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ANNUAL REPORT
OF THE
COCONUT RESEARCH INSTITUTE
FOR
1961

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(Botanist, Coconut Research Institute)

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Editor: Dr. M.L.M. SALGADO, Director
Coconut Research Institute

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ANNUAL REPORT OF THE COCONUT RESEARCH INSTITUTE FOR 1961

The present report is the 33rd Annual Report of the Coconut Research Institute, which was established by Ordinance No. 29 of 1928 dated December, 1928.

REPORT OF THE CHAIRMAN

On January 1961, the Coconut Research Board consisted of the following:—

Ex-Officio Members

Chairman—Director of Agriculture: Mr. A.V. Richards, M.Sc. (Calif.), B.Sc. (Lond.), Dip.Agric. (Cantab.), A.I.C.T.A. (Trinidad).

Treasury Representative: Mr. H.E. Peiris, *C.C.S.*

Coconut Rehabilitation Commissioner: Mr. B. Mahadeva, *C.C.S.*

Chairman, L.C.P.A.: Mr. E. Muttukumar.

Director, Coconut Research Institute: Dr. M.L.M. Salgado, Ph.D. (Cantab.), B.Sc. (Lond.), Dip.Agric. (Cantab.).

Nominated Members (for a period of 3 years)

Nominated by the Honourable Minister from Senators and Members of Parliament:—
Mr. W.I. Hugh Fernando, M.P. and Mr. S.D.R. Jayaratne, M.P.

Nominated by the Planters' Association of Ceylon: Mr. C.T. Van Geyzel, *J.P.*, and Mr. B. Warusavithana.

Nominated by the L.C.P.A.: Senator T. Amarasuriya, *O.B.E.* and Mr. C.A.M. de Silva.

Nominated by the Honourable Minister to represent the Small-holders: Mr. M.M. Kumarakulasingham and Mrs. L.J. de S. Seneviratne.

With the amendment of the Coconut Research Ordinance, providing for an elected Chairman, Senator Thomas Amarasuriya, *O.B.E.* was elected Chairman of the Coconut Research Board on 12th August, 1961.

With the retirement of Mr. H.E. Peiris, *C.C.S.* from the Public Service, in July 1961, Mr. G.M. Sparkes, *C.C.S.* took his place as the Treasury Representative on the Board. Mr. Francis Amarasuriya, Chairman of the L.C.P.A. was taken in place of Mr. E. Muttukumar.

Mr. L. W. A. Fernando replaced Mrs. L. J. de S. Seneviratne as the Small-holders Representative on the Board in June 1961.

Mr. B. Warusavithana was elected President of the Planters' Society.

Meetings.—Six meetings of the Coconut Research Board were held during the year on 25th February, 1961, 8th April, 1961, 10th June, 1961; 12th August, 1961, 14th October, 1961 and 8th December 1961, respectively.

Committees

Administration Committee (Personnel at 1st January 1960):

- (1) Mr. A. V. Richards, (Chairman).
- (2) Mr. H. E. Peiris.
- (3) Mr. B. Warusavithana.
- (4) Mr. C. A. M. de Silva.
- (5) Mr. B. Mahadeva.
- (6) Senator T. Amarasuriya.
- (7) Mr. W. I. Hugh Fernando.
- (8) Dr. M. L. M. Salgado, Director, C. R. I.

The 32nd, 33rd, 34th, 35th, and 36th meetings of the Administration Committee were held on 27th January, 4th March, 28th April, 25th August and 4th October 1961 respectively.

Estates and Experimental Committee (Personnel at 1st January, 1961):

- (1) Mr. M. M. Kumarakulasingham, (Chairman)
- (2) Mr. E. Muttukumar.
- (3) Senator T. Amarasuriya.
- (4) Mr. B. Warusavithana.
- (5) Mr. S. D. R. Jayaratne, M. P.
- (6) Mr. A. V. Richards.
- (7) Mr. C. T. Van Geyzel.
- (8) Dr. M. L. M. Salgado, Director, C. R. I.

Three co-opted members:

- (1) Mr. R. H. de Mel.
- (2) Mr. E. Muttukumar.
- (3) Mr. X. Jobin.

The 36th, 37th and 39th meetings of the Estates and Experimental Committee were held on 18th February, 20th May, 19th August and 18th November 1961 respectively.

Extension Committee (Personnel at 1st January, 1961):

- (1) Mr. C. T. Van Geyzel, (Chairman).
- (2) Mr. E. Muttukumar.
- (3) Mr. C. A. M. de Silva.

- (4) Mr. B. Mahadeva.
- (5) Mr. M.M. Kumarakulasingham.
- (6) Mrs. L. J. de S. Seneviratne.
- (7) Mr. L.W.A. Fernando.
- (8) Dr. M.L.M. Salgado, Director, C.R.I.

29th, 30th and 31st meetings of the Extension Committee were held on 11th February, 15th July, and 16th September 1961 respectively.

Editorial Committee (Personnel at 1st January, 1961):

- (1) Mr. M.M. Kumarakulasingham, (Chairman).
- (2) Mr. E. Muttukumar.
- (3) Dr. M.L.M. Salgado, Director, C.R.I.
- (4) Dr. D.V. Liyanage, Botanist, C.R.I.

T. AMARASURIYA,
Chairman, Coconut Research Board.

ANNUAL REPORT OF THE DIRECTOR

Staff of the Coconut Research Institute at the end of 1961 was as follows:—

Administration Division

Director—M.L.M. Salgado, Ph.D. (Cantab.), B.Sc. (Lond.), Dip.Agric. (Cantab.).
Chief Administrative Officer and Secretary to the Board—Mr. S.C. Kahawita, B.Com. (Lond.).
Assistant Secretary—Mr. T.T.A.J.C. Samarasinghe, LL.B. (Ceylon).

Soil Chemistry Division

Soil Chemist—Dr. D.A. Nethsinghe, D.Phil. (Oxon.), B.Sc. (Ceylon), A.R.I.C.
Research Assistant—Mr. T.S. Balakrishnamurthi, B.Sc. (Ceylon).

Chemistry Division

Chemist—Dr. W.R.N. Nathanael, Ph.D. (Lond.), M.Sc. (Lond.), B.Sc. (Lond.), A.R.I.C. ✓
Research Assistant—Vacant.

Botany Division

Botanist—Dr. D.V. Liyanage, Ph.D. (Manch.), B.Sc. (Lond.). ✓
Research Assistant—Vacant.

Agrostology Division

Agrostologist—Mr. K. Santhirasegaram, B.Sc. (Ceylon). (On overseas study leave).
Research Assistant—Miss. Ramalingam, B.Sc. (Ceylon).

Planting Division

Planting Officer—Mr. P.D.L. Fernando.
Assistant Planting Officer—Mr. C.W.S. de Silva.

Advisory Division

Chief Advisory Officer—Mr. C.A. Wickremasuriya, B.Sc. (Ceylon).

Crop Protection Division

Crop Protection Officer—Vacant.
Officer-in-Charge—Mr. J.K.F. Kirthisinghe.

Biometry

Biometrician—Mr. V. Abeywardena. ✓
Research Assistant—(Statistics)—Mr. J.K.T. Fernando, B.Sc. (Ceylon).

Mr. K. Santhirasegaram, Agrostologist was on post-graduate study leave at the Waite Research Institute, Adelaide, Australia. Dr. W.R.N. Nathanael was on study leave in England for a period of one and half months from March and obtained his Ph.D. Degree of the University of London for a Thesis entitled "Uptake and distribution of the major mineral nutrients during the development and germination of the Coconut".

Mr. V. Abeywardena, Biometrician, was on study leave at the Indian Statistical Institute, Calcutta, up to April 1961.

The vacant posts of Research Assistants to the Chemist and Botanist were advertised but could not be filled as suitably qualified candidates were not available.

Dr. D.V. Liyanage, Botanist, attended the Symposium on "Tree Breeding" and "Coconut Breeding" organised by the Pacific Science Congress in Hawaii and presented a paper on the "Genetic improvement of the Coconut Palm".

2. MEETINGS

The Director attended the following meetings besides those of the Coconut Research Board and its Committees:—

- (i) Meetings of the Planters' Associations of Chilaw/Negombo and Kurunegala.
- (ii) District Co-ordinating Committee, Puttalam.
- (iii) Tea Research Institute's Conference.
- (iv) Inaugural Meeting of the F.A.O. Pilot Survey on Coconuts.
- (v) Conference at the Colombo Kachcheri regarding the Development of the Gampaha District.
- (vi) Conference with Land Commissioner regarding nurseries.
- (vii) Ministry's Planning Committee and Sub-Committee on Export Crops.
- (viii) Conference with Additional Land Commissioner regarding Ministry's Highland Colonization Committee and Coconut Sub-Committee.
- (ix) Conference regarding Advisory work on Crop Protection.
- (x) Conference on Agro-Meteorology.

3. RESEARCH CONFERENCES

The following subjects were discussed at Research Conferences.

- (i) Dr. Martin Hutchinson, Nematologist, Tea Research Institute led a discussion on "Nematodes with special reference to the unknown disease in the Gonapinuwala area of the Galle District".
- (ii) Dr. D.V. Liyanage, Botanist, led a discussion on "Progress of Research in the Botany Division".
- (iii) Dr. D.A. Nethsinghe, Soil Chemist, led a discussion on "Optimum Fertilizer Dosages".

4. F.A.O. CONFERENCE

Dr. W.R.N. Nathanael, Chemist, Dr. D.V. Liyanage, Botanist, Dr. D.A. Nethsinghe, Soil

Chemist and Mr. J.K.F. Kirthsinghe, Officer-in-Charge, Crop Protection Division attended the First meeting of the F.A.O. Technical Working Party on Coconut Production, Protection and Processing held at Trivandrum, India from 27th November--2nd December 1961. Dr. M.L.M. Salgado, Director, could not attend owing to illness.

The following papers were presented at this conference:--

- (i) "The use of Isolated Seed Gardens for Coconut Seed Production", by Dr. D.V. Liyanage.
- (ii) "Present situation (1961) of the pests and diseases of the Coconut Palm and their control in Ceylon" by Mr. J.K.F. Kirthsinghe.
- (iii) "Coconut Nutrition and Fertilizer Requirements" by Dr. D.A. Nethsinghe.

5. VISITORS

The visitors during the year included the following:--

Dr. Martin Hutchinson, Nematologist, Tea Research Institute of Ceylon.

His Excellency E.L. Rosal, Envoy Extraordinary and Minister Plenipotentiary for Philip-pines.

His Excellency High Commissioner for Pakistan and the Commercial Secretary.

His Excellency Sir Guy Powles High Commissioner for New Zealand.

Mr. K.V.R. Sastry, F.A.O. Statistician.

Members of the Delegation of the Cocoa, Chocolate and Confectionary Alliance London.

Mr. M.S. Celino, Virologist, Philococa, Philippines.

Prof. G.G.C. Chesters of the University of Nottingham.

The members of the Technical Education Committee.

Dr. W. Ziller, of I.R.H.O. Paris.

Soviet Technical Team re-Utilization of Mutturajawela Peat Deposits.

Dr. A.F. Fagundes, Assistant to Director, Plant Production and Protection, Division, F.A.O.

Mr. W.V.D. Peiris, F.A.O., Coconut Improvement Officer.

6. TRAINEES

Messrs. U. Kan and Hla Maung of Burma, and Mr. Vithien Rattanapuruk, F.A.O. Fellow from Thailand underwent short periods of Training at the Institute.

A course of Training was held for SLDO's of the Land Commissioner's Department.

7. FIELD DAY

A Field Day for members of the Low Country Products Association was held at the Head Quarters on 24th July 1961.

8. PUBLICATIONS

The Director contributed the articles on "Coconuts in 1960" and "Activities of the Coconut

Research Institute in 1960", to the Annual Report of the Planters' Association of Ceylon. An article entitled "Research and the Coconut Economy" was contributed by the Director to the Industrial and Engineering Supplement of the Times of Ceylon.

The Ceylon Coconut Quarterly, the Coconut Planters' Review and the Sinhalese Quarterly *Pol Pawath* were published in the course of the year.

NOTES ON REPORTS OF DIVISION

The following notes draw attention to points of interest relating to the detailed reports of the Technical and Extension Work of the Institute.

Chemistry

On a request made by the F.A.O. Statistician in connection with the Pilot Survey of Coconut yields in Ceylon, experiments were carried out to determine a copra conversion ratio in terms of the husked nut, when fresh green nuts are harvested in contrast to withered nuts. When husked nuts are weighed without tuft the weight of copra was found to be 30.5% of the husked nut weight, and *with* the tuft 29.7%. In contrast after the fresh green nuts are seasoned for 30 days the corresponding ratios are 31.3% and 30.3%.

Sand Culture Experiment

A third pot culture experiment was carried out. Visual symptoms and other effects of positive diagnostic value characterising absolute deficiencies of N, P, K, Ca and Mg have now been established unequivocally.

Germination of the Coconut

The germination experiment which has been concluded has revealed that the coconut seedling is so adapted that it is only partly dependent on the nutrient reserves in the drupe components for its growth activities during the two year period following onset of germination. These observations supply the need for judicious and proper manuring of the soil during early field culture of coconut seedlings.

Botany

Progeny trials at Marandawila, Walpita and Bandirippuwa were maintained during the year and a number of Selection Indices that would be useful in a selection programme are being worked out.

Work on Hybridisation between varieties and forms of the coconut palms have been continued. The observation plot of first generation Tall \times Dwarf palms planted in 1950 gave an average yield of 129 nuts/palm and a husked nut weight of 226 lbs. per palm during the 11th year after planting.

Paired crosses and other crosses involving prepotent palms were continued at 8 stations and 17,000 nuts resulting from their crosses were harvested.

Satisfactory progress has been made in the Isolated Seed Garden at Ambakelle for the mass production of improved strain of seed nuts, the extent planted being 92 acres.

1,254,628 seed-nuts were harvested from selected mother palms and supplied to the Planting Division Nurseries.

The Pollen Bank was maintained and 4,235 samples of pollen were issued to 5 private estates to help them to implement their programmes of controlled pollination.

Soil Chemistry

For the first time since it was laid down in 1935, the 3 × 3 × 3 NPK manurial experiment at Bandirippuwa has shown a significant response to phosphate manuring. At Ratmalagara responses to phosphate and potash have been again obtained on both bearing and young palms, while nitrogen too proved effective on young palms. Annual manuring has given a better response at Marandawila compared to biennial manuring.

Studies on magnesium deficiency have received considerable prominence during the year and yellowing of fronds in estates in the western and southern provinces have been confirmed to be due to magnesium deficiency. It has also been shown that magnesium deficiency can be diagnosed by foliar analysis.

Work from the angle of possible major and minor nutrient deficiencies has also been continued on the Leaf Scorch Disease of the Southern Province.

In studies of the uptake of Radio active Phosphorus applied to the soil moderately mature leaves have been shown to be the most suitable plant organ for such investigations.

Agrostology

Soil nutrient studies have been continued.

The infestation of *Brachiaria brizantha* plots with *Brachiaria miliformis* reported in last year's report at Ratmalagara has been confirmed. It is expected to report the statistical analysis of the data of the pasture experiments in the report for next year.

Crop Protection

Unusual outbreaks of Coconut Scale (*Aspidiotus destructor*) was a notable feature during the year. A campaign to control the pest by the application of kerosene oil emulsion was put into operation. With the limited number of power sprayers and limited staff there yet remained a waiting list of estates that had to be sprayed.

Red Weevil (*Rhynchophorus ferrugineus*) yet remained the most destructive pest of coconut palms in Ceylon and was in evidence mostly in peasant Highland Colonisation Schemes. Treatment of infested palms with the systemic insecticide Systox proved effective.

In the biological control of coconut caterpillar (*Nephantis serinopa*) in the Eastern Province a Parasite Breeding Station was established at Batticaloa, in charge of the Colombo Plan Entomologist, Mr. Dharmaraju. At this station Mr. Dharmaraju conducted breeding techniques of parasites captured in Ceylon and also parasites imported from India and succeeded in the mass breeding of *Steniatomyia bezziana*.

Considerable attention was paid to the preliminary studies of the "Leaf Scorch" disease of coconuts in the Southern Province and with the assistance of Dr. Martin Hutchinson, Nematologist of the Tea Research Institute, a preliminary examination for the possible infestation with Nematodes was made.

The control of Bud Rot which occurs in isolated pockets in the Kurunegala District has remained an elusive problem. The Plant Pathologist, Department of Agriculture has successfully isolated the fungus *Phytophthora palmivora* from disease coconut buds and successfully inoculated coconut seedlings.

Biometrics

Besides routine statistical analysis of the Field Experiments of the different Research Divisions certain fundamental statistical studies were carried out by the Biometrician of which the following may be mentioned:

- (a) The statistical distribution of the initial flowering period,
- (b) A peculiar feature in experimental plots during the initial flowering phase,
- (c) Statistical control of "non-additive" errors in yield data pertaining to young coconut palms.

These studies have been applied to the analysis of the yield data of the fertiliser experiment on young palms at Ratmalagara in ensuring a more correct interpretation of the data.

Nurseries

Seed nuts. 2,510,872 seed nuts were planted in the nurseries and orders for 1,522,417 seedlings were booked during the year.

Advisory and Extension Work

In addition to the normal Advisory and Extension work, the Field Staff co-operated with the F.A.O. Pilot Survey, and also in connection with the planting up of 7,071 acres of Citronella Lands with coconuts under the Subsidy Scheme.

GENERAL

In last year's report reference was made to the financial difficulties of the Institute and as in 1960, 1961 ended with a deficit.

The present position is that the cost of Advisory and Extension services has to be met from the cess which is primarily meant for the Research Activities of the Institute. Fortunately in the 1960/61 Budget Government has made provision for a grant of Rs. 100,000 for this purpose.

The post of Crop Protection Officer which remained vacant due to the resignation of Mr. Hilary Goonewardene was not filled. The post of Research Assistants in Chemistry and Botany were not filled and similarly several posts of District Officers and Advisory Field Officers remained vacant.

Fortunately 1961 was a peak year for Coconut production and due to the favourable exports of coconut products during the year cess collection which finance the Institute's activities were correspondingly satisfactory.

Nevertheless research activities have been in progress and the Institute has endeavoured to meet the requirements of the Industry with the limited resources at its disposal. It is hoped that next year Government will be in a position to give us an increased grant to meet the cost of our Advisory and Extension Services.

M.L.M. SALGADO,
Director, Coconut Research Institute.

ANNUAL REPORT OF THE SOIL CHEMIST

SUMMARY

The five major field experiments on manuring which were in progress during 1960 were continued in 1961. For the first time since it was laid down in 1935, the 3³ N.P.K. experiment at Bandirippuwa has shown a significant response in yield of nuts to phosphate application. The response to potash has continued. At Ratmalagara, responses to phosphate and potash have been obtained again on both adult and young palms, while nitrogen also proved to be effective in the young plantation. The experiment on annual vs. biennial application of fertilisers at Marandawila has indicated a better response to annual manuring.

A new field experiment on adult palms comparing different methods of placing fertilisers on a lateritic gravel soil type was commenced late in 1961 at Walahapitiya Estate, Nattandiya. In this experiment, the effects of liming on acid soil is also being tested.

The first annual differential manuring of the 4³ N.P.K. factorial experiment on coconut seedlings (planted in 1960 in a jungle clearing) at Pothukulana sub-station was commenced at the end of 1961. Soil analysis has shown the experimental area to be composed of a uniform sandy loam carrying moderate supplies of exchangeable bases.

The simple observation trials on soil applications of magnesium to yellow palms at Walgama and Mattegoda estates in the Western province were also continued in 1961. The yellowing is confirmed to be due to magnesium deficiency—soil applications of both dolomite and magnesium sulphate bringing about a marked improvement in leaf colour and yields. A similar yellowing of mature fronds in the Southern province has also been traced to magnesium deficiency by the technique of foliar spraying. Laboratory investigations have shown that provided a proper sampling technique is adopted, magnesium deficiency can be conveniently diagnosed by foliar analysis.

A further problem has arisen in the Southern province where the mature fronds show symptoms of scorching and wither prematurely, resulting in gradual death of the palms. The possible association of this problem with a trace-element deficiency is being investigated. Foliar spraying trials with various combinations of trace elements were commenced.

Studies on the relative merits of analysis of toddy, nut water, leaf and inflorescence as a means of investigating the uptake of radioactive phosphorus applied to the soil have shown that the moderately mature leaves are the most suitable plant organs for such work.

DETAILED REPORT

A. FIELD EXPERIMENTS

1. 3 × 3 × 3 N.P.K. Factorial Experiment (Bandirippuwa Estate)

(See C.R.I. Annual Report 1949 and 1951 for details of treatment and design).

The 26th year of this experiment and its 13th biennial manuring was completed in November 1961. The yield data for the main effects for 1961 given in Table I(a) show a distinct increase over the figures for the previous year—a result of the good distribution of rainfall in 1960.

The response to potash has continued to show marked significance.

TABLE I (a)
Yield data for 1961—3³ N.P.K. Experiment, Bandirippuwa

Treatment	Lbs. Copra per acre	Nuts per acre	Calculated as %		Difference		Copra out-turn nuts/candy	Difference in nuts/candy
			Copra	Nuts	lbs. Copra per acre	Nuts/Acre		
N ₀ (0.0 lbs. N)	1,998	4,279	100	100	—	—	1,199	—
N ₁ (0.5 lbs. N)	1,947	4,282	97	100	- 51	+ 3	1,231	+ 32
N ₂ (1 lb. N)	1,889	4,241	95	99	- 109	- 38	1,257	+ 58
P ₀ (0 lbs. P ₂ O ₅)	1,873	4,035	100	100	—	—	1,206	—
P ₁ (1 lbs. P ₂ O ₅)	1,951	4,285	104	106	+ 78	+ 250	1,245	+ 39
P ₂ (2 lbs. P ₂ O ₅)	2,010	4,480	107	111	+ 137	+ 445	1,248	+ 42
K ₁ (0.75 lbs. K ₂ O)	1,718	3,972	100	100	—	—	1,295	—
K ₂ (1.50 lbs. K ₂ O)	1,984	4,274	115	108	+ 266	+ 302	1,207	- 88
K ₃ (2.25 lbs. K ₂ O)	2,133	4,553	124	115	+ 415	+ 581	1,196	- 99

Significant difference P. 05 is 162 lbs. copra/acre and 321 nuts/acre.

For the first time the phosphate response has reached statistical significance in the yield data for nuts. Although the increased weight of copra due to phosphate manuring has not been significant, the data indicate a visible trend in this direction. Nitrogen has again failed to show a significant response in its main effects.

The mean yields in 1961 for the various treatment combinations are given in Table I (b).

TABLE I (b)
lbs. copra/acre

	N ₀	N ₁	N ₂	K—Total
K ₁	1,848	1,699	1,605	1,718
K ₂	2,063	1,977	1,912	1,984
K ₃	2,083	2,166	2,149	2,133
N—Total ..	1,998	1,947	1,889	1,945
	P ₀	P ₁	P ₂	K—Total
K ₁	1,662	1,692	1,799	1,718
K ₂	1,958	1,968	2,026	1,984
K ₃	1,998	2,195	2,204	2,133
P—Total ..	1,873	1,951	2,010	1,945
	P ₀	P ₁	P ₂	N—Total
N ₀	1,870	2,053	2,072	1,998
N ₁	1,941	1,865	2,036	1,947
N ₂	1,807	1,937	1,922	1,889
P—Total ..	1,873	1,951	2,010	1,945

2. Manurial × Cultivation Experiment (Ratmalagara Estate).

(See C.R.I. Annual Report 1959 for details of treatment and design).

The 18th year of this experiment and its 10th biennial manuring was concluded in June 1961. The yield data for the main effects for the year 1960/61 are given in Table II.

TABLE II

Yield data for 1961 Manurial × Cultivation Experiment, Ratmalagara Estate

<i>Treatment</i>	<i>Lbs. Copra/ acre</i>	<i>Calculated as %</i>	<i>Difference lbs. copra/ acre</i>	<i>Copra out- turn nuts/ candy</i>	<i>Difference in nuts/ candy</i>
P ₀	1,195	100	—	1,166	—
P	2,034	173	+ 839	1,198	+ 32
C ₀	1,543	100	—	1,192	—
C	1,686	109	+ 143	1,180	- 12

Significant difference P. 05 = 143 lbs. per acre.

K ₀	1,462	100	—	1,209	—
K ₁	1,641	112	+ 179	1,199	- 10
K ₂	1,741	119	+ 279	1,154	- 55

Significant difference P. 05 = 175 lbs. per acre.

The marked response to phosphate has been the highest recorded hitherto for this experiment. The response to potash has continued.

The effect of ploughing has shown significance for the fourth year in succession after the practice of disc harrowing all plots for weed control was discontinued since 1956.

3. 3 × 3 × 3 N.P.K. Experiment on Young Palms (Ratmalagara Estate)

(See C.R.I. Annual Report 1959 for details of treatment and design).

The 13th year of this experiment was completed in 1961. The annual manuring was done in November.

The yield data showing the main effects of N, P and K for the year 1961 are given in Table III (a). The pattern of response to fertilisers closely follows that of the adult palms at Ratmalagara—both phosphate and potash giving significant increase in crop yields. The response to nitrogen has also been significant. The effects of phosphate and nitrogen on yields are in marked contrast to those obtained in the N.P.K. experiment on adult palms at Bandirippuwa. The mean yields for the various treatment combinations are given in the two-way Table III (b).

TABLE III (a)
Yield data for 1961—3³ N.P.K. experiment on young Palms,
Ratmalagara Estate

	<i>Lbs. Copra per acre</i>	<i>%</i>	<i>Difference in lbs.</i>	<i>Out-turn Nuts/candy</i>	<i>Difference in nuts</i>
N ₀	1,335	100	—	1,068	—
N ₁	1,565	117	+230	1,059	- 9
N ₂	1,514	113	+179	1,101	- 33
P ₀	983	100	—	1,064	—
P ₁	1,693	172	+710	1,073	+ 9
P ₂	1,737	177	+754	1,087	+23
K ₀	1,336	100	—	1,113	—
K ₁	1,431	107	+ 95	1,075	- 38
K ₂	1,648	123	+312	1,049	- 64

TABLE III (b)

	N ₀	N ₁	N ₂	P—Total
P ₀	1,065	1,018	865	983
P ₁	1,490	1,846	1,741	1,693
P ₂	1,449	1,831	1,935	1,739
N—Total ..	1,335	1,565	1,514	1,472

	N ₀	N ₁	N ₂	K—Total
K ₀	1,449	1,467	1,292	1,336
K ₁	1,230	1,531	1,531	1,431
K ₂	1,525	1,697	1,719	1,648
N—Total ..	1,335	1,565	1,514	1,472

	P ₀	P ₁	P ₂	K—Total
K ₀	965	1,457	1,585	1,336
K ₁	865	1,680	1,747	1,431
K ₂	1,118	1,939	1,884	1,648
P—Total ..	983	1,693	1,739	1,472

4. Manurial Experiment on Organics vs. Inorganics, and frequency of manuring (Co-operative experiment at Marandawila Group, Bingiriya).

(See C.R.I. Annual Report for 1959 for details of treatment and design).

The 3rd year of this experiment comparing the effects of annual and biennial applications of inorganic and organic fertilisers was completed in June 1961. The yield data (adjusted by co-variance analysis) for the first three years of the experiment (MI, MII and MIII) are given in Table IV.

TABLE IV

Yield data for 1959-61

Experiment on Organics vs. Inorganics — Marandawila Estate

	Yield/Acre lbs. Copra			Percentage			Difference in lbs.			Out-turn Nuts per Candy			Difference in nuts		
	M I (1959)	M II (1960)	M III (1961)	M I	M II	M III	M I	M II	M III	M I	M II	M III	M I	M II	M III
Control ..	2,247	2,013	2,547	100	100	100	—	—	—	1,125	1,099	1,097	—	—	—
Inorganic Annually ..	2,214	2,169	2,765	99	108	109	-33	+156	+218	1,118	1,102	1,088	-7	+3	-9
Inorganic in 2 years ..	2,222	2,219	2,604	99	110	102	-25	+206	+57	1,093	1,101	1,071	-32	+2	-26
Organic Annually ..	2,217	2,047	2,864	99	110	112	-30	+34	+317	1,105	1,146	1,076	-20	+47	-21
Organic in 2 years ..	2,320	2,239	2,791	103	111	110	-27	+226	+244	1,095	1,078	1,062	-30	-21	-35
Cattle manure Supplemented ..	2,334	2,319	2,907	104	115	114	-13	+306	+360	1,082	1,084	1,059	-43	-15	-38

All treatments, except inorganics applied biennially, have proved to be significantly better than the control (no manure) plots. The other treatment differences which showed statistical significance at the end of the third manurial year are as follows:

Organics annually > Inorganics biennially
 Cattle manure with supplement > " "

The data show a clear trend in favour of more frequent manuring, particularly when inorganic fertilisers are used.

5. 4 × 4 × 4 N.P.K Experiment on adult palms (Bandirippuwa Estate).

(See C.R.I. Annual Report 1960 for details of treatment and design).

The 2nd annual manuring of this experiment was done in October 1961. The yield data showing the main effects of N.P.K. treatments for the first manurial year are given in Table V.

TABLE V
 4³ N.P.K. Experiment, Bandirippuwa Estate

	<i>Lbs. copra/ acre</i>	<i>Percentage</i>	<i>Difference in lbs.</i>	<i>Copra out-turn nuts/candy</i>	<i>Difference in nuts</i>
N ₀	1,667	100	—	1,337	—
N ₁	1,587	95	- 80	1,334	- 3
N ₂	1,663	98	- 4	1,284	- 53
N ₃	1,721	103	+ 54	1,294	- 44
P ₀	1,682	100	—	1,301	—
P ₁	1,730	103	+ 48	1,280	- 21
P ₂	1,656	98	- 26	1,332	+ 31
P ₃	1,572	93	-110	1,336	+ 35
K ₀	1,744	100	—	1,302	—
K ₁	1,645	94	- 99	1,293	- 9
K ₂	1,549	89	-195	1,349	+ 47
K ₃	1,702	98	- 42	1,305	+ 3

It is premature to expect any difference due to treatments. The experimental area was acquired by the C.R.I. in 1958, and prior to this it appears that no manuring had been done for about ten years. This probably accounts for the lower yields and poorer copra out-turns in this experiment when compared with the data of the 3³ N.P.K. experiment at Bandirippuwa, although the entire area had been treated with N.P.K. fertiliser mixture at the rate of 15 lbs. per palm at the end of 1958.

6. Methods of placement and liming experiment on adult palms (Co-operative experiment at Walahapitiya Estate, Nattandiya).

The object of this experiment is to determine the relative efficiency of fertiliser utilisation by the adult coconut palm on a lateritic gravel soil under the following different methods of fertiliser placement—(a) half circular trenches (b) broadcasting and harrowing (c) spreading round the base of the palm and forking in. Each of these methods of placement is tested at two levels of the complete N.P.K. fertiliser mixture consisting of sulphate of ammonia, saphos phosphate and muriate of potash (50%) in the ratio 5: 4: 5 by weight. The levels of fertiliser used are $F_1 = 3\frac{1}{2}$ lbs. mixture per palm per annum and $F_2 = 7$ lbs. mixture per palm per annum.

The two levels of fertiliser will be tested with and without the application of lime (L_1 and L_0) in order to determine the effect of liming an acid soil on coconut yields. The quantity and frequency of application of lime will be such that the soil acidity is reduced to a pH of 6-7 after liming. The lime is broadcast and harrowed.

The experiment consists of a split-plot randomised block design in which the main plots receive the treatments F_1 and F_2 sub-plots L_0 L_1 , and sub-sub-plots O (no manure), C (circular trench), B (broadcast), and S (spreading round bases). Each treatment is replicated thrice. There are 3 blocks of 16 sub-sub-plots each. Each sub-sub-plots consists of 18 palms.

The first manuring of the experiment was done in October 1961. Lime was applied at the rate of 10 cwts. per acre. (pH of unlimed soil was about 4.2).

7. 4 × 4 × 4 N.P.K. Experiment on Young Palms, Pothukulama Estate

The object of this experiment is to determine the growth and yield response curves of young coconut palms to the application of inorganic N.P.K. fertilisers for assessing the optimum levels of fertiliser application under the soil (new jungle clearing, sandy loam) and climatic conditions represented at the Pothukulama sub-station.

The experimental lay out consists of a 4 × 4 × 4 single replicated factorial design where the second order interactions are confounded with those of blocks. There are 4 blocks of 16 plots each, each plot having 18 palms. The first differential manuring was commenced at the end of 1961. Each of the fertilisers sulphate of ammonia, saphos phosphate, and muriate of potash (50%) was applied at the four levels 0 lbs., 0.5 lbs., 1.0 lbs., and 1.5 lbs.

The experiment covers an area of 40 acres. The jungle was burned, cleared and stumped in early 1960, after which a cover of cowpea was established and grown till the seedlings were planted in December 1960. The plot palms are artificially pollinated seedlings supplied by the Botanist, while the guard rows consist of selected open pollinated seedlings.

During the year 1961, the control of weeds, particularly illuk, was a problem.

8. Observation trials on Yellowing palms, Walgama Estate, Rukmale, and Mattegoda Estate, Polgasowita, (see C.R.I. Annual Report 1960).

(1) *Walgama Estate*

A census of the yellow palms receiving various fertiliser treatments since 1957, indicate nearly complete recovery of palms treated with magnesium sulphate, in contrast to those not receiving any magnesium at all. (see Table 8 (a)).

TABLE 8 (a)

Yield data for 1961 and condition of adult yellow palms at Walgama Estate given various treatments in groups of ten (census in December 1961)

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensely yellow palms</i>	<i>Total yield (nuts) for 1961</i>
Control	1	2	7	150
5 lbs. N.P.K. only	1	2	7	212
5 lbs. N.P.K. + 1 lb. MgSO ₄	5	3	1	306
5 lbs. N.P.K. + 2 lbs. MgSO ₄	9	1	0	429
5 lbs. N.P.K. + 3 lbs. MgSO ₄	5	5	0	342

Healthy looking green palms treated with N.P.K. only since 1957 have given a yield of 37 nuts per palm for the year 1961, whereas yellow palms treated similarly gave a yield of 21 nuts per palm. With the addition of magnesium sulphate at 2 lbs. per palm per annum the yield of green palms was increased to 57 nuts per palm, yellow palms to 43. The green palms, although not showing any visual symptoms are also deficient in magnesium, as indicated by the increased yields obtained by applications of magnesium. (see Table 8 (b)). This is in keeping with the expectation that reduction of yields precedes the appearance of any visual symptoms of a deficiency.

TABLE 8 (b)

Yield data for 1961 and condition of adult green palms at Walgama Estate given various treatments in groups of ten

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensely yellow palms</i>	<i>Total yields (nuts) for 1961</i>
Control	8	2	0	310
5 lbs. N.P.K. only	8	2	0	367
5 lbs. N.P.K. + 1 lb. MgSO ₄	9	1	0	484
5 lbs. N.P.K. + 2 lbs. MgSO ₄	9	1	0	572
5 lbs. N.P.K. + 3 lbs. MgSO ₄	10	0	0	402

(ii) *Mattegoda Estate*

Here too the yellow palms receiving magnesium, in addition to N.P.K. mixture have shown nearly complete recovery at the census taken in December 1961, over 4 years after the trials were commenced.

The palms receiving N.P.K. only are seen to be in a worse condition than the controls which do not get any manures at all. Cattle manure palms were no better than the controls. Recovery from applications of dolomite is seen to be slower than recovery from the magnesium sulphate treatments (Table 8 (c)). The pattern of response has been similar in the case of young palms which had turned yellow (Table 8 (d)).

TABLE 8 (c)

Yield data for 1960-61 and condition of adult yellow palms at Mattegoda Estate given various treatments in groups of 40 at Census in December 1961

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensely yellow palms</i>	<i>Total yield (nuts) of 40 palms</i>
Control	4	29	7	1490
N.P.K. only	0	17	23	1596
N.P.K. + 454 gms. MgSO ₄	19	19	2	1960
N.P.K. + 408 gms. dolomite	8	30	2	1984
Cattle manure + supplements	6	27	7	1627
40 green palms receiving N.P.K. only	37	3	0	2774

TABLE 8 (d)

Condition of young yellow palms at Mattegoda Estate given various treatments in groups of 40 palms at Census in December 1961

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of yellow palms</i>
Control	10	18	12
5 lbs. N.P.K. only	6	9	25
5 lbs. + 227 gms. MgSO ₄	30	9	1
5 lbs. + 204 gms. dolomite	21	10	9

MATTEGODA ESTATE

MAGNESIUM TRIALS

YIELD DATA FOR GROUPS OF FORTY YELLOWED PALMS
AND
A GROUP OF FORTY GREEN PALMS

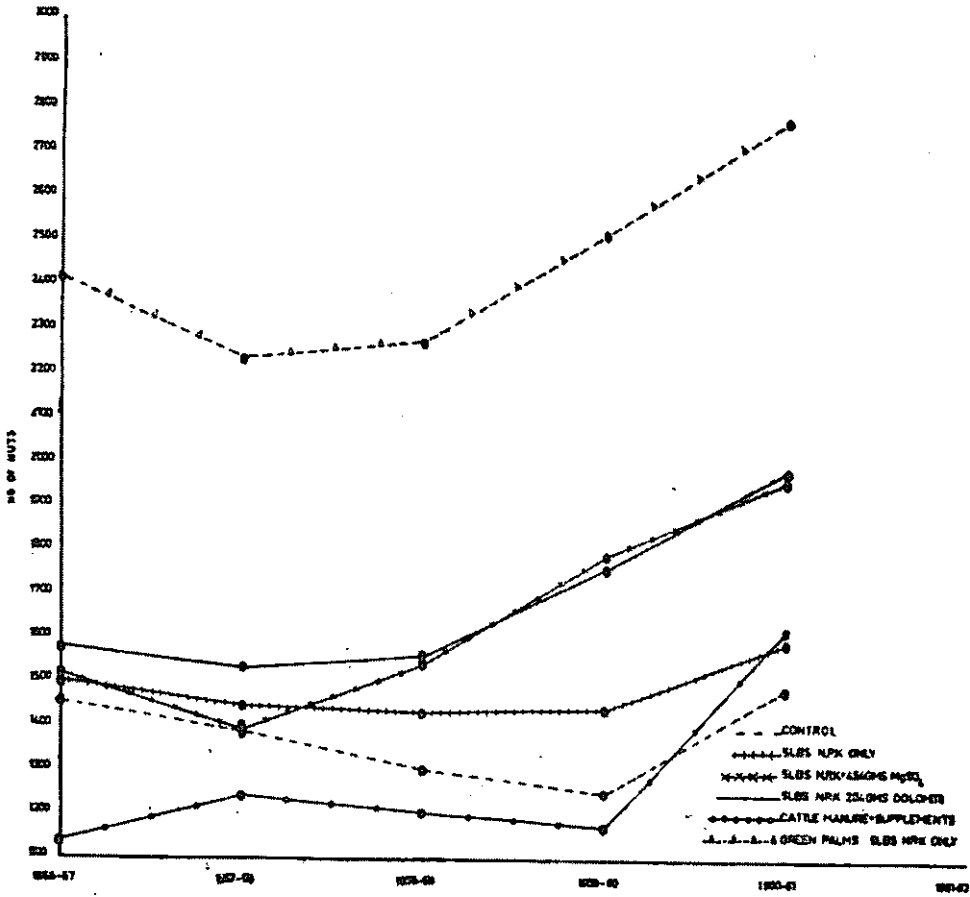


Fig. 1

The annual yield data for the different treatments for the period 1956-61 presented graphically in Fig. 1 show the increased yields obtained by the application of magnesium to yellow palms. The healthy green palms have given a yield of about 70 nuts per palm for the year 1960-61, whereas the affected palms not receiving any magnesium have produced about 38 nuts per palm. The application of magnesium, both as dolomite and magnesium sulphate—has increased the yields of yellowed palms to 50 nuts per palm in 1960-61.

During the year 1961 a number of instances of yellowing were reported from the southern province. Foliar spraying trials with 2% magnesium sulphate on adult yellow-palms at Kahatapitiya Estate, Batapola, and Fred's Ruhue Estate, Baddegama confirmed that these too were due to magnesium deficiency.

9. Nutrient spraying trials on "leaf scorch" palms, Gonapinuwela area.

Within the last couple of years we have received a number of reports of a new coconut disease in the Gonapinuwela—Dodanduwa area (southern province). The leaflets of mature fronds of adult palms develop a brown, scorched appearance, beginning at the tips and extending upwards. This is accompanied by a slight curling of the scorched leaflets. The fronds wither prematurely, resulting in a gradual reduction of the number of fronds and nuts. The palm tapers, and ultimately dies—sometimes within a couple of years after the symptoms of disease are observed. According to reports from planters, heavy bearing palms are more susceptible to the disease. The disease is not confined to particular blocks, but occurs in isolated instances on palms scattered all over the area.

In view of the fact that the disease has occurred on the highly leached lateritic soils of the heavy rainfall areas where coconuts have grown for a long period, the possibility of the problem being associated with a nutritional deficiency cannot be overlooked. Preliminary investigations from a nutritional angle were therefore commenced in June 1961. Since even palms regularly manured with sulphate of ammonia, saphos phosphate and muriate of potash have been affected, and the symptoms are quite different to those associated with magnesium deficiency, the possibility of a major element deficiency is ruled out. The nutritional studies have hence been confined to minor elements.

In the case of magnesium deficiency, the technique of foliar spraying proved to be the simplest method of diagnosing the then unknown visual symptoms of deficiency (see Annual Report C.R.I. 1960). A similar approach was adopted towards this problem.

Diseased palms at Kirimetiya Estate, Elpitiya were sprayed in groups of ten with solutions containing the following combinations of minor elements:—

Group A—Zinc sulphate, Sodium molybdate and boric acid (0.1% concentrations of each),

Group B—Sulphates of iron, copper and manganese (0.1% concentrations of each).

After five fortnightly sprayings commencing on 26th June 1961, the group B sprays were discontinued as the palms appeared to be adversely affected. As group A showed some promise, a further thirty diseased palms were sprayed fortnightly in groups of ten with each of the elements zinc, molybdenum and boron separately (0.3% solutions of the Group A compounds were used), commencing on 6th September 1961. Owing to the heavy rains, no further sprayings were done for the year after 17th October 1961.

While the results obtained hitherto do not give sufficient support to the idea that the symptoms of leaf scorch may be associated with a nutrient deficiency, they do not yet permit the complete rejection of this possibility. Further studies on soil applications of minor elements and foliar analysis are contemplated. But since the problem is a serious one, the need for simultaneous research from a pathological angle cannot be over emphasised.

B. LABORATORY INVESTIGATIONS

1. Diagnosis of magnesium deficiency by leaf analysis.

Leaf analysis figures published previously (C.R.I. Annual Report 1959) showed no difference between healthy and affected palms. As this may have been due to faulty sampling, a second leaf sampling was done. Leaflet samples were taken individually from ten healthy adult green palms and ten yellow palms both at Mattegoda and Walgama Estates. Fronds of a similar age were selected, (10th to 13th fully opened fronds), the age being so chosen that fronds sampled from affected palms were all yellow. Leaflets were sampled from the middle parts of fronds and subject to chemical analysis after removal of mid ribs. The mean chemical composition of the leaflets are given in Table I B (a). It is seen that the samples from yellow palms at Mattegoda have not only a significantly lower content of magnesium, but also lower contents of manganese, nitrogen and phosphorus. The samples from Walgama Estate showed a similar pattern, except that no difference was obtained for phosphorus, and the yellow samples showed a higher content of potassium. These data do not permit any definite conclusion to be drawn on the cause of the yellowing.

A further leaf sampling was therefore done at Walgama Estate where leaflets from the first and sixth fully opened fronds were sampled as described above from ten healthy and ten yellow adult palms. The choice of fronds was such that it ensured that only healthy green leaves were sampled from both green and yellow palms. The chemical analysis data in Table I B (b) clearly indicate a deficiency of magnesium in the samples from the yellow palms.

This work has shown that magnesium deficiency can be conveniently diagnosed by leaf analysis provided that a proper technique of leaflet sampling is adopted. The sampling of chlorotic leaves from affected palms should be avoided as these may show considerable variation from healthy fronds in their content of elements other than that which is actually deficient, as illustrated by the results in Table I B (a).

TABLE I B (a)

Mean chemical analysis (oven dry basis) of coconut leaflet samples taken from 10th-13th fronds of ten green and ten yellow palms

(date of sampling 18th-19th October 1960)

			N	P ₂ O ₅	K ₂ O	Ca	Mg	Fe	Mn
			%	%	%	%	%	ppm.	ppm.
Mattegoda Estate	Green Palms }	Mean	2.34	0.288	1.50	0.291	0.135	185	207
		Std. Error	0.05	0.009	0.07	0.027	0.016	14	18
	Yellow Palms }	Mean	*1.95	*0.241	1.68	0.307	*0.041	213	*73
		Std. Error	0.05	0.013	0.10	0.020	0.007	12	15
Walgama Estate	Green Palms }	Mean	2.32	0.285	1.33	0.304	0.102	155	234
		Std. Error	0.05	0.007	0.14	0.024	0.016	12	18
	Yellow Palms }	Mean	*1.80	0.254	†2.10	0.336	*0.015	153	*49
		Std. Error	0.05	0.013	0.07	0.008	0.004	11	5

*Significantly lower than composition of samples from green palms.

†Significantly higher than composition of samples from green palms.

TABLE I B (b)

Mean chemical analysis (oven dry basis) of coconut leaflets samples taken from 1st and 6th fronds of ten green and ten yellow palms, Walgama Estate

(date of sampling 11th and 12th September 1961)

			N	P ₂ O ₅	K ₂ O	Ca	Mg	Fe	Mn
			%	%	%	%	%	ppm.	ppm.
1st Frond	Green Palms }	Mean	1.87	0.321	2.23	0.254	0.172	155	35
		Std. Error	0.08	0.011	0.13	0.026	0.011	11	7
	Yellow Palms }	Mean	1.88	0.322	2.40	0.233	*0.060	118	37
		Std. Error	0.09	0.006	0.06	0.020	0.007	10	5
6th Frond	Green Palms }	Mean	2.37	0.327	1.54	0.404	0.194	172	236
		Std. Error	0.07	0.011	0.14	0.053	0.025	12	29
	Yellow Palms }	Mean	2.41	0.358	1.74	0.409	*0.063	145	146
		Std. Error	0.05	0.004	0.06	0.040	0.010	6	12

*Significantly lower than composition of samples from green palms.

2. Radio Isotopes (P³²) Project

(See C.R.I. Annual Report 1960).

The work under this project was directed towards a further study of the distribution of radioactive phosphorus in leaves, nut water and spathes when P³² is applied in the manure

circle of an adult coconut palm—the P^{32} being now applied with an extremely small amount of carrier phosphate. Five millicuries of P^{32} diluted in $2\frac{1}{2}$ litres water with 0.14 gms. P was applied round the palm. Analysis of the phosphate in leaves, nut water and spathes six weeks after application showed a comparatively high accumulation of phosphate in the leaves. Table 2 B (a) gives the distribution of radio activity in leaflets of different fronds according to their position in the frond. The fronds are numbered in increasing order of maturity, No. 1 being the first fully opened leaf.

TABLE 2 B

Specific activity of phosphate in leaflets and nut water
(counts per minute per mg. P_2O_5)

(a) Leaflets

Section	Frond No.							
	1	2	3	4	6	9	13	last
Upper	19.8	69.8	94.9	91.45	88.6	90.8	84.7	32.9
Middle	12.6	44.6	74.4	73.4	80.4	81.1	80.3	19.2
Base	13.1	16.6	52.5	49.4	64.5	67.5	61.2	12.6

(b) Nut Water

Bunch No.	No. of nuts	Total Volume of Water ml.	Specific activity
3	8	1320	1.33
4	12	1840	4.49
5	8	2150	9.89
6	9	1600	6.65
7	9	2900	16.42
8	10	3680	11.0
9	14	5300	22.0
10	13	2920	22.2

The youngest and most mature fronds have the lowest specific activities. In all fronds the leaflets in the upper sections of the fronds show a greater accumulation of radioactivity, while the greatest uniformity in the distribution of P^{32} is seen between fronds 3 to 13.

The bunches, numbered in decreasing order of maturity, show the highest specific activity in the water of the least mature nuts.

Analysis of the spathes showed an accumulation of radioactivity in the male and female flowers intermediate between that of the nut water and leaves.

Even though the quantity of carrier phosphate applied was very small, there has been a considerable uptake of P^{32} by the palm.

The leaflets from moderately matured fronds have proved to be the most suitable plant organ for these studies.

3. 4^s N.P.K. Experiment at Pothukulama

(i) Study of uptake of nutrients by cowpea from Pothukulama soil

Samples of tops, roots, seed and husk of cowpea grown at Pothukulama in the 40 acre manurial experiment prior to the planting of seedlings in 1960 were analysed for N, P, K, Ca and Mg. The purpose of this study was to assess the amounts of plant nutrient removed from the soil by the harvested seed and the amounts of nutrients returned to the soil through turning in the cowpea cover. The samples taken from each of the four blocks of the experiment gave a similar chemical analysis indicating uniformity of soil conditions. The mean percentage chemical analysis is given in Table 3 B (a).

TABLE 3 B (a)

Chemical analysis of cowpea, Pothukulama
Mean percentage values (oven dry basis)

	N	P ₂ O ₅	K ₂ O	CaO	MgO
Tops ..	1.96	0.157	3.03	1.560	0.396
Roots ..	1.33	0.207	2.31	0.737	0.355
Seeds ..	4.55	0.113	1.91	0.073	0.157
Husks ..	0.88	0.782	1.73	0.486	0.279

The quantity of seed harvested from the 40 acres amounted to 2.9 cwts. per acre (air dry). Table 3 B (b) gives the amounts of nutrient mobilised by various components of the cover. Significant amounts of nitrogen have been removed by the harvested pods.

TABLE 3 B (b)

Amounts of nutrients mobilised by cowpea in lbs. per acre

	CaO	MgO	N	P ₂ O ₅	K ₂ O
Tops ..	21.1	5.7	31.2	1.90	48.5
Roots ..	0.85	0.43	1.62	0.21	2.5
Seeds ..	0.22	0.47	13.5	2.30	5.6
Husks ..	0.57	0.37	1.03	0.12	1.9
Total ..	22.74	6.97	47.36	4.53	58.5

Fertiliser equivalents in lbs. per acre

	Sulphate of ammonia (20.6%N)	Sapros phosphate (28% P ₂ O ₅)	Muriate of Potash (60% K ₂ O)
Removed by Harvest	70.5	8.6	12.5
Returned to Soil	159.5	7.5	85.5

(ii) *Analysis of Pothukulama soils*

The mean chemical analysis data for soil samples taken from each of the four experimental blocks before planting of seedlings in 1960 is given in Table 3 B (c).

The soil in the experimental area has been characterised as a uniform sandy loam carrying moderate supplies of exchangeable bases, but poor in available phosphate (Truog method). Since there was little change in the profile characteristics with depth, only the data for the 0-9" layer are shown.

TABLE 3 B (c)
Chemical analysis of Pothukulama Soil (0-9")

	Total exch. bases me %	Exch. K ₂ O me %	Exch. Ca me %	Exch. Mg me %	Truog P ₂ O ₅ ppm.	Total N ppm.	Nitrate N ppm.	Ammo- niacal N ppm.	Total C %	C N
Block 1	3.12	0.085	2.11	0.608	17.5	336	3.6	7.6	0.680	20.2
Block 2	3.81	0.140	2.50	0.646	22.6	389	2.2	7.2	0.522	13.4
Block 3	2.78	0.159	2.06	0.500	14.0	392	2.5	7.2	0.581	14.8
Block 4	5.03	0.144	3.58	0.691	29.7	480	3.0	8.6	0.757	15.8

C. MISCELLANEOUS

I. The Soil Chemist delivered the following papers during the course of the year:—

- (i) "Magnesium deficiency in Coconuts"—to the Kurunegala Planters' Association.
- (ii) "Optimum fertiliser dosage for coconuts"—(Joint paper with the Biometrician, Mr. V. Abeywardena) to the Ceylon Association for the Advancement of Science.
- (iii) "Coconut nutrition and fertiliser requirements—the Soil Approach" to the F.A.O. Technical Working Party on coconuts, (Trivandrum Conference).

D. PERSONNEL

There were no changes in the staff during the course of the year.

D.A. NETHSINGHE,
Soil Chemist, Coconut Research Institute.

REPORT OF THE CHEMIST

COPRA

1. *Copra Conversion Factor for FAO Survey.*—On a request made by the FAO Statistician, an experiment was started during the year in order to obtain a copra conversion ratio in terms of the husked nut, when fresh green nuts as harvested, are handled in estate practice.

That copra constitutes 32% of the husked nut weight is a relationship evolved by previous workers for withered coconuts and not freshly harvested nuts. The purpose of the experiment has been to ascertain whether there is any significant difference in the factors for the two types of nuts.

Ten thousand nuts selected from each bimonthly pick (at Bandirippuwa) were used for the experiment. The examination of the selected nuts from all six picks for 1961 has already been completed. The nuts from each pick besides being grouped and examined in their fresh state and after seasoning for a period of 30 days, have also been examined when de-husked and weighed with and without the tuft.

The ten thousand nuts from each pick were examined as follows:—

A. Five thousand nuts examined in the *fresh green state*.

- (1) 2,500 were weighed whole, then husked, and the husked nut weight obtained with the tuft. The 2,500 husked nuts were cured into copra in five lots of 500 each. Each lot of copra was weighed carefully and moisture estimations done in duplicate on a representative sample as soon as possible after the kiln-dry weight was obtained.
- (2) 2,500 were weighed whole, then husked and the husked nut weight obtained *without the tuft*. The rest of the operations, connected with the conversion to copra etc., were carried out precisely as with A (1) above.

B. Five thousand nuts examined *after seasoning* for a period of 30 days.

- (1) 2,500 were treated in exactly the same way as A (1) above.
- (2) 2,500 were treated in exactly the same way as A (2) above.

The average figures obtained for each pick for the respective categories of nuts and the calculated overall values have been charted in Tables I and II.

TABLE I
Fresh Green Nuts (Six Picks for 1961)

Pick (Bandirip- pura 1961)	Av. weight per whole nut (gms.)	Av. weight per husked nut (gms.)	% moisture in copra	Wt. of copra/nut (gms.)		Kiln-dry copra as % of husked nut	Copra (6% moisture) as % of husked nut
				kiln-dry	6% mois- ture (calc.)		
I	1,778	777	6.94	228	225	29.3	29.1
II	1,506	634	6.64	188	187	29.7	29.5
III	1,560	718	6.29	223	222	31.0	30.9
IV	1,453	653	5.38	206	208	31.6	31.8
V	1,641	739	6.41	231	230	31.3	31.2
VI	1,790	791	5.85	242	242	30.6	30.6
Mean	1,621	719	6.25	220	219	30.6	30.5
S.D.	128.31	58.49	0.51	17.78	17.51	0.80	0.94
C.V. (%)	7.91	8.14	8.19	8.09	8.00	2.91	3.08
S.E.	52.38	23.88	0.21	7.26	7.15	0.36	0.38

HUSKED NUTS WEIGHED WITH THE TUFT							
I	1,771	783	6.85	227	225	29.1	28.8
II	1,508	649	6.24	188	188	29.0	28.9
III	1,560	742	6.52	221	220	29.9	29.7
IV	1,471	679	5.59	208	208	30.6	30.8
V	1,634	756	6.06	231	231	30.6	30.6
VI	1,786	824	5.62	240	241	29.2	29.3
Mean	1,622	739	6.15	219	219	29.7	29.7
S.D.	121.71	59.38	0.45	17.00	17.06	0.68	0.78
C.V. (%)	7.51	8.04	7.39	7.76	7.80	2.28	2.62
S.E.	49.69	24.24	0.10	6.94	6.97	0.28	0.32

TABLE II
Seasoned Nuts (Six Picks 1961)

I	1,477	771	6.13	231	231	30.0	29.9
II	1,494	678	6.76	208	206	30.6	30.4
III	1,280	684	6.59	216	215	31.6	31.4
IV	1,347	674	5.83	215	215	31.9	31.9
V	1,336	687	7.30	226	223	32.9	32.4
VI	1,317	739	6.10	236	236	31.9	31.9
Mean	1,375	706	6.45	222	222	31.5	31.3
S.D.	80.80	36.43	0.49	9.78	10.21	0.94	0.80
C.V. (%)	5.88	5.16	7.61	4.41	4.62	3.00	2.83
S.E.	33.02	14.87	0.20	3.99	4.17	0.39	0.36

HUSKED NUTS WEIGHED WITH THE TUFT							
I	1,483	783	6.10	230	229	29.3	29.3
II	1,514	699	6.45	207	206	29.6	29.5
III	1,306	713	6.30	214	213	30.0	29.9
IV	1,353	689	6.33	215	215	31.3	31.2
V	1,338	716	6.86	224	222	31.3	31.0
VI	1,308	762	5.94	235	235	30.9	30.9
Mean	1,384	727	6.33	221	220	30.4	30.3
S.D.	83.30	33.93	0.29	9.72	9.83	0.80	0.76
C.V. (%)	6.02	4.67	4.57	4.40	4.47	2.65	2.51
S.E.	34.01	13.85	0.12	3.97	4.01	0.33	0.31

S.D. = Standard deviation. C.V. = Coefficient of variation. S.E. = Standard error.

The results show that the differences between the values obtained for the ratio COPRA: HUSKED NUT (when the copra weight is taken on the kiln dry basis and again when it is calculated on 6% moisture content) are not significant for the four categories of nuts examined: viz. Fresh nuts with and without tuft and Seasoned Nuts with and without tuft. The reason for this is of course that under the conditions of the present experiment the moisture content of the kiln-dry copra has not been widely divergent from 6 per cent. It should however be reasonable to assume that for over-dried or grossly under-dried copra the ratio in question would be affected. In other words, in the practical application of the conversion factor it should be remembered that the weight of copra actually refers to the product that has been dried to a moisture content in the region of six per cent.

In testing the level of significance of the differences between the values obtained for the ratio COPRA: HUSKED NUT for the different categories for the six picks, it is considered that the normal t-test could not be appropriately applied as the percentage value as such, that has been obtained for each pick does not strictly constitute a random variable, so that the distribution could not be assumed to be "normal". Hence for testing the levels of significance of the values obtained with the different categories of nuts the non-parametric sign test for $n = 6$ has been employed with the following results:—

**Statistical comparisons of differences in COPRA:
HUSKED NUT ratios**

<i>Category</i>	<i>Significance</i>	<i>Probability</i>
A. Without Tuft		
(1) Weight of kiln-dry Copra-Fresh-Green Vs. Seasoned	significant	0.03
(2) Weight of copra (calc. on 6% moisture) Fresh Green Vs. Seasoned	significant	0.03
B. With Tuft		
(1) Weight of kiln-dry Copra-Fresh-Green Vs. Seasoned	significant	0.03
(2) Weight of copra (calc. on 6% moisture) Fresh Green Vs. Seasoned	significant	0.03

On the basis of the overall results that have been obtained from this study, it may be legitimately concluded that as long as copra is dried down to 6.0% ($\pm 0.5\%$) moisture content, the following conversion factors (for COPRA: HUSKED NUT) could be appropriately applied to the respective categories.

A. Fresh Green Nuts as Harvested

- (1) When Husked nut is weighed *without* the tuft — Wt. of Copra
= 30.5% of Husked nut weight.
- (2) When Husked nut is weighed *with* the tuft — Wt. of Copra,
= 29.7% of Husked nut weight.

B. Fresh green nuts after seasoning for 30 days

- (1) When Husked nut is weighed *without* the tuft—Weight of Copra
= 31.3% of Husked nut weight.
- (2) When Husked nut is weighed *with* the tuft—Weight of Copra
= 30.3% of Husked nut weight.

It will be seen from the data for six picks charted in Tables I and II, that the coefficients of variation for the factor COPRA: HUSKED NUT for the different categories, all fall under three per cent. This index of variation gives further support to the validity of the conclusions that have been drawn from the study, and also confirm the reliability of the respective factors for practical application.

II. In view of the fact that the preliminary experiment on the evaluation of copra quality in relation to the maturity of the drupe (reported last year) gave interesting results, it was repeated again during the year with greater precision with the object of ensuring the ages (i.e. maturity) of the respective categories: fallen nuts, first bunch nuts, second bunch nuts, third bunch nuts and fourth bunch nuts. This experiment was completed during the year and it is proposed to publish the results in full, elsewhere.

POT CULTURE EXPERIMENT

I. A third pot culture experiment on 288 seedlings was laid down on 1st February 1961, in order to study the effects of amputation on coconut seedlings (both on their physical and internal chemical characteristics) when carried out at intervals ranging from one to five months from planting in pots. The non-amputated seedlings were used as control and the following treatments were laid down in the study:—

+ALL, —ALL, —N, —P, —K, —Ca and —Mg.

Six non-amputated control seedlings (planted on 1.2.61) from each of the seven treatments were uprooted on 1.8.61, i.e. six months after planting. The other seedlings (six from each treatment) were uprooted exactly six months after their respective dates of amputation. Apart from growth measurements on individual seedlings taken at monthly intervals, all the seedlings uprooted during the course of the experiment were weighed separately and sampled into shoots and roots individually. Powdered samples were prepared as usual for chemical analyses.

II. The visual symptoms characteristic of each particular mineral deficiency, as established from the pot culture studies, have already been reported.

The statistical examination of the results obtained on the physical factors (height, girth and leaf counts) from the First Pot Culture Experiment has now been completed. Tables III to V contain summaries of the analyses of variance between the (+ ALL) and the different treatments for the physical characters—seedling heights, seedling girth at base and leaf counts. On the basis of the experimental results, visual symptoms and other effects of positive diagnostic value characterising absolute deficiencies of N, P, K, Ca and Mg have now been established unequivocally.

III. The work of the Division during the year was focussed principally on analytical aspects. The chemical examination of samples (numbering over 150) from Pot Culture Experiments I and II for N, P, K, Ca and Mg has been completed.

TABLE III

POT CULTURE EXPERIMENT I

Summary of Analysis of Variance—Seedling Girth at Base
 - (Difference between (+ALL) and Respective Treatments)

I	2	3	4	5	6	7	8	9	10	11
Date	Amputation	Treatment	Amputation × Treatment	+ALL -N	+ALL -P	+ALL -K	+ALL -Ca	+ALL -Mg	+ALL -T.E.	+ALL -ALL
12. 8.58	—	—	—	1.4	-0.1	-0.1	0.1	1.9	-2.8	-6.4*
12. 9.58	—	—	—	-0.7	-2.2	-0.2	-0.2	1.2	-2.7	-5.3
12.10.58	—	—	†	-1.7	-0.8	1.7	-2.3	-0.5	-0.8	-0.5
12.11.58	—	†	†	6.9†	4.1	4.7*	7.2†	4.3	9.3§	9.3§
12.12.58	—	—	*	5.4*	3.3	1.8	4.7	1.8	3.1	7.3†
12. 1.59	—	—	—	13.0§	11.3§	4.9	14.2§	6.7*	7.1†	17.3§
12. 2.59	—	—	—	13.6§	10.0†	9.8†	13.9§	11.1†	11.8†	25.5§
12. 3.59	—	—	—	14.0§	10.0§	4.8*	15.1§	13.1§	4.9*	38.0§
12. 4.59	—	—	—	24.7§	19.9§	11.6*	17.7§	25.8§	10.3*	49.5§
12. 5.59	—	—	—	24.9§	21.9§	4.7	13.6†	27.1§	5.5	57.9§
12. 6.59	—	—	—	31.1§	24.7§	14.0*	20.3†	34.8§	5.0	73.6§
12. 7.59	—	—	—	35.8§	24.6†	4.0	14.6	43.0§	3.2	83.9§
12. 8.59	—	—	—	57.7§	42.8§	16.5*	31.0§	56.4§	4.2	109.1§

* Significant at P = 0.05

† Significant at P = 0.01

§ Significant at P = 0.001

TABLE IV

POT CULTURE EXPERIMENT I

Summary of Analysis of Variance—Leaf Counts on Seedlings
(Difference between (+ALL) and Respective Treatments)

1	2	3	4	5	6	7	8	9	10	11
Date	Amputa- tion	Treat- ment	Amputation × Treatment	+ ALL -N	+ ALL -P	+ ALL -K	+ ALL -Ca	+ ALL -Mg	+ ALL -T.E.	+ ALL -ALL
12. 8.58	—	—	—	—	—	—	—	—	—	—
12. 9.58	—	—	—	-0.8	-0.8	0.1	0.0	0.3	-0.2	-1.0
12.10.58	—	*	—	0.7	0.2	0.9	2.0*	2.5†	0.5	0.0
12.11.58	—	*	—	1.2	1.4	2.1	3.2†	3.5†	1.9	2.9*
12.12.58	—	†	—	2.9*	2.1	2.1	4.0†	4.0†	1.5	4.6†
12. 1.59	*	†	—	5.0†	3.6*	3.8*	6.4†	4.1*	2.1	7.8§
12. 2.59	*	§	—	4.0†	3.4*	3.7*	6.4§	3.7*	0.2	10.2§
12. 3.59	—	†	—	6.5†	6.1*	4.1	8.0†	5.6*	4.8*	13.3§
12. 4.59	†	§	—	6.3†	4.5*	2.3	5.5*	3.5	0.3	13.8§
12. 5.59	*	§	—	5.6*	4.8*	3.3	6.1†	3.9	0.1	16.0§
12. 6.59	*	§	—	5.2	3.9	1.8	6.0*	4.7	0.1	19.5§
12. 7.59	§	§	—	6.4†	6.9†	1.9	6.0†	4.2*	1.2	19.4§
12. 8.59	*	§	—	6.4*	4.7*	2.4	5.6*	5.2*	0.2	20.0§

* Significant at $P = 0.05$ † Significant at $P = 0.01$ § Significant at $P = 0.001$

TABLE V

POT CULTURE EXPERIMENT I

Summary of Analysis of Variance—Height of Seedlings
(Difference between (+ALL) and Respective Treatments)

I	2	3	4	5	6	7	8	9	10	11
Date	Amputa- tion	Treatment	Amputa- tion × Treatment	+ ALL -N	+ ALL -P	+ ALL -K	+ ALL -Ca	+ ALL -Mg	+ ALL -T.E.	+ ALL -ALL
12. 8.58	—	—	—	-16.0	-9.6	-10.7	-5.5	-1.5	1.5	-5.2
12. 9.58	—	—	—	6.9	0.1	-1.8	-0.2	16.8	30.7	-6.5
12.10.58	—	—	—	23.3	10.3	20.7	14.5	24.2	71.2§	33.0
12.11.58	—	—	—	26.4	-5.3	33.7	12.4	14.8	29.1	40.4*
12.12.58	—	—	—	55.0*	20.3	17.2	0.7	34.3	32.0	71.6†
12. 1.59	†	*	—	63.2*	18.8	24.1	32.8	46.1	37.9	112.0§
12. 2.59	†	†	—	114.8†	41.8	40.5	35.4*	87.6*	44.8	185.8§
12. 3.59	†	†	—	140.0§	49.2	42.1	18.5	93.8†	45.1	263.0§
12. 4.59	†	†	—	190.6§	98.5†	18.0	70.0*	120.5†	25.0	332.9§
12. 5.59	†	†	—	220.5§	109.0§	0.2	60.0*	161.0§	-13.5	422.0§
12. 6.59	†	†	—	284.7§	119.5†	-8.6	103.0*	208.5§	14.0	545.8§
12. 7.59	†	†	*	318.8§	177.2§	15.8	87.1†	235.7§	-65.1*	625.1§
12. 8.59	†	†	*	387.9§	237.8§	-16.9	103.4*	289.2§	-18.6	679.4§

* Significant at P = 0.05

† Significant at P = 0.01

§ Significant at P = 0.001

GERMINATION EXPERIMENT

It has been reported earlier that a Germination Experiment has been laid down as a corollary to the main Pot Culture experiment. The experiment which has been in progress for two years was concluded during the year.

The study has revealed that the coconut seedling is so adapted that it is only partly dependent on the nutrient reserves in the *drupe components* for its growth activities, during the two year period following the onset of germination. In fact, the bulk of its requirements towards the end of this period are drawn from its medium of growth. Though a reticulum of roots and rootlets characterise the exocarp as the process of germination advances, yet roots have been found to permeate the soil as early as two months from planting. These observations would imply the need for judicious and proper fertilization of the soil during early field culture of coconut seedlings. All the same, the fruit components have doubtless been found to be an important source of mineral nutrients from which the seedling makes demands throughout a period of two years. The study has revealed that *via* the cotyledon (scutellum) practically all the nutrients contained in the endosperm and nut water are eventually absorbed by the growing seedling.

The study has revealed that a *typical* seed coconut at the time of planting in the nursery (after a month's withering in the field), would contain about 2.65 gms. N, 0.429 gm. P, 6.16 gm. K, 0.505 gm. Ca, and 0.638 gm. Mg. Regarding the gross uptake of the different macronutrients by the growing seedling, the totals during sixteen predetermined stages have been found to appear in the order $K \rightarrow N \rightarrow Mg \approx Ca \rightarrow P$, so far as relative magnitudes are concerned.

Further, the experiment has shown that the *endosperm* and then the *husk* are the most important *fruit components* from the point of view of nutrient supply to the young seedling. Whilst certain amounts of all the macronutrients (excepting Ca) are supplied by the former, the husk is an important source of K. It has been observed that the endosperm reserves of almost all the nutrients are utilised fairly completely during the first two year period. The endosperm though a poor source of calcium has been found a particularly rich source of nitrogen. The following experimental data relevant to the endosperm have been found extremely informative:—

NUTRIENT	Amount/Drupe at Stage G I (gms.)	Amount/Drupe at Stage G XVI (gms.)	Difference (G I—G XVI) (gms.)	Difference as % of original amount in G I
Nitrogen (as N)	1.53	0.208	1.322	86.4
Phosphorus (as P)	0.268	0.029	0.239	89.2
Potassium (as K)	0.737	0.016	0.721	97.8
Calcium (as Ca)	0.021	0.014	0.007	33.3
Magnesium (as Mg)	0.129	0.032	0.097	75.2
Ash	2.96	0.42	2.54	85.8

The above figures give sufficient factual proof that with the exception of calcium (which in any case is present only in a small amount) very high proportions of the other macro-nutrients actually present in the endosperm are translocated *via* the cotyledon to the growing seedling. Regarding the liquid endosperm (nut water)—the study has revealed that it completely disappears at stage G VIII (5.5 months after planting). In other words, it would be plausible to infer that the nutrients contained therein are also fully absorbed as the liquid soaks up and passes into the spongy cotyledon.

Though a discussion of the full results would not be appropriate in the present context it may be said that it has been possible to evaluate from this germination study, the progressive changes and uptake inter-relationships between the drupe components, seedling components and the soil medium. Further, it has been possible to obtain a thorough elucidation of the pattern of nutrient distribution in the different seedling components (including laminae and rachids according to leaf rank) during physiological ontogeny. The most significant fact that has emerged from this study is of course the importance of adequately fertilizing the seed beds with calcium and magnesium during nursery culture of coconut seedlings.

EMULSIFICATION OF COCONUT OIL

Some experiments are in progress to determine the precise composition of "Coconut Milk" as used for culinary purposes and also determine the possibility of producing a similar product by appropriate fortification and emulsification of coconut oil. Among other things lecithin is being tried out as a possible emulsifying agent. The experiment is being continued.

MISCELLANEOUS WORK

I. Analyses and reports have been made on a few samples of copra, desiccated coconut and acetifying toddy.

II. Help and advice have been given to a vinegar-maker at Nainamadama (in the Chilaw District), who has installed a plant for the manufacture of vinegar by the "Generator" process.

W.R.N. NATHANAEL,
Chemist, Coconut Research Institute.

ANNUAL REPORT OF THE BOTANIST

1. PROGENY TRIALS

The three progeny trials situated at Marandawila, Walpita and Bandirippuwa were maintained during the year. Yield data collected from the first trial has been subjected to further analysis. It is yet premature to analyse the yield data of the other two trials.

Already heritabilities of, and genetic correlations between various productive traits of the coconut palm have been worked out from the data collected from the Marandawila Trial. It has been pointed out that the genetic correlations between different productive traits are of considerable importance in a selection programme. Since the yield of nuts and copra are highly correlated positively ($r_g = 0.79$), and the flowering-period and yield of copra are highly correlated negatively ($r_g = -0.81$), selection of seed parents on early flowering and number of nuts will tend to increase the yield of the progeny with respect to copra production. As a number of characters have to be considered in the selection of seed palms, it would be generally useful to construct selection indices. An index I using three characters has been computed as follows:—

$$I = x_1 - 14.70x_2 - 4.47x_3$$

Where x_1 = number of nuts per palm per year,

x_2 = weight per husked-nut (lb.),

and x_3 = flowering-period of palm (months).

It is generally necessary to construct a number of selection indices using different criteria and then ascertain the most efficient index by determining expected genetic progress. This work is in progress.

2. HYBRIDISATION BETWEEN VARIETIES AND FORMS

The programme of work on breeding and selection was continued during the year. New experiments initiated were, (a) a diallel cross involving 8 *typica* palms, (b) 6 palms from the Isolated Seed Garden being tested as male transmitters and (c) crosses to study the effect of male parent particularly on endosperm characters of the nut.

Typica × *pumilla*

The observation plot of 22 first generation palms of *typica* × *pumilla* (tall × dwarf) planted in 1950 have given an average yield of 129 nuts and a husked-nut weight of 226 lb. per palm during the 11th year after planting. The mean yield per palm of 10 *typica* × *typica* palms planted in the same field during the same period was 121 nuts and a husked-nut weight of 212 lb. The main advantage of the F_1 hybrid palms appears to be the high initial yields obtained (Table I).

TABLE I
Mean yield per progeny of F₁ palms

Year after planting	<i>typica</i> × <i>pumilla</i>		<i>typica</i> × <i>typica</i>	
	Nuts	Weight of husked-nuts (lb.)	Nuts	Weight of husked-nuts (lb.)
5th	23	36.0	—	—
6th	68	106.1	22	35.8
7th	86	122.9	52	70.0
8th	65	110.5	65	102.2
9th	103	147.0	84	126.7
10th	108	187.8	88	—
11th	129	225.6	121	212.3

Out of the F₁ palms planted in May 1958, there are 193 of *typica* × *pumilla* and 72 of *typica*, excluding supplies. By the end of the year (age of palms 3.5 years), 87 per cent of the former and 19 per cent of the latter were in flower. Further 18 families of the former type with at least 4 progenies each, have shown 100 per cent flowering, and their mean flowering-period calculated from the date of transplanting has varied between 31 and 38 months. The total number of green leaves carried on these palms were scored in May 1961; *typica* × *pumilla* had an average of 16.3 leaves per palm against 12.2 for *typica*, the difference being highly significant ($P < 0.001$). Apparently leaf production is more in the former type of palm in the fourth year.

From the programme of work on back-crossing and selfing F₁ palms of *typica* × *pumilla*, 69 and 91 nuts respectively were harvested and the seedlings will be transplanted in 1962.

122 seedlings of *typica* × *pumilla* and of the female parents open-pollinated were planted at Bandirippuwa Estate in May 1961. This trial would indicate the relative degree of general combining ability between the male parents and the pre-potency between the female parents.

Typica × typica

24 palms taken at random from the Latin Square Experiment at Ratmalagara Estate were selfed in 1960 and the seedlings were transplanted at Pothukulama in April 1961. Seedlings of 7 families were rejected as they produced less than 5 seedlings per cross. 167 selfed and 154 open-pollinated progenies of the remaining 17 palms were planted. The purpose of the trial is to study the effect of in-breeding on coconut palms.

Eight palms taken at random from the Replantation Experiment at Bandirippuwa were crossed in a diallel manner. Paired crosses and other crosses involving pre-potent palms were continued at 8 stations, and 63,561 female flowers have been pollinated. 17,000 nuts resulting from crosses done during the previous year were harvested.

141 progenies composed of crosses between 5 female parents and 3 pre-potent palms as the male and of open-pollinated seedlings of the respective female parents were planted at Bandirippuwa Estate in May 1961 in order to measure the increase of crop, if any, of the F₁ palms over the open-pollinated.

Isolated Coconut Seed Garden

The seed garden for the mass production of an improved strain of seed coconuts is being implemented in two stages. The first stage is establishing a plantation with seedlings derived by hand pollination and the second stage is identification of a sufficient number of male transmitters from the palms within the seed garden.

Satisfactory progress has been made on stage I, and already 7,205 hand pollinated seedlings have been transplanted, covering an area of 92 acres (approx.). In Field No. 1 where 328 seedlings were planted initially, 95.7 per cent of the palms were in flower and 37.8 per cent were in bearing at the end of the year, *i.e.* 6th year after planting. In Field Nos. 2 (416 palms) and 3 (341 palms) planted in November 1956, 41.6 and 51.9 per cent respectively of the palms were in flower. Work on the 2nd stage was started during the year and 6 palms selected from the bearing palms in Field No. 1 are being tested for male potency.

3. PLANTING TECHNIQUES

Size of Seed Hole

This experiment to study the relationships, if any, between the size of the seed-hole used to transplant a coconut seedling and its subsequent growth has completed six years. It has been shown that there were no significant differences between treatments with respect to production of leaves and early flowering up to the end of the fifth year. At the end of the sixth year (1961), 86.1 per cent of the palms were in flower and again differences between treatments were not statistically significant. The number of palms in flower in the separate treatments were as follows: (a) 1 × 1 × 1 ft. seedhole—83.3 per cent, (b) 3 × 3 × 3 ft. seedhole—85.2 per cent, (c) cruciform type—87.0 per cent and (d) post-hole borer type—88.9 per cent.

Depth of planting

The leaf production data (*i.e.*, total number of green leaves and the new leaves produced during the year per palm) and the number of palms in flower at the end of the 5th year after planting, do not show any significant differences between the treatments (Table 2). Deep planting of coconut seedlings up to 2 ft. from ground level has not adversely affected the growth of the palm or flowering during the fifth year.

TABLE II
Mean number of leaves per palm and palms in flower in the depth of planting trial at the end of the fifth year

Treatment	New leaves produced during the year	Total number of green leaves	Per cent palms in flower
6 ins. deep planting	12.0	20.0	11.1
12 ins. "	10.8	17.6	11.1
18 ins. "	12.3	20.0	15.6
24 ins. "	11.9	19.2	15.6

4. MISCELLANEOUS

Seed Supply Scheme

Out of 17 estates inspected for selection of suitable blocks for palm selection, selection work was completed on five estates. 13,794 palms were selected from these estates, bringing

the total number of palms selected to 40,134. 1,254,628 seednuts from the selected palms were supplied to the Planting Division.

Pollen Bank

The establishment of a Pollen Bank (Annual Report of the Botanist 1959) and the subsequent issues of pollen to the Division's pollination stations as well as to private estates implementing their own programmes of controlled pollination necessitates quick and reliable methods of testing pollen viability. In this connection, "The peroxidase reaction as an indicator of pollen viability" was tried with coconut pollen. Although the colour reaction was characteristic of the test, there was no method of determining percentage viability with any degree of reliability.

The long established germination test consists of dusting pollen in a medium composed of 10 per cent sucrose and 2 per cent gelatine, and counting the percentage germination after about 2 hours. One drawback was the occurrence of burst pollen tubes which made counting difficult and at times inaccurate. Germination of pollen at varying relative humidities between 10 to 90 per cent still gave about 20 to 30 per cent bursting at all humidities, and the use of other concentrations of sucrose did not have the desired effect. The element boron is believed to play an important part in the reproductive cycle of flowering plants and as it is reported to quicken and facilitate pollen tube growth, it was decided to incorporate boron (in the form of borax) in the standard germinating medium. A series of trials were conducted with different concentrations of borax, and it was observed that the use of 0.1 per cent aqueous borax in the ratio 1 part of borax: 10 parts of mixture of 10 per cent sucrose and 2 per cent gelatine gave very consistent results with good pollen tube growth and almost negligible bursting, thus facilitating viability counts under the microscope.

3,635 pollen samples from pre-potent *typica* palms and 2,873 samples from selected *pumilla* palms have been sealed and stored under deep-freeze conditions. 4,235 samples of pollen were issued to 5 private estates to help them to implement their own programmes of controlled pollination.

Other Field Trials

Routine observations, yield recording and cultural operations of Latin Square Experiment, Dwarf Palm Block and of Hybrid Palms were continued.

Personnel

Dr. D.V. Liyanage, Botanist, attended the symposiums on "Tree Breeding" and "Coconut Breeding" organised by the Pacific Science Congress in Hawaii in August 1961 and presented a paper on "The Genetic Improvement of the Coconut Palm". Dr. D.V. Liyanage attended the F.A.O. Technical Working Party on Coconut Production, Protection and Processing at Trivandrum, India, in December 1961 and presented a paper on "The Use of Isolated Seed Gardens for Coconut Seed Production".

Mr. M.A.P.P. Manthiraratne, Technical Assistant resumed duties in June after long study leave. Mr. M.H. Karunadasa, Field Attendant, was promoted as Field Assistant with effect from 1st March. Mr. M.A.M. Niyaz, Clerk/Typist resigned in December.

D.V. LIYANAGE,
Botanist.

ANNUAL REPORT OF THE DIVISION OF AGROSTOLOGY

A. SOIL FERTILITY STUDIES

1. Lateritic Soils at Bandirippuwa Estate

(a) Follow-up Experiments

Soils 3 years after manuring:—

The two experiments set up late last year with soils sampled three years after manuring, were completed this year.

Experiment I

This was a 2^4 factorial experiment with two replicates of all treatments planted on the three soil types—Sand, Loam and Gravel, to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

N. as $(\text{NH}_4)_2\text{SO}_4$	—	Nil and 5 cwts./acre.
P. as NaH_2PO_4	—	Nil and 3 cwts./acre.
K. as K_2SO_4	—	Nil and $4\frac{1}{2}$ cwts./acre.
Ca. as CaCO_3	—	Nil and 10 cwts./acre.

The experiment was carried through two harvests.

The results obtained indicate a high response for Nitrogen—this being especially evident in the case of the sand and loam (increments of yields being 1,050% and 487% respectively) and significant at the 0.1% level. A lesser response to Potassium for the loam was noted (increment of yields being 71.27%).

Ca. gave small increments of yields at the second harvest for the loam and gravel.

Experiment II

This was a 4^2 factorial experiment with two replicates of all treatments planted on the three soil types—Sand, Loam and Gravel, to *Paspalum commersonii*. The nutrients and the levels tested were as follows:—

N. as $(\text{NH}_4)_2\text{SO}_4$	—	Nil, $1\frac{1}{2}$, $2\frac{1}{2}$ and 5 cwts./acre.
K. as K_2SO_4	—	Nil, $1\frac{1}{2}$, 3 and $4\frac{1}{2}$ cwts./acre.

The experiment was carried through two harvests.

The results indicate a high response for added nitrogen—the Sand indicating a high deficiency; found to a lesser extent for the loam and still less for the gravel.

The same trend of responses was found in the case of Potassium too—However, the magnitude of deficiency was much less.

(b) Soil from B/E (Cinnamon Sand from the P₇ experimental area)

This experiment is the same as the one given in Annual Report for 1960. The experiment was planted to *Brachiaria brizantha* late last year and is still in progress.

The experiment has been carried through six harvests so far.

The trend of responses obtained was similar to that obtained in the case of *Brachiaria milliformis*—N, P and K being deficient—the deficiency due to N being acute. The increments of yields noted for N, P and K were 159.30%, 20.26% and 14.73% respectively.

2. Cinnamon Sand at Horrekelle Estate

(i) Soils 2½ years after manuring

The two experiments set up with this soil late last year have been completed.

Experiment I

This was a 2⁶ factorial experiment with two replicates of all treatments, planted to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

N.	as (NH ₄) ₂ SO ₄	—	Nil and 5 cwts./acre.
P.	as NaH ₂ PO ₄	—	Nil and ¾ cwt./acre.
K.	as K ₂ SO ₄	—	Nil and 3 cwts./acre.
Ca.	as CaCO ₃	—	Nil and 5 cwts./acre.
Mg.	as MgSO ₄	—	Nil and ¾ cwt./acre.

The experiment has been harvested twice. The results indicate very acute deficiencies of N and K. The same was true of these soils 2 years after manuring.

Experiment II

This was a 4² factorial experiment with two replicates planted to *Paspalum commersonii*. The nutrients and levels tested were:—

N.	as (NH ₄) ₂ SO ₄	—	Nil, 2½, 5 and 7½ cwts./acre.
K.	as K ₂ SO ₄	—	Nil, 3, 6 and 9 cwts./acre.
Ca.	as CaCO ₃	—	4 cwts./acre (basal).

The experiment was harvested thrice.

The data indicate a very high deficiency of N and to a lesser extent, K. The increments of yields for added N and K were 1467.39% and 169.37% respectively.

(ii) Soils 3 years after manuring

Soils were sampled 3 years after manuring in April this year and the following experiments set up:—

Experiment III

This was a 2^5 factorial experiment with 2 replicates of all treatments to measure the effect of the major nutrients, N, P, K, Ca and Mg on the growth of *Paspalum commersonii*.

The nutrients and levels applied were as follows:—

N. as $(\text{NH}_4)_2\text{SO}_4$	—	Nil and 5 cwts./acre.	
P. as NaH_2PO_4	—	Nil and 3 cwts./acre.	
K. as K_2SO_4	—	Nil and 3 cwts./acre.	
Ca. as CaCO_3	—	Nil and 10 cwts./acre.	
Mg. as MgSO_4	—	Nil and $1\frac{1}{2}$ cwts./acre.	
Fe. as FeSO_4	—	7 lbs./acre	} Basal dressing.
Cu. as CuSO_4	—	7 lbs./acre	
Zn. as ZnSO_4	—	7 lbs./acre	
Mn. as MnSO_4	—	7 lbs./acre	
Mo. as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$	—	1 lb./acre	

The experiment was harvested four times.

The results indicate an acute deficiency of N, significant at the 0.1% level. K was also acutely deficient—and was more so with later harvests.

Experiment IV

This was a 4^2 factorial experiment set up as for Experiment II.

The experiment was carried through four harvests.

Acute deficiencies of N, and to a lesser extent K were noted. Increments of yields for added N and K were 631.32% and 132.41% respectively.

(iii) Soils $3\frac{1}{2}$ years after manuring

Soils were sampled $3\frac{1}{2}$ years after manuring this October and the following experiments set up:—

Experiment V

This was a 2^5 factorial experiment set up as for Experiment III. However, the basal dressing was omitted.

The experiment was set up late this year and has been carried through the first harvest only.

Experiment VI

This was a 4^2 factorial experiment set up as for Experiment II.

This experiment was also set up late this year, and has proceeded through the first harvest.

3. Soils from Ratmalagara Estate

Follow-up experiments:—

(a) Soils 18 months after manuring

The two experiments set up with soils 18 months after manuring late last year have been completed this year.

Experiment I

This was a $3 \times 2 \times 2$ factorial experiment with three replicates of all treatments planted to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

N.	as $(\text{NH}_4)_2\text{SO}_4$	—	Nil, $2\frac{1}{2}$ and 5 cwts./acre.
P.	as NaH_2PO_4	—	Nil, and 2 cwts./acre.
K.	as K_2SO_4	—	Nil, and 2 cwts./acre.

The experiment was harvested twice. The results indicate that all tested nutrients (N, P and K) increased yields significantly.

Experiment II

This was a 4^3 factorial experiment with two replicates of all treatments, planted to *Paspalum commersonii*. The nutrients and levels applied were as follows:—

N.	as $(\text{NH}_4)_2\text{SO}_4$	—	— 5 cwts./acre (basal).
P.	as NaH_2PO_4	—	Nil, 1, 2 and 4 cwts./acre.
K.	as K_2SO_4	—	Nil, 1, 2 and 4 cwts./acre.

The experiment was harvested twice. The data indicate that P increased yields especially in the early stages of growth; while K increased yields at the later stages of growth. Increments of yields were 50.08% and 51.42% for P and K respectively.

(b) Soils 6 months after manuring

The two experiments set up with soils, sampled 6 months after manuring of the new follow-up plot, late last year, have been completed this year.

Experiment III

Same as Experiment (a) I.

This experiment was harvested thrice.

The data indicate a deficiency of N, P and K.—P increasing yields during the early stages of growth while the effect due to K. was evident only during the later stages of growth.

Experiment IV

Same as Experiment (a) II.

The experiment was harvested twice and 'thinnings' included for additional data.

Increments of yields noted for P and K were 17.66% and 12.82% respectively.

(c) Soils 2 years after manuring

Soils were sampled of the old follow-up plot, two years after manuring in April this year and two experiments set up with these soils.

Experiment V

Same as Experiment (a) I.

The experiment was harvested thrice.

The data indicated similar responses for all three tested nutrients as was found for Experiment (b) III.

Experiment VI

Same as Experiment (a) II.

This experiment was also harvested thrice. The results gave high increments of yields, for both P and K. The increment due to added P was high, especially during the early stages of growth,—being 327.88% at the first harvest, while the increment for added K was only 83.55% at the same harvest.

(d) Soils 1 year after manuring

Soils were sampled of the new follow-up plot one year after manuring, this April, and two experiments set up.

Experiment VII

Same as in Experiment (a) I.

The experiment was harvested four times. The data indicate a deficiency of all tested nutrients—N, P and K. The effect due to P. was only during the early stages of growth however.

Experiment VIII

Same as in Experiment (a) II.

This experiment was also harvested four times. Both P and K gave high increments of yields—the response to P. being during the early stages of growth; while that for K was during the later stages of growth. Increments of yields recorded for P and K were 18.42% and 91.71% respectively.

(e) Soils 18 months after manuring

Soils were sampled of the new follow-up plot 18 months after manuring in November this year. The following two experiments were set up with these soils.

Experiment IX

Same as Experiment (a) I.

This has been harvested once and is in progress.

Experiment X

Same as Experiment (a) II.

This has also been harvested once and is in progress.

4. Pothukulama forest soils

(a) Soils under forest cover

The two experiments commenced last year have been completed this year.

Experiment I

This was a 4^2 factorial experiment with two replicates of all treatments, to test the effect of different forms of K and Mg. on the growth of *Paspalum commersonii*. The forms and levels of nutrients applied were as follows:—

K. as Nil	}	301.1 lbs. K/acre.
K_2CO_3		
KCl		
K_2SO_4		
Mg. as Nil	}	84 lbs. Mg/acre.
$(COO)_2Mg$		
$MgCl_2$		
$MgSO_4$		
N. as NH_4NO_3	}	3 cwts./acre (basal dressing)
P. as NaH_2PO_4		

The experiment was harvested twice for the first planting, last year, and twice for the second planting this year.

Results obtained for the second planting indicated a similar trend of responses as for the first planting—both K and Mg. increasing yields—the response due to K being higher than that for Mg.

The sulphates of both tested nutrients registered the highest yields.

Experiment II

This was a 4^2 factorial experiment with two replicates of all treatments planted to *Paspalum commersonii*. The forms and dosage of nutrients applied were as follows:—

N. as $(NH_4)_2SO_4$	—	Nil, $2\frac{1}{2}$, 5 and $7\frac{1}{2}$ cwts./acre.
K. as K_2SO_4	—	Nil, 3, 6 and 9 cwts./acre.
P. as NaH_2PO_4	—	3 cwts./acre (basal dressing).

The experiment was harvested thrice. The response to added N and K were highest at 5 cwts./acre and 3 cwts./acre respectively.

(b) Soils after the forest was cleared and burnt

The experiment set up with these soils late last year was completed.

Experiment III

This was a simple experiment to study the effect of increasing doses of Sulphur—nil, S_1 , S_2 , S_3 and S_4 on the growth of:—

- (i) *Paspalum commersonii*.
- (ii) *Phaseolus lathyroides*, and
- (iii) *Medicago sativa*.

All treatments were replicated twice.

The experiment was harvested thrice each for *Paspalum commersonii* and *Medicago sativa*; and twice for *Phaseolus lathyroides*.

The data indicate a high response for added S. in all three plant species tested—the highest responses being recorded at S₁ for all three plant species.

(c) *Soils under old coconut plantations*

Soils were sampled from an area under coconut plantations at Pothukulama, and experiments set up to determine the nutrient status of these soils. The data of these experiments when completed will be compared with the data already collected from experiments set up with soils from forest areas.

Experiment IV

This was a 2⁶ factorial experiment, to test the effect of the major nutrients, N, P, K, Ca and Mg. on the growth of:—

- | | | |
|-----------------------------------|---|--------------|
| (i) <i>Paspalum commersonii</i> | — | 2 replicates |
| (ii) <i>Phaseolus lathyroides</i> | — | 1 replicate |
| (iii) <i>Sesamum indicum</i> | — | 1 replicate |

The forms and levels of nutrients applied were:—

N. as (NH ₄) ₂ SO ₄	—	Nil and 5 cwts./acre.	
P. as NaH ₂ PO ₄	—	Nil and 3 cwts./acre.	
K. as K ₂ SO ₄	-	Nil and 3 cwts./acre.	
Ca. as CaCO ₃	--	Nil and 10 cwts./acre.	
Mg. as MgSO ₄	--	Nil and 1½ cwts./acre.	
Fe. as FeSO ₄	—	7 lbs./acre	} Basal dressing.
Cu. as CuSO ₄	—	7 lbs./acre	
Zn. as ZnSO ₄	—	7 lbs./acre	
Mn. as MnSO ₄	—	7 lbs./acre	
Mo. as (NH ₄) ₆ Mo ₇ O ₂₄	—	1 lb./acre	

The experiment was harvested five times for *Paspalum commersonii*; twice for the first planting and once for the second planting for *Phaseolus lathyroides*, and once each for two plantings for *Sesamum indicum*. 'Thinnings' were included in all cases.

The data for *Paspalum commersonii* indicate a deficiency of N, P and K. A depression due to Ca was noted during the early stages of growth. Both Ca. and Mg. were responsible for increments of yields at the later stages of growth.

The pattern of responses obtained show a close parallel to those obtained with soils under forest cover and soils from which the forest had been cleared and burnt.

The data for *Phaseolus lathyroides*—indicate a negligible response to N showing that effective nodulation had taken place, this plant being a legume.

The data for *Sesamum indicum* indicate a similar pattern of responses as that obtained for *Paspalum commersonii*.

Experiment V

This was a 2^5 factorial experiment to test the effect of the micro-nutrients, Fe, Cu, Zn, Mn and Mo on the growth of :—

- (i) *Paspalum commersonii*.
- (ii) *Medicago sativa*.

The forms and levels of nutrients applied were:—

Fe. as FeSO_4	—	Nil and 7 lbs./acre.	
Cu. as CuSO_4	—	Nil and 7 lbs./acre.	
Zn. as ZnSO_4	—	Nil and 7 lbs./acre.	
Mn. as MnSO_4	—	Nil and 7 lbs./acre.	
Mo. as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$	—	Nil and 1 lb./acre.	
N. as $(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre	} Basal dressing.
P. as NaH_2PO_4	—	3 cwts./acre	
K. as K_2SO_4	—	3 cwts./acre	
Ca. as CaCO_3	—	5 cwts./acre	
Mg. as MgSO_4	—	1 cwt./acre	

The experiment was harvested five times, for *Paspalum commersonii*; and thrice for *Medicago sativa*.

None of the tested nutrients gave any appreciable response. A slight depression in yields was registered for added Cu., and interactions of Cu. with other nutrients tested, at the later stages of growth of *Paspalum commersonii*.

Experiment VI

This was 3×2^2 factorial experiment, with two replicates of all treatments to test the effect of Calcium, Boron and Molybdenum on the growth of *Medicago sativa*.

The forms and levels of nutrients applied were:—

Ca. as CaCO_3	—	Nil, 5 cwts. and 10 cwts./acre.	
B. as $\text{Na}_2\text{B}_4\text{O}_7$	—	Nil, and 6 lbs./acre.	
Mo. as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$	—	Nil and 1 lb./acre.	
N. as $(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre	} Basal dressing.
P. as NaH_2PO_4	—	3 cwts./acre	
K. as K_2SO_4	—	3 cwts./acre	
Mg. as MgSO_4	—	1 cwt./acre	

The experiment was harvested thrice.

The data indicate a slight increase in yields to added Ca. at the early stages of growth—while Ca. depressed yields significantly at the later stages of growth. B. and Mo. decreased yields slightly during the early stages—but increased yields at later harvests.

Experiment VII

This was a 4^2 factorial experiment to test the effect of different forms of Nitrogen and Calcium on the growth of (a) *Paspalum commersonii* and (b) *Phaseolus lathyroides*.

The forms and levels of nutrients applied were:—

N. as Nil.			
	NH_4NO_3	—	3 cwts./acre (188 lbs. N)
	$(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre (188 lbs. N)
	$\text{Co}(\text{NH}_2)_2$	—	2.27 cwts. acre (188 lbs. N)
Ca. as Nil.			
	$\text{Ca}(\text{OH})_2$	—	3.75 cwts./acre (220 lbs. Ca)
	CaCO_3	—	5.00 cwts./acre (220 lbs. Ca)
	CaSO_4	—	8.75 cwts./acre (220 lbs. Ca)
P. as NaH_2PO_4	—	3 cwts./acre	} Basal dressing.
K. as K_2SO_4	—	3 cwts./acre	
Mg. as MgSO_4	—	$1\frac{1}{2}$ cwts./acre	

The experiment was harvested thrice, for *Paspalum commersonii*; twice for the first planting and once so far for the second planting for *Phaseolus lathyroides*.

The data indicate an increase in yields due to added Nitrogen. There was no significant difference between forms of Nitrogen. Calcium had no significant effect on yields.

Experiment VIII

This was a 4^3 factorial experiment to measure the effect of increasing doses of P, K and Mg. on the growth of *Paspalum commersonii*.

The forms and levels of nutrients applied were:—

P. as NaH_2PO_4	—	Nil, 3, $4\frac{1}{2}$ and 6 cwts./acre.
K. as K_2SO_4	—	Nil, 3, $4\frac{1}{2}$ and 6 cwts./acre.
Mg. as MgSO_4	—	Nil, 1, 2 and 3 cwts./acre.
N. as NH_4NO_3	—	3 cwts./acre.
Ca. as CaCO_3	—	5 cwts./acre.

The experiment was harvested thrice.

The data indicate an early response to P. while the response to K. was evident at later harvests. Mg. increased yields slightly—the highest increment of yields being at 1 cwt./acre.

Increments of yields were 75.07% for P; 48.15% for K and 5.96% for Mg.

Experiment IX

This was a 4^2 factorial experiment, with two replicates of all treatments to measure the effect of increasing doses of N. and K. on the growth of *Paspalum commersonii*.

The forms and levels of nutrients applied were:—

N. as NH_4NO_3	—	Nil, $1\frac{1}{2}$, 3 and $4\frac{1}{2}$ cwts./acre.
P. as NaH_2PO_4	—	Nil, $1\frac{1}{2}$, 3 and $4\frac{1}{2}$ cwts./acre.

The experiment was set up late this year.

It has been harvested once and is in progress.

5. Keenekelle Soils

A yellow sandy loam from Block I of the Keenekelle Group, Marawila, was sampled and experiments set up to determine the nutrient status of these soils.

Experiment I

This was a 2^6 factorial experiment to measure the effect of the major nutrients N, P, K, Ca. and Mg. on the growth of :—

- (i) *Paspalum commersonii* — 2 replicates
- (ii) *Phaseolus lathyroides* — 1 replicate, and
- (iii) *Sesamum indicum* — 1 replicate.

The forms and levels of nutrients applied were:—

N. as NH_4NO_3	—	Nil and 3 cwts./acre.	
P. as NaH_2PO_4	—	Nil and 3 cwts./acre.	
K. as K_2SO_4	—	Nil and 3 cwts./acre.	
Ca. as CaCO_3	—	Nil and 10 cwts./acre.	
Mg. as MgSO_4	—	Nil and $1\frac{1}{2}$ cwts./acre.	
Fe. as FeSO_4	—	7 lbs./acre.	} Basal dressing.
Cu. as CuSO_4	—	7 lbs./acre.	
Zn. as ZnSO_4	—	7 lbs./acre.	
Mn. as MnSO_4	—	7 lbs./acre.	
Mo. as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$	—	1 lb./acre.	

The experiment was harvested four times for *Paspalum commersonii*; twice for the first planting and once so far for the second planting for *Phaseolus lathyroides* and once for the first planting for *Sesamum indicum*. 'Thinnings' were included in all cases for additional data.

The data indicate a deficiency of N, P and K, the response to added P. being evident more during the early stages of growth; while the response to added K. was evident more at the later stages of growth. Ca. depressed yields initially—but increased yields at the later stages of growth.

Experiment II

This was a 4^2 factorial experiment to measure the effect of different forms of nitrogen and calcium on the growth of *Paspalum commersonii*.

The forms and levels of nutrients applied were :—

N. as Nil.		
NH_4NO_3	—	3 cwts/acre (118 lbs. N)
$(\text{NH}_4)_2\text{SO}_4$	—	5 cwts/acre (118 lbs. N)
$\text{CO}(\text{NH}_2)_2$	—	2.27 cwts/acre (118 lbs. N)
Ca. as Nil.		
$\text{Ca}(\text{OH})_2$	—	3.75 cwts/acre (220 lbs. Ca)
CaCO_3	—	5.00 cwts/acre (200 lbs. Ca)
CaSO_4	—	8.75 cwts/acre (220 lbs. Ca)

The experiment was harvested five times.

The data indicate a high response to added N. There was no significant difference recorded between the forms of nitrogen tested, though NH_4NO_3 gave the highest increments of yields being 257.74% while those for $(\text{NH}_4)_2\text{SO}_4$ and urea were 214.28% and 177.11% respectively.

The response to Ca. was negligible. $\text{Ca}(\text{OH})_2$ depressed yields, whereas a slight increment of yields was recorded for CaCO_3 and CaSO_4 . Increments of yields were recorded for all three salts of Ca. tested at the 4th harvest.

Experiment III

This was a 2⁵ factorial experiment, to test the effect of the minor nutrients Fe, Cu, Zn, Mn and Mo. on the growth of:—

- | | | |
|-----------------------------------|---|------------------|
| (i) <i>Paspalum commersonii</i> | — | 2 replicates |
| (ii) <i>Phaseolus lathyroides</i> | — | 1 replicate, and |
| (iii) <i>Medicago sativa</i> | — | 1 replicate. |

The forms and levels of nutrients applied were:—

Fe. as FeSO_4	—	Nil and 14 lbs/acre.	
Cu. as CuSO_4	—	Nil and 14 lbs/acre.	
Zn. as ZnSO_4	—	Nil and 14 lbs/acre.	
Mn. as MnSO_4	—	Nil and 14 lbs/acre.	
Mo. as $(\text{NH}_4)_6\text{Mo}_7 \cdot \text{O}_{24}$	—	Nil and 2 lbs/acre.	
N. as NH_4NO_3	—	3 cwts/acre	} Basal dressing.
P. as NaH_2PO_4	—	3 cwts/acre.	
K. as K_2SO_4	—	3 cwts/acre.	
Mg. as MgSO_4	—	1 cwt/acre.	
Ca. as CaCO_3	—	10 cwts/acre	

This experiment was set up late this year, and is in progress.

B. Pasture Trials.

All operations, in respect of each of the pasture trials, were carried out according to schedule.

1. Comparison of four Grasses. (Bandirippuwa Estate)

[*Brachiaria milliformis*, *Brachiaria brizantha*, *Panicum maximum* and *Paspalum commersonii* (now control)].

The *Brachiaria brizantha* and *Brachiaria milliformis* plots were grazed as for last year — with two cows/plot.

The *Panicum maximum* plot was grazed as in previous years.

All plots were manured with 1 cwt/acre Sulphate of Ammonia with the South-West Monsoon rains; and 1 cwt/acre each of Muriate of Potash and Sulphate of Ammonia with the North-East Monsoon rains.

The highest yield was recorded for *Brachiaria milliformis*.

The guinea grass plot was grazed four times for the year.

2. Pasture × Type of Manuring (Bandirippuwa Estate)

All operations in relation to this experiment have been carried out to schedule.

The plots were manured with 1 cwt/acre Sulphate of Ammonia along with the South-West Monsoon rains; and 1 cwt/acre each of Sulphate of Ammonia and Muriate of Potash along with the North-East monsoon rains. No palm manuring was done this year.

The pastures were grazed by two and four adult cows/plot; for the 'new' *Brachiaria milliformis* and 'old' *Brachiaria milliformis* respectively, as was done for the previous year.

3. Cultivation × Pasture Experiment (Ratmalagara Estate)

This experiment was maintained as for last year.

The plots were manured with 1 cwt/acre Sulphate of Ammonia in May/June along with the South West Monsoon rains and 1 cwt/acre each of Sulphate of Ammonia, Muriate of Potash and Saphos Phosphate broadcast in October/November along with the North East Monsoon rains. The plots were disc-harrowed after manure application.

Two milking cows were allowed to graze alternately in the two plots (each plot consisting of half sub-soiled and half not sub-soiled) for a period of four weeks. This was the same as for last year.

Cattle weights and milk yields have been recorded.

Grazing was observed to be uneven in these plots, weed infestation especially *Mimosa pudica* occurring in the over-grazed patches. Due to the even distribution of rain, growth of pastures was abundant and is in excess of the needs of the cows grazing these pastures.

4. Intensity of grazing trial (Ratmalagara Estate)

This experiment was maintained as for last year.

Grazing by two milking cows/plots was continued as was done last year—and sampling done to schedule by the stratified randomized method.

All plots were manured with 1 cwt/acre Sulphate of Ammonia in May/June along with the South West Monsoon rains and 1 cwt/acre each of Sulphate of Ammonia, Muriate of Potash and Saphos Phosphate broadcast in October/November along with the North East Monsoon rains. All plots were disc-harrowed after manure application.

The infestation of some of the *Brachiaria brizantha* plots with *Brazachiaria milliformis* still continues. An interesting feature is that these particular plots receive rather heavy shade cast by the young palms found in these plots. Observations and data on the percentage of infestation are being recorded for study.

5. Rotational Grazing vs. Continuous Grazing (Ratmalagara Estate)

The grazing and sampling schedules followed last year have been followed this year too.

All plots were manured with one cwt/acre Sulphate of Ammonia in May/June along with the South West Monsoon rains; and one cwt/acre each of Sulphate of Ammonia, Muriate of Potash and Saphos Phosphate, in October/November along with the North-East Monsoon rains.

Grazing in the continuous grazing plots has been very uneven. Weed infestation—especially *Mimosa pudica*—is found in the over-grazed patches.

There is an abundance of feed available due to the favourable weather conditions this year—which is in surplus of the requirements of the cattle grazing these plots.

6. Pasture cum Manurial Trial (Bandirippuwa Estate)

All operations in relation to this experiment have been carried out to schedule.

The experiment was manured with split dose (half total dosage) of Sulphate of Ammonia; full dosage of Muriate of Potash and Saphos Phosphate, along with the South West Monsoon rains in May/June and the remaining split dose (half total dosage) of Sulphate of Ammonia along with the North East Monsoon rains in November this year.

All pasture plots were lightly harrowed prior to nutrient application; whereas the Estate (control) plots were harrowed lightly after nutrient application.

7. Frequency of cutting trial (Ratmalagara Estate)

Regular samplings of pastures were made as per schedule.

The plots were mown to an approximate height of 3 inches before manuring.

The two levels of Nitrogen (1 and 2 cwt/acre Sulphate of Ammonia) were applied every six months in two split doses with the monsoon rains (May/June and October/November 1961). After each manuring, the first samples were taken two weeks after mowing. The samples are being stored for chemical analysis.

8. Nitrogen Manuring × Type of Planting trial (Ratmalagara Estate)

This experiment has been carried out to schedule.

Sulphate of Ammonia was applied twice for the year along with the monsoon rains - 56 lbs/acre/season being added to N₁ plots and 112 lbs/acre/season being added to N₂ plots.

Sampling has been carried out to schedule — at fortnightly intervals. All dried samples are being preserved for chemical analysis.

C. ANIMAL HUSBANDRY

Herd Strength

The herd strength at the beginning and end of the year were as follows:—

	Bulls		Cows		Heifers		B. Calves		Total	
	B/E	R/E	B/E	R/E	B/E	R/E	B/E	R/E	B/E	R/E
January	2	3	29	31	42	15	48	19	117	68
December	3	1	28	30	51	22	47	18	129	71

Herd Figures

The herd figures for the full year were as follows:—

	Services		Births		Sold		Dead	
	B/E	R/E	B/E	R/E	B/E	R/E	B/E	R/E
Total for the Year	45	28	27	26	4	24	1	—

Yield Particulars

The average yield particulars for the year were as follows:—

	<i>Av./No. Cows in Milk</i>		<i>Av. Yield/Cow/Month</i> (in pints)		<i>Av. Yield/Cow/Day</i> (in pints)	
	<i>B/E</i>	<i>R/E</i>	<i>B/E</i>	<i>R/E</i>	<i>B/E</i>	<i>R/E</i>
Annual Averages	18.89	17.97	141.40	156.78	4.65	5.13

Milk Distribution

The milk at both stations was supplied to the staff. The surplus at Bandirippuwa Estate was sold to the National Milk Board — while that at Ratmalagara Estate was separated into Ghee and sold at Rs. 4/- per bottle.

Animal Health

The health of the herd has been very satisfactory. Very few cases of rumen impactions were recorded.

All animals were inoculated against Hoof and Mouth disease and Haemarhaigic Septicaemia. All animals were wormed.

Feed available for animals has been abundant this year due to the favourable weather conditions.

(Mrs.) N. Rajaratnam,
Acting Agrostologist.

ANNUAL REPORT OF THE BIOMETRICIAN

Overseas Training

The Biometrician resumed charge of the Division in April 1961, after a 9-months' course of training at the Indian Statistical Institute, Calcutta, through a C-Plan Fellowship, during which period Mr. J.K.T. Fernando, Research Assistant (Statistics), acted as officer-in-charge of the Division.

The course of training included, in addition to the substantive courses in Auxiliary Mathematics and Theory of Statistics, also special courses in applied fields such as — Economics, Econometrics, Sampling Surveys, Experimental Designs, Biometrics, Operations-Research, Cost of Living Indices and the operation of Tabulating Machines and the Electronic Computer. To meet our special needs, the Government of India very kindly sponsored for him a 2 months' study tour in India — the first such extensive tour arranged for a student of the International Statistical Education Centre, during the fourteen years of its operation.

During this tour, visits were arranged to (1) The Coconut Research Institute at Kyangulam and Kasaragod, (2) Food Technological Research Institute, Mysore, (3) Department of Agricultural Meteorology, Poona, (4) Indian Statistical Institute (branch) Bombay and (5) The Indian Council of Agricultural Research, New Delhi.

It is with the utmost sincerity, that we record herein our gratitude to the Government of India and its various establishments — The Indian Statistical Institute in particular — for the whole-hearted cooperation extended.

Statistical Work

Routine Work:

This division as usual assisted the Research Divisions in their routine computing work and also by way of advice in the design of experiments, the statistical analysis of experimental data and also the interpretation of results.

Special Studies

Special studies were undertaken during the year in respect of certain inevitable problems in the statistical analysis and interpretation of experimental data pertaining to young coconut palms.

The following are some of the noteworthy findings that emanated out of these studies:

(a) The Statistical distribution of the initial flowering period.

Contrary to popular assumptions, the statistical distribution of the initial flowering period departs strongly from normality and is positively skewed. From the highly significant "t" values shown for the moment co-efficients (β_1 & β_2), it appears that the positive skewness — namely the tendency for the latter 50% of the palms to take a much longer time for initial flowering than could be reasonably accounted for by the "Normal curve of errors" — is an universal feature in a coconut plantation grown under sub-optimum conditions.

It is suggested that this tendency is the result of competition for nutrients and soil moisture from the early flowerers which are now bearing and therefore more exacting. It may also be due to the depletion of nutrients during the first half of the initial flowering phase, thereby the palms that remain to flower later in the natural order of events, get their nourishment only from a depleted environment.

From the view point of statistical validity, it is recommended that prior to statistical analysis, this A-normality in the distribution of the initial flowering period be corrected through a logarithmic transformation, because it is found that this variable follows the log-normal distribution approximately.

(b) A peculiar feature in experimental plots during the initial flowering phase.

It is observed that an experimental plot that commences the flowering phase early will complete the flowering phase relatively late as compared to a plot that commences the phase late — provided the initial handicap is not too large, in which case too the relatively higher speeding up of flowering on the part of the delayed plot is clear although it may not really catch up with the former.

It is suggested that this feature too is due to the fact that in the case of the plot which commences the flowering phase early, there are relatively more bearing palms offering competition to the palms yet to flower as compared with the plot which commences the phase late.

This feature of experimental plots has to be borne in mind in the statistical analysis and interpretation of data in respect of the flowering period, because a certain treatment which turns out to be favourable in the early stages may show up as unfavourable during the latter stages purely by virtue of this inherent phenomenon.

(c) Statistical control of high variability in yield data pertaining to young coconut palms:

During the initial flowering phase and the period immediately after, swift changes take place in the composition of experimental plots, from the point of view of the number of bearing palms and also the average age of maturity of the bearing palms in the plots. Such changes may introduce considerable variation in the yield of the experimental plots, quite independent of the effect of current treatments or the "random error" — thereby vitiating the interpretation of results.

Multiple covariance methods have to be employed in order to (1) detect the presence of such vitiating factors (2) assess the extent of their influence and (3) make suitable adjustments for them with a view to ensuring correct interpretation.

A typical such analysis carried out on the yield data of the "fertilizer experiment on young palms" of the Soil Chemist, apart from confirming the utility of this method of analysis in ensuring a more correct interpretation of the data, also revealed the following very useful findings.

(i) Within the phase of "initial flowering", the influence of the number of bearing palms in a plot on the yield of a plot is curvilinear in character and follows the law of diminishing returns. For the particular data analysed, an equation of the following form was more suitable:—

$$\hat{y} = a - bx + c/\bar{x}$$

Where y is the expected plot yield; x is the number of bearing palms in the plot; and a , b & c are constants to be estimated.

Due to this feature, one should be guarded against the indiscriminate use of the index "mean yield per palm" to correct for differences in the stand of palms in experimental plots. Even correction by means of a single covariance although it does not introduce erroneous trends (*per se*) as does the "mean yield per palm", yet it will not be sufficient to meet the situation.

(ii) The influence of the average age of maturity of the bearing palms in a plot on the yield of a plot is also curvilinear in character and showed diminishing returns.

(d) "Optimum Fertilizer Dosages".

A more precise quantitative estimation of the optimum fertilizer dosages for coconuts was made for the Soil Chemist from data of the N.P.K. experiment at Bandirippuwa Estate, on the basis of a fertilizer mixture determined from the trends of the experimental results.

The production function was derived from a polynomial model of the type,

$$\hat{y} = a - bx + c/\bar{x}$$

where \hat{y} is the total income from yield and x is the level of fertilizer.

The cost function was a linear model,

$$\hat{y}_1 = a_1 + b_1x$$

where \hat{y}_1 is the total cost of fertilizer; a_1 is the cost of application and b_1 is the cost per unit of fertilizer.

The optimum fertilizer dosage — namely the dosage which gives the maximum absolute profit — is given by the value of x when the differential coefficient of the profit function ($\hat{y} - \hat{y}_1$) is equated to zero. This is given by;

$$x_{\text{optimum}} = \frac{1}{2} [c/(b + b_1)]^2$$

The "unusual" square root model we used to derive the production function appears to be in our experience, a model that is suitable for most situations showing diminishing returns. As far as this particular problem was concerned, we were confident of the ad hoc validity of the

model and in fact latterly we observed that this model is not unusual because it has been very successfully used in some of the latest work on "economics of fertilizer use" in Iowa State. But the adaptability shown by this model in some of the applied problems, makes us feel that this model can claim much more than mere ad hoc suitability. A further investigation was therefore initiated by us in order to make a comparative study, on the basis of certain accepted econometric criteria, of some popular mathematical models used for fitting curves on univariate fertilizer response data. This investigation is now proceeding and the results so far have been very revealing.

Agri-Meteorology

(a) Meteorological Stations

The Meteorological stations at Bandirippuwa Estate, Ratmalagara Estate, and the Isolated Seed Garden, have been maintained satisfactorily and the recordings have been made uninterruptedly.

(b) Agri-Meteorological Studies

Due to pressure of work in our substantive field of activity — namely Biometrics — hardly any time could be devoted to agri-meteorological studies.

However the analysis of the incidence of dry spells in the main coconut growing areas of Ceylon which was commenced during the previous year, was completed. Details are not given due to lack of space. A summary of the findings will be embodied in an article that will be submitted for publication in the Ceylon Coconut Quarterly in due course.

Rainfall 1961 and Crop Prospects 1962

Rainfall

The rainfall in five stations representative of the important coconut growing areas is given below.

Crop Prospects

In most coconut growing areas, except Kurunegala, the total rainfall during 1961 was appreciably lower than in 1960 which happened to record the best rainfall for coconuts in recent times. In Chilaw and Madampe areas, the total rainfall was even lower than average.

The effective rainfall too was lower than 1960 except in Lunuwila and Kurunegala areas, though generally it was above average.

However the distribution of rainfall in all these areas is very favourable—being considerably better than 1960 or the average for the last ten years.

Therefore in all these areas, coconut crops should continue to maintain the upward trend shown during the last few years. Even Chilaw area whose rainfall has been even below average, one could expect anything above average crops. If however the rainfall during the first quarter of 1962 fails us, then, the last crop of 1962 may disappoint to some extent; but will not offset the optimistic picture of the whole year's crop.

Rainfall.

The rainfall in five stations representative of the important coconut growing areas is given below.

Area	Total Rainfall			Effective Rainfall			*Distribution Indices		
	1961	1960	Av. 53-60	1961	1960	Av. 53-60	1961	1960	Av. 53-60
Lunuwila (b/e)	84.5	88.5	78.9	83.8	83.1	74.5	(i) 2.326 (ii) 2.90	1.83 2.77	1.76 2.81
Madampe (r/e)	64.2	73.1	66.0	64.2	72.2	63.9	(i) 2.64 (ii) 3.48	1.64 2.66	1.64 2.35
Chilaw	58.8	75.7	63.3	58.8	74.3	59.7	(i) 1.96 (ii) 3.08	1.90 2.63	1.44 2.04
Puttalam	46.3	55.0	45.8	46.3	47.4	43.1	(i) 1.85 (ii) 2.47	1.40 1.93	1.24 1.56
Kurunegala	84.2	72.2	86.5	84.2	70.4	79.3	(i) 2.74 (ii) 3.74	1.90 2.90	1.82 2.68

*The distribution Indices are the values of $\frac{\text{MEAN}}{\text{STD. DEV.}}$ over the 2- and 3-year moving averages of monthly rainfall totals corrected for maximum effectiveness (i.e. 14 inches).

Production and Exports

(a) Production

The estimated production of coconuts in Ceylon for the year 1961, is 2,796,000,000 nuts — the highest since 1932. This production is 18.4% higher than 1960, 17.0% higher than last five years' average and 1.8% higher than the earlier peak production recorded in 1955.

(b) Exports

(i) Quantity

Total quantity of major coconut products exported (in terms of nut equivalent) in 1961, is 1,373,000,000 nuts — this being 40.9% higher than 1960, 27.3% higher than the last five years' average, and 10.9% lower than the previous record exports registered in 1955.

(ii) Value

The average value of exports in 1961 is Rs. 148.32 per 1,000 nuts— this being 21.2% lower than 1960, 17.8% lower than the last five years' average, and 42.6% lower than the previous record in 1951.

Publications

(a) A joint paper with Dr. D.A. Nethasinghe Soil Chemist, Coconut Research Institute, on "Optimum fertilizer dosages for coconuts" was read at the 1961 sessions of the Ceylon Association for the Advancement of Science.

(b) A paper entitled "Statistical Control of high variability in experimental yield data pertaining to young coconut palms" is being prepared for publication.

(c) A paper entitled "Some noteworthy features of the initial flowering pattern of a coconut plantation" has been submitted to the Editor, Ceylon Coconut Quarterly, for publication.

Honorary Work

The Biometrician was consulted by the Soil Chemist's Division of the Rubber Research Institute of Ceylon in the design of experiments and analysis of data.

V. ABEYWARDENA,
Biometrician,
Coconut Research Institute.

ANNUAL REPORT OF THE CROP PROTECTION DIVISION.

INTRODUCTION

During the year under review, a notable pest infestation was the appearance of the Coconut Scale pest (*Aspidiotus destructor*), in unusual out-breaks. This pest has been known, to occur in coconut plantations for several years back, but it has not appeared so extensively as it occurred during this year.

In its control, the spraying of kerosene oil emulsion was found to be effective. The difficulty encountered in the application of this insecticide was the spraying of tall palms. However, with a number of power sprayers and the few field Officers available, a campaign to control the out-breaks, was put into operation. At the end of the year, some estates were yet awaiting spraying of affected palms. Those that were treated recovered very satisfactorily; only a single spraying was necessary.

With such a control programme in hand and with limited staff, it was not possible to devote time on a detail study on the bionomics of the pest and estimate the loss due to damage. However, it has been observed that as the youngest fronds are not infested, the palms could recover satisfactorily that they did not show declining symptoms.

The out-breaks of the Coconut Scale pest was phenomenal during the year under review, as compared with several years back; yet the damage done by this pest, falls less important to the Red Weevil pest (*Rhyncophorus ferrugineus*) which remains to be the most destructive pest of the coconut palms in this country. Its occurrence has slightly increased with the new plantations under the rehabilitation scheme, and also due to the negligence in treating or destroying affected palms.

During the studies of this pest; in the field, some interesting features in its control have been noted. Firstly, some estates are almost free of this pest damage. Those that are affected, form a group indicating a colony of affected area. The vigilance and preventive measures are in real demand in plantations within these affected colonies. In those plantations which are not in close proximity to such colonies, the expense in vigilance and preventive treatment can be lessened.

Secondly, it takes considerable time for populations to get built up, to that extent of an out-break. The out-breaks recorded up to now, do not indicate an ever increasing population rise, as natural control or the growth of palms beyond the age of susceptibility keeps the pest in check, to a very great extent.

Thirdly, the appearance of the pest is so sporadic and the damage so scattered that mass scale treatment is necessary for preventive measures. Very often, the damage is not extensive

enough to warrant repeated treatment of unaffected palms for the mere sake of prevention, with such a low probability of the incidence of damage.

The treating of infested palms with a systemic insecticide like systox or metasystox was effective in destroying grubs inside palms. These insecticides are not readily available, particularly, to small-holders. Again, where the incidence is low, the cultural treatment of scooping out and removing grubs, remains to be the cheaper method of control.

Before any methods of chemical control could be considered, the practice of phytosanitation has to be seen to. From field studies, it has been observed that negligence in destroying infested palms which are beyond recovery, remains the main source of increase and spread of this pest. In any infested area, where even a large colony has got itself established, it has been observed that by the practice of phytosanitation alone, without chemical treatment, the pest could be brought down considerably. This method of control was recommended strongly to small-holders, who found it difficult to resort to costly treatments with chemicals.

The control of the coconut caterpillar pest (*Nephantis serinopa*) by biological methods has been mentioned in the past reports. Its work was further advanced by the opening of a Parasite Breeding Station in Batticaloa. At this station and also at the Insectary at Lunuwila, the mass breeding of parasites was done. These parasites were liberated in the pest affected estates, in all the districts; a larger number of them was required in the Eastern Province where the pest is almost endemic.

The Colombo Plan Entomologist, working at the Batticaloa Station, conducted research in the breeding techniques of parasites captured in this country and also those imported from foreign countries. He has been successful in finding methods of mass breeding the parasite *Stomatomyia bezziana*. After a study from the recovery of the parasites that were liberated in the field, it is possible now to select those that suit well to particular districts.

The Indian Station of the Commonwealth Institute of Biological control supplied parasites and conducted studies in Bangalore. When populations of the imported parasites were sufficiently built up, here, it become unnecessary to import further consignments.

The presence of some pre-maturely declining palms in the Southern Province has been mentioned earlier. The cause of this pre-mature decline, following a leaf scorch, is yet unknown.

The stages in which the decline takes place has been broadly separated into three; the first symptoms to appear is a leaf scorch on the tips of mature fronds. In the next stage, the leaflet scorching is more advanced and present in fronds towards the middle of the crown. In the last stages the crown diminishes in size, so also the nuts and the yield drops rapidly. The trunk tapers. Eventually, the small crown may drop off. It is reported that palms die within 2-6 years after the first symptoms are observed.

The condition of these palms in the advanced stage, can be easily mistaken to those which have declined and tapered due to causes like senility, hard soil waterlogged conditions; general debility of a dud palm and so forth.

Whether nematodes could be the cause of the decline of these palms was looked into. In this investigation, directions were obtained from the Nematologist of the Tea Research Institute, Talawakelle, through the kind permission of the Director, T.R.I. The preliminary observations did not reveal a possible association. However, a more extensive examination had to be put off for the next year.

Whether this condition is an uncommon disease, is a matter that has to be ascertained through unceasing investigation. The coconut cultivation in this country is already beset with pestilence, though not so heavy as in other countries, but until what has now appeared is diagnosed. It is feared what grip it would take in its toll, as its cause and limitations are unknown. It could perhaps be also only a localised condition.

As the next step in the investigation of these declining palms, a survey was planned out by the end of this year for the purpose of obtaining precise information on loss of palms, rate of decline, and other data so vitally necessary for an investigation of this nature. The survey should indicate the magnitude of the problem and what investigational measures should be adopted.

1. THE BIONOMICS AND CONTROL OF THE RED WEEVIL PEST (Rhyncophorus ferrugineus)

(i) Ecology

Field studies have revealed that breeding takes place in infested palms which if not treated or destroyed become sources of further infestations that spread out. There are colonies of infestations in definite localities. A report of its presence in one plantation, usually, proves its presence in the neighbourhood. Yet, the pest is not evenly distributed like the Rhinoceros beetle.

In some areas, until the first infested palm fall, there is no visible indication of an infestation. When the first affected palm is noticed, the population density would have risen to an extent as to infest about ten more palms in that locality; if no control measures are adopted there will be a gradual rise in the populations.

It has been observed that due to the sporadic nature of the infestations, mass scale treatment is worth the costs, only if a large number of palms are affected, or will be affected. From a study of the infestations it has been found that the extent of damage is not great in all places. Therefore, a control campaign has to be adjusted, relative to the probable damage which can be estimated in different localities, from records of Red Weevil infestations in those localities.

When the pest does not appear at all, even the cost of regular inspection is unwarranted; actually, in some plantations, inspection is not done, even to look for the first attack. When the infestation is low, regular inspection and treatment may still be uneconomical. The chart below indicates, stages at which regular inspection and treatment, which is costly, can be considered.

A chart illustrating the value of inspection and treatment in the control of the Red Weevil pest.

Years		1	2	3	4	5	6	7	8	9	10
Mortality (No. of palms per annum)	1										
	2										
	3										
	4										
	5										

Explanation—

At a mortality rate of 1 palm, 1 yr. old per acre per annum.
Regular inspection is optional



At a mortality rate of 1 palm, 6 yr. old, per acre per annum.
Regular inspection is warranted



At a mortality rate of 3 palms, 7 yr. old, per acre per annum.
Regular inspection and preventive treatment is warranted



FIG. I

(ii) Chemical Control

The injection of a systemic insecticide by means of a tin funnel yet remains the most satisfactory method of application of insecticides. In trials with Metasystox, it was observed that the rate of intake of the dilution is slower in harder wood of grown up palms (experimented with 8 year old palms). In these palms, the intake was faster when the funnel stem was pushed right into the centre of the trunk.

In an experiment to place the insecticide (Metasystox) in several holes in the trunk, at a low dilution, the results showed phytotoxic effects on the stem.

(8) THE BIONOMICS AND CONTROL OF THE COCONUT CATERPILLAR PEST (Nephantis serinopa).

A parasite breeding station was opened at Batticaloa in the Eastern Province. Mass breeding of parasites was done at this station and also at the Insectary, at Head Quarters.

A report on this project has been presented by the Colombo Plan Entomologist. (Vide page 74). Two Senior Technical Assistants were trained in parasite breeding, by the Entomologist, at his station.

(3) The Coconut Scale (Aspidiotus destructor) and its Control

Past records of this pest, indicate its appearance in out-breaks of five to ten per year. Since last year, the number of out-breaks has increased. Its distribution during the year under review is illustrated in the diagram below.

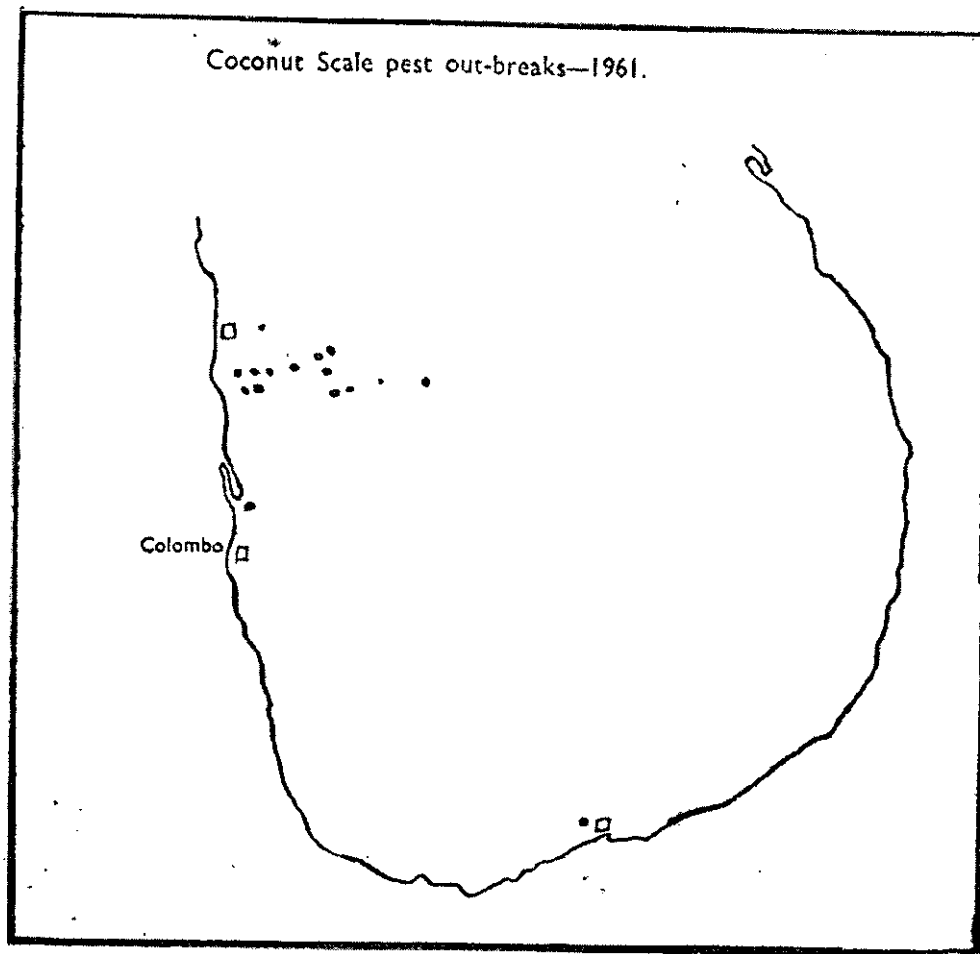


FIG. II

The trend of infestations that appeared during the past seven years are represented graphically in Figure 3.

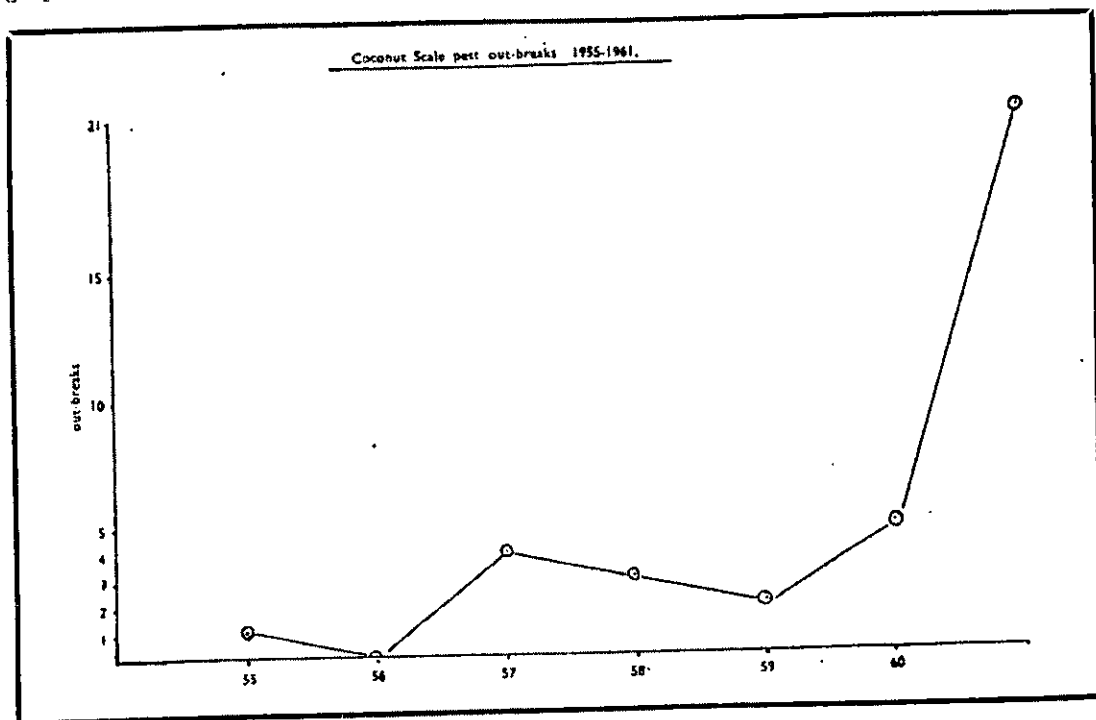


FIG. III

(i) *Ecology*

In a heavily infested palm, over 10 to 15 fronds may turn yellow. A loss of yield is expected, but no decline to a fatal extent occurs. Single infestations over 10 to 12 acres have not been observed.

Climate has a profound influence on the well-being or decline of this pest. Once established, it can remain tolerant to short periods of rainy weather, without effective control by the rains.

The population densities recorded on coconut leaflets were indicative of three generations infesting a single leaflet.

It would take nearly four good dry seasons for an increasing population to reach out-break proportions. Under natural conditions, with the increase in the pest population a concomitant increase of its natural enemies has been observed. Even with no control measures adopted, the cumulative effects of natural enemies and changes in weather, has brought several infestations under control in about an year's time.

(ii) *Chemical control*

The spraying of kerosene oil emulsion is a very quick method of control. This treatment has shown to be very effective in arresting the spread of an out-break. The diagram below illustrates the effects of spraying kerosene oil emulsion. Over 60% kill was obtained in a single spraying within five days time. The results so obtained are in spite of heavy rain soon after the spraying was done.

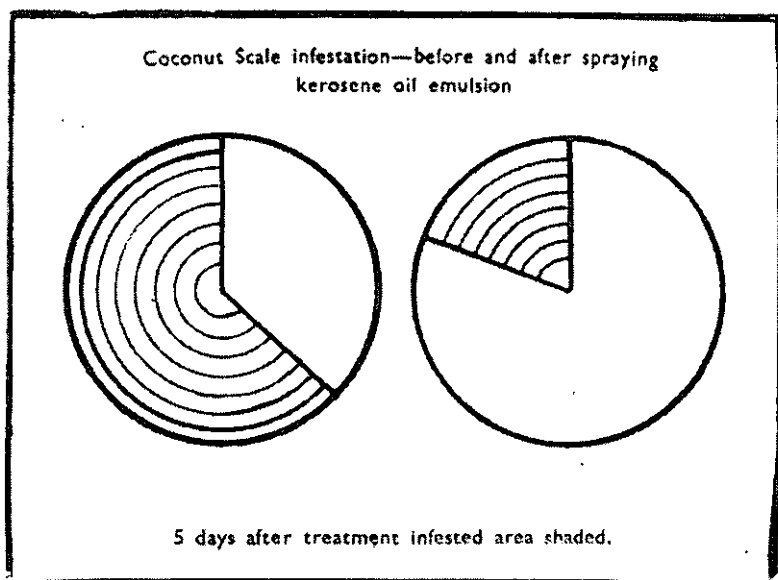


FIG. IV

In the recommendations for the control of this pest, the need for vigilance for the appearance of this pest and the cheap and effective treatment by cutting and burning in the early stages, was pointed out, repeatedly.

(4) Leaf Blights and their Control

A leaf blight disease broke out on young palms in some land development colony allotments, in the Puttalam district. The parasitic fungus *Helminthosporium incurvatum* was associated with the disease as its cause.

An experiment to find the efficacy of fertilizers in the control of this disease was carried out.

Classification of palms — affected palms were categorised into three stages viz. Incipient, Intermediate, Advanced.

- Treatments
- (1) N, P, K (1 lb. each)
 - (2) N₀ P₁ K₀
 - (3) N₁ P₀ K₁
 - (4) N₀ P₁ K₁
 - (5) Control

Degree of infection — was taken from lesion counts of leaf samples.

Experimental results — Three months after treatment, the disease showed a 40% decline in the treatment comprised of 1 lb. of Muriate of Potash and 1 lb. of Saphos Phosphate. The results are illustrated further in the Figures 5 and 6 below.

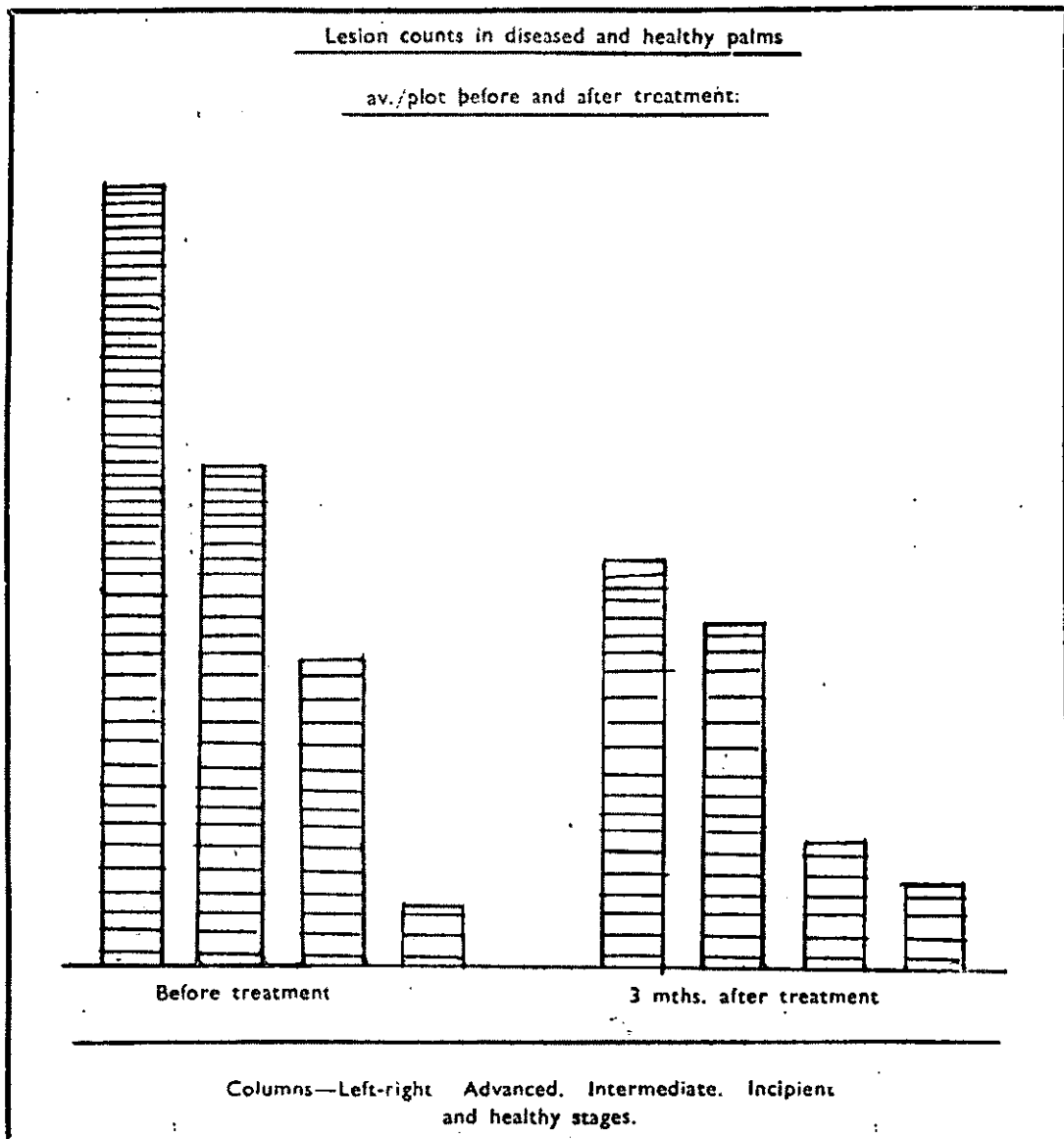


FIG. V

Control of leaf blight (*Helminthosporium incurvatum*)
by fertilizer treatments

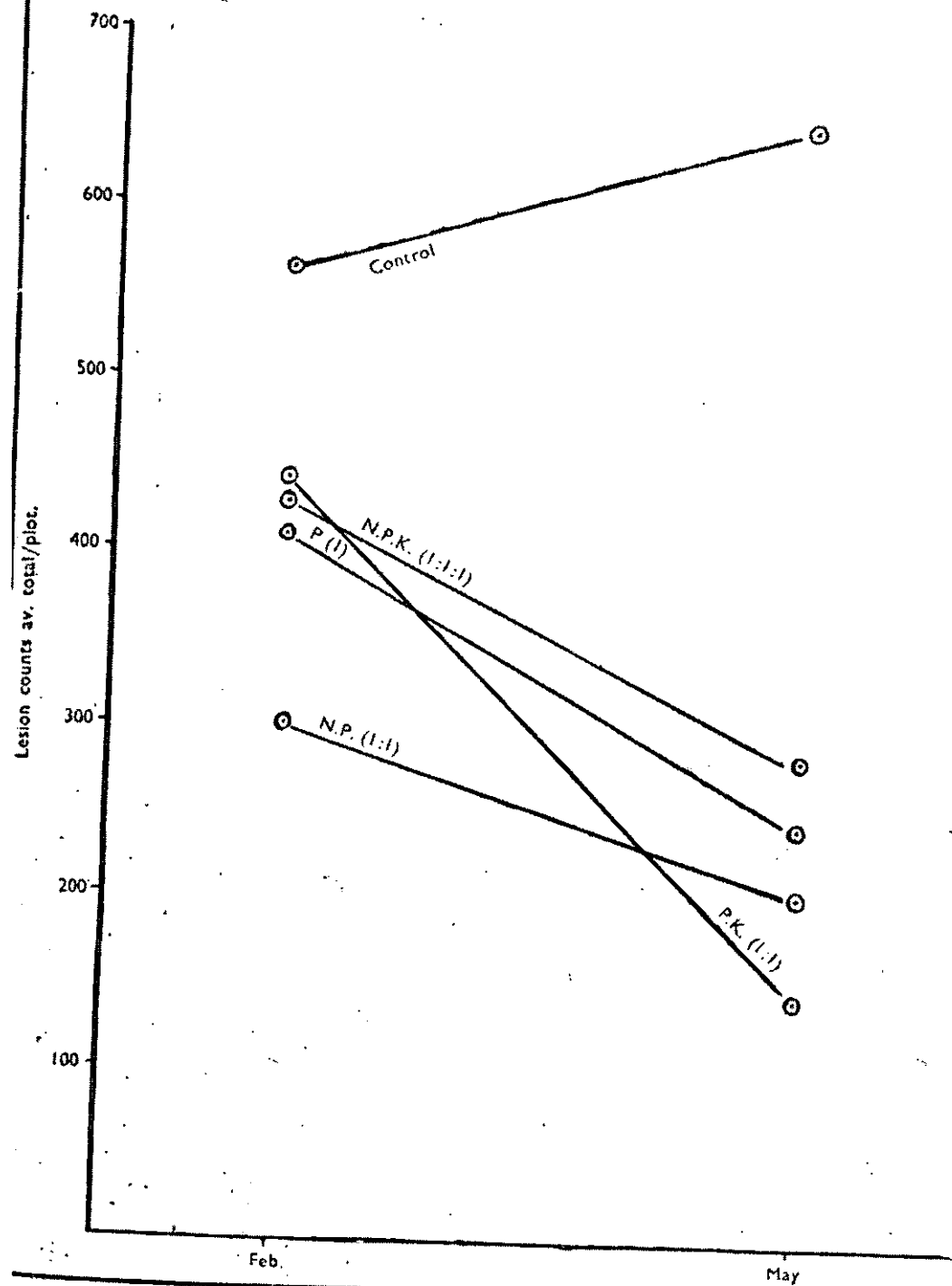


FIG. VI

(5) Bud Rot and Its Control

In the course of an experimental treatment against bud rot disease on young palms, it has been observed that prophylactic treatment becomes excessively costly. For protection, it is necessary that all palms in the affected area, should be treated, periodically. Due to the sporadic nature of the disease and its scattered appearance, it is not possible to isolate areas into blocks for preventive treatment. Costly treatment is warranted only when the incidence of the disease is so great as to cover a large area of the plantation. The bud rot disease does not assume such large proportions.

The total loss of palms in some estates may still be considered heavy. But a control experiment conducted in one of these estates, did not show up effects of the treatment, beneficial or other-wise, because the incidence of the disease was not extensive enough. In this estate, the total loss for a number of years together may be considered heavy, but if treatments are done for that period it will be uneconomical.

The cheaper method of control, that is by cutting off the affected bud leaf and applying tar on the cut surface, is possible when detection is done early.

Among the fungicides, Bordeaux mixture or paste, remains to be satisfactory for treating isolated palms where individual attention could be given.

The Plant Pathologist of the Department of Agriculture in his laboratories at Peradeniya has been able, successfully to isolate from diseased coconut buds the fungus *Phytophthora palmivora*. After inoculating coconut seedlings, the typical symptoms have also been observed.

Further work, with the co-operation of the Plant Pathologist, Department of Agriculture was considered.

(6) The Pre-Maturely Declining Palms in the Southern Province

The presence of some declining palms in the Gonapinuwela village, near Hikkaduwa in the Southern Province, has been mentioned in the past reports.

The typical symptoms are, in the early stage, a scorching of leaflet tips of the older fronds. In the intermediate stage palms, the scorching effects are found on fronds towards the centre of the crown. In the more advanced stages, the crowns diminish in size and so do the nuts. The yields fall low. Later the diminished crowns may fall off.

The rate of decline has been assessed by planters in that locality, who report the period to be 2-6 years from the time the first symptoms are observed to complete death of palm. The loss of palms per annum is variable and the reports so far obtained are unreliable.

It became evident that a proper survey should be conducted to gather information such as—

- (i) Incidence
- (ii) Distribution
- (iii) Rate of decline
- (iv) Loss of palm (per annum)
- (v) Other data on history, agronomic practises, etc.

Such a survey was planned out towards the end of the year; the work will be taken in hand early next year. Also, included in this survey, is the study of the rate of decline and pathological observations on some selected palms.

Early in the year, a study was conducted to look into nematode infestations. This work was done with directions obtained from Dr. M.T. Hutchinson, Nematologist of the Tea Research Institute, Talawakelle.

Some of the results obtained in this study are tabulated in table below.

Nematodes extracted from soil near palms, prematurely declining and healthy—

Stages	Groups of Samples	<i>Nematodes per 100 gms. soil x5 estates.</i>							
		Meadow	Root Knot	Pin	Spiral	Dagger	Sheath	Ring	Stylet
Incipient	1	0	0	559	60	1	1	0	0
	2	0	48	417	10	3	13	1	0
	3	0	10	88	114	0	18	0	4
Intermediate	1	2	8	245	88	3	3	8	1
	2	0	439	291	6	0	113	2	0
	3	—	—	—	—	—	—	—	—
Advanced	1	0	0	93	22	11	3	3	0
	2	0	0	15	25	0	0	0	0
	3	0	0	0	0	2	0	1	0
Healthy	1	0	0	209	118	3	17	1	0
	2	56	5	419	30	9	17	1	0
	3	0	66	207	2	0	0	0	0

The figures do not indicate any correlation. Further examinations were considered.

(7) Other pest infestations and incidences of diseases

(i) *Termites*. (*Odontotermes* Sp).

Reports of termite damage on transplanted seedlings were received from the Southern Province. The new planting scheme in the Citronella lands used the insecticide "Aldrin" successfully in the control of this pest.

(ii) *The Black Beetle* (Oryctes rhinoceros)

There were no reports of serious damage by this pest.

(iii) *The Nettle Grub* (Parasa lepida)

Small infestations of this pest appeared in some districts. After the prompt attention taken by the superintendents of these estates, by destroying infested leaves, and also by spraying insecticides, the imminent out-breaks were prevented.

(iv) *Leaf Blights* (Pestalotiopsis palmarum and Helminthosporium incurvatum)

Reports of young palms affected by leaf blight disease were received mostly from Land Development Colonies. It was observed that these palms were not manured and watered during the droughts. The land was also intercropped heavily. The loss of palms was however, below 10% in the affected plantations.

As a control measure, the fertilizing of these palms was recommended.

(8) **Leaflets and Articles**

Advisory leaflets were prepared on:

- (i) The Red Weevil and its control
- (ii) Termites and their control

The following articles for the Ceylon Planters' Review were prepared.

- (i) The Coconut Caterpillar control project
- (ii) Termites and their control
- (iii) Teach and practise safety in the use of insecticides

The Ceylon Coconut Quarterly, Volume XI Nos. 1-2 published the article "The Rhinoceros Beetles in Ceylon" Parts IIB and IIC by Hillary F. Goonewardene.

(9) **Training**

The training courses followed by officers are as follows:—

- (i) The techniques of Nematode extraction, under Dr. M.T. Hutchinson, T.R.I., Talawakelle } F. Kirthisinghe, O.I.C., Crop Protection Division.
- (ii) Parasite Breeding under the Colombo Plan Entomologist } S.M.P. Subasinghe, Snr.Tech.¹
Asst. Mr. P.A.C.R. Perera, Snr. Tech. Asst.

The training courses granted to visitors were as follows—

- (iii) Methods of Crop Protection in Coconut Cultivation } To some students in Coconut Plantation Management.

(iv). A few overseas visitors, who spent short periods in the Division, were given instructions on the methods of crop protection in Coconut cultivation as practised in this country.

(10) Conferences

A paper on the Present Situation of Pests and Diseases and their control in Ceylon (1961), was read at the F.A.O., Conference at Trivandrum, India.

The Division staff participated on the Field Day for the Low Country Products Association.

The Division Staff participated in the Annual Conference of Field Officers at Headquarters.

A talk on Coconut Scale and its control was given to the Negombo-Chilaw Planters' Association.

(11) Staff

It is with much regret that we record the retirement of Dr. Hillary F. Goonewardene former Crop Protection Officer, who went to America for post-graduate studies. During his term of office, he has contributed valuable literature on the Rhinoceros beetle, the Red Weevil and other pests and diseases of the Coconut palm. He initiated work on parasite breeding at the Institute. He expanded the activities of the Division in various ways.

- (i) *Promotions.* Mr. J.G. Pinto, was promoted to the post of Field Assistant, attached to the Parasite Breeding Station, Batticaloa.
- (ii) *Granted permanent employment.* The following officers were made permanent in their posts:

Mr. K.M.J. Fernando, Insectary Attendant,
Mr. D.M. Jayakody, Insectary Attendant.

- (iii) *Recruitments.*

Mr. W.S.J. Fernando was recruited, Insectary Attendant Temporary.

(12) Crop protection service

The Crop Protection service unit was in great demand throughout the year for spraying work against the Coconut Scale pest. With the use of a single power sprayer it was possible to spray tall palms from the ground, at a speed of about 5-6 acres per day. When the men in the estate get trained for the work after some days of spraying, a few more acres could be covered per day. The spraying operations carried out by this unit were very satisfactory.

J.K.F. Kirthisinghe,
Officer-in-Charge Crop Protection Division.

ANNUAL REPORT OF THE COLOMBO PLAN ENTOMOLOGIST FOR 1961

INTRODUCTION

I arrived in Ceylon from India on 20-11-1960. My services have been placed by the Government of India at the disposal of the Government of Ceylon under the Technical Cooperation Scheme of the Colombo Plan for assignment as Entomologist to the Coconut Research Institute of Ceylon.

I reported for duty as Entomologist at Coconut Research Institute on 21-11-1960. F.N. and assumed charge of work connected with the biological control of the coconut leaf caterpillar, *Nephantis serinopa* Meyrick, which in recent years has been causing more damage than in the past in Ceylon.

(2) Staff (At Batticaloa and Lunuwila)

Mr. Edwin Dharmaraju	—	Colombo Plan Entomologist
Mr. P.A.C.R. Perera	—	Senior Technical Assistant
Mr. S.M.P. Subasinghe	—	—do—
Mr. J. Graeme Pinto	—	Field Assistant
Mr. Mervyn J. Fernando	—	Lab. Attendant
Mr. Marceline Jayakody	—	—do—
Mr. S. J. Fernando	—	—do—

The Colombo Plan Entomologist was stationed at Batticaloa and visited the Parasite Breeding Unit, Lunuwila once every month to inspect the progress of breeding work.

(3) Establishment of Parasite Breeding Station at Batticaloa

A Parasite Breeding Station for the mass breeding of different parasites of *Nephantis serinopa* M. was opened at Batticaloa in the Eastern province on 10-2-1961. This is in addition to the Parasite Breeding Unit already in existence at Lunuwila.

Sanction has also been accorded for the construction of a permanent building for the new station at Mylambavelly nursery; which is about 6 miles from Batticaloa; on the Batticaloa—Polonnaruwa road.

(4) Pest position

During the year under review the caterpillar pest *Nephantis serinopa* M. was noted in Eastern, Western, Central, Southern and North West provinces. It was severe in certain parts

of Eastern, North Western and Southern provinces. Among the estates affected were Puttuku-dirippu and Pottuvil estates in Eastern province, Iranavilla, Mahayaya and Gurugoda estates in North Western province and Sitrakala estate in Southern province.

(5) Preliminary study of indigenous parasites

Studies were conducted on the parasite complex available in different tracts during the course of the year. While the parasites *Apanteles taragamae* Vier., *Stomatomyia bezziana* Bar., *Brachymeria nephantidis* G., and *Diocles* sp. are available freely in nature in the Eastern province, the larval parasite *Perisierola nephantidis* is found only in small numbers. The other larval parasites (viz) *Microbracon brevicornis* W., and *Elasmus nephantidis* R., are conspicuous by their total absence. It is therefore felt that while the indigenous parasites should be allowed to play their role, attempts should be made to colonise *Microbracon brevicornis* and *Elasmus nephantidis* by laboratory multiplication and large scale field releases.

Trichospilus pupivora F., an effective pupal parasite in India, is both a primary as well as a hyper-parasite in Ceylon. It is found to hyper-parasitise puparia of the tachnid *Stomatomyia bezziana* Bar. with the result that its importance as a primary parasite is very much reduced.

Although large quantities of the other pupal parasite *Tetrastichus israeli* M&K., have been released in the Southern province, field recoveries are not very encouraging. This is being studied further. In South India (Kerala) it has been recorded that there was nearly 80% recovery in the field.

(6) Breeding of parasites

The following parasites were under rearing :—

- | | | |
|--|---|-----------------|
| (a) <i>Microbracon brevicornis</i> W. | — | Larval parasite |
| (b) <i>Perisierola nephantidis</i> M. | — | —do— |
| (c) <i>Tetrastichus israeli</i> M & K. | — | Pupal parasite |
| (d) <i>Trichospilus pupivora</i> F. | — | —do— |

Of these, parasites (a), (b) & (c) have been bred from the nucleus material imported from India during 1960 through the Commonwealth Institute of Biological Control, Bangalore. Nucleus material for parasite (d) was obtained locally.

The larval parasites were bred throughout on caterpillars of the stored product pest *Corcyra cephalonica*.

The pupal parasites were bred on pupae of *Corcyra cephalonica*, *Prodenia litura* and *Nephantis serinopa*.

It was found that the alternate host material in the laboratory *Corcyra cephalonica* thrives better on maize flour than cholam. The entire life cycle is completed in 29 days. In addition, maize flour is cheaper than cholam.

The maximum temperature recorded during the year at Lunuwila was 88°F. At Batticaloa, the temperature shot upto 99°F. during the month of August. The temperature stood beyond 90°F for a total of 15 days during August and for 6 and 4 days during the months of July and September respectively.

With the rise in temperature, commencing from July, there was a sharp decline in the egg-laying capacity of the females accompanied by high mortality in both the sexes. Special precautions like increasing the number of feeds, setting the cages almost immediately the parasites are ready for ovipositing, increasing the vigour of the parasites in the laboratory by mixing them up with adults secured in the field etc., were some of the measures taken to overcome the disadvantages of the high temperature. In addition, as far as possible, breeding work was done during the cool hours of the fore-noon and afternoon.

(7) New parasites brought under laboratory rearing

The following parasites, which were not under rearing before, were brought under laboratory multiplication. The staff were trained in the breeding techniques of these new parasites: —

- (a) *Elasmus nephantidis* R. — Pre-pupal parasite
- (b) *Stomatomyia bezziana* Bar — Larval parasite
- (c) *Trichogramma minutum* R. — Egg parasite

(8) Production and release of parasites

The combined out-put of the two stations during the year was 38.80 lakh parasites. Of these, a total of 12.37 lakh parasites were released as detailed below :

S.No.	Name of the parasite	Total out-put at Batticaloa & Lunuwila stations	No. of parasites released in the various provinces					Total parasites released
			E.P.	W.P.	C.P.	S.P.	N.W.P.	
(1)	<i>Microbracon brevicornis</i> W.	12,31,440	1,73,500	3,000	1,600	83,200	1,44,600	4,05,500
(2)	<i>Perisierola nephantidis</i> M.	5,59,420	77,400	—	200	26,500	53,800	1,58,100
(3)	<i>Elasmus nephantidis</i> R.	6,940	880	—	—	—	—	880
(4)	<i>Tetrastichus israeli</i> M&K.	11,05,900	1,63,850	—	—	38,400	1,10,950	3,13,200
(5)	<i>Trichospilus pupivora</i> F.	9,76,960	1,62,400	—	—	37,200	1,59,750	3,59,350
		38,80,660	5,78,030	3,000	1,800	1,85,300	4,69,100	12,37,030

The above parasites were released in 56 coconut estates affected by the pest.

(9) Laboratory studies on the behaviour of the different parasites

The following are some of the observations made during the year:

(A) *Trichospilus pupivora* F.

(i) Average No. of days taken from time of parasitisation to emergence of adults with pupae of <i>Prodenia litura</i> as host material	} 17 days
(ii) —do— with <i>Corcyra cephalonica</i> as host material	— 16 days
(iii) Average No. of parasites emerging from each pupa of <i>Prodenia litura</i>	— 382
(iv) —do— with <i>Corcyra cephalonica</i>	— 43

(B) *Tetrastichus israeli* M & K.

(i) Average No. of days taken from time of parasitisation to emergence of adults with pupas of <i>Prodenia litura</i> as host material	} 15 days
(ii) —do— with <i>Corcyra cephalonica</i>	— 15 days
(iii) Average No. of parasites emerging from each pupa of <i>Prodenia litura</i>	— 232
(iv) —do— from <i>Corcyra cephalonica</i>	— 19

(10) Exchange of parasites with other countries

Biological control for its greater effectiveness, depends to a large extent on the natural agents (viz: parasites, predators etc.), introduced from other countries, in addition to conservation of the native beneficial agents. Imported natural agents also have the great advantage of being usually free from hyper-parasites. With this in view, on a request made by us, the Director of Agriculture, Government of Andhra-Pradesh, Hyderabad and the Director, Central Coconut Research Station, Kayangulam, Kerala State have kindly agreed to exchange parasites with us on a reciprocal basis, involving no cost to either country. This arrangement is working very well and we have already received many consignments from India.

The Colombo Plan Entomologist is in contact with the Entomologists in Pakistan, Burma, Thailand etc., regarding obtaining parasites, which are not available in Ceylon.

(11) Miscellaneous

Parasites and hyper-parasites collected in Ceylon during the year were sent for identification to Dr. E.O. Pearson, Director, Commonwealth Institute of Entomology, London.

Edwin Dharmaraju,
Colombo Plan Entomologist, Batticaloa.

ANNUAL REPORT OF THE SOIL SURVEY UNIT

In 1961 the Soil Surveys were conducted with great emphasis on aerial photo interpretation. Secondly the work was either semidetailed or detailed, and was mostly carried out in the marginal areas.

The Koddiarpathu Soil Survey

This is a coastal area in the Kathiravelli one inch sheet, between Mudduchchenai and Punaidi.

Rainfall and Vegetation

Average annual precipitation was between 50"-75", and the vegetation was a thorn scrub jungle.

Geomorphology

The landform was a mature coastal plain bounded by two rivers, the Uppu aru and Shavar aru. The meander bends of the former gave rise to an associated flood plain, which formed about 20% of the area.

Soil Classification

Soils of the flood plain were sandy clays, with massive structure, and high water table.

Land use: No coconut palms were growing in the area. Land use was for paddy cultivation.

Coastal sands: These were loose sandy soils, which were slightly loamy towards the flood plain. The water table was high.

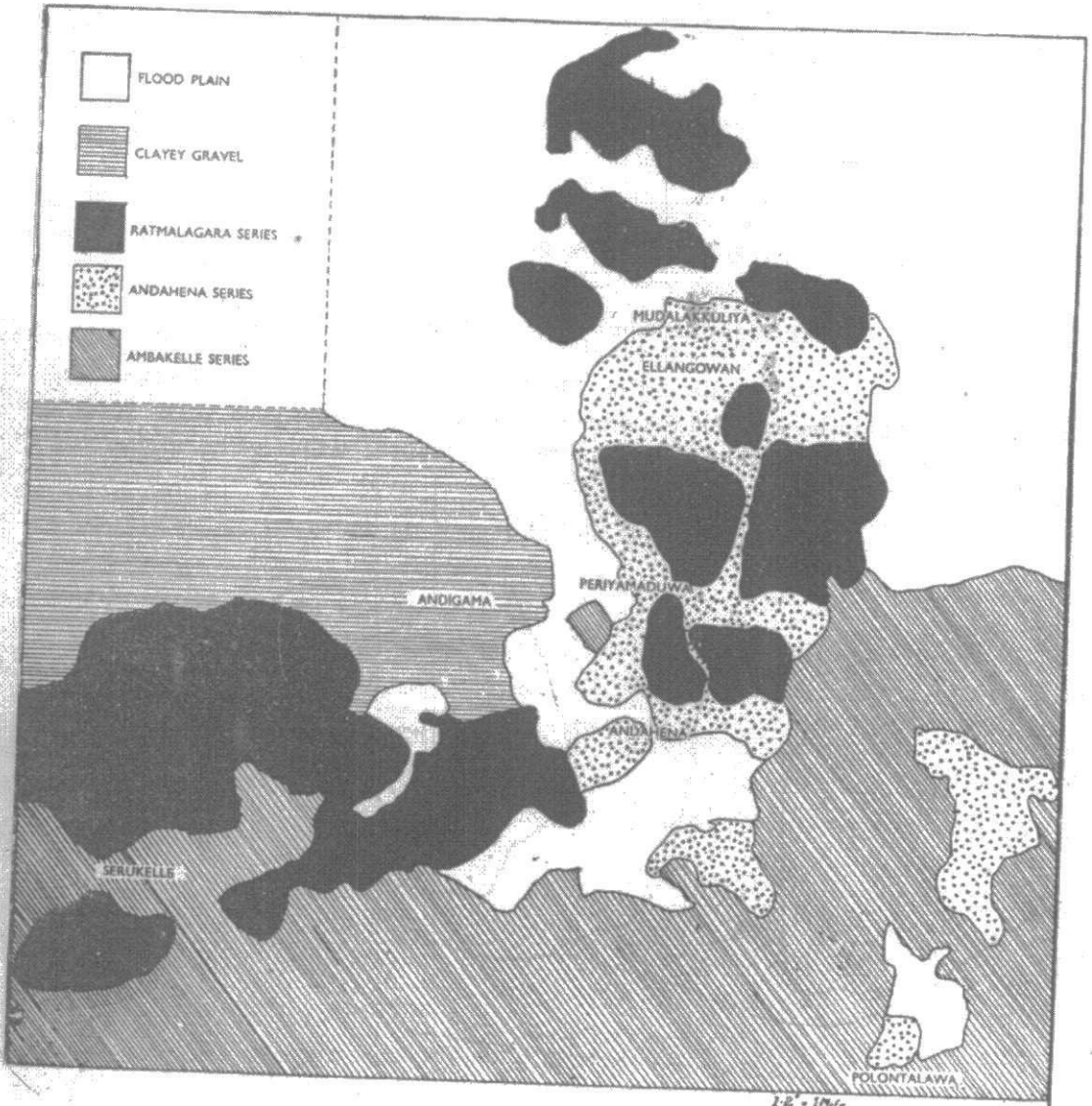
Land use: Coconut palms grown in smallholdings such as at Mudduchenai were thriving, and very large nuts were produced.

Mineralogy: The coarse sand fraction consisted of quartz with ferric inclusions. The heavy minerals of the fine sand fraction consisted of garnets, rutile zircon, ilmenite and magnetite. This demonstrates the sedimentary origin of the soils, these being marine and river sediments.

Soil Survey of Sampur in the Trincomalee one inch sheet

Two large lagoons in the area gave rise to a marshy plain which composed most of the land. The soil here was a solonetz, and the only land suitable for coconut cultivation was a narrow coastal strip, as at Illakantai, which was composed of coastal sands.

SOIL MAP OF THE ANDGIAMA CATENA



Soil Survey of Andigama (Battu'uoya — Wariyapola one inch sheet)

The soil survey of Andigama was on flight lines A 31, A 32, A 33, and photo numbers 60, 61, 54, 53.

Rainfall and Vegetation

The average annual precipitation was between 50"–75" and the vegetation was a dry zone forest climax.

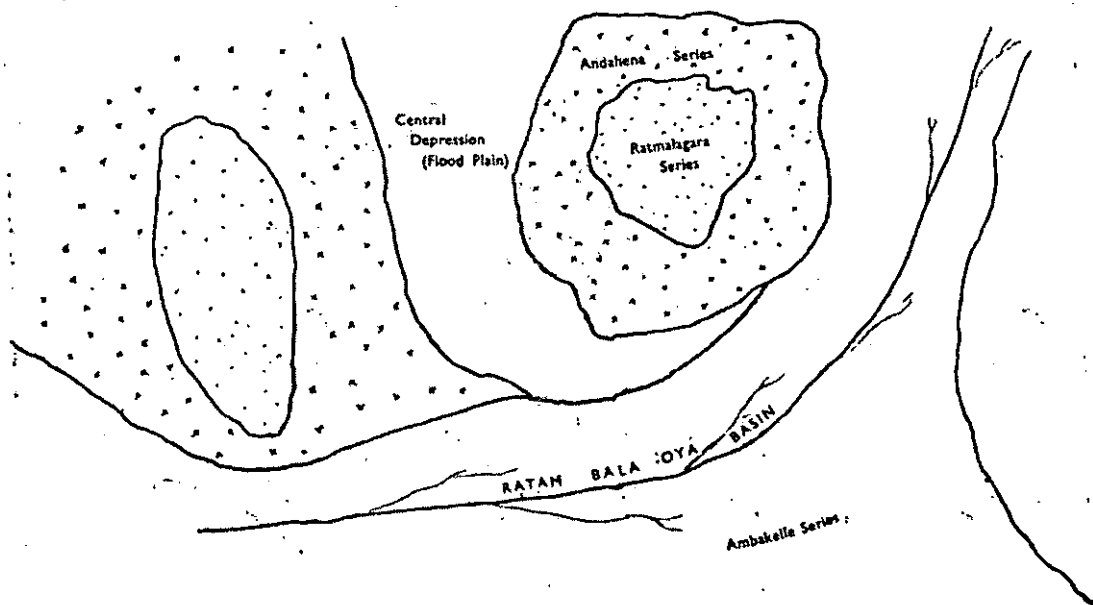
Geomorphology: The landform consisted of rounded hills and shallow valleys, and the chief drainage system was the Ratambala oya and its tributaries.

Geology: Basement rocks were black and brown shales. These confirm the Jurassic history of the area round Andigama. In the Southern region were rocks of the khondalite series.

Soil Classification: The Andigama Catena

The Andigama Catena consists of (a) The Ratmalagara series on the hilltops and upper slopes (b) The Andahena series, on the pediment (c) The central flood plain extending towards Anamaduwa (d) The peripheral plain which is the basin of the Ratambala oya which comprises the Ambakelle Series.

Diagrammatic Representation of the Catena



It is possible that the Ambakelle series is developed by deposition of river sands on weathered rocks of the khondalite series.

Ratmalagara Series

Gravelly clays on the summits and upper slopes of the catena.

Land use: Middle class schemes for coconut cultivation at Nagawila and Siyambalagas wewa were not successful.

Andahena Series

This is formed on the lower slopes of the catena, the quartz and gravel being transported material from the summit. There is evidence of slight laterisation and most of the feldspers have been kaolinized.

- 0 — 14" 10YR 4/3, loamy sand, roots good, moist, blocky structure changes to
- 14" — 33" 10YR 7/4, loamy sand, moist, yellowish brown mottling, horizon change clear to
- 33" — 47" 10YR 6/3, Very coarse sandy clay, moist, very sticky and plastic. Quartz angular or rounded. Few feldspers present, kaolin present.
- 47" — 72" Coarse sandy clay, very sticky, plastic, kaolin abundant.

Flood plains

The base of the Andigama catena consisted of a central alluvial plain that stretched from Periyamaduwa towards Anamaduwa. The soils were water logged with gleyed horizons.

Land use: Paddy cultivation.

Ambakelle Series

Soils were sandy loams on top, with a sub soil of sandy clay. This series has been described in earlier reports. e.g. Battuluoya soil survey.

Land use: The best soils were in this series as illustrated by the thriving coconut lands at Pothukulama, parts of Serukelle and Ambakelle.

The mineralogical study of the Andigama catena is being conducted to find the origin and interrelationships of the series.

K. S. O. Perera,
Officer-in-Charge, Soil Survey Unit.

ANNUAL REPORT OF THE ADVISORY DIVISION

Free advice and demonstrations, in regard to Coconut cultivation, was continued to be made available to Coconut growers through a network of officers stationed in various parts of the Island. In addition, these officers have carried out inspections under the Coconut Fertilizer Subsidy Scheme and the Citronella Subsidy Scheme. Besides the above, free delivery of seedlings from Coconut Research Institute nurseries have also been made by the Field Staff to those persons who desired to have such assistance.

In carrying out this extension service, the staff have visited a number of large and small holdings and provided owners of lands or those in charge of them, information, instructions and demonstrations on improved methods of planting and maintaining Coconut lands. These persons have, in most instances, been given assistance on methods of new planting, replanting old and uneconomic stands, care of seedlings, soil and moisture conservation, draining of low lying areas, diagnosis and control of pests and diseases, importance of manures and their application. Demonstration Centres, to serve as visual aids for the benefit of Coconut growers, that had been established at Koggala, Pallai, Mundel, Hettipola and Ratmalagara continued to be maintained while work on a sixth at Alampil was initiated during the year.

Summarized below is a statement of the work done.

1. GENERAL ADVISORY VISITS TO SMALLHOLDINGS AND ESTATES

A. *Small Holdings*

1. No. of holdings visited for general advisory work	5246
2. No. of holdings visited for soil conservation work	150
3. Extent of drains traced for soil conservation work	2211 chains
4. No. of holdings visited to advice on draining of low lying lands	47
5. Extent of drains pegged in these holdings	278 chains

B. *Large Holdings*

1. No. of holdings visited for general advisory work	774
2. No. of holdings visited for soil conservation work	47
3. Extent of drains traced for soil conservation work	1819 chains
4. No. of holdings visited to advice on draining of low lying lands	12
5. Extent of drains pegged in these lands	113 chains

2. Inspections under the fertilizer subsidy scheme

a. No. of small holdings visited	583
b. No. of manure application forms distributed to small holders	1447
c. No. of manure application forms distributed to large holders	87

3. Pests and Diseases

No. of holdings visited

	<i>Small Holdings</i>	<i>Large Holdings</i>
a. Termites	537	127
b. Black Beetle	613	197
c. Red Weevil	279	97
d. Caterpillar	37	39
e. Grey Blight	130	34
f. Scale Insect	7	9
g. Other Pests and Diseases	57	53

4. Pre — Planting and Follow — Up service

A. Pre — Planting

1. *Small Holdings*

a. No. of holdings lined for planting	319
b. Extent lined for planting	390 acres
c. No. of holdings visited for soil conservation work	25
d. Extent of drains traced for soil conservation work	560 chains
e. No. of holdings visited to advice on draining of low-lying lands	11
f. Extent of drains pegged in these lands	76 chains

2. *Large Holdings*

a. No. of holdings lined for planting	88
b. Extent lined for planting	152 acres
c. No. of holdings visited for soil conservation work	6
d. Extent of drains traced for soil conservation work	402 chains

B. Follow — Up

1. *Small Holdings*

a. No. of visits for follow up work	836
b. No. of holdings visited for soil conservation work	14
c. Extent of soil conservation drains traced	279 chains
d. No. of holdings visited to advice on draining of low lying lands	7
e. Extent of drains pegged in these lands	70 chains

2. *Large Holdings*

a. No. of visits for follow up work	139
b. No. of holdings visited for soil conservation work	5
c. Extent of soil conservation drains traced	23 chains

5. Meetings and Talks

a. No. of meetings attended by the Field Staff	82
b. No. of talks delivered by the Field Staff	41

6. Demonstration centres

At Pallai, the adult palms in all blocks except in A₁ were manured with General Coconut Fertilizer Mixture at the rate of 6 lbs. per palm. The underplanted seedlings too were manured with the same mixture at the rate of 2 lbs. per plant. Poor and dead seedlings were replaced. Manuring of block A₁, which had not been underplanted, was carried out during the year with the following, for which purpose the block was divided into three plots.

- Treatment 1. Tethering a pair of cattle for 5 nights, + 3 lbs. Saphos Phosphate and 2 lbs. Muriate of Potash per palm.
- .. 2. Tethering a pair of cattle for 10 nights, + 2 lbs. Saphos Phosphate and 1½ lbs. Muriate of Potash per palm.
- .. 3. Tethering a pair of cattle for 10 nights per palm

As felling and removal of the old stand in the underplantation, have been found to be expensive, "Atlas Tree Killer" was tried out on a few palms. In case this poisonous chemical is found to be effective it is proposed to determine whether such palms could be allowed to remain and undergo gradual decay without Black Beetle breeding in them.

At Mundel, the blocks that had been underplanted, on the triangular and square systems with Tall × Tall and Tall × Dwarf seedlings were manured during the year. On one section of the land Cow-pea was established with a view to controlling the growth of Illuk, and with its die back, after harvest, growth of Illuk was found to be prolific once again. Therefore it has been proposed to establish a more lasting mixed leguminous cover of Calopogonium mucunoides and Centrosema pubescens as a control measure against this weed.

At Hettipola and Ratmalagara, contour drains have been cut to arrest soil wash. In the latter the palms were manured at 6 lbs. each with General Coconut Fertilizer Mixture.

At Koggala, the entire old stand has been manured with General Coconut Fertilizer Mixture at the rate of 12 lbs. per palm. Holing for replanting on the square and triangular systems has been done in blocks A, B, C, E and F. Work on draining of the low — lying blocks is in progress.

At Alampil, the jungle has been felled but only 9 acres out of the 15 acres could be burnt well owing to unexpected weather conditions. The cleared area has been divided up into two blocks and planted on the triangular and square systems.

SECTION II

CITRONELLA SUBSIDY SCHEME

The Scheme provides, besides free advice and demonstrations, Coconut seedlings and fertilizer during the first year of planting and an annual outright grant of -/50 cts. per plant for a period of eight years. Such assistance is given to owners of Citronella lands, of 20 acres and under, in the Matara and Hambantota Districts, who desire to plant their lands in Coconut.

This work, with the exception of the payment of the annual cash subsidy which is being done by the Commissioner of Coconut Rehabilitation, continued to be in charge of the Chief Advisory Officer. Although a field staff comprising six Advisory Field Officers and thirteen

Field Attendants had been recruited for the purpose, the work had to be carried out with a smaller number, as four Advisory Field Officers were detailed for work under the Department of Census and Statistics, in connection with the F.A.O. Pilot Coconut Survey. As a result it was not possible for the field staff to visit every holding and demonstrate lining and planting. Instead, the field staff have given such demonstrations in villages to groups of land owners on 1342 blocks covering an extent of 2485 acres.

Damage to seedlings by Termites (White Ants) was commonly noticed in the majority of the planted areas. As such damage was found, in most instances, to kill the seedlings, "Aldrex", an insecticide for the control of Termites, was distributed free of cost for applying round seedlings.

A summary of the work done is given below.

1. Distributions

May/June 1961 Planting Season

No. of applicants who took delivery of seedlings and fertilizer	822
Quantity of fertilizer issued	63 tons 1 cwt. 98 lbs.
No. of seedlings issued	189237
Acreage	2522 acres 2 roods 10 perches.

Oct/Nov. 1961 Planting Season

No. of applicants who took delivery of seedlings and fertilizer	562
Quantity of fertilizer issued	88 tons 15 cwts.
No. of seedlings issued	266276
Acreage	3549 acres 1 rood 8 perches.
Aldrex—issued	21372 ozs.

2. Issue of Aldrex

Aldrex 2 — for control of Termites was distributed among 3746 applicants, who had taken delivery of seedlings and fertilizer during the issues May/June, Oct./Nov. 1960 and May/June, 1961. Amount of Aldrex issued was 36859 ozs.

3. Cash subsidy inspections

15 Field Officers from the Advisory Section were detailed to inspect holdings that had been planted with seedlings.

STAFF

Mr. R.W. Senaratne, District Coconut Instructor and Messrs. K.B. Samarakkody, R.M. Peiris Singho, M.A.S. Perera and K.N.L.P. Seneviratne Coconut Instructors were temporarily released to work on the F.A.O. Pilot Coconut Survey under the Director of Census and Statistics. Mr. C. Iddawela too who was loaned for this work was later recalled to Head Office and Mr. H.H. Samarakoon Coconut Instructor went in his place.

The services of Mr. Remy Perera, Clerk/Typist were terminated during the latter part of the year.

Messrs. P.J. Fernando, Clerk/Typist and C.W. Dissanayake Field Attendant resigned in October, 1961 to take up appointments elsewhere.

Messrs. J.A. Randeniya, Field Attendant and B.K.S. Jayasekera, Coconut Instructor vacated their posts.

C. A. Wickremasooriya,
Chief Advisory Officer.

ANNUAL REPORT OF THE PLANTING DIVISION

Nurseries : *Seednuts* — 2,510,872 seednuts were planted in the nurseries during the year.

The distribution of seednuts in nurseries is as follows :

SEEDNUTS PLANTED IN 1961 FOR ISSUE OF SEEDLINGS IN :

	Oct./Nov.'61	May/June'62	Total
1. Ratmalagara Nursery ..	297,215	— 140,928	438,143
2. Eraminigolla Nursery ..	28,100	— 35,000	63,100
3. Carmel Nursery	233,385	— 103,450	326,835
4. Walpita Nursery	100,000	— 95,817	195,817
5. Hettipola Nursery	36,675	— 25,000	61,675
6. Handapangala Nursery	274,850	— —	274,850
7. Mylambavelly Nursery	199,938	— —	199,938
8. Kalawewa Nursery	150,000	— —	150,000
9. Pallai Nursery	77,500	— —	77,500
10. Wilpotha Nursery	204,550	— 96,939	301,489
11. Kilinochchi Nursery	100,525	— —	100,525
12. Koggala Nursery	65,000	— 55,000	120,000
13. Alampil Nursery	101,000	— —	101,000
14. Weeraketiya Nursery	100,000	— —	100,000
	<u>1,958,738</u>	<u>552,134</u>	<u>2,510,872</u>
15. Weeraketiya Nursery (Citronella Subsidy Scheme)	499,440	— 125,000	624,440
16. Mapalana Nursery (Citronella Subsidy Scheme)	—	— 122,950	122,950
	<u>499,440</u>	<u>247,950</u>	<u>747,390</u>

Seedlings :

Orders for 1,522,417 seedlings were received for both planting seasons i.e. May/June and Oct./Nov. 1961.

The distribution of seedlings from the nurseries is as follows :

<i>Name of Nursery</i>	<i>Total No. of seedlings booked for May/June</i>	<i>Total No. of seedlings booked for Oct./Nov.</i>	<i>Total No. of seedlings booked for both seasons</i>
1. Ratmalagara Nursery	78,221	156,474	234,695
2. Walpita Nursery	58,067	72,851	130,918
3. Carmel Nursery	56,763	143,139	199,902
4. Wilpotha Nursery	40,200	128,375	168,575
5. Koggala Nursery	35,998	30,637	66,635
6. Eraminigolla Nursery	11,666	27,855	39,521
7. Hettipola Nursery	25,180	26,840	52,020
8. Medamulana Nursery	—	38,654	38,654
9. Kilinochchi & Pallai Nurseries	—	115,793	115,793
10. Alampil Nursery	—	76,325	76,325
11. Mylambavely Nursery	—	121,755	121,755
12. Kalawewa Nursery	—	96,205	96,205
13. Handapangala Nursery	—	181,419	181,419
	<u>306,095</u>	<u>1,216,322</u>	<u>1,522,417</u>

3. **Inspections :** The nurseries were inspected by Planting Officer, Assistant Planting Officer and Senior Field Assistant, as follows :

<i>Nurseries</i>	<i>No. of Visits for the year</i>		
	<i>P.O.</i>	<i>A.P.O.</i>	<i>S.F.A.</i>
(Ratmalagara — Hettipola Wilpotha Nursery)	4	3	8
Kalawewa — Karawaddane	3	4	11
Mylambavely	1	4	4
Kilinochchi — Alampil	2	3	5
Koggala — Dematawela and Handapangala	2	2	6
Walpita — Eraminigolla	5	2	12

(Sgd.) P.D.L. FERNANDO,
Planting Officer.

REPORT OF THE WELFARE OFFICER

	<i>Senior</i>	<i>Intermediate</i>	<i>Assistant</i>	<i>Minor</i>
The Staff position was as follows:				
At the end of 1960	8	7	116	103
New appointments in 1961	—	—	6	9
<hr/>				
Less resignations and retirements in 1961	8	7	122	122
	—	1	8	3
<hr/>				
Promotions	8	6	114	109
Confirmations	—	—	—	2
	—	—	19	30
<hr/>				
Position as at 31.12.1961	8	6	114	108

The cadre of the entire staff at the end of 1961 was 237 as compared with 234 last year. Filling of vacancies to the approved cadre of the staff were restricted as far as possible during the year on orders of the Coconut Research Board in view of the financial position of the Institute. Two minor staff grade officers were promoted to the Assistant Staff Grade II as Field Assistants during the year. Out of the 9 appointments to the Minor Staff Grade as Field & Lab Attendants 3 candidates were selected from the Institute's Labour force. The concession granted to the Minor Staff employees in laying down a specific period of service in lieu of qualifications with the Institute as a minimum qualifications for eligibility to the higher grade has not yet been extended to the entire staff. This is essential to make all employees more persevering and enthusiastic in their work as stated in my last report.

Labour Force: According to the Employees Provident Fund Register the labour force as at 31.12.61 was 705 distributed as follows:

On monthly pay — 33
On daily pay — 672

The monthly paid workers referred to above are not attached to the staff but are entitled to Dearness and Special Living Allowance at Government rates. The daily paid employees are also not attached to the staff and are paid according to the respective Trades they are classified according to the nature of their work. A number of workers have also qualified for the Service Allowance of -/15 cts. per day for those who have 5 years continuous service and above and a few workers have also qualified for a further service allowance of -/25 cts. on completion of 10 years continuous service and above. The Board's acceptance of the recommendations made for the payment of full wages for the first seven days of an accident has been implemented from the beginning of the year. Industrial accidents have been on the increases. 22 accidents including a death case have been reported during the year as against 16 accidents last year. A sum of Rs. 132.44 on 11 temporary disablement cases have been received from the Insurance Company and compensation for the rest of the cases are yet been dealt with by the Company. As a rule,

workers who are bitten by snakes while on duty are despatched to the nearest Government Hospital and in almost every such case the worker concerned have preferred to take native treatment from nearest specialists for snake bites. This has created a big problem as there is no provision to meet any expenses of the native physician and prompt attention is needed in all such cases to save the lives of such workers. There is neither any provision under the Workmen's Compensation Ordinance for any Insurance Company to meet medical and incidental expenses so as to reimburse such expenses even at a later stage. This matter is now being referred to the Board as unlike in establishments situated within town limits the scope for such casualties in lands under experiments is very great.

Housing: 3 Rest Rooms for labourers at Bandirippuwa Estate, Rathmalagara Estate and Koggala Nursery have been built up at a cost of Rs. 11,378/- during this year. One Assistant Staff Bungalow at Wilpotha Nursery and one temporary Assistant Staff Bungalow at Weeraketiya Nursery were also built during this period at a total cost of Rs. 22,309/-. One labour cottage was built at a cost of Rs. 3,000/-. Three sets of Assistant Staff Grade furniture and one set of Minor Staff Grade furniture were supplied at a total cost of Rs. 4,200/-. 8 meetings of the Housing Committee consisting of the Chief Administrative Officer (Chairman), a representative of the Coconut Research Institute Research and Extension Staff Officers Association and a representative of the Coconut Research Institute Employees Union, with Welfare Officer as Secretary were held during the year and 12 applicants were allocated living quarters including Hostel Accommodation. The Institute still holds a proud record of having canteen, bath-room and a few other facilities common to all employees of the Institute without any discrimination on the class or category of work and their status.

Financial Aid: All applications from employees for Provident Fund, Gratuity, Medical Aid, Transport Loans, Distress Loans, Housing Loans, Allocation, furnishing and maintenance of quarters, Transport arrangements, Guest House accommodation and generally the establishment work of the Institute have been dealt with during the year. A sum of Rs. 59,500/- and a sum of Rs. 99,460/- have been granted as loans to 24 officers for construction of houses and building sites respectively during the year. 115 officers have taken Insurance policies from the Provident Fund monies lying to their credit during this period. Transport Loans granted was Rs. 2,948.50 as against 65,900/- last year. A sum of Rs. 16,450/- to the Staff and 16,700/- to the non-staff have been paid as Festival Advances during the year. The granting of transport loans and festival advances were stopped by the Board from the early part of the year as it was considered ultra-vires. A sum of Rs. 77,094/- was contributed to the Staff Provident Fund by the Officers to which the Board contributed an equal amount during the year. Interest in each case was Rs. 20,500.42 and 20,347.28 respectively.

Medical Aid: The amount lying to the credit of members on 1.1.1961 in the Medical Aid Fund was Rs. 25,188.37 which the members contributed at the rate of Rs. 10/- per month in the case of Senior and Intermediate Staff and Rs. 6/- per month in the case of Assistant and Minor Staff. The Board contributed an equal amount at the end of each month. A sum of Rs. 22,048.94 was paid to members on medical aid claims approved at 9 meetings held during the year. A loan of Rs. 319/- was also granted under rule 14 of the Fund. Special concessions to members have been obtained from doctors in the panel.

Thrift, Savings and Supply of Goods: The Coconut Research Institute Co-operative Welfare Society Ltd. made satisfactory progress during the year. It caters to the economic needs of the members, the Stores of the Society made available to members food and curry stuffs and other essential; requirements at competitive rates while the canteen continued to supply tea and refreshments. Thrift and savings were also a part of the Society's business during the year. The Board's annual grant is Rs. 1,500/-.

A fully furnished Rest Room with canteen facilities and radio music have been provided to the Staff and the cost of Rest Room labourers wages are met from the grant payable to the Co-operative Welfare Society Ltd. As the welfare amenities provided by the Board are to its employees the Rest Room/Canteen section have been taken over by the Administration.

Recreation and Cultural Activities: The "D" Division Cricket team of the Coconut Research Institute Recreation Club participated in the Government Service Cricket Tournament and was eliminated in their first round with the Railway. Two friendly matches were also played with Mercantile firms. The Coconut Research Institute Recreation Club also participated in Government Service Indoor games tournament including Table Tennis, Carrom, Draughts and Contract bridge competitions. The Club held its Club days and Christmas Party during the year. The party was mainly organised for the benefit of the officers children and over 200 gifts were distributed among them. A sports meet and variety entertainment organised by the Coconut Research Institute Art Circle were the main features of the Party. The Board's annual grant is Rs. 500/- and a sum of Rs. 130/- was incurred from the Institute's funds for the Government Service Cricket Tournament.

The Coconut Research Institute Art Circle made satisfactory progress during the year. A library was opened and novels books were made available to members. The members participated in a two-day excursion to Wahacotte—Sigiriya — Dambulla. A day's excursion was also arranged to Colombo to afford an opportunity to see the historical play entitled "Vessantara" staged at the Y.M.B.A. Hall. A set of musical instruments suitable for cultural shows was also purchased during the year.

Industrial Relation: The employer-employee relationship have now been strengthened and over 75% of employees ranging from the Senior staff officers down to labourers are members of Trade Unions. The Lanka Estate Workers Union ceased to represent the labourers of the Institute. The Board recognised the Agricultural, Industrial and General Workers Union which represents the same gang of labourers who were members of the former union. Labour conferences with representatives of the respective Unions are often held to avoid trade disputes as far as possible and a number of problems relating to alleged victimisation and terms and conditions of service have been amicably settled during the year. Liaison between the Institute and its social and welfare organisations have been maintained throughout the year in the role of promoting sound industrial relationships within employees of the Institute.

F. H. D. Felix Silva,
Welfare Officer,
Coconut Research Institute of Ceylon.

REPORT ON THE ESTATES

Bandirippuwa Estate

Acreage

B/E.	(1)	Estate Section		
		A.	R.	P.
	(2) A	153.	0.	00
	B	118.	0.	38
	C	59.	3.	26
		34.	3.	07
Total		365.	3.	31

The above acreages comprises as follows:

Research Section (res. a/c)	75	2	04
Research Section (Est. a/c)	99	2	00
Estate Section	168.	0	13
Buildings, Streams and Roads	17	0	00
Waste land and Paddy	0	3	14
Playing Field	5	0	00
Total estate working a/c acreage	365	3	31
	267	2	15

Census

Census of palms as at February 1961 is as follows:

Particulars	Research		Estate Section			Grand Total
	Section	Pasture Plots	Res.p. Curve	N.P.K. G.R.	Estate	
Full bearing	1584	1776	1037	652	11953	17002
Partial bearing	227	377	204	45	1747	2600
Duds	29	277	52	11	659	1028
In flower	57	5	2	2	64	130
With Stem	47	9	2	6	75	139
Established Plants	41	12	—	3	47	103
Supplies	28	—	—	—	10	38
Vacancies	35	135	77	22	648	965
Total	2048	2591	1374	741	15251	22005
Left out for the Playing field						462
Unplantable Vacancies						1388
						23855

Underplanted Areas

Particulars	Estate Section					Grand Total
	Research Section	Pasture Plots	Resp. Curve	N.P.K. G.R.	Estate	
Full bearing	2	—	—	—	—	2
Partial bearing	19	—	—	—	—	19
Duds	—	—	—	—	—	—
In flower	14	—	—	—	—	14
With stem	130	—	—	—	16	146
Established Plants	426	—	—	—	160	586
Supplies	1639	—	—	—	317	1986
Vacancies	6	—	—	—	—	6
Total	2266	—	—	—	493	2759
Grand Total						26614

Field Notes

Weeding — The whole estate was freed of heavy growth by frequent disc-harrowing for this year.

Drains — Altogether 711 fathoms of drains were cut in the newly acquired estates on the contours and 3051 fathoms of old drains have been closed.

Roads and Bridges — All estate roads have been maintained in good order. A new road was constructed in B/E (2) A.

Streams — 6137 fathoms, stream in B/E (1), B/E (2) A and B was cleaned twice for the year.

Husk pits — 947 husk pits have been done in B/E (2) B and C.

Pest and Diseases — The incidence of beetle attack on young Palms was very rear as frequent examination has been undertaken.

Disc-harrowing — The whole estate has been disc-harrowed twice by Tractor.

Rainfall

This compares with the previous years as follows:

Average 1934/50	Months	1960 inches	Wet days	1961 inches	Wet days
2.20	January	0.57	3	2.24	4
2.17	February	0.03	—	4.30	6
5.38	March	2.02	4	7.06	10
8.40	April	17.59	18	9.92	12
10.31	May	14.10	19	14.09	15
7.42	June	3.50	8	14.13	19
2.82	July	15.58	16	5.22	11
3.45	August	0.91	3	5.43	14
4.28	September	2.15	5	10.66	17
12.56	October	14.07	9	5.47	17
12.92	November	12.64	17	10.60	12
4.81	December	1.02	4	2.20	8
76.72	Total	84.18	106	91.26	145

There was very little rain in the first 3 months of the year but it has not effected on the crops as in the previous year. The rainfall for the last few months was satisfactory.

Crops:

This compares as follows:

B/E (1)	Pick	1957	1958	1959	1960	1961	5 year average
	1	74720	43996	74787	34374	60813	55813
	2	95564	65862	122447	94034	106583	90841
	3	105526	107669	97380	105134	155581	104456
	4	101281	112139	89864	102947	125910	102842
	5	85069	68850	63412	61539	76130	71063
	6	49779	45825	29892	57584	53158	47696
Total		<u>511939</u>	<u>444341</u>	<u>477782</u>	<u>455612</u>	<u>578175</u>	<u>427711</u>
Research		83030	73464	86362	83041	114684	78630
Est. Total		<u>428909</u>	<u>370877</u>	<u>391420</u>	<u>372571</u>	<u>463491</u>	<u>394081</u>
B/E (2)	1	—	—	78036	37850	72174	
	2	—	—	94414	71581	127490	
	3	—	—	96406	97677	182944	
	4	—	54163	88332	103747	162395	
	5	—	48462	66884	75473	109181	
	6	—	51541	46466	62166	67460	
Total		—	<u>154166</u>	<u>472538</u>	<u>448494</u>	<u>721644</u>	
Grand Total		<u>511939</u>	<u>598507</u>	<u>950320</u>	<u>904106</u>	<u>1299819</u>	

The total crop realised for 1961 on both estates was 1,299,819 nuts from 19,602 palms equivalent to 311 acres. Thus the nuts per palm were 66.3 nuts and 4179.5 nuts per acre.

The disposal of Crops were as follows:

Sold on Contract	262145
Sold to Planting Division	25350
Sold to Research	3665
Sold to Staff	476
Research Nurseries	1766
Allowances to Staff	27033
Cured	966740
Empties	12744 1.0%
	<u>1299819</u>

The 966740 nuts cured into copra obtained 753 Candies 550 lbs. on an out-turn of 1282 nuts to a candy. The nuts per candy of copra has been good owing to the fact of regular manuring and the satisfactory distribution of rainfall in the previous year. The percentage of No. 1 Copra was 95%.

Manuring:

The following palms have been manured for 1961:

B/E (1)	No.	3 field	1180 palms	
"	"	4 "	760 palms	3 lbs. Sulphate of ammonia
"	"	BB "	30 palms	4 lbs. Saphos phosphate
B/E (2)	"	A "	345 palms	3 lbs. Muriate of potash (60%)
"	"	B "	929 palms	—
"	"	C "	800 palms	10
			<u>4044</u>	

All palms were manured by cutting circular trenches round palms and all the palms received a supply of husk. 381 young palms have been manured for the year.

Expenditure:

The Estate expenditure for the year is as follows:

General Charges	Rs.	34065.44	@	28.74	Estimated	Rs.	39477.00	@	32.80
Upkeep		22681.06	@	19.14	"		27290.00	@	22.74
Cultivation		10266.20	@	8.66	"		25550.00	@	21.29
Collection		17678.22	@	14.92	"		18138.00	@	15.11
Total		<u>84690.92</u>		<u>71.46</u>			<u>110455.00</u>		<u>92.04</u>

General

It was possible to complete the programme of work for the year satisfactorily.

D.F. Withana,
Superintendent, Bandirippuwa Estate.