.20
September.	24.3	28.3	16.0	5.4	18.50
October	21.9	16.1	14.0	10.0	15.50
November.	47.8	45.6	13.7	43.3	37.60
December	30.2	80.5	51.2	61.7	55.90
January	84.3	94.1	71.2	28.8	69.60
February	29.3	31.5	56.6	25.4	45.50
March	30.7	19.5	30.6	13.7	28.10
April	51.8	42.6	39.4	62.4	53.10
May	40.8	33.0	51.4	84.3	58.90
June	58.1	22.9	22.6	83.1	46.08

TABLE VII

Hybridisation between selected palms

Female parent (1)	Male parent (2)	No. of flowers pollinated (3)	Number set (4)	Percentage set (5)
1886	1097	16	nil	nil
	1098	18	10	55.5
	471	39	nil	nil
	80	52	2	3.8
	594	51	5	9.8
	360	15	nil	nil
	1092	45	4	8.8
	Open	65	4	6.1
	Self	--	—	—
1098	471	121	7	5.8
	80	42	9	21.4
	594	66	2	3.0
	360	50	3	6.0
	482	43	9	20.9
	1092	65	3	4.7
	1886	48	1	2.8
	1126	61	3	4.9
	Open	189	74	39.2
	Self	73	nil	nil
471	80	36	nil	nil
	360	53	4	7.5
	482	27	1	3.7
	1059	34	4	11.7
	1098	35	1	2.8
	1126	26	1	3.8
	1886	30	nil	nil
	594	29	1	3.4
	Self	42	2	4.9
	Open	133	57	42.8
80	360	49	5	10.2
	482	64	nil	nil
	1059	17	nil	nil
	1092	31	nil	nil

(1)	(2)	(3)	(4)	(5)
	1098	24	nil	nil
	1126	42	2	4.7
	1886	38	nil	nil
	Self	63	nil	nil
	Open	114	43	37.7
482	80	30	3	10.0
	360	45	3	6.6
	471	8	3	37.5
	1059	19	1	5.3
	1092	13	1	7.7
	1126	47	4	8.5
	594	28	nil	nil
	Self	38	1	2.6
	Open	65	44	67.7

TABLE VIII

Preliminary studies on progeny behaviour of mother palms

(Mean data of 20 palms)

Mother Palm number	Total No. of leaves shed	Total No. of inflores-cences produced	% of in-florescences to leaves shed	Mean No. of female flowers produced per palm	Percentage set (recor-ded after two months)
KMJ 2	162	130	80.2	1364.2	17.64
SDK 16	151	100	66.2	927.0	28.26
SDK 14	157	93	59.2	740.4	14.54
SDK 13	149	101	67.7	842.8	16.84
SDK 6	132	80	60.6	865.7	18.73
SDK 4	132	89	67.4	926.0	22.30
KMJ 13	138	101	73.1	946.9	20.08
SRJ 6	163	118	72.3	1047.0	19.82
SRJ 9	138	109	78.9	1014.6	17.06
SRJ 15	156	127	51.4	1164.0	24.87

TABLE IX

Effect of selection of seednuts on germination and future performance

Treatments: 1) Unselected bulk nuts.
2) Selected bulk nuts.
3) Unselected nuts from mother palms.
4) Selected nuts from mother palms.

Treatment	Germination percentage	% of vigorous seedlings	% of rejected seedlings	Girth (cm.)	Height (cm.)	Number of leaves
I.	92.67	26.00	1.00	.98	37.49	2.27
II.	95.33	36.33	1·00	1.06	39.31	2·37
III.	98.67	10.00	2.33	.97	35.31	2.10
IV.	96.28	11.67	1.33	.99	37.10	2.12
S. E. of mean	.97	2.69	1.02	·62	.52	.02
C. D. (P=0.05)	2.92	5.73	—	.05	1.11	.05
S. E. per plot	2.39	6.60	2.50	.04	1.29	0.7
Overall mean	95.70	21.00	1.41	.99	37.38	2.22
C. V. (%)	2.49	31.40	177.3	4.0	3.40	3.10

TABLE X.

Supplementing natural pollination by spray method to improve fruit-set.

Month	Open pollination + pollination by spraying. Pollen suspended in sucrose solution.			Open pollination + spraying sucrose solution.			Open pollination only		
	Total flowers	Number set	Percentage	Total flowers	Number set	Percentage	Total flowers	Number set	Percentage
June	1916	81	4.2	1599	72	4.5	1556	40	2.6
July	1071	31	3.0	1828	64	5.1	1211	25	2.1
August	1813	227	12.5	1808	30	1.7	1729	10	0.6
September	1951	254	13.0	2110	52	2.5	2329	64	2.7
October	2580	335	13.0	2176	180	8.3	1996	144	7.2
November	2334	1075	46.5	2382	356	15.0	2012	350	17.4
Total	11665	2003	17.2	11903	754	6.3	10833	633	5.8

TABLE XI

Frequency distribution of number of nuts germinated in different lots and their Bartlett's indices

No. of weeks taken for germination	Number of nuts germinated in each week in the ten different lots of:—									
	1	2	3	4	5	6	7	8	9	10
5	0	0	0	0	0	0	0	3	29	59
6	0	0	0	0	0	0	0	29	24	64
7	0	0	0	0	0	1	6	55	37	4
8	0	0	1	0	6	12	46	28	12	0
9	0	12	2	12	46	32	49	6	1	0
10	6	64	20	64	62	20	3	2	3	0
11	4	58	15	58	14	20	0	0	0	0
12	15	34	8	34	8	0	0	0	0	0
13	12	3	2	3	0	0	0	2	0	0
14	6	7	1	7	2	1	0	0	0	0
15	2	1	1	1	0	1	0	0	0	0
16	2	4	0	4	0	1	0	0	0	1
Total No. of nuts germinated in each plot.	47	183	50	183	138	88	104	125	106	128
Bartlett's index of each lot.	0.377	0.423	0.4930	0.501	0.595	0.606	0.710	0.818	0.879	0.945

TABLE XII (a)

To determine the frequency of occurrence of nuts possessing different floating habits and their relative merits as seednuts

Germination data—1962-'63

Treatment means

Treatment	Germination percentage
1. Vertically floating nuts	98.12
2. Slantingly ,,	93.12
3. Horizontally ,,	97.50
General mean	96.25
S. E per plot	4.86
C. V. (%)	5.04
S. E. of mean	1.72

TABLE XII (b)

Morphological data (1962-'63)

Treatment means

Treatment	Girth (cm)	Height (cm)	No. of leaves
Vertically floating nuts	2.07	72.03	4.37
Slantingly ,,	1.89	64.48	4.23
Horizontally ,,	1.71	57.90	3.96
S. E. per plot	0.40	5.92	0.33
Overall mean	1.89	64.80	4.19
C. V.%	21.10	9.13	7.83
S. E. of means	0.20	2.96	0.16
C. D. (P=0.05)	—	6.33	—

TABLE XIII

Studies on the performance of nuts gathered at different stages of maturity for seed purposes.

Morphological data (1961-62).

Treatment	Treatment means		
	Girth (cm.)	Height(cm.)	No. of leaves
1. Nine months old nuts.	1.50	50.74	3.48
2. Nine-and-a-half months old nuts	1.67	60.17	3.54
3. Ten months old nuts	1.45	51.52	3.35
4. Ten-and-a-half months old nuts	1.56	55.17	3.47
S. E. per plot	0.54	13.81	0.77
Overall mean	1.54	54.67	3.46
C. V. %	35.0	25.2	22.2
S. E. of mean	0.18	4.60	0.25

TABLE XIV

Studies on the performance of nuts gathered at different stages of maturity for seed purposes.

Maturity studies—Field Trial

Germination data (1962-63)

Treatment means

Treatment	Germination percentage
Lower bunch	94.90
Upper bunch	86.40
S. E. per plot	10.03
S. E. of mean	2.24
C. D. (P=0.05)	6.62
General mean	90.65
C. V. %	11.06

TABLE XV (a)

Study of different positions cum depths of sowing arecanuts. Pooled analysis of three years' data.

Treatments: Positions:
1. Vertical.
2. Slanting.
3. Horizontal.

Depths:
1. 0″
2. 1″
3. 2″
4. 3″

Analysis of variance

Variation due to:	D. F.	S. S.	M. S.	F
Years	2	274.40	135.35	1.76
Treatments:				
Position A.	2	512.10	256.10	3.27*
Depths: B.				
Linear	1	1916.70	1916.70	24.50**
Quadratic	1	1174.80	1174.80	15.00**
Cubic	1	184.40	184.40	2.30
A X B (Position x depths)	6	1235.30	205.90	2.63
Treatment X years.	22	4073.30	185.14	78.24@
Pooled error	165		63.98	

* Significant at 5% level.
** Significant at 1% level.
@ Pooled error with 187 df.

TABLE XV(b)

Mean Germination percentage.

B. Depth of sowing	A. Position of nuts			
	Vertical	Slanting	Horizontal	Mean
0"	90.00	95.34	95.90	93.77
1"	96.52	95.41	90.41	94.12
2"	95.01	93.59	93.19	93.94
3"	84.16	90.41	80.28	84.95
Mean	91.40	93.60	89.90	—

S. E. of A.	1.28
S. E. of B.	1.47
S. E. of A x B.	2.55
C. D. for A. (P=0.05)	3.54
C. D. for B. do	4.07

TABLE XVI

Effect of different spacing-cum-efficacy of sowing unsprouted and sprouted seeds on seedling performance.

Treatments:

Nature of seed arecanuts:
1. Unsprouted.
2. Sprouted

Spacing:
1. 9″ x 9″
2. 12″ x 12″
2. 15″ x 15″
4. 18″ x 18″

Morphological data (1961-62 sowing)

Treatment Means

B. Spacing	A. Seednuts								
	Height (cm.)			Girth (cm.)			No. of leaves		
	Un-sprouted	Sprouted	Mean	Un-sprouted	Sprouted	Mean	Un-sprouted	Sprouted	Mean
9″ x 9″	64.50	49.87	57.19	1.57	1.15	1.36	4.12	3.70	3.91
12″ x 12″	70.35	57.67	64.01	1.75	1.45	1.60	4.20	4.25	4.22
15″ x 15″	66.02	49.80	57.91	1.95	1.30	1.62	4.02	4.02	4.02
18″ x 18″	59.55	46.77	53.16	2.42	1.30	1.86	3.60	3.50	3.55
Mean	65.10	51.03	—	1.92	1.30	—	3.99	3.87	—

S. E. per plot	12.40	S. E. per plot	0.52	S. E. per plot	0.58
Overall mean	58.07	Overall mean	1.61	Overall mean	3.92
C. V. %	21	C. V. %	32	C. V. %	14
S.E. of mean A	3.10	S.E. of mean A	0.13	S.E. of mean A	0.14
S.E. of mean B	4.38	S.E. of mean B	0.18	S.E. of mean B	0.20
S.E. of mean AB	6.20	S.E. of mean AB	0.26	S.E. of mean AB	0.29
C.D.A (P=0.05)	6.45	C.D.A. (P=0.05)	0.27	—	

TABLE XVII (a)

Effect of different intensities of shade in seed bed and in secondary nursery beds on growth performance of seedlings.

Germination data (1962-63)

Treatment means

Treatment	Percentage of germination
1. Open	94.25
2. Partial shade	96.87
3. Complete shade	96 25
S. E. of mean	1.28
S. E. per plot	3.63
Overall mean	95.79
C. V. %	3.8

TABLE XVII (b)

Germination data (1963-64)

Treatment means

Treatment	Percentage of germination
1. Open	89.75
2. Partial shade	96.37
3. Complete shade	95.37
S. E. of mean	1.12
C. D. (P=0.05)	3.39
S. E. per plot	3.17
Overall mean	94.00
C. V. %	3.4

TABLE XVII (c)

Mortality counts in the shade vs no shade experiment

Treatments	1961	1962	1963
1. Open	48.75	12.97	3.63
2. Partial shade	0.75	2.28	0.60
3. Complete shade	1.25	0.25	0.0
S. E. per plot	14.16	6.74	1.85
Overall mean	16.91	5.16	1.41
C. V. %	84	130	131
S. E. of treatment means	5.00	2.38	0.65
C. D. (P=0.05)	10.50	5.10	1.36

TABLE XVIII

Standardisation of media and methods of sprouting seed arecanuts

Treatments:

1. Sowing seed arecanuts in soil medium.
2. Sowing seed arecanuts in sand medium.
3. Arranging seed arecanuts in country baskets with straw as cover.
4. Tying seed arecanuts in straw bundles.
5. Heaping the seed arecanuts in shade.

Germination data (pooled means for three years).

Analysis of variance

Variation due to	D F	S S	MSS	F.
Years	2	511.29	255.79	5.1*
Treatments	4	901.24	225.31	4.4*
Treatments x years	8	401.11	50.14	

* Significant at 5% level

Treatment means

Treatments	*Germination percentage*
1	94.00
2	94.26
3	83.10
4	78.50
5	78.96
S. E. of means	4.09
C. D.	13.34

TABLE XIX

Influence of pre-sowing treatments and period of sowing on seednut performance

Morphological data (1961-62)

Treatments:—

1. Harvesting and immediate sowing.
2. Treating in cowdung slurry and immediate sowing.
3. Treating in cowdung slurry and air drying for 3 days and sowing.
4. Treating in cowdung slurry and air drying for 6 days and sowing.
5. Treating in cowdung slurry and air drying for 9 days and sowing.
6. Sundrying for two days and sowing.
7. Sundrying for four days and sowing.
8. Sundrying for six days and sowing.
9. Air drying for three days and sowing.
10. Air drying for six days and sowing.
11. Air drying for nine days and sowing.
12. Soaking in water for three days and sowing.

Treatment means.

Treatment No.	Girth(cm.)	Height(cm.)	Number of leaves
1.	1.43	43.94	3.22
2.	1.47	45.88	3.52
3.	1.47	44.33	3.32
4.	1.42	46.12	3.30
5.	1.51	47.54	3.52
6.	1.56	49.97	3.34
7.	1.59	45.73	3.56
8.	1.52	41.72	3.24
9.	1.27	40.05	3.46
10.	1.33	38.79	2.96
11.	1.42	39.76	2.76
12.	1.41	42.04	3.30
S. E. of mean	0.08	3.28	0.41
S. E. per plot	0.017	7.34	0.92
Overall mean	1.45	43.82	3.29
C. V. %	11.7	16.7	27.9

TABLE XX

Standardisation of method of packing seedlings.

Treatments:

Main treatments—Planting intervals.

Main treatments: 1. Five days.
2. Ten days
3. Fifteen days.
4. Twenty days.

Sub-treatments — Materials for packing.

Sub-treatments: 1. Dry grass (muli)
2. Areca leaf sheath.
3. Alkathene film.

Percentage of establishment (1963-64)

Sub-treatment B.	Treatment means			
Main treatment A.	Dry grass	Areca leaf sheath	Alkathene Film	Mean
Five days	72.5	85.0	97.5	85.0
Ten days	45.0	72.5	92.5	70.0
Fifteen days.	60.0	35.0	67.5	54.2
Twenty days	35.0	50.0	47.5	44.2
Mean	53.1	60.6	76.5	—

S. E. for the difference between

A means.	6.26
B means.	7.98
Two B means at the same level of A	15.95
Two A means at the same level of B	14.46
Critical difference for A.	14.16
Critical difference for B.	16.51
S. E. per main plot	15.33
Overall main plot mean	190.00
C. V. %	8.1
S. E. per sub plot.	22.57
Overall sub-plot mean	63.33
C. V. %	35.6

TABLE XXI(a)

Determination of optimum intervals of irrigation for germinating seed arecanuts.

Germination data (1962-63)

Treatment means

Serial No.	Treatments	Mean percentage of germination.
1.	Watering the seed beds once daily	73.89
2.	,, once in two days	78.33
3.	,, once in three days	50.00
4.	,, once in four days	44.44
5.	,, once in five days	36.11

S. E. per plot	24.31
Overall mean	56.55
C. V. %	42.9
S. E. of mean	9.92
S. E. of treatment difference	14.02
C. D.	29.24

TABLE XXI (b).

Germination data (pooled means for three years).

Treatment means

Serial No.	Treatments	Mean percentage of germination
1.	Watering the seed beds once daily	87.22
2.	,, once in two days	86.66
3.	,, once in three days	67.59
4.	,, once in four days	56.48

S. E. of means	6.51
S. E. of treatment difference	9.20
C. D. (P=0.05)	22.51

TABLE XXII

Study of different shade crops other than banana.

Morphological data (1962-'63)

Treatment means

Treatment No.	Girth (cm.)	Height (cm.)	No. of leaves
1. *Crotalaria anagyroides*	1.70	54.52	3.72
2. *Coccinia indica*	2.72	95.90	4.72
3. *Cyamopsis psonaloides*	2.60	93.24	4.56
4. *Tripsacum laxum*	2.20	67.64	4.18
5. No shade	2.66	81.32	4.54
S. E. per plot	0.37	21.43	0.42
General mean	2.38	78.40	4.34
C. V. %	15.5	27.4	9.6
S. E. of means for treatments 1, 2, 3 and 4	0.16	9.55	0.18
S. E. of means for treatment No. 5	0.20	11.82	0.23
C.D. to test treatments 1, 2, 3 and 4.(P=0.05)	0.45	27.02	0.51
C. D. to test for treatment No. 5 with others (P=0.05)	0.58	33.52	0.65

TABLE XXIII.

Effect of different media and method of raising seed beds on germination of seednuts

1963-64 sowing

Method of sowing A/Media of sowing B.	Germination percentage			Bartlett's index of earliness		
	Trenches	Raised bed	Mean	Trenches	Raised bed	Mean
Soil	94.5	96.5	95.5	0.74	0.67	0.71
Sand+Soil	95.0	94.5	94.8	0.69	0.66	0.68
Burnt earth	93.5	94.0	93.8	0.71	0.75	0.73
Sand	96.0	94.0	95.0	0.71	0.67	0.69
Mean	94.8	94.8	—	0.71	0.69	—
S. E. per plot		2.24		0.05		
Overall mean		94.80		0.70		
C. V. %		2.36		0.71		
S. E. of A. mean		0.56		0.12		
S. E. of B. mean		0.79		0.17		
S. E. of AXB mean		1.12		0.24		

TABLE XXIV (a)

Determination of optimum spacing in the main field

Morphological data (1963-'64)

Date of planting: November, 1958.

Treatment means (adjusted)

Treatments (spacings)	Girth at permanent mark	Girth at last node	Number of leaves	No. of nodes above permanent mark	Height (cms.)
1. 6' x 6'	46.1	30.1	7.1	15.3	430.7
2. 9' x 6'	49.2	39.6	9.5	17.6	321.4
3. 12' x 6'	50.2	43.6	9.5	18.7	310.1
4. 9' x 9'	52.8	44.3	9.8	18.4	266.9
5. 12' x 9'	57.7	49.8	10.9	21.7	304.9
6. 12' x 12'	52.2	46.5	9.9	20.6	286.4
Gain in precision	2%	4%	5%	1%	2%
S. E. of mean	10.56	8.38	1.66	4.29	117.17

TABLE XXIV (b)

Production of spadices (1963-64)

(Experimental palms only)

Treatment (spacing)	Total No. of palms in each treatment in six replications	Total no. of palms flowered during the year in six replications.	% of trees flowered in each treatment	Mean No. of spadices per tree in each treatment.
6' x 6'	330	267	80.9	3.6
6' x 9'	198	172	86.8	4.3
6' x 12'	132	118	89.3	4.8
9' x 9'	126	118	93.6	5.7
9' x 12'	84	79	94.0	4.2
12' x 12'	60	58	96.7	5.9
Total	930	812		

TABLE XXIV(c).

Female flowers produced and fruit set (1963-64)

Treatment (spacing)	No. of spadices produced in 30 trees (1-1-64 to 30-6-64)	Total No. of female flowers produced	Total No. of flowers set	Average No. of female flowers per spadix	% of flowers set.
6' x 6'	88	12908	1875	146.6	14.52
6' x 9'	121	19332	5763	159.7	29.81
6' x 12'	129	21351	4864	165.5	22.26
9' x 9'	146	24874	10872	170.4	43.70
9' x 12'	137	21474	7097	156.7	33.04
12' x 12'	139	26144	6786	188.1	25.95

TABLE XXIV (d)

Yield obtained (1963-64)

Treatment (spacings)	Total yield per treatment (No.of fruits)	Calculated yield per acre (No. of fruits)	No. of trees that can be planted in an acre.	Mean yield per palm (No. of fruits)
6' x 6'	9651	35,387	1210	29.3
6' x 9'	10631	43,329	807	53.4
6' x 12'	8446	38,711	605	63.0
9' x 9'	6514	27,814	538	51.6
9' x 12'	7623	36,572	403	90.7
12' x 12'	2596	13,066	302	43.2

TABLE XXV

Response of seedlings of varied time of germination to different levels of manuring.

Morphological data (1962-63)

Treatments: Period of germination. 1. Early. 2. Late 3. Very late.

Manurial doses: 1. No manuring. 2. Moderate manuring. 3. Heavy manuring.

A. Time of germination/B. Manuring	Girth (cms)				Height (cms)				No. of leaves			
	No. manuring	Moderate manuring	Heavy manuring	Mean	No. manuring	Moderate manuring	Heavy manuring	Mean	No. manuring	Moderate manuring	Heavy manuring	Mean
Early germinated	1.59	1.68	1.80	1.69	55.55	64.48	73.39	64.47	3.58	3.87	4.06	3.83
Late germinated	1.60	1.86	1.97	1.81	59.28	73.15	70.95	67.79	3.89	4.17	4.04	4.03
Very late germinated	1.44	1.78	1.77	1.67	56.53	69.90	68.37	64.93	4.07	4.05	3.79	3.90
Mean	1.54	1.77	1.85	—	57.12	69.17	70.90	—	3.63	4.13	4.02	—
S. E. per plot		0.22				14.37				0.44		
Overall mean		1.72				65.73				3.94		
C. V. %		12.79				21.86				11.16		
S. E. of A, B.		0.07				4.79				0.14		
S. E. of A. B.		0.13				8.29				0.25		
C.D. for B (P=0.05)		0.20				—				—		

TABLE XXVI (a).

Determination of optimum N. P. K. requirements in the mainfield

Date of planting: October, 1961. Date of observation: October, 1963.

Treatments:

Nutrients or manures	*Levels*			
Nitrogen	0,	50,	100	Pounds per 500 palms
$P_2 0_5$	0,	40,	80	
$K_2 0$	0,	75,	150	
Green leaf	0,	7500.	15000	

Analysis of variance

Variation due to	DF	Girth			Height			No. of leaves		
		SS	MSS	F	SS	MSS	F	SS	MSS	F
							**			**
Block	8	223.23	29.90	1.81	26377.50	3297.18	7.71	12.12	1.51	8.36
N.	2	23.67	11.83	0.77	1231.60	615.80	1.44	0.32	0.16	0.88
P.	2	13.90	6.95	0.45	445.30	222.65	0.52	0.20	0.10	0.55
K.	2	1.05	0.52	0.03	115.30	57.65	0.13	0.17	0.08	0.44
G.	2	56.80	28.40	1.84	4489.70	2244.85	5.25**	0.25	0.12	0.67
NP.	4	12.95	3.24	0.21	2170.60	542.65	1.27	0.14	0.03	0.17
NK.	4	34.78	8.79	0.57	2854.70	713.67	1.67	1.59	0.39	2.17
NG.	4	3.76	0.94	0.61	252.40	63.10	0.15	0.70	0.17	0.94
PK.	4	63.07	15.76	1.02	3434.70	858.67	2.01	1.05	0.26	1.44
PG.	4	21.09	5.27	0.34	1241.80	310.45	0.73	0.95	0.23	1.28
KG.	4	4.28	1.07	0.06	1759.50	439.87	1.03	0.63	0.15	0.83
*Error.	40	613.62	15.34	—	17094.30	427.36	—	7.10	0.18	—
Total	80	1072.20	—	—	61467.40	—	—	25.22	—	—

* All higher order interactions.

** Significant at 1% level of significance.

TABLE XXVI (b)

Morphological Data (1963-64)

Treatment means

Levels	Girth (cms)			Height (cms)			No. of leaves		
Nutrients	0	1	2	0	1	2	0	1	2
N	29.19	21.23	26.41	203.53	211.40	211.79	5.50	5.65	5.61
P	25.71	25.60	26.53	205.62	211.14	209.59	5.52	5.53	5.65
K	26.86	25.87	26.01	208.37	207.67	210.48	5.62	5.62	5.52
G	24.82	26.17	26.83	199.10	210.22	217.18	5.51	5.65	5.60
S. E. per plot			3.82	S.E. per plot		20.67	S.E.per plot		0.42
Overall mean			25.94	Overall mean		208.84	Overall mean		5.58
C. V. %			14.79	C. V. %		10.1	C. V. %		7.52
S. E. of mean NPKG				S. E. of mean			S.E of mean		
			0.73		NPKG	3.97		NPKG	0.08
C. D. for G (P=0.05).				10.99					

TABLE XXVII (a)

Uniformity trial - Collection of yield data of palms

Yield data (1961-62)

Coefficient of variation of plots of various sizes and shapes

Palms in rows / Palms in columns	1	2	3	4	6	12
1	54	39	28	25	20	15
2	38	25	19	17	14	12
3	31	22	16	14	12	9
4	25	12	12	9	7	7
6	21	12	12	9	7	6
12	16	7	7	5	5	—

TABLE XXVII (b)

Yield data (1962-63)

Coefficient of variation of plots of various sizes and shapes

Palms in rows / Palms in columns	1	2	3	4	6	12
1	61	36	32	25	24	18
2	43	30	25	20	17	15
3	34	25	21	19	17	15
4	29	20	13	13	8	6
6	26	16	11	10	7	5
12	17	13	8	8	5	—

TABLE XXVIII.

Quality of produce as influenced by the degree of maturity

Treatments: Nuts harvested at the same time from (1) lower bunch (higher maturity) (2) upper bunch (lesser maturity).

Mean values

	Lower bunch	Upper bunch	't' for difference
1. Percentage of dry kernel weight to wet weight	25.14	23.94	2.30*
2. Percentage of dry kernel weight to dry weight	60.61	60.19	0.45
3. Percentage of good kernels	83.90	79.90	1.19
4. Weight of 100 dry kernels (kg.)	0.88	0.94	2.71*

*Significant at 5% level.

APPENDIX III

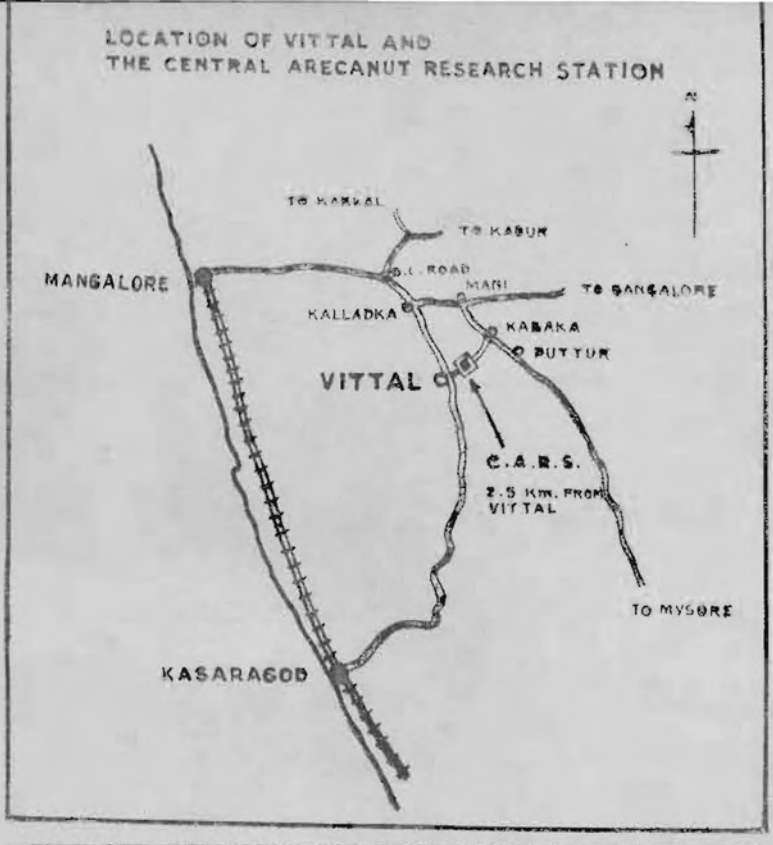
Set-up of the Central Arecanut Research Station. Vittal.

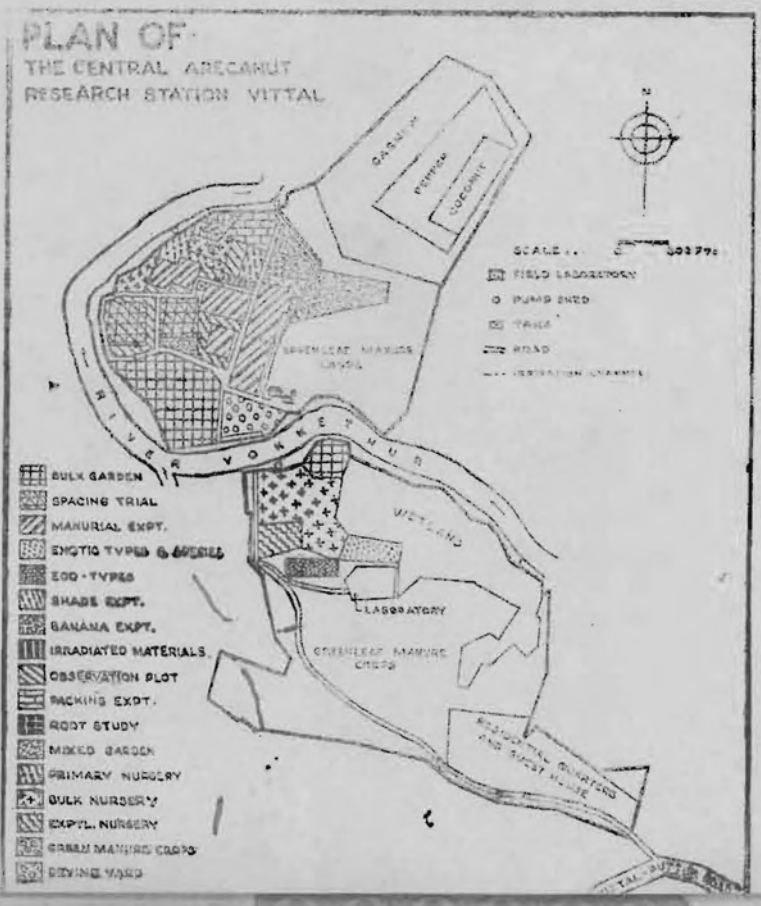
(exclusive of Class IV)

S. No.	*Name and qualification.*	*Designation*
1.	Vacant	Arecanut Speciaitst.
2.	Shri K. V. Ahamed Bavappa, M.Sc. (Ag).	Botanist.
3.	,, K. Shama Bhat, M.Sc. (Ag.)	Offg. Agronomist.
4.	,, P. R. Ramachander, M. A.	Statistical Officer.
5.	Dr. A. R. Kalbande, Ph.D., Assoc. I. A. R. I.	Soil Chemist.
6.	Vacant	Farm Superintendent.
7.	Vacant	Botany Assistant.
8.	Shri K. S. Nagaraja Rao, M.Sc.	Senior Research Assistant (Pathology).
9.	,, P. Muddappa Gowda, B. Sc. (Ag.), D. H.	Senior Research Assistant (Agronomy).
10.	,, N. Thirumaleshwara Bhat, B.Sc. (Ag.)	Agronomy Assistant.
11.	Kumari M. Leela, B.Sc. (Ag:)	,,
12.	Vacant	,,
13.	Vacant	Farm Assistant
14.	Vacant	Research Assistant (Chemistry)
15.	Vacant	Research Assistant (Entomology)
16.	Shri E. Velappan, B.Sc. (Ag.)	Nursery Assistant
17.	,, S. Visweswara Raju	Artist-cum. Photographer
18.	,, K. K. Krishnan Nambiar	Fieldman
19.	,, P. T. Sreedharan Nair	,,
20.	,, D. Sankaran	,,
21.	,, K. Kunhirama Panicker	,,
22.	,, E. R. Narayanan	,,
23.	,, K. Krishnayya Gopal	,,
24.	,, U. Vijaya Kumar.	,,
25.	,, P. Narayana	,,
26.	Vacant	Computor.
27.	Vacant	Meteorological Observer.

Non-technical staff

1.	Shri N. K. Srinivasa Murthy, B.Com.	Asst. Administrative Officer.
2.	„ V. F. John Sylvester.	Stenographer.
3.	Kumari H. Shreemanthini Bai	Head Clerk-cum-Accountant.
4.	Shri K. Thampi	Clerk-Typist.
5.	Vacant	Junior Clerk.
6.	Vacant	Store Clerk.
7.	Shri P. T. Sankaran Nair	Jeep Driver.


LOCATION OF VITTAL AND
THE CENTRAL ARECANUT RESEARCH STATION
N
TO KARKAL
TO KABUR
MANGALORE
S.C. ROAD
MANI
TO BANGALORE
KALLADKA
KABAKA
PUTTUR
VITTAL
C.A.R.S.
2.5 Km. FROM
VITTAL
TO MYSORE
KASARAGOD


PLAN OF
THE CENTRAL ARECANUT
RESEARCH STATION VITTAL
N
SCALE :
FIELD LABORATORY
PUMP SHED
TANK
ROAD
GREENLEAF MANURE CROPS
RIVER VONKENEHUR
WETLAND
LABORATORY
GREENLEAF MANURE CROPS
RESIDENCE QUARTERS AND GUEST HOUSE
BULK GARDEN
SPACING TRIAL
MANURIAL EXPT.
EXOTIC TYPES & HYBRIDS
EGG - TYPES
SHADE EXPT.
BANANA EXPT.
IRRADIATED MATERIALS
OBSERVATION PLOT
PACKING EXPT.
ROOT STUDY
MIXED GARDEN
PRIMARY NURSERY
BULK NURSERY
EXPTL. NURSERY
GREEN MANURE CROPS
DRYING YARD