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ANNUAL REPORT  
OF THE  
COCONUT RESEARCH INSTITUTE  
FOR  
1960

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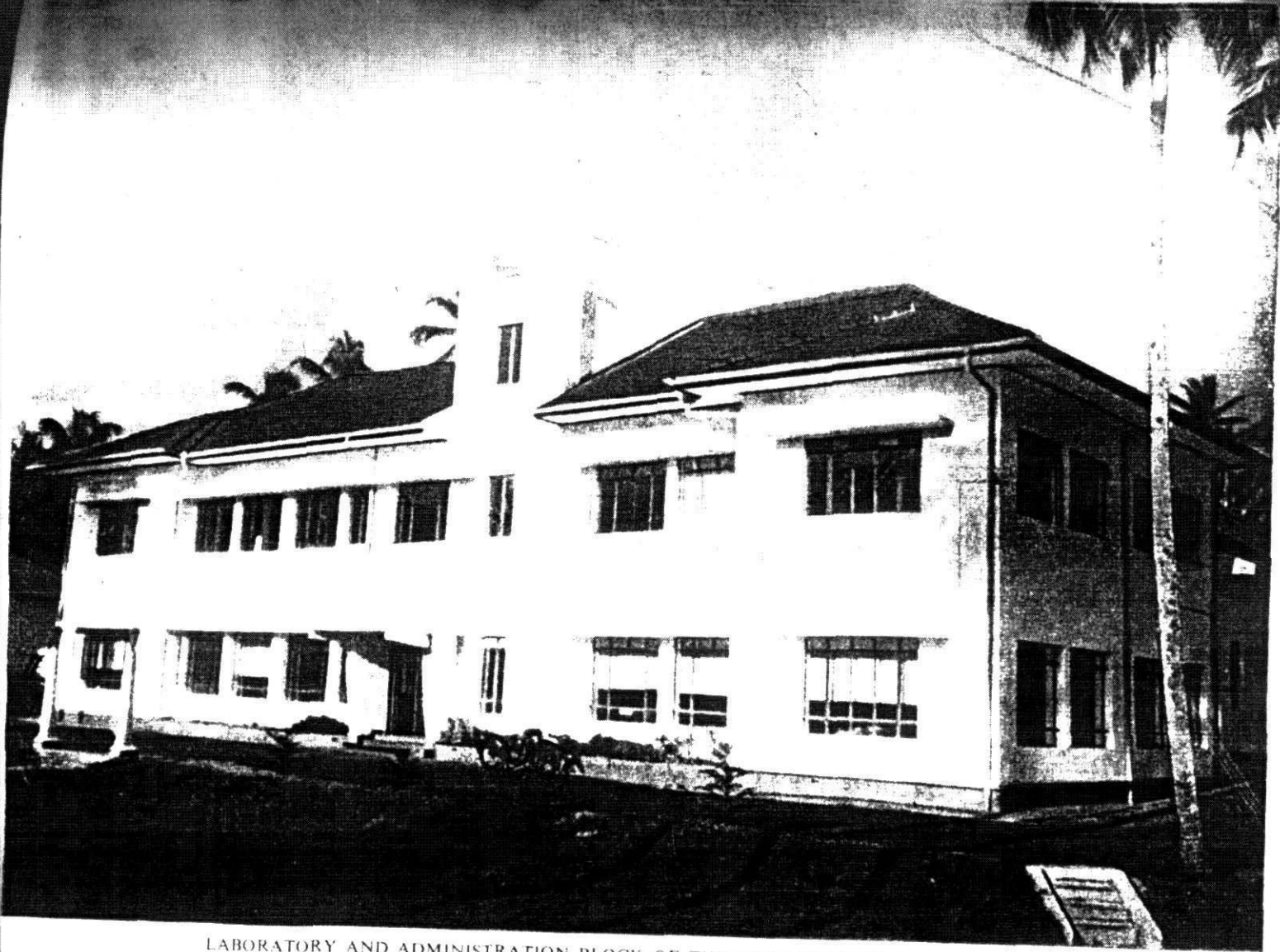
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# CEYLON COCONUT QUARTERLY

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# ANNUAL REPORT OF THE COCONUT RESEARCH INSTITUTE FOR 1960

The present report is the 32nd 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 1st 1960 the Coconut Research Board consisted of the following:—

### Ex-Officio Members:

Chairman — The Director of Agriculture: Dr. M.F. Chandraratne. Ph.D., B.Sc. (Lond.), D.I.C.,  
*M.B.E.*

Treasury Representative: Mr. E.B. Wiratunge.

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

Chairman, L.C.P.A.: Mr. C.S. Samaraweera.

Director, C.R.I.: 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 — Vacant.

Nominated by the Planters' Association of Ceylon: Mr. C.T. Van Geysel, *J.P.* and Mr. E. Muttukumar, *J.P.*

Nominated by the L.C.P.A.: Mr. C.A.M. de Silva and Senator Thomas Amarasuriya.

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

Mr. E. Muttukumar, *J.P.* was elected Chairman of Low Country Products Association in place of Mr. C.S. Samaraweera.

Dr. I.A. Senanayake was nominated by the L.C.P.A. to act for Mr. C.A.M. de Silva during his absence from the Island.

Mr. B. Warusavitharne was nominated by the Planters' Association in Mr. Muttukumar's place from 27th April.

Senator T. Amarasuriya was re-nominated by the L.C.P.A. as its representative on the Board.

Mr. C.T. Van Geysel, *J.P.* was re-nominated by the P.A. as its representative on the Board.

Mr. H.E. Pieries, Deputy Secretary to the Treasury, took the place of Mr. E.B. Wiratunge as the Treasury Representative on the Board as from 8th July.

Mr. W.I. Hugh Fernando, *M.P.*, Deputy Speaker, was nominated with effect from 30th August.

Mr. S.D.R. Jayaratne, *M.P.* was nominated with effect from 1st April.

**Meetings.**—Seven Meetings of the Coconut Research Board were held during the year — on 2nd January, 16th January, 12th March, 10th June, 20th August, 10th September and 10th December.

#### Committees

*Administration Committee (Personnel at 1st January 1960):*

- (1) Dr. M.F. Chandraratne, Chairman.
- (2) Mr. E.B. Wiratunge.
- (3) Mr. C.A.M. de Silva.
- (4) Senator Thomas Amarasuriya, *O.B.E.*
- (5) Mr. C.S. Samaraweera.
- (6) Mr. B. Mahadeva.
- (7) Dr. M.L.M. Salgado, Director, C.R.I.

The 29th, 30th and 31st Committee Meetings of the Administration Committee were held on 22nd April, 22nd July and 29th October respectively.

*Extension Committee (Personnel at 1st January, 1960):*

- (1) Mr. C.T. Van Geysel, *J.P.*
- (2) Mr. C.A.M. de Silva.
- (3) Mr. B. Mahadeva.
- (4) Mr. E. Muttukumar.
- (5) Mrs. L.J. de S. Seneviratne.
- (6) Dr. M.L.M. Salgado, Director, C.R.I.

The 24th, 25th, 26th, 27th and 28th Meetings of the Extension Committee were held on 15th January, 11th February, 2nd July, 13th August and 12th November.

*Research Committee (Personnel at 1st January, 1960):*

- (1) Mr. M.M. Kumarakulasingham.
- (2) Dr. M.F. Chandraratne.
- (3) Mr. E. Muttukumar.
- (4) Mr. C.S. Samaraweera.
- (5) Senator Thomas Amarasuriya, *O.B.E.*
- (6) Dr. M.L.M. Salgado, Director, C.R.I.

The 33rd, 34th, 35th Meetings of the Research Committee were held on 21st May, 27th August and 19th November.

*Editorial Committee (Personnel at 1st January, 1960):*

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

Three meetings were held on 30th January, 14th May and 8th October.

T. AMARASURIYA,  
*Chairman, Coconut Research Board.*

# ANNUAL REPORT OF THE DIRECTOR

## 1. STAFF

STAFF of the Coconut Research Institute at the end of 1960 was as follows:

### Administration Division

Director — Dr. 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. (Lond.).  
Research Assistant — Mr. T.S. Balakrishnamurti, B.Sc. (Lond.).

### Chemistry Division

Chemist — Mr. W.R.N. Nathanael, 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 N. 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 — Mr. Hilary F. Goonewardene, B.Sc. (Sydney), B.Agric.Sc. (N.Z.):  
overseas study leave).  
Officer-in-Charge — Mr. J.K.F. Kirthisinghe.

### Biometry

Biometrician — Mr. V. Abeywardene (on study leave).  
Research Assistant (Statistics) — Mr. J.K.T. Fernando, B.Sc. (Ceylon).

Dr. D.A. Nethsinghe, Soil Chemist was away in India undergoing a training course in the use of Radio Isotopes for 5 weeks.

## 2. MEETINGS

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

- (i) Sub-Committee on Export Crops of the Planning Committee.
- (ii) Fertilizer Committee of the Ministry of Industries.
- (iii) Meetings of the Kurunegala and Chilaw Planters' Associations.
- (iv) Meeting regarding F.A.O. Pilot Survey summoned by Director of Commerce.
- (v) District Co-ordinating Committee, Puttalam.

## 3. CONFERENCES

Conferences were held to discuss the following subjects:

- (i) Conference of Heads of Divisions regarding acquisition of an estate at Ganewatte for a Sub-Station.
- (ii) Conference of Advisory Field Officers.
- (iii) The following subjects were discussed at Research Conferences:
  - (a) 'Varieties and Forms of the Coconut Palm' led by Botanist.
  - (b) 'Pasture Experiments' led by Acting Agrostologist.
  - (c) 'Soil Surveys in relation to Coconut Cultivation' led by Senior Technical Assistant, Soil Survey Unit.
  - (d) 'Biological Control of Coconut Pests' led by O.I.C., Crop Protection.
  - (e) 'A Possible Use for Coir Dust' led by Mr. S.M. Jayaratne, Technical Assistant, Chemistry Division.
  - (f) 'Animal Husbandry Investigations at C.R.I.' led by Animal Husbandry Officer.
- (iv) Several Conferences were held with the officers of the Department of Statistics in connection with the F.A.O. Pilot Survey.

## 4. F.A.O. CONFERENCE

Mr. W.R.N. Nathanael, Chemist, submitted a paper entitled 'Economic Losses to the Coconut Industry Consequent on the Deterioration of Underdried Copra' to the F.A.O. Conference on Copra Quality and Grading held at Rome. The paper was presented by Mr. C.T. Van Geysel, the leader of the Ceylon Delegation.

Mr. K. Santhirasegaram, Agrostologist left the Island on a Colombo Plan Scholarship to Australia on 2-3-60.

Mr. V. Abeywardene, Biometrician, was sent to India on 22-7-60 to undergo a course of training in Statistics.

### Appointments

The following have been appointed to the staff during the course of the year:

*Senior Staff* — Nil.

*Intermediate Staff* — Nil.

*Assistant Staff Grade I* — Mr. M.D.H. Seneviratne, B.A. (Ceylon), Publications Officer.

*Assistant Staff Grade II* — 2 Technical Assistants, 3 Coconut Instructors, 8 Clerk-Typists, 8 Field and Laboratory Assistants, and 3 Estate Superintendents.

*Minor Staff* — 8 Nursery Attendants, 21 Laboratory and Field Attendants and 3 Office Attendants.

### Promotions

The following were promoted during the course of the year:—

*Senior Staff* — Nil.

*Intermediate Staff* — Mr. K. Santhirasegaram confirmed as Agrostologist as from 1-1-60.

Miss N. Ramalingam, Acting Agrostologist as from 2-3-60.

*Assistant Staff Grade I* — Nil.

*Assistant Staff Grade II* — Mr. R.W. Seneviratne, Senior Field Assistant to Assistant Staff Grade I as District Coconut Instructor as from 16-5-60.

Mr. R.B. Rodrigo to Grade I as Field Officer as from 1-8-60.

Mr. D.C. Ellewela, Field Assistant as Senior Field Assistant from 3-1-60.

Mr. G. Richard, Clerk-Typist, as additional Book-keeper as from 1-7-60.

Mr. M.A.T. de Silva, Technical Assistant as Senior Technical Assistant as from 3-7-60.

Mr. D.K. Thangasalam, Technical Assistant as Senior Technical Assistant as from 16-7-60.

*Minor Staff* — Mr. D.M.K. Banda, Office Attendant as Clerk-Typist as from 1-1-60.

Mr. W.A. Sivapragasam, Nursery Attendant as Nursery Assistant as from 1-1-60.

### 5. VISITORS

The visitors during the year included the following:—

U.K. Trade Commissioner.

Dr. Tanada of U.S.O.M.

Miss Blair of F.A.O.

Dr. Sinco and Dr. Murali of the University of Philippines.

Dr. F.R. Tubbs, Director, East Malling Research Station.

Dr. D.L. Gunn, Director, Tea Research Institute, Ceylon.

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

Dr. K.I. Sakai, National Institute of Genetics, Japan.

Prof. and Mrs. J.B.S. Haldane, Mr. T.A. Davis, and Mr. Dronrajah of the Indian Statistical Institute, Calcutta.

Dr. Gamini Corea, Planning Secretariat, Colombo.

### 6. TRAINEES

Mr. Abdul Majeed, an Officer of the Government of East Pakistan was trained in the processing of coconuts and copra manufacture under the Colombo Plan.

## 7. STUDY LEAVE AND TRAINING

Mr. M.A.P. Manthiratne (Botanist Division) and Mr. M.A.T. de Silva (Soil Chemistry Division) were granted two years study leave under the Scheme for Technical Assistants to complete the B.Sc. (Lond.) Part II Examination.

Dr. D.A. Nethsinghe, Soil Chemist, attended a course of Training on Radio Isotopes at New Delhi.

Mr. K. Santhirasegaram, Agrostologist proceeded on overseas study leave at the Waite Research Institute, Adelaide.

Mr. V. Abeywardene, Biometrician, attended a course of Training at the Indian Statistical Institute, Calcutta.

Mr. J.K.F. Kirthisinghe, Officer-in-Charge, Crop Protection studied methods of Biological Control of Coconut Caterpillar at the Commonwealth Institute of Biological Control, Bangalore and the Research Station at Razole, Andrapradesh.

## 8. PUBLICATIONS

There was a change of Policy regarding the Institute's publications.

The Ceylon Coconut Quarterly was published as a purely technical journal.

The publication of a new popular quarterly Journal was commenced — the COCONUT PLANTERS' REVIEW. Main articles published in this Journal were reprinted and issued as Leaflets.

Pol Pawath continued to be published quarterly and was a Sinhalese Translation of the Coconut Planters' Review.

The Director contributed the articles on 'Coconuts' and 'Summary of work carried out by the Coconut Research Institute in 1959' to the Annual Reports of the Planters' Association of Ceylon and the Low Country Products Association.

## 9. NOTES ON REPORTS OF DIVISIONS

The following notes draw attention to points of interest relating to the detailed reports of the technical and extension work of the Institute.

### Chemistry

#### Copra:

- (1) On a request made by FAO, certain special studies were carried out during the year in order to make an assessment of the economic losses to the coconut industry consequent on deterioration of under-dried copra. The investigations have convincingly shown that half cured and under-dried copra is a very unstable and unsatisfactory product. It is indeed very susceptible to processes of biological deterioration which bring in their train concomitant losses to the producer and the industry. It has been found that these losses could assume very severe proportions under extreme conditions. On the basis of Ceylon's export statistics, it has been computed that losses ranging between 14 and 36 million rupees could be incurred by the industry annually, if the two major export products (copra and coconut oil) are prepared from the grossly underdried meat.
- (2) A fairly comprehensive experiment was carried out during the year in order to evaluate copra quality in relation to the maturity of the drupe. Five categories of nuts (a) when freshly harvested and (b) when seasoned for 30 days, have been considered in the study. They are: fallen nuts, first bunch nuts, second bunch nuts, third bunch nuts and fourth bunch nuts.

The results have clearly shown that the practice of seasoning is decidedly beneficial as it effects all round improvement in quality of all the categories of nuts employed, particularly the grossly immature kernel. Whilst first and second bunch nuts have been found to be equally suitable for copra making, the use of the immature kernel from third and fourth bunch-nuts have been found to involve appreciable offsets in economic returns to the producer.

#### *Sand Culture Experiment:*

- (1) The second sand-pot-culture experiment on 324 coconut seedlings which was laid down in October, 1959 was maintained satisfactorily during the year. Growth measurements were recorded on the seedlings at monthly intervals, and at pre-determined periods they were uprooted for examination of physical and chemical characteristics. The physical and visual symptoms characteristic of each particular deficiency have now been established.
- (2) The work of the Division during the year was focussed principally on analytical aspects. The chemical examination of samples (175) from lots I, III, V and VII (of the First Pot Culture Experiment) for N.P.K. Ca and Mg has been completed.

#### **Botany**

During the year, investigations on the following problems were continued; (1) Hybridisation between varieties and forms of coconut, (2) Identification of prepotent palms by the method of progeny trials, (3) In-breeding of *typica* palms, and (4) Planting techniques.

A number of estates have organised their own controlled pollination programmes to raise quality seednuts and the Institute has helped them with advice and also by supplying pollen from the pollen bank of prepotent palms.

Twenty acres (approx:) at the Isolated Seed Garden were planted with seedlings derived by artificial pollination where the male parents were exclusively prepotent palms.

A selection index using five characters was worked out from the data of the Marandawila Progeny Trial.

In the 9th year after planting, the palms of Tall  $\times$  Dwarf crosses have given an *average* yield of 103 nuts per palm, with an *average* weight of 1.48 lb. per husked-nut. These average yields are indeed very satisfactory considering that the palms are only 9 years old.

#### **Soil Chemistry**

##### *Field Experiments:*

The manurial experiment at Bandirippuwa has continued to show a response to potash and no response to phosphoric acid. At Ratmalagara, phosphoric acid has again proved to be the dominant requirement of both adult and young palms, while a response to potash and ploughing was also shown.

The method of application experiment at Marandawila was closed down in June 1960 after completing its 11th year. There was no difference between the application of fertilisers in circular trenches and broadcasting on this sandy soil.

Two new manurial experiments with 4 levels of N, P and K were commenced late in 1960 — one at Bandirippuwa on adult palms, and the other on seedlings just planted on a virgin jungle clearing at Pothukulama.

The yellowing of leaves of palms grown on the heavily leached lateritic soils of the Western Province in spite of regular manuring with inorganic fertilizers has been traced to magnesium deficiency. Soil applications of magnesium have improved leaf colour after three years. Magnesium sulphate has given better results than dolomite. Yield data have shown no improvement yet. Fortnightly foliar spraying with 1.2 per cent magnesium sulphate of both adult and young palms brought about complete recovery within a few months. The yellowing has been accentuated where inorganic fertilizers have been applied without magnesium.

#### *Laboratory Investigations:*

Work was commenced on the Radio Isotope P32 project for assessing the relative efficiency of utilisation of phosphatic fertiliser by the coconut palm under different forms and methods of application. Preliminary studies have shown that radio active phosphorus is found in the toddy within 2 hours of its application to the soil. Examination of the relative merits of toddy, nut water and leaf analysis as a means of studying the uptake of radio active phosphorus applied to the soil has indicated that the toddy from the spathe ready for tapping about 2 months after the application would be the most suitable.

Storage studies on fertiliser mixtures containing Urea showed that the mixtures absorbed considerable amount of moisture when stored under the usual conditions in gunny bags.

#### *Agrostology*

##### *Soil Nutrient Studies:*

The studies with the soils from Mattegoda and Vanathavillu commenced in 1959 were completed.

Pot Experiments on soils from Pothukulama, Ratmalagara and Horrekelle Estate and Bandirippuwa Estate were continued.

##### *Pasture Trials:*

Grazing of the Pasture  $\times$  Manurial experiment at Bandirippuwa Estate was commenced in August.

The infestation of *Brachiaria brizantha* plots with *Brachiaria milliformis* in some of the experiments at Ratmalagara Estate is a feature of considerable interest that has been noted this year.

##### *Animal Husbandry:*

Two Scindi stud bulls were purchased from the Department of Agriculture for the purpose of upgrading the Sinhala herd at Ratmalagara.

The total milk production for the year was 51,303 pints with an average of 4.6 pints per cow per day.

##### *Crop Protection :*

As in 1959, Crop Protection received considerable attention, in contrast to actual Research Activities owing to the outbreak of Coconut Caterpillar in the Ganewatte area in the Kurunegala District and elsewhere during the latter half of 1959. By concentrated efforts the pest was brought under effective control, but the Field Laboratory at Ganewatte continued to operate and breed the parasite *Trichospilus Pupivora* which was released on a mass scale.

With the co-operation of the Commonwealth Institute of Biological Control, Bangalore Station, supplies of other parasites were secured and bred in the Insectory, among them — *Microbracon brevicornis*, *Elasmus nephantidis*, and . . . *Perslerola nephantidis*.

Under Colombo Plan Aid Mr. Edwin Dharmaraju's services were obtained as an Entomologist through the good offices of the Government of India. He will be in charge of the Field Laboratory at Batticaloa where mass breeding and release of parasites for the control of the pest which has been endemic will be carried out.

Red Weevil (*Rhyncophorus ferrugineus*) formed the major pest of young palms both in replanted areas and on new clearings, in all parts of the island ranging from Puttalam, Chilaw and Hambantota Districts; a simple and effective method of injecting a Systemic insecticide 'Sytox' has been tried out.

#### Nurseries

*Seednuts.*—2,101,845 seednuts were planted during the year 1960 in planting Division Nurseries. 685,650 seednuts were planted during this year for the Citronella Subsidy Scheme.

Fourteen Nurseries were maintained as in previous years and in addition, a nursery at Medamulana (Weeraketiya) and one at Mapalana (near Matara) were opened for the supply of Seedlings for the Citronella Subsidy Scheme.

*Seedlings.*—Demand for seedlings exceeded the available supply of seedlings and orders were accepted for 1,318,076 seedlings for the year 1960.

*Citronella Subsidy Scheme.*—386,945 seedlings were issued to applicants.

#### Advisory

The normal advisory work of the Institute was considerably curtailed in view of the work involved in the planting up of about 6,000 acres of Citronella lands under the Subsidy Scheme.

### GENERAL

The activities of the Coconut Research Institute which had been expanding had to be curtailed owing to shortage of funds. The year 1960 ended with a deficit and unless the Government Grant is increased at least to meet the cost of the Small Holders Advisory Services as in the case of the R.R.I., the cumulative and progressively increasing deficits as years go by will place the Institute in a grave situation.

Besides the Research activities, the Institute has to bear the cost of a large Advisory Division consisting of a Chief Advisory Officer, a District Officer and 24 Advisory Field Officers working in Ranges. Furthermore besides carrying out inspections in connection with the Government Subsidised Manure Scheme in the case of Small Holdings, the Institute has undertaken the main responsibility in connection with the planting up of 18,000 acres of Citronella lands with coconuts in the Hambantota and Matara districts, at the rate of 6,000 acres a year within three years.

The establishment of our largest Nursery at Weeraketiya has been an added responsibility on the Planting Division, while the pre-planting service, the issue of seedlings and the post-planting service, and inspection of the Citronella lands after planting for payment of Subsidy by the Commissioner of Coconut Rehabilitation have been carried out by the Advisory Division, at the sacrifice of its normal legitimate function of Advisory and Extension work in the respective ranges.

Furthermore proposals for carrying out a Pilot Sampling Survey to estimate yield of coconuts in Ceylon under the auspices of the F.A.O., through the Department of Census and Statistics will mean a further demand on the already fully occupied staff of Advisory Field Officers.

Research activities have kept pace and the Institute has continued to fill a unique place in stabilising the Coconut Economy by placing its Research and Advisory Services at the disposal of the Coconut Growers.

M.L.M. SALGADO,  
Director.

# ANNUAL REPORT OF THE SOIL CHEMIST FOR 1960

## SUMMARY

### FIELD EXPERIMENTS

Five major field experiments were in progress during the year 1960. The manurial experiment at Bandirippuwa continued to show a response to potash and no response to phosphoric acid. At Ratmalagara, phosphoric acid has again proved to be the dominant requirement of both adult and young palms, while a response to potash and ploughing was also obtained. The experiment on methods of application at Marandawila was closed down in June 1960 on the completion of its eleventh year. On this sandy soil there was no difference between broadcast application of fertilizer and placement in circular trenches. The experiment on organics vs. inorganics and frequency of fertilizer application at Marandawila showed no differences at the end of its second manurial year.

The simple observation trials on yellowing palms at Mattegoda and Waigama estates in the Western province were also continued. The yellowing of leaves has been traced to magnesium deficiency. Soil applications of magnesium has improved leaf colour after three years. Fortnightly foliar spraying with 1-2 per cent magnesium sulphate of both adult and young palms brought about complete recovery within a few months.

A new manurial experiment on adult palms comparing the application of N, P and K at four levels was commenced at Bandirippuwa Estate late in 1960. Seedlings were planted in December 1960 on 40 acres of a virgin jungle clearing at Pothukulama for a similar experiment on young palms. One year's premanurial recording was completed at the end of 1960 on the proposed new field experiment to be laid down at Walahapitiya estate, Nattandiya on methods of fertilizer placement.

### LABORATORY INVESTIGATIONS

Work was commenced on the radio isotopes (P32) project for assessing the relative efficiency of utilisation of phosphatic fertilizer by the coconut palm under different forms and methods of application. Preliminary studies have shown that radio active phosphorus is found in the toddy within 2 hours of its application to the soil. The relative merits of toddy, nut water and leaf and inflorescence analysis as a means of studying the uptake of radio active phosphorus applied to the soil were examined.

Storage studies on fertilizer mixtures containing Urea showed that the mixtures became deliquescent and subsequently caked-up when stored under the usual conditions in gunny bags. The nitrogen content was reduced by half within 2 months — presumably as a result of urea being lost in the solution exuded from the bags. Fertilizer mixtures containing sulphate of ammonia showed little change when stored under similar conditions.

Chemical analysis of soils sampled in 1950 and 1960 from the Methods of Application Experiment at Marandawila showed that there was little accumulation of bases even though manuring had been done regularly since 1950. The soil is a loamy coarse sand of poor base exchange capacity. The results indicate the preference for more frequent application of small amounts of fertilizers (with reference to easily soluble N and K fertilizers) under such soil conditions.

Samples of tops, roots, seed of cow pea grown in this experimental area at Pothukulama were analysed for N, P, K, Ca, Mg to determine the amounts of nutrients removed from the soil by the harvested seed and the amount of nutrients turned back into the soil.

#### A. FIELD EXPERIMENTS

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

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

The 25th year of this experiment was completed in November 1960. The yield data for the main effects for 1960 are given in, Table I (a).

TABLE I (a)

<i>Treatment</i>	<i>Lbs. copra per 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>
N <sub>0</sub> (0.0 lbs. N)	1,396	100	—	1,181	—
N <sub>1</sub> (0.5 lbs. N)	1,429	102	+ 33	1,209	+ 28
N <sub>2</sub> (1 lbs. N)	1,325	95	- 71	1,229	+ 48
P <sub>0</sub> (0 lbs. P <sub>2</sub> O <sub>5</sub> )	1,343	100	—	1,186	—
P <sub>1</sub> (1 lbs. P <sub>2</sub> O <sub>5</sub> )	1,383	103	+ 40	1,207	+ 21
P <sub>2</sub> (2 lbs. P <sub>2</sub> O <sub>5</sub> )	1,423	106	+ 80	1,225	+ 39
K <sub>1</sub> (0.75 lbs. K <sub>2</sub> O)	1,156	100	—	1,268	—
K <sub>2</sub> (1.5 lbs. K <sub>2</sub> O)	1,455	126	+ 299	1,194	- 74
K <sub>3</sub> (2.25 lbs. K <sub>2</sub> O)	1,538	133	+ 382	1,171	- 97

Significant difference P.05 = 104 lbs. copra/acre.

Nitrogen and phosphoric acid have again showed no response. Potash has continued to show a marked response.

The mean yields in 1960 (lbs. copra/acre) for the various treatment combinations are given in the two-way tables below:

TABLE I (b)

	$N_0$	$N_1$	$N_2$	$K - Total$
$K_1$	1,254	1,160	1,055	1,156
$K_2$	1,476	1,548	1,341	1,455
$K_3$	1,457	1,579	1,579	1,538
$N - Total$ ..	1,396	1,429	1,325	1,383

	$P_0$	$P_1$	$P_2$	$K - Total$
$K_1$	1,116	1,162	1,191	1,156
$K_2$	1,507	1,420	1,439	1,455
$K_3$	1,407	1,567	1,640	1,538
$P - Total$ ..	1,343	1,383	1,423	1,383

	$P_0$	$P_1$	$P_2$	$N - Total$
$N_0$	1,389	1,387	1,412	1,396
$N_1$	1,394	1,423	1,470	1,429
$N_2$	1,247	1,339	1,388	1,325
$P - Total$ ..	1,343	1,383	1,423	1,383

2. Manurial  $\times$  Cultivation Experiment (Ratmalagara Estate)

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

The 17th year of this experiment was concluded in June 1960. The yield data for the main effects for the year 1959-60 are given in Table II.

TABLE II

Treatment	Lbs. copra/acre	Calculated as %	Difference lbs. copra/acre	Copra out-turn nuts/candy	Difference in nuts/candy
$P_0$	1,350	100	—	1,145	—
$P$	2,026	150	+676	1,219	+74
$C_0$	1,603	100	—	1,210	—
$C$	1,772	110.5	+169	1,178	-32
Significant difference $P.05 = 143$ lbs. copra/acre.					
$K_0$	1,597	100	—	1,220	—
$K_1$	1,646	103	+49	1,203	-17
$K_2$	1,820	114	+223	1,159	-61
Significant difference $P.05 = 175$ lbs. copra/acre.					

The response to phosphate has maintained a high level. Ploughing has again produced a significant effect, and so has potash at the higher rate of application.

3. 3 × 3 × 3 N.P.K. Manurial Experiment on Young Palms (Ratmalagara Estate)  
(See C.R.I. Annual Report 1959 for details of treatments and design).

The 12th year of the experiment was completed in 1960. The annual manuring was done in November. The rates of fertilizer applied were the same as in the previous year.

The yield data in lb. copra per acre for the main effects is given in Table III (a).

TABLE III (a)

Treatment	Lbs. copra/ acre (55 palms/acre)	Calculated as %	Difference in lbs. copra/ acre	Copra out- turn nuts/ candy	Difference in nuts/ candy
N <sub>0</sub>	1,186	100	—	1,053	—
N <sub>1</sub>	1,375	116	+ 189	1,063	+ 10
N <sub>2</sub>	1,309	110	+ 123	1,093	+ 40
P <sub>0</sub>	861	100	—	1,050	—
P <sub>1</sub>	1,514	176	+ 653	1,061	+ 11
P <sub>2</sub>	1,496	174	+ 635	1,091	+ 41
K <sub>0</sub>	1,160	100	—	1,103	—
K <sub>1</sub>	1,255	108	+ 95	1,065	-38
K <sub>2</sub>	1,456	126	+ 296	1,049	-54

Significant difference P.05 = 131 lbs. copra/acre.

Phosphoric acid has again had a marked effect on the yields, but at the higher level phosphate has not brought about an added response.

Nitrogen has shown a significant response at the first level, while potash has effected a marked improvement only at the second level.

The mean yields for 1960 (lbs. copra/acre) for the various treatment combinations are given in the 2-way Table III (b) below.

TABLE III (b)

Treatment	N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	K — Total
K <sub>0</sub>	1,053	1,280	1,146	1,160
K <sub>1</sub>	1,129	1,328	1,307	1,255
K <sub>2</sub>	1,376	1,516	1,474	1,456
N — Total	1,186	1,375	1,309	1,290
	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	K — Total
K <sub>0</sub>	788	1,297	1,395	1,160
K <sub>1</sub>	757	1,489	1,519	1,255
K <sub>2</sub>	1,037	1,755	1,574	1,456
P — Total	861	1,514	1,496	1,290
	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	N — Total
N <sub>0</sub>	933	1,382	1,243	1,186
N <sub>1</sub>	901	1,625	1,598	1,375
N <sub>2</sub>	748	1,534	1,646	1,309
P — Total	861	1,514	1,496	1,290

4. Manurial Experiment on Methods of Application — (Marandawila Group — Bingiriya)  
(See C.R.I. Annual Report 1959 for details of treatment and design).

This experiment was discontinued in June 1960 after the completion of its 11th year. The yield data for the 11th year given in Table iv(a) has again showed no differences between the two methods of fertiliser application — broadcasting (B) vs. circular trench placement (C).

TABLE IV (a)  
(Yields adjusted by co-variance analysis)

Treatment	Lbs. copra/ acre	Calculated as %	Difference in lbs. copra/acre
N <sub>o</sub>	1,511	100	—
N <sub>a</sub>	1,496	99	-15
N <sub>c</sub>	1,527	101	+ 16
P <sub>o</sub>	1,381	100	—
P <sub>a</sub>	1,600	116	+ 219
P <sub>c</sub>	1,552	112	-171
K <sub>o</sub>	1,376	100	—
K <sub>a</sub>	1,548	112	+ 172
K <sub>c</sub>	1,610	117	+ 234

Significant difference P.05 = 110 lbs. copra/acre.

The application of nitrogen has shown no response, but potash and phosphoric acid have given responses.

5. Manurial Experiment on Organics vs. Inorganics, and frequency of Manuring (Marandawila Group, Bingiriya)

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

This experiment comparing the effects of annual and biennial application of inorganic and organic manures on adult palms was commenced in June 1958. The yield data for the first and second manurial years given in Table V do not indicate any significant differences between the various treatments although a distinct response to manuring has been obtained. It is still too premature to draw any conclusions.

TABLE V  
Yields adjusted by co-variance analysis

Treatment	Lbs. copra/ acre		Percentage		Difference in lbs. copra/acre		Copra out-turn nuts/candy		Difference in nuts/candy	
	M. I	M. II	M. I	M. II	M. I	M. II	M. I	M. II	M. I	M. II
	(1st year) 1958-59	(2nd year) 1959-60								
Control	2,206	1,976	100	100	—	—	1,145	1,119	—	—
Inorganics annually	2,212	2,167	100	110	+ 6	+ 191	1,119	1,102	-26	-17
Inorganics once in two years	2,236	2,231	101	113	+ 30	+ 255	1,087	1,095	-58	-24
Organics annually	2,254	2,181	102	110	+ 48	+ 205	1,087	1,076	-58	-43
Organics once in 2 years	2,302	2,224	104	113	+ 96	+ 248	1,103	1,085	-42	-34
Cattle manure with supple- ments once in 2 years	2,342	2,326	106	118	+ 136	+ 350	1,079	1,080	-66	-39

## 6. Observation trials on Yellowing palms, Walgama Estate, Rukmale, and Mattegoda Estate, Polgasowita

(See also C.R.I. Annual Report 1956)

In recent years an intense yellowing of mature leaves has been observed in coconut palms grown on the heavily leached lateritic soils in the high rainfall areas of the Western Province. The yellowing commences at the tips of leaflets at the lower end of mature fronds, gradually spreading to the upper parts of both leaflets and fronds.

The manuring of coconut palms has been hitherto confined to the application of nitrogen, phosphoric acid, and potash. Yellowing of foliage has occurred in spite of systematic manuring with artificial fertilisers. In Malaya, Coulter and Rosenquist (1955 — Malayan Agric. Journ. 38, 214-236) have shown that the yellowing of mature leaves of the oil palm (which belongs to the same family as the coconut) is due to magnesium deficiency. Similar findings on the oil palm in West Africa have been reported by Bull (1954-Journ. W. African Inst. Oil Palm Research 2, 94-129).

However, simple trials on the soil applications of magnesium sulphate and dolomite since early 1957 gave no indication that the problem of yellowing on coconuts was associated with magnesium deficiency even after nearly three years (see C.R.I. Annual Report 1959). It is known that soil application of magnesium is generally slow acting. In 1960, therefore, as a quick diagnostic measure, it was decided to try the effects of spraying a dilute solution of magnesium sulphate on intensely yellow palms. The results of both the spraying trials and trials on soil application of magnesium are given below.

### *A Experiments on foliar sprayings of magnesium sulphate*

On 30th March 1960 ten intensely yellow young palms at Mattegoda Estate were sprayed with a solution of 2 per cent commercial magnesium sulphate containing 2 pints teepol (as a wetting agent) per 30 gallons. Using a power sprayer, each palm was sprayed for 2 minutes with about 3 gallons solutions so as to completely wet the foliage. A fortnight after the first spraying it was observed that there was a tendency for the leaves to wither. The subsequent sprays were therefore done with 1 per cent magnesium sulphate. The sprayings were continued fortnightly. Within three months the palms showed complete recovery and the sprayings were stopped at the end of June 1960. This result was most encouraging since at the beginning of this experiment there was a certain amount of doubt as to whether owing to the waxy nature of the coconut leaflet it would absorb any nutrient at all. Comparatively dry weather prevailed during the period of spraying.

A leaf count of green, moderately yellow, and intensely yellow leaves on the palms which had been sprayed taken on 25th August 1960 showed that there was a tendency for the leaves to turn yellow again. Two weeks later the condition had become worse, showing that magnesium deficiency was setting in. Subsequent leaf counts taken fortnightly have indicated a further deterioration of the palms. Unfortunately no such leaf counts were taken during the period of spraying as such a rapid improvement was not anticipated.

A further set of ten yellow young palms were sprayed with 1 per cent magnesium every fortnight commencing on 22nd August 1960. Leaf counts of these palms were done fortnightly along with the sprayings. Similar leaf counts were made on a control group of ten yellow palms receiving N.P.K. fertiliser only in order to assess the rate of improvement of the sprayed palms. In the second set of sprayings the improvement has not been so striking as in the first set, presumably owing to the heavy rainfall in October and November. These sprayings are being continued.

A similar spraying trial was commenced on adult yellow palms at Walgama Estate on 18th April 1960 using 2 per cent magnesium sulphate. No adverse effects were observed at this concentration. The sprayings were done fortnightly for 6 months after which complete recovery was observed.

These trials have given conclusive evidence that the problem of yellowing on these estates is associated with magnesium deficiency. The technique of foliar spraying has proved to be a quick and useful method of diagnosis. But it would not be practicable to carry out routine large scale spraying of adult palms as a curative or preventive measure. This must be done through the proper soil application of magnesium fertilisers.

*B. Experiments on the application of magnesium to the soil*

1. WALGAMA ESTATE

In 1956 fifty yellow palms and fifty healthy green palms were selected and each set divided into 5 groups of 10 palms each. Each group was subject to one of the following treatments per palm, commencing in February 1957.

- (a) Control (no fertilisers).
- (b) 5 lbs. N.P.K. Coconut fertiliser only.
- (c) 5 lbs. N.P.K. fertiliser +  $\frac{1}{2}$  lb. magnesium sulphate (1 lb. since 1958).
- (d) 5 lbs. N.P.K. fertiliser + 1 lb. magnesium sulphate (2 lbs. since 1958).
- (e) 5 lbs. N.P.K. fertiliser +  $1\frac{1}{2}$  lbs. magnesium sulphate (3 lbs. since 1958).

The fertilisers were applied in alternate half circles annually. The dosage of magnesium sulphate was double from the second manuring onwards. The fourth annual manuring was done in July 1960. The yield data for groups of ten palms given in Table VI (a) appear to indicate a slight improvement where magnesium sulphate has been applied. Considering the green palms together it is seen that they have given an average yield of 41 nuts per palm per annum in the last four years, while the corresponding figure for yellow palms is only 22.

A census of the palms taken in July 1960 shows that there has been a small but distinct improvement in the colour of foliage amongst the affected palms receiving magnesium sulphate.

In Table VI (b) the 50 yellow palms receiving the various treatments in groups of 10 have been classified according to the intensity of yellowing of foliage as observed visually in July 1960, 3 years after the trials were commenced. It is seen that while the control and N.P.K. treatment groups show no green palms and a large number of intensely yellow palms (6 and 9 out of 10 respectively) the number of intensely yellow palms amongst the groups receiving magnesium sulphate has been comparatively small (1 to 2). The set of healthy green palms showed no change in their condition during the three years of the experiment — irrespective of whether they received magnesium sulphate or not.

TABLE VI (a)  
Walgama Estate, yield data for groups of ten palms

Treatment	YELLOWED PALMS			
	1956-57	1957-58	1958-59	1959-60
Control (no fertiliser)	186	100	147	138
N.P.K. only	191	125	201	164
N.P.K. + 1 lb. MgSO <sub>4</sub>	225	170	324	222
N.P.K. + 2 lbs. MgSO <sub>4</sub>	224	238	376	327
N.P.K. + 3 lbs. MgSO <sub>4</sub>	200	177	294	274
	GREEN PALMS			
Control	355	232	288	259
N.P.K. only	348	322	374	352
N.P.K. + 1 lb. MgSO <sub>4</sub>	423	346	449	458
N.P.K. + 2 lbs. MgSO <sub>4</sub>	500	470	612	538
N.P.K. + 3 lbs. MgSO <sub>4</sub>	428	378	495	473

**TABLE VI (b)**  
Condition of adult yellow palms at Walgama Estate given various treatments in groups of 10 at Census July 1960

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensively yellow palms</i>
Control	0	4	6
5 lbs. N.P.K. only	0	1	9
5 lbs. N.P.K. + 1 lb. MgSO <sub>4</sub>	3	4	2
5 lbs. N.P.K. + 2 lbs. MgSO <sub>4</sub>	7	2	1
5 lbs. N.P.K. + 3 lbs. MgSO <sub>4</sub>	3	5	2

**MATTEGODA ESTATE**

200 intensively yellow adult bearing palms and 40 healthy green palms were selected for the trials. The yellow palms were divided into 5 groups of 40 palms each. Each group was subject to one of the following treatments per palm annually, commencing in July 1957.

- (a) Control (no fertilisers).
- (b) 5 lbs. N.P.K. fertiliser only.
- (c) 5 lbs. N.P.K. fertiliser + 454 gms. MgSO<sub>4</sub>
- (d) 5 lbs. N.P.K. fertiliser + 408 gms. dolomite.
- (e) 2 lbs. muriate of potash + 2½ lbs. Saphos phosphate, Cattle manure (pair of neat cattle tethered round palms for 7 nights).

The quantities of dolomite and magnesium sulphate used were equivalent.

The 40 green palms were treated with 5 lbs. N.P.K. fertiliser only. In 1960 the cattle manure treatment consisted of tethering a pair of buffaloes round each palm for 21 days.

The yield data for groups of 40 palms given in Table VI (c) seems to indicate some tendency for improvement where magnesium has been applied. Here too the green palms have given a much higher yield than the yellow ones — (60 nuts per palm per annum for greens, and 35 for yellows).

**TABLE VI (c)**  
Yield data for groups of 40 yellow palms at Mattegoda Estate

<i>Treatment</i>	1956-57	1957-58	1958-59	1959-60
Control	1,459	1,391	1,308	1,254
5 lbs. N.P.K. fertiliser only	1,506	1,450	1,439	1,447
5 lbs. N.P.K. + 454 gms. MgSO <sub>4</sub>	1,522	1,399	1,549	1,796
5 lbs. N.P.K. + 408 gms. dolomite	1,583	1,537	1,566	1,764
Cattle manure + supplements	1,137	1,244	1,205	1,174
40 GREEN PALMS				
5 lbs. N.P.K. fertiliser only	2,419	2,236	2,278	2,520

Table VI(d) shows the condition of the palms according to various treatments at a census taken in July 1960, 3 years after the trials commenced. It is seen that the application of magnesium sulphate has affected a noticeable improvement in leaf colour. Dolomite has also been effective, but to a lesser extent. The palms receiving N.P.K. only are in a worse condition than the control.

TABLE VI (d)

Condition of adult yellow palms at Mattegoda Estate (given various treatments in groups of 40) at Census in July 1960

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensely yellow palms</i>
Control	13	20	7
N.P.K. only	3	16	21
N.P.K. + 454 gms. MgSO <sub>4</sub>	17	17	6
N.P.K. + 408 gms. dolomite	8	24	8
Cattle manure + supplements	12	17	11

A similar trial was carried out on a replanted block of young palms which had yellowed. Group of 40 palms each were subject to the various treatments given in Table VI (e) annually since July 1957. The condition of the palms at a census taken in July 1960 is seen in Table VI (e). Here again the application of magnesium has produced a marked improvement in the condition of the palms, magnesium sulphate being more effective than dolomite. The palms receiving N.P.K. fertiliser only is in the worst condition.

TABLE VI (e)

Condition of young yellow palms at Mattegoda Estate (given various treatments on groups of 40) at Census in July 1960

<i>Treatment</i>	<i>No. of green palms</i>	<i>No. of moderately yellow palms</i>	<i>No. of intensely yellow palms</i>
Control	4	13	23
5 lbs. N.P.K. only	4	6	30
5 lbs. N.P.K. + 227 gms. MgSO <sub>4</sub>	22	10	8
5 lbs. N.P.K. + 204 gms. dolomite	13	10	17

Magnesium deficiency is known to be accentuated by the presence of excess H<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, K<sup>+</sup>, and Ca<sup>++</sup> ions due to ion antagonism. The acid leached lateritic soils receiving regular dosages of refined inorganic N.P.K. fertilisers (sulphate of ammonia, saphos phosphate and muriate of potash) therefore present optimum conditions for the development of magnesium deficiency in plants grown on them. This explains the observation that magnesium deficiency symptoms are particularly marked in palms receiving inorganic N.P.K. fertilisers only.

The results indicate that soluble magnesium sulphate is more effective than dolomite as an immediate remedial measure. However, dolomite being considerably cheaper, it could be preferably used where long term preventive measures are to be taken.

**7. 4 × 4 × 4 N.P.K. Experiment on adult palms, Bandirippuwa Estate**

The object of this experiment is to determine the yield response curve of adult coconut palms to the application of inorganic N, P and K fertilisers for assessing the optimum levels of fertiliser application under the soil (lateritic gravel) and climatic conditions represented by Bandirippuwa Estate (Blocks 2B and 2C) which is typical of a comparatively large area of coconut land.

The experimental layout consists of a 4 × 4 × 4 single replicated factorial design where the 2nd order interactions are confounded with those of blocks. There are 4 blocks of 16 plots each, each plot having 18 palms.

The four treatment levels of each of the nutrients N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are 0, 0.5 lbs., 1.0 lb. and 1.5 lbs. per palm per annum, applied in the form of sulphate of ammonia, saphos phosphate and muriate of potash. The first differential manuring was done in October 1960. The manures were sprinkled in full circles round the palms and mammotty forked.

**8. 4 × 4 × 4 N.P.K. Experiment on young palms, Pothukulama**

An experiment similar to the above is to be carried out on young palms at the Pothukulama sub-station, on a virgin jungle clearing where the soil is a sandy loam. In early 1960 the jungle clearing was completed and the seedlings planted in 40 acres in December 1960. The plot palms are artificially pollinated seedlings supplied by the Botanist, while the guard rows consist of selected open pollinated seedlings. The first differential manuring will be carried out late in 1961.

**9. Methods of application experiment, Walahapitiya Estate, Nattandiya**

The object of this experiment is to determine the relative efficiency of fertiliser utilisation (as indicated by yield data) by the adult coconut palm on a lateritic gravel soil under the following different methods of placement — (a) Half circular trenches, (b) Broadcasting and harrowing, (c) Spreading round the base of the palm and forking in.

One year's premanurial recording was completed in October 1960.

## B. LABORATORY INVESTIGATIONS

**1. Radio isotopes (P<sup>32</sup>) project.**

The ultimate objective of this project is to assess the relative efficiency of utilisation of phosphatic fertiliser by the coconut palm under different forms and methods of application. The standard field experimental methods adopted for such studies depend on yield data. But in the case of a perennial like the coconut palm, field experiments depending on yield data necessarily involve long term periods of 8 to 10 years at least. The application of radio isotopes in fertiliser trials seems to offer a much quicker means of obtaining the required information.

**Preliminary experiment No. 1 (Commenced 30th September 1960)**

**Objects.**—(i) To determine the time interval between the application of radioactive phosphorus to the soil and its transportation to the crown of the palm (as determined by its presence in toddy) in sufficient quantities for detection and measurement.

(ii) To examine the relative merits of analysis of toddy, nut water, leaf, and inflorescence as a means of studying the uptake of radioactive phosphorus applied to the soil.

*Procedure.*—2½ litres of a solution containing 5 millicuries  $P^{32}$  in 14 per cent  $KH_2PO_4$  were sprinkled uniformly round the opened manure circle of an adult palm which was being tapped for toddy. Samples of toddy collected daily in the morning and afternoon for 11 days were analysed for  $P^{32}$  and  $P^{31}$ . One month after application of the radioactive phosphate, the palm was stripped of its bunches of nuts, and the nut water of each individual nut analysed for  $P^{31}$  and  $P^{32}$ . At the same time, three fronds were also cut — the 1st and 4th fully opened leaves, and a fully matured leaf. Leaflets from the base, middle and upper end of the fronds were analysed for  $P^{32}$  and  $P^{31}$  (after removing midribs).

Seven weeks after the application of  $P^{32}$ , another spadix was tapped twice a day for 30 days and  $P^{32}$  and  $P^{31}$  in toddy samples analysed.

Fifteen weeks after the application of  $P^{32}$  a third spadix was tapped and the toddy similarly analysed for 3 days. This spadix, and another younger unopened spadix was then removed from the palm, and the male and female flowers at the base, middle and upper end of the inflorescence analysed for  $P^{32}$  and  $P^{31}$ .

*Results:*

(i) Radioactive phosphorus was found in the toddy within 2 hours of its application to the soil.

(ii) There was no large increase with time in the quantity of radioactive phosphorus in the toddy from the first spadix.

The specific activity of phosphorus in the toddy samples (ratio of active to non-active phosphorus in counts per minute per mg.  $P_2O_5$ ) showed a fluctuating increase from 2 to 14 in the 11 days the spadix was being tapped.

(iii) The toddy from the second spadix (tapping commenced 7 weeks after  $P^{32}$  application) had a higher quantity of radioactivity, but here too the specific activity of phosphate in the toddy samples showed a day to day fluctuating increase from 87 to 370.

(iv) The specific activities of the phosphate in nut water from individual nuts in the different bunches are tabulated in Table I (B) (a). The bunches are arranged in decreasing order of maturity. The nuts are numbered according to their position from the base of the stalk upwards.

The specific activities of the phosphate in the nuts of mature bunches A, B, and C though low, are remarkably close, and there is comparatively little variation between individual nuts in the same bunch. There is a greater accumulation of radioactivity in the less mature bunches D to H. In these also the variation between individual nuts in bunches is small. The youngest bunch H picked 11 weeks after the  $P^{32}$  application shows a much higher accumulation of radioactive phosphorus.

The specific activities of the phosphate in the leaflets sampled 30 days after  $P^{32}$  application are given in Table I B (d). These show remarkable consistency for the 2nd and 3rd leaves, in which the radioactivity is higher than in the 1st and mature leaves. In all leaves the radioactivity is seen to be uniformly distributed throughout the whole leaf.

The leaf and nut water analyses show that there is a tendency for the recently absorbed phosphate to accumulate in the less mature parts. The remarkable uniformity in the specific activities of phosphate in the water of mature nuts and leaf is noteworthy. It suggests considerable mobility of phosphate ions even in mature nuts.

TABLE 1 (B) (a)  
Specific activity of phosphate in nut water 30 days after application of P<sup>32</sup>

Bunch No.	Nut No.	Volume of Water cc.	Inorganic P <sub>2</sub> O <sub>5</sub> Mg./100 cc.	Specific activity counts/minute/mg. total P <sub>2</sub> O <sub>5</sub>	Mean sp. activity for bunch
A	1	235	22.5	8.7	10.7
	2	205	15.2	12.8	
B	1	250	15.3	13.9	11.4
	2	240	18.0	10.3	
	3	210	15.2	13.2	
	4	226	17.4	11.6	
	5	220	16.4	11.9	
	6	190	22.4	8.6	
	7	250	14.9	15.3	
	8	250	17.4	11.2	
C	1	255	13.4	4.9	13.4
	2	250	13.8	15.1	
	3	290	20.0	10.4	
	4	280	21.5	10.9	
	5	305	15.5	12.8	
	6	245	14.8	16.7	
	7	210	13.0	22.8	
D	1	315	13.8	19.1	16.2
	2	315	11.9	22.2	
	3	345	24.8	12.7	
	4	335	19.0	12.5	
	5	405	18.0	14.5	
	6	415	16.4	16.3	
E	1	265	19.3	—	29.1
	2	310	15.8	29.4	
	3	305	15.5	24.6	
	4	285	13.5	29.3	
	5	260	13.0	31.0	
F	1	365	12.5	29.9	28.5
	2	335	10.5	26.8	
	3	375	9.8	29.2	
	4	330	10.0	27.3	
	5	385	9.5	29.2	
G	1	365	13.2	16.3	25.5
	2	335	12.6	29.0	
	3	317	11.6	19.6	
	4	295	10.8	23.6	
	5	355	11.6	22.8	
	6	373	9.8	23.2	
	7	297	15.2	28.0	
	8	369	11.6	17.4	
	9	339	10.8	25.7	
	10	339	8.4	43.2	
	11	321	11.6	31.5	

Bunch No.	Nut No.	Volume of Water cc.	inorganic $P_2O_5$ Mg./100 cc.	Specific activity counts/minute/mg. total $P_2O_5$	Mean sp. activity for bunch
H	1	199	21.4	21.2	22.4
	2	291	10.8	23.6	
	3	293	11.0	25.0	
	4	279	13.4	20.2	
	5	275	12.6	19.4	
	6	337	13.4	23.6	
	7	300	13.4	23.7	

(Youngest bunch picked 77 days after  $P^{32}$  application)

1	94	330	307
2	84	369	
3	93	265	
4	98	276	
5	83	311	
6	87	289	

TABLE I (B) (b)

Specific activity of phosphate in leaflets sampled 30 days after  $P^{32}$  application

	% $P_2O_5$	Specific activity cts./mt./mg. $P_2O_5$
1st fully opened leaf —	Top leaflets	9.8
	Middle leaflets	10.0
	Base leaflets	10.0
2nd fully opened leaf —	Top	23.8
	Middle	24.4
	Base	22.8
3rd fully opened leaf —	Top	23.7
	Middle	23.0
	Base	23.1
Mature leaf —	Top	10.6
	Middle	8.4
	Base	11.5

(v) The specific activities of phosphate in toddy and various parts of the inflorescence from the spadix tapped 15 weeks after  $P^{32}$  application are given in Table I B(d). There has been considerable accumulation of radioactive phosphorus in this spadix. The toddy contains less activity than the various parts of the inflorescence. In the younger unopened spadix sampled at the same time there is a similar amount of radioactivity.

The female flowers and spikes show the highest accumulation of radioactive phosphorus.

TABLE I B (d)

Specific activities of phosphate in toddy and various parts of inflorescence from spadix tapped 15 weeks after  $P^{32}$  application

		<i>Specific activity in counts/ mt./mg. <math>P_2O_5</math></i>
Toddy	1st day	478
	2nd "	591
	3rd "	507
Female flowers	upper	2,472
	middle	1,190
	lower (near base of spadix)	1,177
Male flowers	upper	916
	middle	660
	lower	565
Spikes	upper top	1,131
	lower "	1,119
	upper middle	717
	lower "	1,093
	upper bottom	842
	lower "	1,015
<i>Younger unopened spadix sampled at same time —</i>		
Female flowers	middle	1,254
	lower	1,134
Male flowers	upper	381
	middle	446
	lower	1,405

(vi) Soil analysis showed movement of the applied radioactive phosphorus to a depth of 20 inches after one week.

The results indicate that (a) transport of phosphate from the soil to the crown of the palm is very rapid, (b) accumulation of recently absorbed phosphorus tends to take place chiefly in the developing spadices (in the female flowers and spikes in particular), and also in the less mature leaves and nuts (c) the phosphate ions in water of mature nuts and leaves are in a state of dynamic equilibrium.

Leaves, nut water and female flowers appear to be the more promising plant organs for studying the uptake of radioactive phosphorus applied to the soil.

## 2. Storage studies on fertiliser mixtures containing urea.

Coconut fertiliser mixtures containing urea (in pellet form) as the source of nitrogen was found to absorb a considerable amount of moisture and become deliquescent when stored under the usual conditions in gunny bags on the floor both inside and in the verandah of the manure shed. Some soluble

fertiliser was exuded out as a solution which wet the floor and other bags. The mixtures become sticky, and caked on drying. Within two months the percentage of nitrogen in the mixture was reduced to half the original value, presumably as a result of urea having been lost in the exuded solution.

Fertiliser mixtures containing sulphate of ammonia instead of urea showed little change under similar conditions of storage.

### 3. Soil analysis — Methods of application experiment, Marandawila

The following chemical analysis of the soil samples taken in January 1960 were completed:—

- (a) Truog phosphate.
- (b) Total nitrogen.
- (c) Base exchange capacity.
- (d) Total exchangeable bases.
- (e) Exchangeable potash, calcium and magnesium.
- (f) pH.

Soil samples were taken from each of the 27 plots of the experiment at depths of 0-9", 9-18", and 18-30", both from manure circles and centres of squares.

Details of these analyses, comparing them with the figures for the 1950 series of soil samples taken from the same plots in the same manner are given in the Tables below.

The analytical data show the following points:—

- (i) The soil is a foamy coarse sand (see Table III B (a) for mechanical analysis data).
- (ii) The soil has a low base-exchange capacity. The 1950 series was about 50% base saturated, while the 1960 series shows full base saturation (see Table III B (b)). On account of its low base exchange capacity, the soil has shown little tendency towards base accumulation although the plots have been regularly manured since 1950. In fact, little difference is observed between the control and fertilised plots in their nitrogen and potash contents, although the sampling in 1960 was done within 6 months of the last application of fertilisers in June 1959 (see Table III B (c)). This indicates the preference for more frequent application of small amounts of fertiliser (with reference to the easily soluble nitrogen and potash fertilisers) under such soil conditions.
- (iii) The residual effect of phosphate is observed in its high concentration up to a depth of 18 inches in the manure circle applications. When broadcast, the increased phosphate concentrations in the soil is spread over a wider area — though the actual increase in phosphate content is considerably lower (see Table III B (c)).
- (iv) The regular application of sulphate of ammonia and muriate of potash has not had any noticeable effect on the exchangeable calcium and magnesium contents of the soils (Table III B (d)).
- (v) The soil pH has shown a tendency to decrease where sulphate of ammonia is applied without saphos phosphate (Table III B (e)). There is an increase in the calcium content of soils from manure circles where saphos phosphate has been applied in circles.

**TABLE III B (a)**  
**Methods of Application Experiment — Marandawila**  
**Mechanical Analysis of Soil Samples — 1950 Series**  
 (Samples from centres of squares)

	Plot No.	Depth	Coarse sand %	Fine sand %	Silt %	Clay %
BLOCK 1	2	0 - 9"	75.59	12.86	0.8	7.0
		9 - 18"	70.44	18.22	0.9	8.1
	3	0 - 9"	77.56	16.09	2.25	6.55
		9 - 18"	88.13	8.17	nil	5.4
BLOCK 2	4	0 - 9"	85.64	11.07	0.1	4.5
		9 - 18"	74.19	16.76	nil	10.5
	12	0 - 9"	70.52	16.41	1.5	12.1
		9 - 18"	73.75	15.91	0.5	11.8
14	0 - 9"	64.96	19.88	1.15	15.55	
	9 - 18"	76.38	14.24	0.1	10.2	
BLOCK 3	15	0 - 9"	65.66	20.44	1.0	14.3
		9 - 18"	72.53	17.87	1.0	10.5
	19	0 - 9"	66.65	21.87	1.9	11.7
		9 - 18"	74.71	18.87	0.4	8.3
21	0 - 9"	66.65	24.48	2.15	8.35	
	9 - 18"	70.94	21.97	0.7	8.1	
24	0 - 9"	69.53	20.36	0.9	11.6	
	9 - 18"					

**TABLE III B (b)**  
**Methods of Application Experiment — Marandawila**  
**Base exchange capacity and base saturation of soils from manure circles**

Plot No. and Treatment	1950 Series			0-9" 1960 Series		
	Total Exch. Bases me. %	Base Exchange Capacity me. %	% Base Saturation	Total Exch. Bases	Base Exch. Capacity	% Base Saturation
3 — N <sub>c</sub> K <sub>o</sub> P <sub>o</sub>	0.55	1.21	45	2.32	1.49	100
6 — N <sub>a</sub> K <sub>o</sub> P <sub>o</sub>	—	1.12	—	0.97	1.06	91
8 — N <sub>c</sub> K <sub>o</sub> P <sub>c</sub>	0.63	1.17	54	1.72	1.68	100
10 — N <sub>c</sub> K <sub>o</sub> P <sub>o</sub>	0.86	1.06	81	1.50	1.67	90
21 — N <sub>o</sub> K <sub>o</sub> P <sub>o</sub>	0.76	1.39	54	1.52	1.22	100
24 — N <sub>o</sub> K <sub>o</sub> P <sub>o</sub>	0.78	1.22	64	1.52	1.26	100

TABLE III B (c)

Methods of Application Experiment, Marandawila  
Chemical Analysis of Soil — 1950 and 1960 Series

Mean values for plots receiving zero, broadcast, and circular trench placements of N, P and K.

(a) TOTAL NITROGEN

Treatment	ppm. N Series	Manure Circles			Centres of Squares		
		0-9"	9-18"	18-30"	0-9"	9-18"	18-30"
N (No nitrogen)	1950	293	211	—	266	184	—
	1960	339	251	199	307	250	191
N <sub>b</sub> (Nitrogen broadcast)	1950	276	246	—	272	172	—
	1960	374	258	205	317	244	197
N <sub>c</sub> (Nitrogen in circles)	1950	243	170	—	235	145	—
	1960	350	204	174	279	207	180

(b) AVAILABLE PHOSPHATE (Truog's method) Ppm. P<sub>2</sub>O<sub>5</sub>

P <sub>0</sub> (No phosphate)	1950	5.7	3.8	—	18.0	3.1	—
	1960	2.6	4.5	3.4	5.8	2.5	8.4
P <sub>b</sub> (Phosphate broadcast)	1950	8.6	3.7	—	18.8	2.8	—
	1960	11.0	6.4	3.8	21.9	4.6	8.2
P <sub>c</sub> (Phosphate in circles)	1950	24.5	4.7	—	18.7	3.2	—
	1960	195.8	58.0	5.3	4.1	3.8	7.6

(c) EXCHANGEABLE POTASH (me./100 gms. soil)

K <sub>0</sub> (No potash)	1950	0.059	0.056	—	0.090	0.054	—
	1960	0.075	0.073	0.052	0.046	0.036	0.050
K <sub>b</sub> (Potash broadcast)	1950	0.081	0.061	—	0.067	0.073	—
	1960	0.086	0.082	0.067	0.048	0.049	0.051
K <sub>c</sub> (Potash in circles)	1950	0.064	0.056	—	0.096	0.058	—
	1960	0.122	0.175	0.149	0.062	0.040	0.050

TABLE III B (d)

Methods of Application Experiment — Marandawila  
Exchangeable Calcium and Magnesium in Soils — 1960 Series

(Plot means according to different treatments)

Treatment	Calcium as Ca-me./100 grms. soil						Magnesium as Mg-me./100 grms. soil					
	Manure Circles			Centres of Squares			Manure Circles			Centres of Squares		
	0-9"	9-18"	18-30"	0-9"	9-18"	18-30"	0-9"	9-18"	18-30"	0-9"	9-18"	18-30"
K <sub>0</sub>	0.65	0.67	0.75	0.48	0.45	0.66	0.086	0.060	0.046	0.054	0.052	0.072
K <sub>b</sub>	0.62	0.58	0.77	0.48	0.33	0.49	0.092	0.062	0.052	0.050	0.048	0.058
K <sub>c</sub>	0.61	0.51	0.95	0.43	0.40	0.58	0.084	0.050	0.050	0.052	0.050	0.070
P <sub>0</sub>	0.47	0.53	0.84	0.36	0.46	0.59	0.074	0.060	0.048	0.050	0.040	0.060
P <sub>b</sub>	0.57	0.63	0.85	0.48	0.39	0.57	0.084	0.068	0.058	0.050	0.060	0.058
P <sub>c</sub>	0.81	0.61	0.71	0.45	0.48	0.57	0.100	0.026	0.046	0.054	0.050	0.070

**TABLE III B (e)**  
**Methods of Application Experiment, Marandawila**  
**Soil pH in 10<sup>-2</sup> M. CaCl<sub>2</sub> — 1950 and 1960 series**

Plot No.	Treatment	Manure Circle 0-9"	
		1950	1960
5	N <sub>0</sub> P <sub>0</sub> K <sub>0</sub>	5.2	5.5
14	N <sub>0</sub> P <sub>0</sub> K <sub>C</sub>	5.3	5.2
9	N <sub>C</sub> P <sub>0</sub> K <sub>B</sub>	5.6	5.0
26	N <sub>C</sub> P <sub>0</sub> K <sub>0</sub>	5.9	4.7
11	N <sub>B</sub> P <sub>0</sub> K <sub>0</sub>	4.6	4.6
20	N <sub>0</sub> P <sub>C</sub> K <sub>0</sub>	5.2	5.6
2	N <sub>0</sub> P <sub>C</sub> K <sub>C</sub>	5.4	5.7
17	N <sub>C</sub> P <sub>C</sub> K <sub>0</sub>	5.0	5.1
27	N <sub>C</sub> P <sub>C</sub> K <sub>C</sub>	5.2	5.3
8	N <sub>B</sub> P <sub>C</sub> K <sub>0</sub>	5.2	5.6

**4. Study on uptake of nutrients by cow-pea from soil of N.P.K. experiment at Pothukulama**

Samples of tops, roots, seed and husk of cow-pea grown in the experimental area were taken from each of the four blocks. The samples are being analysed for N, P, K, Ca and Mg to determine.

(a) the amount of nutrient removed from the soil by the harvest, and

(b) the amount of nutrients turned back into the soil. Hitherto, the P and K analysis have been completed.

Samples of soils were also taken from the different blocks for analysis.

### C. MISCELLANEOUS

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

- (i) 'Fertilising on Coconut Estates' — to the Low Country Products Association.
- (ii) 'The validity of chemical extraction Methods for determining the availability of soil phosphorus' — to the Ceylon Association for the Advancement of Science.
- (iii) 'A preliminary note on Magnesium deficiency in Coconut Palms' (joint paper with the Director) to the C.A.A.S.

An article on 'The manuring of Adult Coconut Palms' by the Soil Chemist was published in the Ceylon Coconut Planters Review, Vol. I, No. 1.

### D. PERSONNEL

**D. Staff**

Soil Chemist: Dr. D.A. Nethsinghe, B.Sc. (Cey.), D.Phil. (Oxon.), A.R.I.C.

Research Assistant: Mr. T. S. Balakrishnamurthy, B.Sc. (Lond.).

Senior Technical Assistants: Messrs. M.A.T. de Silva, B.Sc. (Lond.), K.Thanigasalam, B.Sc. (Cey.).

Technical Assistants: Messrs. V. Nalliah, D.E.G. Nedimala.

Senior Field Assistants: Messrs. G. Rajapakse and A.B.A. Jayamaha.

Field Assistants: Messrs. J.H.C. Wirekoon, R.M. de Silva and W.E.I. Soysa.

Laboratory Attendants: Messrs. M.M. Perera, K.V. Walter de Silva and D.M. Pathirage.

Field Attendants: Messrs. F.B. Perera, P.M. Harischandra and M.R. Stanley Fernando.

**Appointments and Promotions:**

Mr. W.E.I. Soysa was appointed to the post of Field Assistant as from 15th January 1960.

Mr. K. Thanigasalam was promoted to the Senior Technical Assistant grade on his passing the B.Sc. (Ceylon) examination as from 16th July 1960.

Mr. M.A.T. de Silva was promoted to the Senior Technical Assistants grade on his passing the B.Sc. (Lond.) examination as from 30th September, 1960.

Mr. T.S. Balakrishnamurthi was transferred to the Division as Research Assistant as from 1st October 1960.

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

# REPORT OF THE CHEMIST 1960

## COPRA

(1) A fairly comprehensive experiment has been carried out during the year in order to evaluate copra quality in relation to the maturity of the drupe. Five categories of nuts (a) when freshly harvested and (b) when seasoned for 30 days have been considered in the study. They are: fallen nuts, first bunch nuts, second bunch nuts, third bunch nuts and fourth bunch nuts.

Approximately 1,000 nuts were examined under each category, and the weight characteristics and copra out-turns are charted in Table I. The actual oil percentages in the kernel are summarised in Table II. The figures in Table III (a) give the percentage distribution of the grades of copra produced, and Table III (b), the computed values in rupees for a ton of copra from each of the stages of maturity, on the basis of the Percentage Distribution of the Grades given in Table III (a). [NOTE — Prices ruling on 1-6-60 have been used in these calculations].

The results clearly show that:—

(a) The practice of seasoning is decidedly beneficial as it affects all round improvement in quality of all categories of nuts employed, particularly the grossly immature kernel. It will be seen that whilst seasoning increases the value of a ton of copra from fallen nuts by Rs. 1/72, the corresponding difference is Rs. 34/80 for the 'fourth bunch' nuts.

(b) The overall average figures for all the categories taken together show that the increased value due to seasoning amounts to Rs. 13/19 on every ton.

(c) There is of course the further point that the actual texture of the kernel from the seasoned coconut is more suitable for milling purposes.

(d) Although there is no question that 'fallen nuts' (whether seasoned or unseasoned) give the best copra, yet the difference in value between them and bunches 1 and 2 are not very great.

(e) First and second bunch nuts are equally suitable for copra making.

(f) The use of the immature kernel from third and fourth bunch nuts involve appreciable offsets in economic returns to the producer. Even after seasoning, the difference in value per ton between the second and third is Rs. 13/28 and that between second and fourth is Rs. 42/-.

(2) On a request made by FAO, certain special studies were carried out during the year in order to make an assessment of the economic losses to the coconut industry consequent on deterioration of under-dried copra.

The investigations have convincingly shown that half cured or under-dried copra is a very unstable and unsatisfactory product. It is indeed very susceptible to processes of biological deterioration which bring in their train concomitant losses to the producer and the industry. It has been found that these losses could assume very severe proportions under extreme conditions.

The present studies have been focussed principally on the quantitative aspects of the degenerative losses involved in the process of copra deterioration, during an observational period of six months. During this period analytical checks have been made on samples of copra dried to different initial moisture contents, which were subsequently kept under satisfactory and unsatisfactory conditions of storage.

For the purpose of the experiment 3,000 typical estate coconuts drawn from the fourth crop (1959) at Bandirippuwa Estate were processed in the form of half-nuts in strict conformity with the operational schedule outlined in Leaflet 15 of the Coconut Research Institute, after seasoning on the field for a period of 4 weeks. Samples were drawn at ten stages of processing, and the cups were looped together in different lots and then hung up in three different types of storage as follows:

**Air-Conditioned Room (Stage 10 only)**

(a) Four weighed loops with 30 cups each (expressly used for quadruplicate weighings at pre-determined intervals).

(b) Two loops with 50 cups each (sampled at intervals for duplicate chemical analyses).

**Well Ventilated Estate Store (All Stages 1 to 10)**

(a) Forty weighed loops in all, each with 30 cups. Four loops (for quadruplicate weighings) drawn from each of the stages 1 to 10.

(b) Twenty loops in all with 50 cups in each. Two loops (for duplicate chemical analyses) drawn from each of the stages 1 to 10.

**Poorly Ventilated Estate Store (All Stages 1 to 10)**

(a) Forty loops in all exactly as in (a) of the Well Ventilated Store.

(b) Twenty loops in all exactly as in (b) of the Well Ventilated Store.

The experiment itself should be considered to be of a somewhat preliminary nature, and it should also be mentioned that it has not been possible to cope with a complete examination of all the samples in the experiment (at each of the intervals they were drawn) owing to the prodigious volume of manipulative and other work involved in sampling and analysis. Discretion had therefore to be exercised in the experimental programme so that work was restricted to essentials from the point of view of the specific information sought. The more important results of the studies, are charted in Tables IV to VI.

Table IV will show that for the storage trial in the Air-Conditioned Room, samples from stage 10 alone were used. The purpose of the trial was of course to make observations on the keeping qualities of the well-dried superior grade copra when stored under fairly stable conditions of temperature and humidity. The results convincingly show that for a period of 22 weeks (5 months) the total loss of anhydrous copra did not exceed 0.58% of the original weight. Though there was no apparent change in the percentage oil content (during this period), it will be seen further (column 8) that the true loss of oil amounts to 0.38% of this total. Even after 22 weeks the free acidity is only 0.11%. Though no pronounced micro-organic action was evident, it would appear that slow acting enzymes already generated in the meat (which act more on the oil than the fibre) are principally responsible for these losses.

The results of the storage trials in the Well and Poorly Ventilated Stores are available in tabulations V and VI. Though the data are less complete than those for the Air-Conditioned Room, yet the results exemplify certain vital facts. It will be seen that there are irregular fluctuations in the moisture contents of the different samples during storage. In general, the tendency is for the very wet samples (stages 1 to 8) to dry out progressively and for the dry ones (stages 9 and 10) to absorb moisture during storage.

Regarding the actual quantitative losses of anhydrous copra, without doubt there are certain interesting and significant features in the results obtained. These are clearly elucidated by figures in the simplified Tables VII to IX, which have been computed from the complete data that have been presented earlier.

That the type of storage definitely influences the extent and degree of deterioration is clearly shown by the analytical figures for free fatty acidity in Table VII. It will be seen that regardless of the exact time stage in the experiment, at which samples were examined, the copra from the Poorly Ventilated Store would yield (relatively) the most inferior oil, with an average acidity of 3.1% ranging between 1.1 and 8.6 per cent. The appropriate figures for the Well-Ventilated Store will be found to be 2.0% within the range 0.5 to 6.6 per cent. Though samples from stage 10 alone were stored in the Air-Conditioned Room, the results clearly show that for a 22 week period the acidity averaged only 0.08% (range 0.06 to 0.12 per cent), which is about ten times lower than the acidities for the corresponding samples in the other stores. It will be easily recognised that the highest acidities have been recorded for stages 1 to 3, where the initial moisture contents of the meat were over 20 per cent.

Regarding actual losses of anhydrous copra (Table VIII), it will again be evident that the biggest losses have been recorded for stages 1 to 3. It would appear that when the initial moisture contents are high, conditions of good ventilation and aeration accentuated the activity of organisms resulting in bigger losses of anhydrous copra. When the copra dries out however to below 10 per cent moisture, the position appears to be reversed so that these losses are somewhat greater under conditions of poor ventilation. The experiment also clearly shows that the initial moisture content of the copra coupled with moisture fluctuations during storage, play a vital role in the determination of the extent of these degenerative losses. Accordingly, it will be seen that the results of the present experiment, as far as they relate to losses of anhydrous copra, have to some extent been complicated by the phenomenon of moisture re-absorption, particularly in the well-ventilated store. That this is so will be clearly evident from the figures summarised in Table IX.

The losses in the foregoing experiment, considered so far, do not include the 'dust' produced during storage of the various samples. What has been reported as 'loss of anhydrous copra' represents only that weight of copra which has actually disappeared in the form of gas and moisture of decomposition. Any 'dust' produced in the various samples was not dislodged from the cups but was carefully weighed at the different stages with the loops.

As a corollary to the main experiment a separate study was made with the object of obtaining a preliminary assessment of the production of 'dust'. In order to avoid unwieldiness, samples from pre-determined stages alone were used. The selected samples were stored in aluminium trays in the Well Ventilated Store. Weight and analytical records were kept at intervals over a period of 21 weeks. The computed results from the study showing the losses of anhydrous copra and dust (calculated as percentages of the original dry weight) are presented in Table X.

The overall average figures show clearly that the losses of both anhydrous copra and 'dust' progressively increase with the reduction in the size-form of the dried copra. This would mean that from the point of view of losses through deterioration copra is best processed in the form of half-nuts (i.e. cups). In very general terms, the results show that the dust produced on storage is of the order of 70 per cent of the loss of anhydrous copra.

The question of actual losses and quality of the oil in these experiments has not been considered owing to the fact that it would not have been possible to cope with the prodigious volume of analytical work that would have been necessitated if samples were drawn for oil analysis at every stage of the experiment.

## DESICCATED COCONUT

On a request made by the Standards Sub-Committee on Desiccated Coconut, certain special studies were carried out during the year on samples of desiccated coconut obtained from various sources. The objectives of the study were *firstly* to determine the range of composition of fresh and rancid samples and *secondly* the possibility of evolving an objective test as such for the estimation of rancidity.

(a) The analytical results on *nine* samples examined are charted in Table XI. This tabular summary contains the descriptions of the respective samples as received. It will be seen from the data that even the good samples had moisture contents over 3.0 per cent, which is the permissible maximum that has been fixed by the Committee. A further point to be noted, is that the free fatty acid estimations carried out on the original solid, extracted oil and pressed oil have given divergent values. It has been recommended that for quantitative assessments the most reliable index of deterioration would probably be obtained from the extracted oil.

(b) Some promising results have been obtained with the Kreis test for the detection of oxidative rancidity in coconut oil by chemical means. To apply the test, 1 ml. of the oil is shaken for one minute with 1 ml. of a 0.1 per cent solution of phloroglucinol in ether. If, on separation the lower acid layer has acquired a red or pink colour, the oil is considered to be rancid, the depth of colour being a rough indication of the degree of rancidity. The question of reproducibility and the possibility of making the test quantitative is being investigated by matching the colour produced with methyl red and permanganate standards.

Regarding the mechanism of the Kreis Reaction (which was originally developed as an empirical test for rancidity), it is now known that the theoretical basis of the reaction is the presence of epihydrin aldehyde (an oxidation product of acrolein) which forms its red condensation product with phloroglucinol. Though the free aldehyde as such has not been isolated in a pure state, because of its instability, its diethyl acetal has been synthesised (by Powick) and shown to respond to the test. There is general acceptance now that the Kreis Reaction is due to the presence, in rancid oils, of an acetal of epihydrin aldehyde, owing to the fact that only in the presence of both acrolein and a peroxide could a colour spectroscopically identical with that given by rancid fats, be obtained.

## POT CULTURE EXPERIMENT

(a) The second sand-pot culture experiment on 324 coconut seedlings which was laid down in October 1959, was maintained satisfactorily during the year. Growth measurements were recorded on the seedlings at monthly intervals, and at pre-determined periods they were uprooted for examination of physical and chemical characteristics. The physical and visual symptoms characteristic of each particular deficiency have now been established.

(b) The work of the Division during the year was focussed principally on analytical aspects. The chemical examination of samples (numbering over 175) from Lots, I, III, V and VII (of the First Pot Culture Experiment) for Nitrogen, Phosphorus, Potassium, Calcium and Magnesium has been completed.

(c) Both the Pot Culture Experiments that have now been completed, confirm each other regarding certain visual and morphological effects produced on coconut seedlings consequent on absolute deficiencies of the different essential macronutrients. On the basis of the results that have been consolidated the following visual symptoms and other effects could be set out positively as characterising the following deficiencies:—

*Minus Nitrogen.*—Very pronounced restriction in growth of both tops and roots. The retardation in height and girth highly significant at the close of one year. Reduction in the number of leaves significant. Leaves small and remain webbed (i.e. without pinnating) much longer than in other treatments. Younger

leaves a diffuse pale yellowish green in colour, the yellow tint becoming more pronounced in the older leaves. Petioles yellow green to canary yellow. Drying and defoliation of the old leaves premature. The stunted spindly growth and lack of succulence of the plant coupled with the visual symptoms make identification easy.

*Minus Phosphorus.*—Significant restriction in growth becomes evident much later than with nitrogen deficiency. Retardation in root development also not so pronounced as with a deficiency of nitrogen. Though plant is stunted in growth, it remains darker green in colour than those in the complete culture. In the early stage the plants were not distinctly different from those in (-ALL) pot, but after 6 months growth, shorter petioles and rosetting of leaves was a characteristic. Phosphate deficient plants were found to be more susceptible to attack by *Helminthosporium*. Leaflets remained dark green throughout and hardly turned yellow before drying. It should be noted that unlike some other crops the symptoms are quite distinct from nitrogen deficiency.

*Minus Potassium.*—Quite contrary to what is generally believed and accepted, a remarkable fact has been established regarding K deficiency. On the basis of consistent results and repeated confirmations obtained in the giant pots as well as in Mitscherlich vessels (on both *nana* and *typica* varieties) it can be categorically stated that during the *first year* of growth an absolute deficiency of K produces no retardation in growth or any visual symptoms. Except for the girth factor during certain stages, all seedlings have appeared at least deceptively healthy with perfectly normal development of both shoot and roots. In fact, in one instance amputated seedlings in the (-K) treatment were found to be definitely better than the (+ALL). There is of course no doubt that K is a dominant requirement in the later growth stages. At what precise stage, K actually assumes importance could very well form the subject of future study.

*Minus Calcium.*—Significant retardation in growth takes place, and as far as the aerial parts are concerned, a somewhat imperceptible transformation gradually takes place in the seedlings whereby they assume a slender form with a sparse appearance of leaves. Slight distortion of the young leaves, with tips hooking back, has also been sometimes noticed. The outstanding symptom of calcium deficiency which the present experiments have revealed, is the significant retardation of root development, characterised by a proliferation of short roots — a symptom not shown by any of the other deficiencies.

*Minus Magnesium.*—For the first time on record, and much against current beliefs, the most spectacular results (with marked foliage symptoms) have been obtained with magnesium deficiency. Except for leaf number, the seedlings suffer highly significant retardation.

The seedlings make anarchic growth and the leaves tend to become tattered. Some of the younger leaves emerge with difficulty and before they are fully exerted, the distal end of succeeding ones may pinnate into leaflets. A characteristic inter-vascular yellowing is of an ochreous to chrome yellow tint (quite distinct from the minus N symptom), commences initially with the older leaves, and proceeds systematically towards the younger ones. Mosaic blotches and brown spots symptomatic of chlorotic effects appear in the older leaves as the deficiency becomes more acute. Root development is not severely retarded as with minus N deficiency. Bronzing followed by defoliation is sometimes severe. Mg. deficiency is so very conspicuous that it could easily be picked out from the rest of the plants even from a distance.

#### MISCELLANEOUS WORK

Analyses and reports have been made on a few samples of copra and coconut oil.

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TABLE I  
Recoveries of Copra and Oil in Relation to Maturity of Coconuts

1									2									
FRESHLY HARVESTED UNSEASONED GREEN NUTS									NUTS SEASONED FOR 30 DAYS									
Maturity of Nut	Number of Nuts	AVERAGE WEIGHT PER NUT (GRAMMES)							Average out-turn of copra (6% Moisture) Nuts/ Candy	Number of Nuts	AVERAGE WEIGHT PER NUT (GRAMMES)							Average out-turn of Copra (6% Moisture) Nuts/ Candy
		Whole Nut	Husked Nut	Anhydrous Kernel	OIL	Copra (6% Moisture)	Copra per Nut as % Husked Nut				Whole Nut	Husked Nur	Anhydrous Kernel	OIL	Copra (6% Moisture)	Copra per Nut as % Husked Nut		
Fallen Nuts	1000	852	452	140	95.6	149	33.0	1702	1005	898	405	126	86.1	134	33.1	1893		
First Bunch	1002	941	459	140	95.6	149	32.5	1709	1005	1077	471	145	99.0	154	32.7	1647		
Second Bunch	975	1139	489	156	107.3	166	33.1	1527	1005	1096	467	140	96.3	149	31.9	1704		
Third Bunch	1010	1418	557	146	103.2	155	27.8	1641	1005	1244	507	130	91.9	138	27.2	1837		
Fourth Bunch	1010	2047	550	116	77.3	123	22.4	2058	1000	1798	648	126	83.9	134	20.7	1900		

TABLE II  
Percentage Moisture and Oil Contents of the Kernel

MATURITY OF NUT	% MOISTURE IN KERNEL	% OIL IN KERNEL (Dry Basis)
Fallen Nuts	43.5	68.3
First Bunch	43.8	68.3
Second Bunch	46.4	68.8
Third Bunch	49.0	70.7
Fourth Bunch	65.2	66.6

(NOTE — 1 Candy = 560 lbs.)

PRICE BASIS FOR COMPUTATIONS IN TABLE III (b)

TABLE III (a)

PERCENTAGE DISTRIBUTION OF THE GRADES

Colombo prices on 1-6-60

No. 1 Copra — Rs. 830/- per ton  
 „ 2 „ — „ 790/- „ „  
 „ 3 „ — „ 750/- „ „

1					2			
FRESHLY HARVESTED UNSEASONED GREEN NUTS					NUTS SEASONED FOR 30 DAYS			
Maturity of Nut	QUALITY				QUALITY			
	No. 1 (%)	No. 2 (%)	No. 3 (%)	Total (%)	No. 1 (%)	No. 2 (%)	No. 3 (%)	Total (%)
Fallen Nuts	95.5	2.6	1.9	100.0	98.6	0.7	0.7	100.0
First Bunch	93.3	3.1	3.6	100.0	98.3	0.5	1.2	100.0
Second Bunch	92.2	7.0	0.8	100.0	92.9	4.2	2.9	100.0
Third Bunch	0.0	89.2	10.8	100.0	65.2	26.4	8.4	100.0
Fourth Bunch	0.0	0.0	100.0	100.0	15.0	57.0	28.0	100.0
Average	56.2	20.4	23.4	100.0	74.0	17.8	8.2	100.0

TABLE III (b)

COMPUTED VALUES IN RUPEES FOR A TON OF COPRA FROM EACH OF THE STAGES OF MATURITY, ON THE BASIS OF THE PERCENTAGE DISTRIBUTION OF THE GRADES GIVEN IN TABLE III (a).

Fallen Nuts	792.65	20.54	14.25	827.44	818.38	5.53	5.25	829.16
First Bunch	774.39	24.49	27.00	825.88	815.89	3.95	9.00	828.84
Second Bunch	765.26	55.30	6.00	826.56	771.07	33.18	21.75	826.00
Third Bunch	0.00	704.68	81.00	785.68	541.16	208.56	63.00	812.72
Fourth Bunch	0.00	0.00	750.00	750.00	124.50	450.30	210.00	784.80
Average	466.46	161.00	175.65	803.11	614.20	140.30	61.80	816.30

TABLE IV

(A) Experimental Results from Storage Trials in Air-Conditioned Room  
(Well-dried, GOOD QUALITY COPRA alone from Stage 10 was used)

1 PERIOD since Commencement of Experiment (weeks)	2 % MOIS- TURE	3 ANHY- DROUS WEI- GHT of COPRA (Gms.)	4 TOTAL LOSS of ANHYDROUS COPRA over original		5 OIL IN COPRA						6 % Free Fatty Acids in Pressed Oil (as lauric)	7 COLOUR on Lovibond scale of Pres- sed and Filtered Oil	8 LOSSES expressed as % of original Anhydrous wei- ght taken for experiment		
			Gms.	Per cent	% Oil (Wet basis)	% Oil (Dry basis)	Total weight of oil in Anhy- drous COPRA (Gms.)	TRUE LOSS IN OIL in terms of oil present in ori- ginal weight of ANHYDR- OUS COPRA		OIL			OIL- FREE MEAT (by diff- erence)	TOTAL ANHY- DROUS COPRA	
								Gms.	Per cent						
			START	2	4	6	8 to 22	24							
START	6.06	2,601	—	—	64.2	68.3	1,776	—	—	0.06	3	—	—	—	
2	5.29	2,591	10	0.38	64.7	68.3	1,770	6	0.34	0.06	3	—	—	—	
4	4.56	2,588	13	0.50	65.2	68.3	1,768	8	0.45	0.06	4	0.23	0.15	0.38	
6	4.91	2,586	15	0.58	64.9	68.3	1,766	10	0.56	0.11	4	0.31	0.19	0.50	
8 to 22	NO LOSSES IN ANHYDROUS WEIGHT — NO SAMPLES ANALYSED														
24	3.08	2,576	25	0.96	65.9	68.0	1,752	24	1.35	0.12	6	0.38	0.20	0.58	
												0.92	0.04	0.96	

NOTE — (1) No visible mould action evident, except for a slight white 'bloom' on the brown testa, which first made its appearance after 12 weeks of storage.

(2) The experiment is being continued.

**TABLE V**  
**Experimental Results from Storage Trials in Well and Poorly Ventilated Stores**

**STAGE 1**

1 (B) WELL VENTILATED STORE						2 (C) POORLY VENTILATED STORE				
PERIOD (Weeks)	% Moisture	ANHY- DROUS WEI- GHT of COPRA (Gms.)	TOTAL LOSS OF ANHYDR- OUS COPRA over original		% Free Fatty Acids (as lauric)	% Moisture	ANHY- DROUS WEI- GHT of COPRA (Gms.)	TOTAL LOSS OF ANHYDR- OUS COPRA over original		% Free Fatty Acids (as lauric)
			(Gms.)	%				(Gms.)	%	
START	43.8	2,189	—	—	—	43.8	2,145	—	—	—
2	12.2	2,136	53	2.4	—	13.2	2,066	79	3.7	—
3	6.6	2,057	132	6.0	4.7	8.4	1,985	160	7.5	—
10	11.3	1,845	344	15.7	4.7	6.2	1,932	213	9.9	5.0
15	6.4	1,794	395	18.0	4.7	7.4	1,758	387	18.0	8.2
17	5.9	1,743	446	20.4	4.4	7.2	1,713	432	20.1	7.8
21	5.4	1,686	503	23.0	4.1	7.1	1,586	559	26.1	7.3

**STAGE 2**

START	33.8	2,491	—	—	—	33.8	2,431	—	—	—
2	16.6	2,238	253	10.2	—	15.7	2,250	181	7.4	—
3	12.4	2,029	462	18.5	4.4	11.1	2,069	362	14.9	—
10	9.7	1,951	540	21.7	8.7	7.6	2,056	375	15.4	6.5
15	7.0	1,855	636	25.5	6.0	8.2	1,926	505	20.8	6.6
17	6.2	1,803	688	27.6	6.6	7.4	1,894	537	22.1	9.3
21	5.3	1,745	746	29.9	7.2	6.6	1,822	609	25.1	11.9

**STAGE 3**

START	22.4	2,548	—	—	—	22.4	2,471	—	—	—
2	10.5	2,401	147	5.8	—	13.4	2,326	145	5.9	—
3	9.3	2,205	343	13.5	2.0	11.2	2,182	289	11.7	—
10	10.0	1,968	580	22.8	3.8	5.1	2,142	329	13.3	4.0
15	7.4	1,888	660	25.9	3.7	7.2	1,996	475	19.2	4.7
17	6.7	1,851	697	27.4	3.0	6.6	1,969	502	20.3	6.1
21	6.1	1,797	751	29.5	2.2	6.0	1,922	549	22.2	7.5

**STAGE 4**

START	12.5	2,305	—	—	—	12.5	2,363	—	—	—
2	8.5	2,240	65	2.8	—	7.7	2,329	34	1.4	—
3	8.0	2,204	101	4.4	0.6	7.2	2,295	68	2.9	—
10	9.2	2,062	243	10.5	1.1	6.0	2,279	84	3.6	1.2
15	6.8	2,040	265	11.5	1.4	5.9	2,218	145	6.1	2.1
17	6.3	2,026	279	12.1	1.6	5.4	2,211	152	6.4	2.0
21	5.8	1,996	309	13.4	1.7	5.0	2,176	187	7.9	1.8

**STAGE 5**

START	11.3	2,460	—	—	—	11.3	2,359	—	—	—
2	7.8	2,432	28	1.1	—	8.2	2,338	21	0.9	—
3	7.4	2,405	55	2.2	0.6	7.2	2,317	42	1.8	—
10	12.2	2,344	116	4.7	1.2	6.0	2,295	64	2.7	1.2
15	7.2	2,282	178	7.2	1.5	6.2	2,214	145	6.1	1.0
17	6.3	2,269	191	7.8	1.2	5.5	2,197	162	6.9	1.5
21	5.4	2,256	204	8.3	0.8	4.9	2,157	202	8.6	1.9

**TABLE VI**  
**Experimental Results from Storage Trials in Well and Poorly Ventilated Stores**  
**STAGE 6**

1						2				
(B) WELL VENTILATED STORE						(C) POORLY VENTILATED STORE				
PERIOD (Weeks)	% Moisture	ANHY- DROUS WEI- GHT of COPRA (Gms.)	TOTAL LOSS OF ANHYDR- OUS COPRA over original		% Free Fatty Acids (as lauric)	% Moisture	ANHY- DROUS WEI- GHT of COPRA (Gms.)	TOTAL LOSS OF ANHYDR- OUS COPRA over original		% Free Fatty Acids (as lauric)
			(Gms.)	%				(Gms.)	%	
START	9.0	2,608	—	—	—	9.0	2,495	—	—	—
2	7.8	2,608	nil	nil	—	6.8	2,464	31	1.2	—
3	7.0	2,607	1	trace	0.7	6.7	2,439	56	2.2	—
10	8.0	2,530	78	3.0	1.4	5.5	2,432	63	2.5	1.1
15	6.8	2,518	90	3.5	0.6	5.9	2,368	127	5.1	0.8
17	6.0	2,510	98	3.8	0.9	5.5	2,359	136	5.5	1.4
21	5.2	2,496	112	4.3	1.2	5.2	2,328	167	6.7	1.9
<b>STAGE 7</b>										
START	7.8	2,695	—	—	—	7.8	2,675	—	—	—
2	7.2	2,682	13	0.5	—	7.2	2,673	2	0.1	—
3	6.6	2,681	14	0.5	0.1	6.7	2,660	15	0.6	—
10	9.0	2,587	108	4.0	1.2	5.7	2,644	31	1.2	1.0
15	6.9	2,579	116	4.3	0.6	5.4	2,552	123	4.6	0.8
17	6.2	2,573	122	4.5	0.6	4.8	2,480	195	7.3	1.4
21	5.5	2,558	137	5.1	0.7	4.2	2,360	315	11.8	2.0
<b>STAGE 8</b>										
START	7.1	2,553	—	—	—	7.1	2,564	—	—	—
2	6.9	2,540	13	0.5	—	6.8	2,530	34	1.3	—
3	6.7	2,532	21	0.8	0.1	6.6	2,526	38	1.5	—
10	9.1	2,464	89	3.5	1.4	5.4	2,517	47	1.8	1.1
15	6.4	2,461	92	3.6	0.5	5.5	2,442	122	4.8	1.1
17	5.6	2,444	109	4.3	0.7	4.9	2,403	161	6.3	2.0
21	4.8	2,436	117	4.6	0.9	4.2	2,363	201	7.8	2.9
<b>STAGE 9</b>										
START	6.8	2,338	—	—	—	6.8	2,466	—	—	—
2	6.9	2,327	11	0.5	—	6.6	2,455	11	0.4	—
3	6.9	2,323	15	0.6	0.1	6.4	2,451	15	0.6	—
10	7.8	2,272	66	2.8	0.5	5.7	2,431	35	1.4	1.1
15	6.8	2,266	72	3.1	0.5	5.6	2,361	105	4.3	0.8
17	6.4	2,254	84	3.6	0.7	5.4	2,296	170	7.4	1.1
21	6.1	2,228	110	4.7	0.8	5.3	2,247	219	8.9	1.4
<b>STAGE 10</b>										
START	6.1	2,365	—	—	—	6.1	2,504	—	—	—
2	6.8	2,360	5	0.2	—	6.1	2,498	6	0.2	—
3	7.5	2,342	23	1.0	trace	6.1	2,486	18	0.7	—
10	9.6	2,268	97	4.1	1.0	5.6	2,483	21	0.8	0.6
15	6.4	2,259	106	4.5	0.8	6.1	2,396	108	4.3	0.7
17	5.8	2,239	126	5.3	0.6	5.4	2,378	126	5.0	1.3
21	5.2	2,232	133	5.6	0.4	4.8	2,336	168	6.7	1.8

**TABLE VII**  
**Free Fatty Acidities of Samples in Storage Trials (Period — 21 weeks)**  
**(Calculated as % lauric acid)**

1 <i>STAGE</i>	2 <i>AIR-CONDITIONED ROOM</i>			3 <i>WELL VENTILATED STORE</i>			4 <i>POORLY VENTILATED STORE</i>		
	<i>Max.</i>	<i>Min.</i>	<i>Average</i>	<i>Max.</i>	<i>Min.</i>	<i>Average</i>	<i>Max.</i>	<i>Min.</i>	<i>Average</i>
	1	—	—	—	4.7	4.1	4.5	8.2	5.0
2	—	—	—	8.7	4.4	6.6	11.9	6.5	8.6
3	—	—	—	3.8	2.0	2.9	7.5	4.0	5.6
4	—	—	—	1.7	0.6	1.3	2.1	1.2	1.8
5	—	—	—	1.5	0.6	1.1	1.9	1.0	1.4
6	—	—	—	1.4	0.6	1.0	1.9	0.8	1.3
7	—	—	—	1.2	0.1	0.6	2.0	0.8	1.3
8	—	—	—	1.4	0.1	0.7	2.9	1.1	1.8
9	—	—	—	0.8	0.1	0.5	1.4	0.8	1.1
10	0.12	0.06	0.08	1.0	trace	0.7	1.8	0.6	1.1
Overall Average	—	—	—	2.6	1.3	2.0	4.2	2.2	3.1
RANGE	—	—	—	0.8 to 8.7	trace to 4.4	0.5 to 6.6	1.4 to 11.9	0.6 to 6.5	1.1 to 8.6

**TABLE VIII**  
**Loss of Anhydrous Copra in Storage Trials (Period — 21 weeks)**  
**(Total loss at different stages expressed as percentages of the original weights taken)**

1 <i>STAGE</i>	2 <i>% Initial Moisture</i>	3 <i>WELL VENTILATED STORE</i>			4 <i>POORLY VENTILATED STORE</i>		
		<i>Maximum</i>	<i>Minimum</i>	<i>Average</i>	<i>Maximum</i>	<i>Minimum</i>	<i>Average</i>
		1	43.8	23.0	2.4	14.2	26.1
2	33.8	29.9	10.2	22.2	25.1	7.4	17.6
3	22.4	29.5	5.8	20.8	22.2	5.9	15.4
4	12.5	13.4	2.8	9.1	7.9	1.4	4.7
5	11.3	8.3	1.1	5.2	8.6	0.9	4.5
6	9.0	4.3	0.0	2.4	6.7	1.2	3.9
7	7.8	5.1	0.5	3.2	11.8	0.1	4.3
8	7.1	4.6	0.5	2.9	7.8	1.3	3.9
9	6.8	4.7	0.5	2.5	8.9	0.4	3.8
10	6.1	5.6	0.2	3.4	6.7	0.2	3.0
Overall Average	16.1	12.8	2.4	8.6	13.2	2.3	7.5
RANGE	6.1 to 43.8	4.3 to 29.9	0.0 to 10.2	2.4 to 22.2	6.7 to 26.1	0.1 to 7.4	3.0 to 17.6

**STAGE 10 Stored in AIR-CONDITIONED ROOM (Period — 24 weeks)**

	<i>Per Cent</i>
Initial Moisture ..	6.1
Maximum Loss ..	0.96
Minimum Loss ..	0.38
Average Loss ..	0.60

TABLE IX

Moisture changes in Storage Trials (Period — 21 weeks) (Percentages)

1 STAGE	2 % Initial Moisture	3 WELL VENTILATED STORE			4 POORLY VENTILATED STORE		
		Maximum	Minimum	Average	Maximum	Minimum	Average
1	43.8	43.8	5.4	9.2	43.8†	6.2	9.3
2	33.8	33.8	5.3	9.1	33.8	6.6	9.0
3	22.4	22.4	6.1	7.2	22.4	5.1	7.2
4	12.5	12.5	5.8	5.7	12.5	5.0	5.0
5	11.3	*12.2	5.4	5.8	11.3	4.9	4.9
6	9.0	9.0	5.2	5.0	9.0	5.2	4.5
7	7.8	* 9.0	5.5	4.9	7.8	4.2	4.2
8	7.1	* 9.1	4.8	4.7	7.1	4.2	4.0
9	6.8	* 7.8	6.1	4.8	6.8	5.3	4.2
10	6.1	* 9.6	5.2	4.7	6.1	4.8	4.0
Overall Average	16.1	16.9	5.5	6.1	16.1	5.2	5.6
RANGE	6.1 to 43.8	7.8 to 43.8	4.8 to 6.1	4.7 to 9.2	6.1 to 43.8	4.2 to 10	4.0 to 9.3

\*These moisture figures *higher* than the initial were recorded after 10 weeks of Storage.  
 †The maximum moisture contents in the Poorly Ventilated Store *never* exceeded the initial moisture contents during the 21 weeks, at any stage.

TABLE X

Losses of Anhydrous Copra and 'Dust' (after storage for 21 weeks) in relation to the Size-form of the Dried-Meat

(WELL VENTILATED STORE)

1 STAGE		2 FULL CUPS % LOSS			3 QUARTER CUPS % LOSS			4 *STRIPS % LOSS			5 *SLICED PIECES % LOSS		
No.	% Initial Mois- ture	Anhy- drous Copra	Dust	Total	Anhy- drous Copra	Dust	Total	Anhy- drous Copra	Dust	Total	Anhy- drous Copra	Dust	Total
2	33.8	9.0	8.9	17.9	12.3	10.2	22.5	19.1	19.8	38.9	20.1	18.7	38.8
4	12.5	5.5	3.5	9.0	6.6	4.4	11.0	8.1	5.7	13.8	8.2	5.6	13.8
6	9.0	4.2	3.6	7.8	8.5	6.9	15.4	5.2	1.5	6.7	11.0	4.3	15.3
8	7.1	7.1	5.1	12.2	2.6	2.9	5.5	5.1	2.1	7.2	8.4	3.4	11.8
10	6.1	5.7	3.2	8.9	9.8	5.3	15.1	10.5	4.1	14.6	8.6	3.9	12.5
Overall Average	13.7	6.3	4.9	11.2	8.0	5.9	13.9	9.6	6.6	16.2	11.3	7.2	18.5
Averages as % of Total Loss		56.3	43.7	100.0	57.6	42.4	100.0	59.3	40.7	100.0	61.1	38.9	100.0
Overall Loss of DUST as % of Loss of ANHYDR- OUS COPRA		77.8%			73.8%			68.8%			63.7%		
											71.0%		

\*Longitudinal

†As used for copra analysis.

TABLE XI  
ANALYTICAL RESULTS ON SAMPLES OF DESICCATED COCONUT

1 Source and Date of Receipt	2 Sample	3 Weight Receiv. (Gms.)	4 Description	5 Mois- ture %	6 % OIL		7 FREE FATTY ACID (% lauric)		
					Wet Basis	Dry Basis	Original Solid	Extracted Oil	Pressed Oil
E. B. Creasy .. (30-11-60) ..	A	348	Fine, white, good taste and smell	3.40	66.7	70.1	0.641	0.100	0.153
	B	459	Fine, off-white with paring specks. Aggregated rancid smell, moist	4.74	65.0	68.3	2.36	1.50	1.90
Ceylon Trading Company .. (22-11-60) ..	A	517	Fine, off-white, not very fresh	3.88	66.9	69.6	0.685	0.101	0.251
	B	433	Fine, off-white, rancid smell	4.57	66.3	69.4	2.54	1.70	1.14
Haldanduwana Mills .. (19-11-60) ..	A	344	Fine, slightly discoloured not very fresh	3.18	67.5	69.8	0.696	0.075	0.076
	B	412	Fine, off-white, rancid smell	5.05	66.4	69.9	1.23	0.460	1.09
Secretary DCN Sub-Com- mittee ..	A	414	Fine, white, good taste and smell	4.29	68.2	71.2	1.12	0.074	0.075
Department of Industries .. (20-11-60) ..	B	457	Coarse, off-white, rancid smell	4.72	66.2	69.5	0.764	0.159	0.175
	C	416	Coarse, slightly, discoloured rancid smell	4.82	65.7	69.0	0.782	0.126	0.105

# ANNUAL REPORT OF THE BOTANIST FOR 1960

## I. VARIETIES AND FORMS OF COCONUT

From the studies on the morphological characters and breeding system of the different types of coconut palms grown in Ceylon, three varieties have been distinguished. Using the terminology of other workers, two varieties are described as *typica* Nar. i.e. the popular tall variety grown on a plantation scale, and *nana* (Griff.) Nar. i.e. the dwarf variety. The third variety is the group to which *King coconut* belongs, a type probably endemic to this country. Since the bright orange colour of nut is a prominent characteristic of this variety, it is described as *aurantiaca* Lij. The salient characters of these varieties are:

### Variety *typica* Nar.

— Stem, broad, attains a height of about 60 feet; leaves, long; flowering late; predominantly out-breeding; nuts, medium to large in size, 4,000 to 5,200 nuts per ton of copra; copra, hard and of good quality; palms tolerate a wide variety of environments; economic production of nuts possible up to 60 years.

### Variety *nana* (Griff.) Nar.

— Stem, narrow, attains a height of about 35 feet; leaves, short; flowering early; predominantly in-breeding; nuts, small, 9,000 to 12,000 per ton of copra, seasonal bearing; copra of poor quality; palms very susceptible to pests and diseases and thrive well only in a favourable environment; economic production of nuts not more than 40 years.

### Variety *aurantiaca* Lij.

— Stem, semi broad, attains a height of about 40 feet; leaves short; flowering late; predominantly in-breeding; nuts, medium size, 8,000 nuts to a ton of copra; epicarp of nut orange in colour; endosperm thin and of little value for copra; palms susceptible to pests and diseases and thrive well only in a favourable environment; economic production of nuts not more than 40 years.

A number of forms have been recognised within each variety, largely due to variations in colour and size of nut and of nut components.

### Forms of the variety *typica* Nar.

- |                                   |         |   |
|-----------------------------------|---------|---|
| (i) <i>Typica</i> .. .. .         | .. .. . | The plantation type; nuts generally oblong; epicarp of nut different shades and of green and reddish brown, endosperm thick giving about 7 ozs. of copra per nut. |
| (ii) <i>Navasi</i> .. .. .        | .. .. . | Chromosome number $2n = 32$ .   |
| (iii) <i>Gon-thembili</i> .. .. . | .. .. . | Epicarp of nut green; mesocarp of immature nut, sweet and edible.   |
| (iv) <i>Ran-thembili</i> .. .. .  | .. .. . | Epicarp of nut and leaf rachis ivory yellow.  |
|                                   |         | Chromosome number $2n = 32$ .   |
|                                   |         | Epicarp green, chalazal region of mesocarp pink in nuts 4 to 6 months old.  |

- (v) *Pora-pol* .. .. Husked nuts small and elongated, endocarp exceptionally hard and very thick. Chromosome number  $2n = 32$ .
- (vi) *Bodiri* .. .. Nuts very small requiring about 20,000 to a ton of copra. prolific bearing.
- (vii) *Kamandala* .. .. Nuts very large,  $1\frac{1}{2}$  times (approx.) larger than *typica* nut.
- (viii) *Dikiri-pol* .. .. Endosperm very soft being of a buttery consistency and gelatinous.

Forms of the variety *nana* (Griff.) Nar.

- (i) *Pumilla* .. .. Inflorescence yellowish green, epicarp of nut green.
- (ii) *Eburnea* .. .. Inflorescence ivory yellow, epicarp of nut yellow.
- (iii) *Regia* .. .. Inflorescence orange. epicarp of nut apricot red.

Forms of the variety *aurantiaca* Lij.

- (i) *Thembili* or King Coconut .. Inflorescence and epicarp of nut orange; sucrose content of tender nut water relatively high (5 to 6 per cent).  
Chromosome number  $2n = 32$ .
- (ii) *Navasi-thembili* .. .. Inflorescence and epicarp of nut orange; mesocarp of tender nut, sweet and edible.

TABLE I  
Quantitative characters of nut components of forms of coconut found in Ceylon.

	Un-husked nut			Husked nut		Endocarp		Thick-ness of endo-sperm m.m.
	Length	Width	Volume	Volume	Weight	Thick-ness	Weight	
	Ins.	Ins.	c.c.	c.c.	oz.	m.m.	oz.	
VARIETY <i>typica</i>								
1. Form <i>typica</i> ..	8.6	7.0	3,200	870	25	3	5.6	15
2. Form <i>navasi</i> ..	8.9	7.6	3,175	877	22	3	6.0	13
3. Form <i>gon-thembili</i>	8.9	6.5	2,535	787	24	3	7.0	13
4. Form <i>ran-thembili</i>	8.6	7.6	3,728	857	29	3	7.0	14
5. Form <i>pora-pol</i> ..	9.0	6.5	1,870	683	19	6	8.0	13
6. Form <i>bodiri</i> ..	4.5	3.8	606	218	7	2	1.8	10
7. Form <i>kamandala</i>	10.6	8.9	5,922	1,760	56	3	11.4	14
8. Form <i>dikiri-pol</i>	—	—	—	—	—	—	—	—
VARIETY <i>nana</i>								
9. Form <i>pumilla</i> ..	7.8	5.4	1,457	367	10	2	2.5	11
10. Form <i>eburnea</i> ..	7.5	5.8	1,591	474	15	2	3.1	12
11. Form <i>regia</i> ..	7.7	4.9	1,140	334	10	2	2.0	11
VARIETY <i>aurantiaca</i>								
12. Form <i>King coconut</i>	8.2	5.3	1,394	559	14	2	6.0	12
13. Form <i>navasi-thembili</i>	7.6	5.7	1,573	525	16	2	3.5	12

TABLE II

Some economic characters of the forms of coconut found in Ceylon

	No. of nuts examined	Weight per husked-nut (lb.)	Weight of copra per nut (oz.)	Nuts per ton of copra	Oil content (dry basis) per cent
VARIETY <i>typica</i>					
1. Form <i>typica</i>	100	1.53	7.52	4,750	68.95
2. Form <i>navasi</i>	19	1.34	6.32	5,675	69.54
3. Form <i>gon-thembili</i>	55	1.53	8.15	4,400	69.20
4. Form <i>ran-thembili</i>	19	1.83	7.79	4,600	68.46
5. Form <i>pora-pol</i>	20	1.18	5.00	7,150	69.73
6. Form <i>bodiri</i>	20	0.43	1.80	19,900	69.58
7. Form <i>kamandala</i>	45	3.54	13.33	2,700	67.65
8. Form <i>dikiri-pol</i>	—	—	—	—	—
VARIETY <i>nana</i>					
9. Form <i>pumilla</i>	52	0.63	4.00	8,950	69.65
10. Form <i>eburnea</i>	100	0.95	3.96	9,050	65.49
11. Form <i>regia</i>	90	0.61	3.07	11,675	65.23
VARIETY <i>aurantiaca</i>					
12. Form <i>King Coconut</i>	100	0.88	5.00	7,150	65.62
13. Form <i>navasi-thembili</i>	21	1.02	4.95	7,250	68.10

Thus, the indigenous coconut palms have been classified into three varieties and 13 forms. Variations between forms relative to out-turns are very large, but that relative to oil content of copra is only appreciable (Table II). The *regia* form of the variety *nana* has given the lowest oil value (65.2 per cent), and the *pora-pol* form of *typica* the highest value (69.7 per cent). The out-turns have varied between 2,700 to 20,000 nuts per ton of copra; both the extreme forms belong to the variety *typica*.

Forms that are useful for breeding are: *kamandala* (high nut weight), *bodiri* (prolificity in bearing, high oil content), *gon-thembili* (low out-turn, high oil content), *pumilla* (early bearing, short habit) and *typica*.

## 2. HYBRIDISATION BETWEEN VARIETIES AND FORMS

A programme of hybridisation between selected forms of coconut have been carried out largely to determine the commercial possibilities of utilising hybrid vigour. From the data collected to date and as pointed out in previous reports, there seems to be some potentiality in the first generation palms (F<sub>1</sub>) of *typica* × *pumilla* to evolve an early bearing and high-yielding strain.

Since the varieties and forms of coconut grown in Ceylon have now been classified, the appropriate names will be used to describe the different crosses, e.g. what has been described earlier as tall × dwarf or *typica* × *nana* will be in future referred to as *typica* × *pumilla*.

### *Typica* × *pumilla*

The 22 first generation palms planted at Ratmalagara in 1950 have given a mean yield of 108 nuts per palm in the 10th year after planting (Table III).

TABLE III  
Mean yield per palm of *typica* × *pumilla*

Cross	No. of progenies	Yield of nuts			Weight of husked nuts (lb.)		
		10th year	9th year	8th year	10th year	9th year	8th year
218 × 1713	5	95	104	84	188.6	203.8	164.6
360 × 1713	4	110	97	68	183.1	144.0	108.8
360 × 1712	5	118	112	76	204.7	168.7	112.7
139 × 2646	4	102	83	56	170.3	116.4	80.1
778 × D	3	—	73	38	—	82.7	53.4
273 × 2646	1	—	144	85	—	198.5	130.0
Mean per progeny	—	108	103	65	187.8	147.0	110.5

In order to test these hybrid palms on a larger scale, 235 *typica* × *pumilla* and 90 *typica* × *typica* seedlings have been planted at Ratmalagara in May 1958. At the end of the year, the total number of green leaves on each plant was scored and plants of the former cross carried 3 leaves (approx.) more than those of the latter type, the difference being statistically significant.

	No. of plants scored	Mean leaf number per plant
<i>Typica</i> × <i>pumilla</i> ..	195	13.8
<i>Typica</i> × <i>typica</i> ..	87	10.8

A programme of crossing was carried out beginning from the latter part of 1959, to isolate *pumilla* palms that exhibit general combining ability to produce high yielding progenies when they are used as the male parent on *typica* as the female. The male parents were selected for early bearing and large size of nut and the female parents for high yield of copra. The pollinations were generally not successful, percentage of setting of female flowers being low. However, a number of crosses were obtained with at least 6 nuts per cross, with 5 *pumilla* palms as the male parent on 4 *typica* palms as the female (Table IV). The reciprocal crosses i.e. *pumilla* × *typica*, using the same parents were still less successful. Nuts harvested during the year were planted in the nursery.

TABLE IV  
Number of nuts harvested from *typica* × *pumilla* crosses to test general combining ability

Female parent ( <i>typica</i> palms)		Male parent — <i>pumilla</i> palms				Total	
		268	319	425	439		447
59	..	20	13	14	16	15	78
285	..	6	11	14	10	10	51
153	..	0	15	8	7	14	44
349	..	7	6	0	7	10	30
Total	..	33	45	36	40	49	203

A programme of work to study the  $F_2$  palms of *typica* × *pumilla*, was initiated in August 1960. The following palms were used: *typica* — 139, 218; *pumilla* — 1713, 2646;  $F_1$  of 218 × 1713 — 105, 110, 113;  $F_1$  of 139 × 2646 — 71, 85, 144. The programme includes selfing of the  $F_1$  palms, back crossing them to both parental types and production of double hybrids.

#### *Typica* × *typica*

Three lines of investigation were continued:—(a) inbreeding, (b) inbreeding of prepotent palms and (c) production of seed coconuts.

In order to study the relative effects of inbreeding, 24 *typica* palms taken at random from the Latin Square Experiment of Ratmalagara were selfed. Length, width and volume of each nut was recorded and a photograph of the typical nut from each palm was taken. Open pollinated nuts from the same palms were collected for relative studies. All the nuts were planted in the nursery in October 1960.

The seven prepotent palms so far identified were selfed during the year for two purposes: (a) to study whether prepotency could be fixed and (b) to continue their line since these palms are almost senile now.

In the programme of production of seed coconuts, 267 selected high-yielding palms distributed over 7 estates were pollinated with pollen collected from the prepotent palms. In 1960, 35,500 female flowers were pollinated and 10,665 nuts from pollinations done during the preceeding year were harvested.

### 3. PROGENY TRIALS

Three progeny trials situated at Marandawila, Walpita and Bandirippuwa are under investigation. The data collected from the first trial (Marandawila) which is 26 years old now, has been used considerably for genetic studies, and already estimates of genetic and environmental correlations, heritability values and genetic progress due to selection have been evaluated (Annual Report for 1958).

Further analysis of data of (i) number of bunches produced per palm per year, (ii) number of female flowers per bunch, (iii) number of nuts per bunch, and (iv) percentage of female flowers that develop into fruits, collected when the palms were 17 to 18 years old, were carried out during the year (Table V).

TABLE V

Mean values of four characters of the Marandawila palms when they were 17 to 18 years old

Family	No. of progenies	Bunches per year	Female flowers per bunch	Nuts per bunch	Ratio of No. of nuts to female flowers per bunch
I ..	57	11.5	22.4	6.5	0.33
IV ..	11	11.6	29.7	6.9	0.24
VI ..	22	12.3	27.7	5.4	0.22
XVI ..	19	11.0	22.4	4.5	0.22
XVII ..	64	11.4	30.3	5.9	0.22
XXII ..	12	12.1	27.8	5.9	0.22
XXIII ..	41	10.2	21.6	6.2	0.34
XXVI ..	42	11.3	20.2	5.6	0.29
XLIII ..	10	12.2	25.2	7.0	0.30
Mean ..	—	11.3	21.9	6.0	—

The differences between families with respect to each of the characters in Table V are significant at  $P < 0.01$ .

The estimates of heritability of these four characters are as follows:—

- (a) Number of bunches per palm per year:  $h^2 = 0.47$   
 (b) Number of female flowers per bunch :  $h^2 = 0.52$   
 (c) Number of nuts per bunch :  $h^2 = 0.50$   
 (d)  $\frac{\text{Number of nuts per bunch}}{\text{Number of female flowers per bunch}}$  :  $h^2 = 0.81$

The first three characters have given intermediate heritability values and the fourth character a high value.

The genetic statistics calculated hitherto have been limited to yield factors or their components. To study the behaviour of vegetative characters of the palm, measurements of stem girth, internode length and plant height (length of stem from ground level to lowest whorl of leaves) of Marandawila palms were taken during the year. Only 10 palms taken at random from each family was measured and their mean values are given in Table VI.

TABLE VI  
Mean values of stem girth, internode length and plant height

Family	Stem girth (ins.)	Internode length (ins.)	Plant height ft.
I ...	31.4	2.7	35.39
IV ...	31.9	2.8	37.36
VI ...	32.6	2.7	37.05
XVI ...	30.9	2.5	34.08
XVII ...	33.7	2.7	34.70
XXII ...	31.1	2.8	33.73
XXIII ...	33.2	3.2	37.71
XXVI ...	31.9	2.5	33.74
XLIII ...	30.6	2.3	33.97

The heritability values for the three vegetative characters are:

Girth of stem:  $h^2 = 0.45$

Internode length:  $h^2 = 0.63$

Plant height:  $h^2 = 0.31$

Correlations between yield of copra and the vegetative characters are as follows:

	Genetic Correlation, $r_G$	Environmental Correlation, $r_E$
Yield of copra $\times$ internode length ...	+0.016	-0.205
" " " $\times$ plant height ...	+0.431	-0.085
" " " $\times$ stem girth ...	-0.361	+0.243

The only significant factor is the genetic correlation between yield of copra and plant height. Construction of selection indexes using the above statistics is in progress.

#### 4. PLANTING TECHNIQUES

##### Size of Seed Hole Experiment

This field trial was planted in November 1955 to study the relationships, if any, between the size of the seedhole used to transplant a coconut seedling and its subsequent growth. The design is simple randomised layout of 4 treatments, 6 replications with 9 plants per plot. The number of new leaves produced during the year, the total number of green leaves per plant and the number of palms in flower at the end of the year were scored (Table VII). An analysis of variance of each set of data indicates that there were no significant differences between the treatments with respect to the three characters listed above. Thus, under the conditions of the experiment the size of the seedhole prepared to transplant a coconut seedling has not materially affected the growth of the young palms in the fifth year with respect to leaf production and early flowering.

TABLE VII

Leaf and flower production at the end of the 5th year of plants in the SIZE of Seed Hole Experiment

Type of seed hole	(Mean per plant)		
	No. of new leaves produced during the year	Total No. of green leaves	Per cent. palms in flower
1 × 1 × 1 feet	12.2	19.3	37.0
3 × 3 × 3 feet	11.5	19.1	44.4
Cruciform type	11.6	18.9	37.0
Post hole borer type	12.2	19.5	33.3

##### Depth of Planting Experiment

The field trial planted in November 1956 to study the relationships, if any, between depth of planting of a coconut seedling and its subsequent growth has completed 4 years. The design is randomised layout of 4 treatments, 5 replications with 9 plants per plot. Leaf production data collected during the year (Table VIII), show that there were no significant differences between treatments with respect to new leaves produced during the year and the total number of green leaves at the end of the year.

TABLE VIII

Mean number of leaves per plant at the end of the 4th year in the Depth of Planting Trial

Treatment	New leaves produced during the year	Total number of green leaves
6 inches deep planting	9.9	14.4
12 " " "	8.9	13.0
18 " " "	10.2	14.2
24 " " "	9.6	13.6

### Hedge Planting

The observation plots of a new system of close planting for selective thinning, planted at Ratmalagara in 1956 and the Isolated Coconut Seed Garden in 1957, show satisfactory growth for the age of the palms in spite of the fact the plants are only 18 feet apart within rows which are spaced 24 feet apart. In each plot, the palms were selectively thinned depending on their vigour and growth.

## 5. SEED SUPPLY SCHEME

With respect to large scale production of coconut seed, the policy of the Institute hitherto has been to collect selected 'block' nuts from selected high-yielding blocks of estates. Since this method of collection of seednuts has been shown to be genetically unsound, it was decided to overhaul the entire system of selection and this division was entrusted with the work of raising the seednuts required by the Industry.

From the studies on progeny trials and heritability estimates, there is evidence to indicate that collection of seed from selected seed parents is an efficient method of selection. Consequently, a programme was drawn up to select about 50,000 seed parents to raise the 3,000,000 seednuts currently required.

The basis of the scheme is that, (a) high yielding blocks are selected from estates under average conditions; the definition of high-yield varies according to district, (b) palms giving a yield of nuts above the average for the block are marked, (c) these palms are further selected for high copra content (per nut and per palm), shape of nut and for other desirable morphological characters. The selected palms will be examined periodically and any undesirable types, if any, will be rejected.

Nuts from the selected palms will be harvested and collected separately from the rest of the palms, and they will be further selected for weight, maturity, etc. The selected nuts will be issued to the nurseries.

Palm selection scheme was initiated in August 1960, and by the end of the year 26,340 palms have been selected from 7 estates.

## 6. MISCELLANEOUS

*Isolated Seed Garden.*—Twenty acres were planted in November with seedlings derived by artificial pollination where the male parent was a prepotent palm. About 80 acres have been planted to date.

*Pollen Bank.*—4,291 pollen samples from prepotent *typica* palms and 1,766 samples from selected *pumilla* palms have been sealed and stored under deep freeze conditions. Besides issue of pollen to our stations, 1,680 *typica* and 1,051 *pumilla* pollen samples have been issued to 8 private estates to help them to implement their own programme of controlled pollination.

*Latin Square.*—Routine observations, yield recording and cultural operations were continued in the Latin Square and other field experiments.

*Personnel.*—Mr. M.A.P.P. Manthirratne, Technical Assistant, was on study leave throughout the period. The following appointments were made: Mr. R.B. Rodrigo (Field Officer), Mr. H.A. Ranasinghe (Superintendent, I.S.G.), Mr. D.L.G. Lokubalasureya (Field and Lab Assistant) and Mr. K. Ubeyratne (Clerk/Typist). The following resignations were accepted: Mr. A.P. Jayawera (Field Assistant) and Mr. K. Ubeyratne (Clerk/Typist).

Dr. K.I. Sakai, Head of the Department of Applied Genetics, National Institute of Genetics, Japan, was attached to the Division in an advisory capacity for two weeks in November 1960.

*Publications.*—The following articles were published.

'Heritabilities of Certain Yield Characters of the Coconut Palm', by Dr. D.V. Liyanage and Dr. K.I. Sakai. *Journal of Genetics*, Volume 57 (1960).

'Varieties and Forms of the Coconut Palm Grown in Ceylon', by Dr. D.V. Liyanage. *The Ceylon Coconut Quarterly*, Volume 9 (1958).

'Method of Artificial Pollination of Coconut Palms', by M.A.P.P. Manthiraratne and Dr. D.V. Liyanage. *Ceylon Coconut Planters Review*, Volume I, No. 2 (1960).

*Acknowledgements.*—My thanks are due to the Chemist, Coconut Research Institute, for determinations of oil content of copra of varieties and forms of coconut reported in Table II.

D.V. LIYANAGE,  
*Botanist, Coconut Research Institute.*

March 10, 1961.

# ANNUAL REPORT 1960

## DIVISION OF AGROSTOLOGY

### A. INTRODUCTION

#### 1. General

Most of the work of the Division was carried out smoothly, inspite of repeated setbacks.

There was considerable difficulty in carrying out soil fertility studies during the second quarter, due to disease attacking a number of plants. An unavoidable delay in sampling of soils, during the latter part of the year, aggravated the situation further.

The re-roofing of the old Phytosoloarium is yet being delayed. The Research Committee decided on the use of glass instead of 'fibrelite' — but the purchase of suitable glass is taking some time.

The grazing of the major pasture cum manurial trial was commenced in August. The water supply to this experiment is being held up due to delay in the purchase of pumps, though all other connected work is complete. Manuring of this experiment was done to schedule though the tractor was constantly undergoing repairs.

#### 2. Staff

Mr. K. Santhiresegaram, was confirmed Agrostologist and left on overseas study leave to Australia on the 2nd of March to do post-graduate work in Pasture Husbandry.

Miss N. Ramalingam, Research Assistant, was made Acting Agrostologist, to act for the Agrostologist, in his absence.

Mr. D.C. Ellewela was appointed Senior Field Assistant as from 1st January.

Mr. I.L. de Livera was appointed to do work directly under the Director as from 13th October.

The following appointments were made during the year:—

Mr. K. Perera	— Field/Lab. Assistant	— 1-1-60
Mr. I.L. de Livera	— Technical	— 1-2-60
Mr. H.R. Nonis	— Field/Lab.	— 15-3-60
Mr. W.S.C. Perera	— Field/Lab.	— 1-6-60
Mr. W.H. Fernando	— Field/Lab.	— 1-6-60

The following officers resigned from the services of the Institute.

Mr. M.K. Perera	— Field/Lab. Assistant	— 31-5-60
Mr. H.R. Nonis	— Field/Lab.	— 31-5-60

— both to continue their studies —

The personnel on 31st December 1960, was as follows:

Agrostologist (on study leave): Mr. K. Santhiresegaram, B.Sc. (Hons.), Ceylon.  
Acting Agrostologist (Research Assistant): Miss N. Ramalingam, B.Sc. (Hons.), Ceylon.

Animal Husbandry Officer: Mr. G.C.M. Goonesekera, Dip.Agric. (Peradeniya).

Technical Assistant: Mr. D.F.E. Fernandez.  
Technical Assistant (working under Director): Mr. I.L. de Livera.

Senior Field Assistant: Mr. D.C. Ellewela.

Field Assistant: Mr. K.C. Muthuchchamy.

Lab. and Field Assistants: Miss Y.G. Fernando

Miss D.I. Hettiarachchi

Mr. W.S.C. Perera

Mr. W.H. Fernando.

Lab. and Field Attendants: Mr. A.G.K. Silva

Mr. K.P.C. Fernando

Mr. P.J.E. Fernando

Mr. R.M. Dayaratne

Mr. A. Dassanayake

Mr. K.A.D.W. Jinadasa

Mr. W.P.T. Perera

Mr. D. Amarasinghe

Mr. J.M.J. Jayamanne

Mr. K.A. Fernando.

## B. SOIL FERTILITY STUDIES

### L. Lateritic soils at Bandirippuwa Estate

#### (a) Follow-up Experiments:

Soils 2 years after manuring:—

#### Experiment I

This was a  $3 \times 3 \times 4$  factorial experiment with two replicates of all treatments—experiments being set up with the three soil types—sand, loam and gravel. All experiments were planted to *Paspalum commersonii*. The nutrients and the levels used were as follows:—

N. as $(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre (basal).
P. as $\text{NaH}_2\text{PO}_4$	—	nil, $1\frac{1}{2}$ and 3 cwts./acre.
K. as $\text{K}_2\text{SO}_4$	—	nil, $1\frac{1}{2}$ , 3 and $4\frac{1}{2}$ cwts./acre.
Ca. as $\text{CaCO}_3$	—	nil, 5 and 10 cwts./acre.

The experiments were carried through four harvests.

Most of the plants of the  $\text{K}_2$  treatments growing on the sand and loam and a few of the gravel, died after the 3rd harvest.

Nutrients	Levels of Nutrients	SAND	LOAM	GRAVEL
CaCO <sub>3</sub>	CaO ..	42.33	36.60	43.79
	Ca <sub>5</sub> ..	48.56	39.26	48.37
	Ca <sub>10</sub> ...	50.58	35.78	42.30
NaH <sub>2</sub> PO <sub>4</sub>	P <sub>0</sub> ..	43.07	36.21	39.35
	P <sub>14</sub> ..	49.61	39.26	43.15
	P <sub>3</sub> ..	49.03	36.16	51.97
K <sub>2</sub> SO <sub>4</sub>	K <sub>0</sub> ..	28.27	20.88	29.61
	K <sub>14</sub> ..	36.16	27.19	33.68
	K <sub>3</sub> ...	36.23	32.35	36.72
	K <sub>44</sub> ..	41.06	32.23	34.46

TABLE I— Giving mean yields (grammes dry weight) for the four harvests for all the treatments and soil types for Experiment I.

The pattern of responses for the various nutrients tested was essentially similar for the three soil types. However in the case of P, though there was no significant increments recorded for sand and loam an increment of 32.07% was recorded for gravel.

K. was responsible for significant increments of yields in all three soil types, being 45.24% for the sand, 54.93% for the loam and 24.01% for the gravel.

Soils 3 years after manuring:—

Soils were sampled 3 years after manuring and the following two experiments set up —

#### Experiment II

This was a 2<sup>1</sup> 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 (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil and 5 cwts./acre
P. as NaH <sub>2</sub> PO <sub>4</sub>	—	nil and 3 cwts./acre
K. as K <sub>2</sub> SO <sub>4</sub>	—	nil and 4½ cwts./acre
Ca. as CaCO <sub>3</sub>	—	nil and 10 cwts./acre.

The experiments were set up late this year and are in progress.

#### Experiment III

This was a 4<sup>2</sup> 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 (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil, 1½, 2½ and 5 cwts./acre
K. as K <sub>2</sub> SO <sub>4</sub>	—	nil, 1½, 3 and 4½ cwts./acre.

These experiments are in the very early stages of growth and are in progress.

(b) Soil from B/E (Cinnamon sand from P<sub>7</sub> experiment area)

#### Experiment IV

This was a 3 × 3 × 4 factorial experiment with two replicates of all treatments planted to *Brachiaria milliformis* on cinnamon sand from the newly acquired section of Bandirippuwa Estate. The forms and levels of nutrients were:—

N. as Sulphate of Ammonia	—	1, 2, 4 and 6 cwts./acre
P. as Saphos Phosphate	—	1, 2 and 4 cwts./acre
K. as Muriate of Potash	—	1, 2 and 4 cwts./acre
Ca. as Limbux	—	4 cwts./acre (basal).

The experiment was planted in clay pots, 12" diameter, and kept on wooden benches in the open. Rain water was used to water the plants.

The experiment was harvested thrice.

The data indicated a deficiency of N, P and K — the deficiency of N. being acute and significant at the 0.1% level. The increments of yields noted for N, P and K are 120.74%, 19.09% and 11.19% respectively. (vide Table II).

Nutrient	Mean yields for 3 harvests
N <sub>1</sub> ..	100.11 grammes
N <sub>2</sub> ..	132.43 ..
N <sub>4</sub> ..	184.23 ..
N <sub>6</sub> ..	220.98 ..
P <sub>1</sub> ..	198.03 ..
P <sub>2</sub> ..	203.88 ..
P <sub>4</sub> ..	235.84 ..
K <sub>1</sub> ..	199.75 ..
K <sub>2</sub> ..	222.11 ..
K <sub>4</sub> ..	215.89 ..

TABLE II — Showing mean yields (grammes dry weight) of the three harvests (grammes dry weight) for the different treatments used.

This experiment is being continued with *Brachiaria brizantha*. The first harvest completed late this year indicates somewhat similar responses as obtained with *Brachiaria milliformis*.

#### 2. Soils from Ratmalagara Estate

Follow-up experiments:—

(a) Soils 6 months after manuring

#### Experiment I

This was 2<sup>2</sup> × 3 factorial experiment with three replicates of all treatments planted to *Paspalum commersonii*. The nutrients and the levels tested were as follows:—

N. as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil, 2½ and 5 cwts./acre
P. as NaH <sub>2</sub> PO <sub>4</sub>	—	nil and 2 cwts./acre
K. as K <sub>2</sub> SO <sub>4</sub>	—	nil and 2 cwts./acre.

The experiment was harvested thrice.

The results of this experiment indicate that while all tested nutrients (N, P and K) increased yields significantly, the effects due to N. and P. were noted early. There was no initial response due to K. (at the 1st harvest stage); but at the 3rd harvest, K. increased yields by 744%.

### Experiment II

This was a 4 factorial experiment with three replicates, of all treatments, planted to *Paspalum commersonii*.

The nutrients and levels tested were as follows:—

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

The experiment was harvested twice. The results of the two harvests are summarised in Table III—

Harvest	Treatment	$P_0$	$P_1$	$P_2$	$P_4$	Effective treatment and levels of significance (%)
Total of 2 harvests	$K_0$ ..	2.69	6.08	7.74	6.08	P—0.1%
	$K_1$ ..	4.09	8.08	8.69	7.27	
	$K_2$ ..	3.09	6.99	9.92	8.86	
	$K_4$ ..	2.41	7.63	8.89	7.77	

TABLE III — Showing mean yields (grammes dry weight) of the 3 replicates of all treatments at the two harvests.

Data from the experiment indicate a pronounced increase in yields due to P. which was significant at the 0.1% level and gave an increment of 65.16%. The response due to K. was comparatively low giving an increment of 21.74%.

(b) Soils 12 months after manuring

### Experiment III

This was a 4<sup>3</sup> factorial experiment, with all treatments replicated thrice and planted to *Paspalum commersonii*. The nutrients and the levels tested were the same as in Experiment II conducted with soils 6 months after manuring (Ratmalagara Estate loam).

The experiment was harvested twice and 'thinnings' included for additional data. The results are summarized in Table IV.

Harvest	Treatment	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>4</sub>	Effective treatments and levels of significance (%)
Total of All	K <sub>0</sub> ..	1.71	2.77	3.11	4.10	P — 0.1%
	K <sub>1</sub> ..	1.98	4.46	5.59	4.79	
	K <sub>2</sub> ..	1.81	4.05	3.99	4.32	
	K <sub>4</sub> ..	1.77	5.27	5.61	6.27	

TABLE IV — Showing mean yields (grammes dry weight) of the 3 replicates for all treatments at the two harvests and levels of significance of effective treatments.

The data indicate that even after one year there was no significant response to added K.P. however was responsible for high increments of yields. The addition of one cwt. of NaH<sub>2</sub>PO<sub>4</sub> per acre (P<sub>1</sub>) increased yields by approximately 200%.

#### Experiment IV

This was a 2<sup>3</sup> × 3 factorial experiment with three replicates of all treatments, planted to *Paspalum commersonii*.

The forms and the levels of nutrients tested were the same as in Experiment I set up with soils sampled 6 months after manuring.

The experiment was harvested thrice, and the 'thinnings' included for additional data.

The data indicate a deficiency of all tested nutrients, the pattern of response being similar to that obtained with soils 6 months after manuring.

#### (c) Soils 18 months after manuring

#### Experiment V

This was a 3 × 2 × 2 factorial experiment with three replicates of all treatments. Nutrients and levels tested were as in Experiment I (a) of the experiments set up with soils 6 months after manuring. This was planted to *Paspalum commersonii* and is in the early stages of growth.

#### Experiment VI

This was a 4<sup>2</sup> factorial experiment with two replicates of all treatments. Nutrients and levels tested were the same as in Experiment II (a). This was planted to *Paspalum commersonii* and is in the early stages of growth.

#### (d) Soils 6 months after manuring

Soils were sampled of the new follow-up plot this November — 6 months after manuring, and the following experiments set up:—

#### Experiment VII

Same as Experiment V (c) planted to *Paspalum commersonii*.

### Experiment VIII

Same as Experiment VI (c) planted to *Paspalum commersonii*.

Both experiments are in the early stages of growth.

#### 3. Cinnamon Sand at Horrekelle Estate

Follow-up experiments:—

##### (a) Soils 2 years after manuring

Soils were sampled 2 years after manuring in April this year, and the following experiments set up:—

#### Experiment I

This was a 2<sup>5</sup> factorial experiment planted to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

N as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil and 1½ cwts./acre.
P as NaH <sub>2</sub> PO <sub>4</sub>	—	nil and ¾ cwts./acre.
K as K <sub>2</sub> SO <sub>4</sub>	—	nil and ¾ cwts./acre.
Ca as CaCO <sub>3</sub>	—	nil and 5 cwts./acre.
Mg as MgSO <sub>4</sub>	—	nil and ½ cwts./acre.

The experiment was carried through two harvests.

N and K increased yields significantly, alone, and in combination with one another and to a lesser extent with P.

At the second harvest Ca depressed yields which was significant at the 5% level.

#### Experiment II

This was a 2<sup>5</sup> factorial experiment planted to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

N as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil and 5 cwts./acre.
P as NaH <sub>2</sub> PO <sub>4</sub>	—	nil and 3 cwts./acre.
K as K <sub>2</sub> SO <sub>4</sub>	—	nil and 6 cwts./acre.
Ca as CaCO <sub>3</sub>	—	nil and 10 cwts./acre.
Mg as MgSO <sub>4</sub>	—	nil and 1½ cwts./acre.

The Experiment was carried through two harvests.

N and K increased yields significantly — alone, and in combination. Ca was responsible for a decrease in yields which was significant at the 1% level at the first harvest.

#### Experiment III

This was a 4<sup>2</sup> factorial experiment with two replicates of all treatments planted to *Paspalum commersonii*. The nutrients and levels tested were.

N as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	nil, 2½, 5 and 7½ cwts./acre.
K as K <sub>2</sub> SO <sub>4</sub>	—	nil, 3, 6 and 9 cwts./acre.

The experiment was harvested thrice. The 'thinnings' were included for additional data. A very high increment of yields of 1062.62% was obtained for N, this being significant at 0.1% level at the 1st harvest.

(b) Soils 2½ years after manuring

Soils were sampled 2½ years after manuring in November this year and the following two experiments set up.

Experiment IV

This was a 2<sup>5</sup> factorial experiment planted to *Paspalum commersonii*. The nutrients and levels tested were as follows:—

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

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

Experiment V

This was a 4<sup>2</sup> factorial experiment set up as for Experiment III. A basal dosage of Ca as CaCO<sub>3</sub> (5 cwts./acre) was however added for this experiment.

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

4. Lateritic Gravel at Mattegoda Estate

The studies with the top-soil and sub-soil have been completed and the data analysed. The results are being written up for publication.

The data from these experiments indicate an acute deficiency of N, P, K and B in the top-soil. Ca was also found to be deficient but to a lesser extent.

In addition to the nutrients deficient in the top-soil, the sub-soil was found to be deficient in Ca and Mg. The acuteness of these deficiencies was such, that, there was practically no plant growth in the absence of these two nutrients.

The optimum requirements of the deficient nutrients for the top-soil as evident from the data are as follows:—

P as NaH <sub>2</sub> PO <sub>4</sub>	—	3 cwts./acre.
K as K <sub>2</sub> SO <sub>4</sub>	—	6 cwts./acre.
Ca as CaCO <sub>3</sub>	—	5 cwts./acre.
Mg as MgSO <sub>4</sub>	—	2 cwts./acre.
B as Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub>	—	6 lbs./acre.

Yannathavillu forest soil

Studies conducted with soils before and after the forest was burnt on both the yellow and red loams are completed. The data analysed are being written up for publication.

The experiments indicate a deficiency of N, P and K in both soil types tested — both before and after the forest was burnt. Calcium gave a depression of yields which was even more acute in soils after the forest was burnt.

No deficiency of micro-nutrients was detected. The optimum dosage of P and K as evident from the data were:—

P as $\text{NaH}_2\text{PO}_4$	—	3 cwt./acre.
K as $\text{K}_2\text{SO}_4$	—	$4\frac{1}{2}$ cwt./acre.

## 6. Pottukulama Forest Soil

### (a) Soils under Forest cover

#### Experiment I

This was a  $2^5$  factorial experiment with two replicates of all treatments planted to *Paspalum commersonii*. The nutrients and levels tested were:—

N as $\text{NH}_4\text{NO}_3$	—	nil and 3 cwt./acre.
P as $\text{NaH}_2\text{PO}_4$	—	nil and 3 cwt./acre.
K as $\text{K}_2\text{SO}_4$	—	nil and 3 cwt./acre.
Ca as $\text{CaCO}_3$	—	nil and 10 cwt./acre.
Mg as $\text{MgSO}_4$	—	nil and $1\frac{1}{2}$ cwt./acre.

The experiment was carried through two harvests. The 'thinnings' were included for additional data.

The data indicate an acute deficiency of N, P and K. K gave increasingly high responses with a yield of the plant, a high increment of 185.62% being recorded at the 2nd harvest. Ca and Mg decreased yields slightly at the thinnings stage — but gave very slight increments of yields at the later stages.

#### Experiment II

This was similar in design to Experiment I. However, this experiment was planted to *Phaseolus lathyroides*. The first planting was harvested twice and two sets of "thinnings" taken for additional data. The second planting was harvested once, and here too, the "thinnings" was included for additional data.

The data obtained show a similar pattern of response as in Experiment I. However, an increase in yields was observed at the later stages for added Ca which was found to be significant at the 0.1% level. The response to N was negligible showing effective nodulation had taken place, this plant being a legume.

#### Experiment III

This was similar in design, to Experiment I, but was planted to *Sesamum indicum*. The Experiment was carried through two plantings — two 'thinnings' and a harvest being recorded for the first planting and a 'thinnings' and harvest being recorded for the second planting.

The data obtained show a similar pattern of responses as in Experiment I. Ca had no effect however in the case of *Sesamum indicum*.

#### Experiment IV

This was a  $4^2$  factorial experiment with two replicates of all treatments, planted to:—

- Paspalum commersonii*
- Phaseolus lathyroides*; and
- Medicago sativa*.

The forms and, levels of nutrients tested were as follows:—

Fe as $\text{FeSO}_4$	—	nil and 7 lbs./acre.	} Basal dressing.
Cu as $\text{CuSO}_4$	—	nil and 7 lbs./acre.	
Zn as $\text{ZnSO}_4$	—	nil and 7 lbs./acre.	
Mn as $\text{MnSO}_4$	—	nil and 7 lbs./acre.	
N as $(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre.	
P as $\text{NaH}_2\text{PO}_4$	—	3 cwts./acre.	
K as $\text{K}_2\text{SO}_4$	—	3 cwts./acre.	
Mg as $(\text{MgSO}_4)$	—	$1\frac{1}{2}$ cwts./acre.	
Ca as $\text{CaCO}_3$	—	10 cwts./acre.	
Mo as $(\text{NH}_4)_6\text{O}_7 \cdot \text{MO}_7$	—	1 lb/acre.	
B as $\text{Na}_2\text{B}_4\text{O}_7$	—	3 lbs./acre.	

The experiment was harvested thrice for *Paspalum commersonii*, thrice with two plantings for *Phaseolus lathyroides* and six times for *Medicago sativa*. None of the tested micro-nutrients was found to increase yields significantly.

#### Experiment V

This was a  $4^2$  factorial experiment with two replicates of all treatments to test the effect of different forms of Ca and N on the growth of *Paspalum commersonii*.

The forms and levels of nutrients used were as follows:—

N as Nil.

$\text{NH}_4\text{NO}_3$	—	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).
$\text{CaCO}_3$	—	5.00 cwts./acre (220 lbs. Ca).
$\text{CaSO}_4$	—	8.75 cwts./acre (220 lbs. Ca).

The experiment was harvested twice each, for the two plantings. The 'thinnings' of this experiment was also included for additional data.

The results obtained are summarized in Table V:—

Harvests	Treatments	Nil	$\text{Ca}(\text{OH})_2$	$\text{CaCO}_3$	$\text{CaSO}_4$	Levels of significance effective treatment (%)
Total of all harvests	Nil	3.78	4.69	4.24	7.67	N — 0.1%
	$\text{NH}_4\text{NO}_3$	12.94	11.88	13.25	13.07	
	$(\text{NH}_4)_2\text{SO}_4$	11.46	11.88	12.91	10.97	
	$\text{CO}(\text{NH}_2)_2$	12.80	12.64	9.09	12.34	

TABLE V — Showing total yields (gms. dry weight) for all harvests and levels of significance of the effective treatments.

The data indicate a significant increase in yields due to added Nitrogen. However, no significant difference between the forms of Nitrogen was noted. Calcium had no significant effect on yields.

### Experiment VI

This was a simple experiment to study the effect of Sulphur on plant growth in this soil. The experiment was planted to *Paspalum commersonii* and *Phaseolus lathyroides*. The dosage and forms of nutrients applied were as follows:—

*Sulphur plus treatments:*—

S as	{	$K_2SO_4$	—	123.6 lbs. S/acre + 301 lbs. K/acre.
		$MgSO_4$	—	123.6 lbs. S/acre + 84 lbs. Mg/acre.
		$CaSO_4$	—	123.6 lbs. S/acre + 170.8 lbs. Ca/acre.
		$H_2SO_4$	—	123.6 lbs. S/acre (Solution) 35 c.c.s. of N/10.
		$S_4$	—	123.6 lbs. S/acre.

*Sulphur nil treatments:*—

KCl	—	301.1 lbs. K/acre.
$MgCl_2$	—	84 lbs. Mg/acre.
$CaCO_3$	—	170.8 lbs. Ca/acre.
HCl	—	35 c.c. of N/10. Solution
N as $NH_4NO_3$	—	3 cwts./acre.
P as $NaH_2PO_4$	—	3 cwts./acre.

} Basal dressing

The experiment was harvested twice. The results of the two harvests are summarized in Table VI.

Plant	Treatment	K <sup>+</sup>	Mg <sup>++</sup>	Ca <sup>++</sup>	H <sup>+</sup>	S <sup>+++</sup>	Mean Difference
<i>Paspalum commersonii</i>	S <sub>0</sub>	2.43	5.58	3.81	4.57	5.17	3.67
	S <sub>4</sub>	10.21	7.85	6.05	8.18	7.62	
<i>Phaseolus lathyroides</i>	S <sub>0</sub>	2.75	3.98	4.45	3.91	3.71	2.80
	S <sub>4</sub>	9.20	6.25	4.68	6.40	6.25	

TABLE VI — Giving total yields (gms. dry weight) for the two harvests and the mean difference for the two plant types tested.

A significant increase in yields was recorded for all sulphur plus treatments for both plant types tested. There was however no difference of behaviour between the different forms of Sulphur used.

### Experiment VII

This was a 4<sup>3</sup> factorial experiment to test the effect of increasing doses of K, P and Mg, on *Paspalum commersonii*. The dosage and forms of nutrients applied were as follows:—

K as $K_2SO_4$	—	Nil, 3 cwts., 4½ and 6 cwts./acre.
P as $NaH_2PO_4$	—	Nil, 3 cwts., 4½ and 6 cwts./acre.
Mg as $MgSO_4$	—	Nil, 1 cwt., 2 and 3 cwts./acre.
N as $NH_4NO_3$	—	3 cwts./acre.
Ca as $CaCO_3$	—	10 cwts./acre.

} Basal dressing

The experiment was harvested twice for the first planting and once for the second planting. 'Thinnings' were included for both plantings for additional data. The data obtained are summarized in Table 7.

Nutrient	Levels of Nutrient	Mean yields for all harvests	Increments of yields	Levels of significance of effective treatments
NaH <sub>2</sub> PO <sub>4</sub>	P <sub>0</sub>	13.08	735.64%	P — 0.1%
	P <sub>3</sub>	107.08		
	P <sub>4½</sub>	109.27		
	P <sub>6</sub>	105.38		
K <sub>2</sub> SO <sub>4</sub>	K <sub>0</sub>	38.02	194.84%	K — 0.1%
	K <sub>3</sub>	87.37		
	K <sub>4½</sub>	97.32		
	K <sub>6</sub>	112.10		
MgSO <sub>4</sub>	Mg <sub>0</sub>	81.80	6.42%	
	Mg <sub>1</sub>	83.35		
	Mg <sub>2</sub>	87.05		
	Mg <sub>3</sub>	82.65		

TABLE VII — Showing mean yields (gms. dry wt.) for all harvests.

The data indicate a very high increase in yields, to added P — an increment of 735.64% being recorded, this being significant at the 0.1% level. K. gave an increment in yields of 194.84% also significant at the 0.1% level while Mg. gave an increment of only 6.42.

#### Experiment VIII

This was a simple experiment to study the effect of increasing doses of Sulphur on the growth of:—

(a) *Paspalum commersonii*

(b) *Phaseolus lathyroides*

and (c) *Medicago sativa*.

All treatments were replicated twice. A basal dressing of N, P, K, Ca, Mg was added. The forms and levels of nutrients tested were:—

S as S <sub>1</sub>	—	62 lbs./acre.	} Basal dressing
S <sub>2</sub>	—	124 lbs./acre.	
S <sub>3</sub>	—	186 lbs./acre.	
S <sub>4</sub>	—	248 lbs./acre.	
N as NH <sub>4</sub> NO <sub>3</sub>	—	3 cwts./acre.	
P as NaH <sub>2</sub> PO <sub>4</sub>	—	3 cwts./acre.	
K as K <sub>2</sub> SO <sub>4</sub>	—	3 cwts./acre.	
Ca as CaCO <sub>3</sub>	—	10 cwts./acre.	
Mg as MgSO <sub>4</sub>	—	1½ cwts./acre.	

The experiment was harvested thrice in the case of all three plant species. The data obtained are summarized in Table VIII:—

Plant species	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	Levels of significance of effective treatments (%)
<i>Paspalum commersonii</i>	2.38	11.35	10.97	11.46	10.88	S—1%
<i>Phaseolus lathyroides</i>	1.36	5.80	5.60	5.92	5.93	S—1%
<i>Medicago sativa</i>	1.55	6.19	6.27	6.00	5.97	S—1%

TABLE VIII — Showing mean yields (gms. dry wt.) for each plant species and levels of significance of the effective treatments.

The data indicate that, added Sulphur gave high increases of yields significant at the 1% level for all plant species tested. The effect due to increasing dosage of Sulphur was negligible — S<sub>1</sub> (62 lbs./acre) being the optimum. With S<sub>1</sub> increments of yields of 376.89%, 326.47% and 299.35% were recorded for *Paspalum commersonii*, *Phaseolus lathyroides* and *Medicago sativa* respectively.

#### Experiment IX

This was a 4<sup>2</sup> factorial experiment with two replicates of all treatment 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 <sub>2</sub> CO <sub>3</sub>		
KCl		
K <sub>2</sub> SO <sub>4</sub>		
Mg as Nil	} 84 lbs. Mg/acre.	
Mg (COO) <sub>2</sub>		
MgCl <sub>2</sub>		
MgSO <sub>4</sub>		
N as NH <sub>4</sub> NO <sub>3</sub>	} — 3 cwts./acre	} Basal dressing.
P as NaH <sub>2</sub> PO <sub>4</sub>		

The experiment has been harvested twice and is in progress. Results obtained so far indicate increase in yields due to both added K and Mg. The Sulphates of both nutrients tested registered the highest yields.

#### Experiment X

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

N as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	— Nil, 2½, 5 and 7½ cwts./acre.
K as K <sub>2</sub> SO <sub>4</sub>	— Nil, 3, 6 and 9 cwts./acre.
P as NaH <sub>2</sub> PO <sub>4</sub>	— 3 cwts./acre (basal dressing).

The experiment has been harvested thrice and is in progress.

The optimum dosage of N and K as evident from the data so far obtained seem to be in the region of 5 cwts./acre and 3 cwts./acre respectively.

b) Soils after the forest was cleared and burnt

Soils were sampled of areas from which the forests had been cleared and burnt, and the following experiments set up:—

Experiment XI

This was a 2<sup>5</sup> factorial experiment planted to:—

- (a) *Paspalum commersonii* — 2 replicates of all treatments.
- (b) *Phaseolus lathyroides* — 1 replicate of all treatments.
- (c) *Sesamum indicum* — 1 replicate of all treatments.

The forms and levels of nutrients applied were as follows:—

N as $(\text{NH}_4)_2\text{SO}_4$	—	Nil and 5 cwts./acre.	
P as $\text{NaH}_2\text{PO}_4$	—	Nil and 3 cwts./acre.	
K as $\text{K}_2\text{SO}_4$	—	Nil and 3 cwts./acre.	
Ca as $\text{CaCO}_3$	—	Nil and 10 cwts./acre.	
Mg as $\text{MgSO}_4$	—	Nil and 1½ cwts./acre.	
Fe as $\text{FeSO}_4$	—	7 lbs./acre.	} Basal dressing.
Cu as $\text{CuSO}_4$	—	7 lbs./acre.	
Zn as $\text{ZnSO}_4$	—	7 lbs./acre.	
Mn as $\text{MnSO}_4$	—	7 lbs./acre.	
Mo as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}$	—	1 lbs./acre.	

The experiment was harvested thrice each, in the case of *Paspalum commersonii*, and *Phaseolus lathyroides*; and once, for *Sesamum indicum*. The 'thinnings' were included in all three cases.

The data indicate a high increase in yields due to added N. and P. K. also gave increases of yields, evident more with age of the plants.

A depression due to Ca was noted. The pattern of responses was very similar to that obtained for the similar experiment set up with soils under forest cover (Experiment VI (a) 1).

Experiment XII

This was a 2<sup>5</sup> factorial experiment to measure the effect of the minor nutrients, Fe, Cu, Zn, Mn and Mo on the growth of:—

- (a) *Paspalum commersonii*
- (b) *Medicago sativa*

A basal dressing of N, P, K, Ca Mg and B, was added.

The forms and levels of nutrients applied were as follows:—

Fe as $\text{FeSO}_4$	—	Nil and 14 lbs./acre.	
Cu as $\text{CuSO}_4$	—	Nil and 14 lbs./acre.	
Zn as $\text{ZnSO}_4$	—	Nil and 14 lbs./acre.	
Mn as $\text{MnSO}_4$	—	Nil and 14 lbs./acre.	
Mo as $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}$	—	Nil and 2 lbs./acre.	
N as $(\text{NH}_4)_2\text{SO}_4$	—	5 cwts./acre.	} Basal dressing.
P as $\text{NaH}_2\text{PO}_4$	—	3 cwts./acre.	
K as $\text{K}_2\text{SO}_4$	—	3 cwts./acre.	
Mg as $\text{MgSO}_4$	—	1 cwt./acre.	
Ca as $\text{CaCO}_3$	—	5 cwts./acre.	
B as $\text{Na}_2\text{B}_4\text{O}_7\cdot 10\text{H}_2\text{O}$	—	6 lbs./acre.	

The experiment has been harvested twice each, so far, and is in progress. The data of the two harvests obtained indicate no significant effect due to any of the added nutrients.

### Experiment XIII

This was a 4<sup>2</sup> factorial experiment with two replicates of all treatments to study the effect due to different forms of Calcium and Nitrogen on the growth of *Paspalum commersonii*.

The forms and levels of nutrients applied were as follows:—

N as Nil

NH <sub>4</sub> NO <sub>3</sub>	—	3 cwts./acre. (118 lbs. of N)
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	—	5 cwts./acre. "
CO(NH <sub>2</sub> ) <sub>2</sub>	—	2.27 cwts./acre. "

Ca as Nil

Ca(OH) <sub>2</sub>	—	3.75 cwts./acre. (220 lbs. of Ca)
CaSO <sub>4</sub>	—	8.75 cwts./acre. "
CaCO <sub>3</sub>	—	5 cwts./acre. "

P as NaH<sub>2</sub>PO<sub>4</sub>

K as K<sub>2</sub>SO<sub>4</sub>

3 cwts./acre. } Basal dressing  
4½ cwts./acre. }

The experiment was harvested twice and the 'thinnings' included for additional data. The results are summarized in Table IX:—

Treatment	Nil	NH <sub>4</sub> NO <sub>3</sub>	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	CO(NH <sub>2</sub> ) <sub>2</sub>	Levels of significance of effective treatments (%)
Nil ..	1.18	8.75	9.89	7.18	N — 0.1%
Ca(OH) <sub>2</sub> ..	1.05	8.77	7.30	4.02	
CaCO <sub>3</sub> ..	1.18	8.23	8.44	6.10	
CaSO <sub>4</sub> ..	1.14	10.47	8.93	5.70	

TABLE IX — Showing mean yields (gms. dry weight) of all harvests and levels of significance of effective treatments.

The data indicate a significant increase of yields due to added Nitrogen. However, no significant difference between the forms of Nitrogen was noted. Calcium had little effect on yields. The pattern of responses is similar to that obtained in the similar experiment with soils under forest cover (Experiment VI (a) V).

### Experiment XIV

This was a simple experiment to study the effect of increasing doses of Sulphur on the growth of:—

(a) *Paspalum commersonii*

(b) *Phaseolus lathyroides*

(c) *Medicago sativa*.

All treatments were replicated twice.

The experiment has been harvested once and is in progress.

## C. 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)

The *Brachiaria brizantha* and *Brachiaria milliformis* plots were grazed with two cows/plot. Grazing commenced in the two plots at the same time. The former *Paspalum commersonii* plot is being maintained under natural cover as control plot.

The *Panicum maximum* plot (Guinea grass) was grazed as in previous years.

All plots were manured with 1 cwt./acre Sulphate of Ammonia in June (the time of application of manure was delayed slightly, due to delay in the monsoon rains); and 1 cwt./acre each of Murizate of Potash and Sulphate of Ammonia in November, this year.

The Yield of nuts were as follows:—

Grass	No. of nuts/plot	No. of nuts/acre
(i) <i>Paspalum commersonii</i> (Control plot) ..	561	2,992
(ii) <i>Brachiaria milliformis</i> ..	734	3,915
(iii) <i>Brachiaria brizantha</i> ..	692	3,691
(iv) <i>Panicum maximum</i> ...	675	3,600

This year the fourth experimental year has been completed. A slight increase for the last three years in yield of nuts, has been recorded. The *Paspalum commersonii* plot now being maintained as control, gave the lowest yields — this being so, for the last three years.

Grass	Yield of nuts/acre		
	1958	1959	1960
<i>Paspalum commersonii</i> (Control) ..	2,357	2,976	2,992
<i>Brachiaria milliformis</i> ..	3,306	3,546	3,915
<i>Brachiaria brizantha</i> ..	3,162	3,461	3,691
<i>Panicum maximum</i> ..	3,173	2,832	3,600

Not much difference in the live weight of animals was noted.

The guinea grass plot was grazed thrice for the year. The number of grazings was one less than that for the previous year. This was due to the drought during the early part of this year.

The following herbage yields (tons dry matter/acre) were recorded:—

	1st	2nd	3rd
Before grazing ..	3.13	3.50	4.19
After grazing ..	1.79	1.71	2.22
No. of days grazing ..	21	20	18

Herbage yields of *Panicum maximum* (tons dry matter/acre).

## 2. Pasture × Type of Manuring (Bandirippuwa Estate)

The *Paspalum commersonii* plot is being now continued under *Brachiaria milliformis* as a second replicate of the former *Brachiaria milliformis* plot.

The plots were manured with 1 cwt./acre Sulphate of Ammonia in June (the delay in the application of manure was due to the delay in the advent of the monsoon rains); and 1 cwt./acre each of Sulphate of Ammonia and Muriate of Potash in November this year. Palm manuring was done in November.

The nut yields of various treatments were as follows:—

Grass	Fertilizer buried in		Fertilizer broadcast in		Total
	Trenches	Circles	Trenches	Circles	
<i>Paspalum commersonii</i> (Now <i>Brachiaria milliformis</i> )	169	296	338	333	1,136
<i>Brachiaria milliformis</i>	226	236	240	250	952
Total	395	532	578	583	2,088

Total nut yields for each treatment for 1960 (6 palms).

The pastures are being grazed by two and four adult cows/plot, for the new *Brachiaria milliformis* and old *Brachiaria milliformis* respectively.

## 3. Cultivation × Pasture Experiment, (Ratmalagara Estate)

The Experiment consists of two plots, each plot being one acre in extent — both plots being maintained under a stand of *Brachiaria brizantha*. Half of each of the plots is sub-soiled to an approximate depth of 18" with a tractor mounted sub-soil plough.

The plots were manured with 1 cwt./acre Sulphate of Ammonia in May and 1 cwt./acre each of Sulphate of Ammonia, Muriate of Potash and Saphos phosphate broadcast in October this year.

Both plots were disc-harrowed after manure application.

The nut yields for the year due to cultivation are as follows:—

	Not sub-soiled	Sub-soiled	Total
1. <i>Brachiaria brizantha</i> (formerly <i>Paspalum commersonii</i> )	1,008	644	1,652
2. <i>Brachiaria brizantha</i>	743	893	1,636
Total	1,751	1,537	3,288

This is similar to the trend observed for the previous two years.

Two milking cows are put alternately into the two plots (each plot consisting of half sub-soiled and half not sub-soiled) for a period of four weeks. Cattle weights and milk yields have been recorded.

#### 4. Intensity of Grazing trial (Ratmalagara Estate)

The experiment consists of the following plots:—

1. Two  $\frac{1}{2}$  acre plots without grass (control).
2. "  $\frac{1}{2}$  " " with *Brachiaria brizantha* (ungrazed).
3. " 1 " " " " " " "
4. "  $1\frac{1}{2}$  " " " " " " "
5. " 2 " " " " " " "

Sampling by the stratified randomized method is done. Three samples per  $\frac{1}{2}$  acre is taken. Sampling is done before and after grazing and for every month during the grazing season.

Grazing is according to the following schedule — Where two milking cows are put into each plot while there is feed for the animals to graze, during the 'grazing' seasons:—

1. 1st January to 31st March — Grazing season.
2. 1st April to 30th June — Resting season.
3. 1st July to 30th September — Grazing season.
4. 1st October to 31st December — Resting season.

All plots were manured with 1 cwt./acre Sulphate of Ammonia in May and 1 cwt./acre each of Sulphate of Ammonia, Muriate of Potash and Saphos Phosphate broadcast in October this year. All plots were disc-harrowed after manure application.

An interesting feature is the infestation of *Brachiaria brizantha* plots with *Brachiaria milliformis*. Further observations are necessary before definite conclusions are drawn.

The nut yields for the various plots for the year are as follows:—

	Average yield/palm (No. of nuts)	Computed yield per acre
Control $\frac{1}{2}$ acre (No grass)	85.58	5,477
" $\frac{1}{2}$ " (Brachiaria brizantha)	69.17	4,427
Brachiaria 1 acre	70.50	4,512
" $1\frac{1}{2}$ "	75.39	4,825
" 2 "	83.04	5,315
Control (Brachiaria brizantha)	63.17	4,043
Brachiaria 1 acre	78.83	5,045
" $1\frac{1}{2}$ "	80.44	5,148
" 2 "	71.08	4,549

Further data under the new design should be recorded before intensity can be calculated.

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

This re-constitution of the mixed pasture trial was done early this year — all plots being under *Brachiaria brizantha*, each replicate of two, one acre plots — one of which was further divided into four, and rotationally grazed by one milking cow.

Another milking cow grazes the other undivided plot continuously, while the corresponding animal in the sub-divided plot, remains.

The grazing was carried out in the two replicates alternately.

Samples before and after grazing (fortnightly) are taken from the sub-plots; and at fortnightly intervals in the undivided plots.

All plots were mowed and manure applied, broadcast — one cwt./acre Sulphate of Ammonia in May and one cwt./acre each of Sulphate of Ammonia, Muriate of Potash and Saphos phosphate in October.

The nut yields for the year are as follows:—

	Average yield/palm	Computed yield/acre
Continuous grazing (Plot A)	54.57	3,492
Rotational grazing (Plot B)		
Sub-Plot 1	69.65	4,458
"    2	51.33	3,285
"    3	53.74	3,439
"    4	62.20	3,981
Continuous grazing (Plot D)	72.09	4,614
Rotational grazing (Plot C)		
Sub-Plot 1	70.20	4,493
"    2	57.27	3,665
"    3	59.55	3,811
"    4	75.40	4,826

The re-constitution has been very recent for any definite indications as yet.

### 6. Pasture cum Manurial Trial (Bandirippuwa Estate)

The experiment was manured with split dose (half total dosage) of Ammonium Sulphate and full dose of Muriate of Potash and Saphos phosphate in April this year. The remaining half dose of Ammonium sulphate was applied in November. The pasture plots were lightly harrowed prior to nutrient application, whereas the Estate (control) plots were harrowed lightly after nutrient application.

Grazing was commenced on the 1st of August, and the cattle have gone through one complete grazing of the three replicates and have just moved into Replicate two for the second grazing.

Moisture readings of all 108 plots, have been recorded at four depths — 6", 1½', 2½' and 3½' from the surface of the ground, from the first of June.

Cattle weights have been recorded weekly. A few cases of rumen impaction were noted in the case of these cattle.

The nut yields for the Experiment for 1959 and 1960 are summarized in the following Table:—

N.P.K. Treat- ment. Cwts. ... per acre	FIRST REPLICATE						SECOND REPLICATE						THIRD REPLICATE					
	Brachiaria milliformis		Brachiaria brizantha		Estate Control		Brachiaria milliformis		Brachiaria brizantha		Estate Control		Brachiaria milliformis		Brachiaria brizantha		Estate Control	
	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960	1959	1960
1- 1 1 ..	47.83	45.42	41.25	51.33	37.38	46.42	26.70	16.92	35.71	23.21	27.58	20.58	42.13	37.46	38.88	30.54	56.30	37.17
2 1 1 ..	37.61	41.83	31.24	27.67	32.96	31.71	30.64	30.50	33.75	34.67	24.67	27.78	25.74	27.71	34.09	44.08	26.22	21.39
4 1 1 ..	29.32	33.71	25.83	26.64	31.74	33.00	34.50	34.61	29.39	27.90	34.95	33.30	22.21	32.82	26.83	27.46	37.63	34.68
1 2 1 ..	24.50	28.50	30.17	36.48	31.00	36.00	27.05	28.65	30.57	29.22	32.43	39.90	26.59	30.14	36.23	39.67	29.45	28.22
2 2 1 ..	20.29	21.49	18.35	19.09	18.75	19.46	38.96	33.18	38.54	21.29	32.62	27.05	48.96	39.83	53.38	41.48	56.74	39.43
4 2 1 ..	22.38	24.57	27.58	27.21	39.50	26.63	34.04	20.58	33.41	24.74	39.30	23.64	35.36	37.14	29.58	29.96	24.45	20.30
1 1 2 ..	40.90	48.65	32.92	33.38	43.22	49.65	26.21	28.75	28.26	35.65	23.68	30.87	40.25	48.10	30.43	31.23	25.85	25.10
2 1 2 ..	61.79	64.67	39.91	49.09	35.17	45.72	49.59	45.62	39.17	31.74	35.33	32.08	25.27	30.50	32.54	33.54	29.62	28.52
4 1 2 ..	14.05	15.00	17.36	16.86	17.39	18.00	29.00	32.95	35.55	38.77	50.65	43.29	33.92	20.08	54.74	28.46	43.00	35.42
1 2 2 ..	27.13	32.71	21.23	23.64	22.75	25.52	28.00	18.29	23.38	23.79	29.87	22.33	40.96	29.29	36.74	37.38	36.13	32.17
2 2 2 ..	31.75	35.65	33.18	42.35	29.76	26.36	37.81	41.48	32.78	31.42	28.21	38.71	35.87	34.38	29.71	28.58	22.61	22.96
4 2 2 ..	32.74	37.50	33.17	39.96	19.17	19.04	29.29	34.96	35.17	37.43	40.91	41.09	30.96	40.63	24.73	22.30	25.00	28.29

Table showing average yields per palm per plot for 1959 and 1960 for the different treatments.

### 7. Frequency of cutting trial (Ratmalagara Estate)

The experiment consists of the following treatments:—

1. A. — No cutting.
2. B. — Cutting every two weeks
3. C. — " " four "
4. D. — " " six "
5. E. — " " eight "

The plots were planted to *Brachiaria milliformis* in May last year and samplings were done as from July this year, after the plots were mown to an approximately uniform height of 3". The first samplings were taken two weeks after mowing. The samples are being stored for Chemical analysis.

The two levels of nitrogen (1 and 2 cwts./acre Sulphate of Ammonia) were applied every six months with the rains (April and October 1960).

The experiment is in progress.

### 8. Nitrogen manuring × type of planting trial (Ratmalagara Estate)

This experiment consists of randomized blocks with main plots for types of planting and split plots for levels of Nitrogen. The treatments are as follows:—

- (a) Types of planting (1) Disc harrowed and hand planted.  
(2) Tractor planting.

- (b) Levels of Nitrogen (1) N<sub>0</sub> — No nitrogen application.  
(2) N<sub>1</sub> — 56 lbs. Ammonia/acre/season.  
(3) N<sub>2</sub> — 112 lbs. Ammonia/acre/season.

The layout of this experiment consists of six blocks, each block with two plots of the Main treatments — each plot being further divided into three squares for the three levels of Nitrogen tested.

This experiment was carried on from the end of 1959. Sampling has been done fortnightly and all plots mowed. During the drought, sampling had to be done every three weeks, and the mowing after each sampling had to be abandoned.

Manuring was done to schedule during May and October.

All dried samples of this experiment are being preserved for Chemical analysis.

## D. ANIMAL HUSBANDRY

### Herd Figures

The following is the herd strength of animals for the year:—

	Bulls	Cows	Heifers	B. Calves.	Total
January	1	27	34	33	95
February	1	21	34	35	89
March	1	21	32	35	89
April	1	21	35	40	97
May	1	23	37	43	104
June	2	25	37	45	109
July	3	25	42	48	118
August	2	25	41	45	113
September	2	25	41	45	113
October	2	25	40	47	114
November	2	25	40	47	114
December	2	25	40	47	114

Bandirippuwa  
Estate

	Bulls	Cows	Heifers	B. Calves	Total	
January	2	18	15	8	43	} Ratmalagara Estate
February	2	23	17	7	45	
March	2	23	17	7	45	
April	2	23	17	12	54	
May	2	23	19	14	58	
June	2	23	19	14	58	
July	3	23	16	13	55	
August	3	25	15	15	58	
September	3	28	16	16	63	
October	3	30	15	17	65	
November	3	31	14	18	66	
December	3	31	15	18	67	

In July 1960, two Scindi Stud Bulls were purchased from the Agricultural Research Station, Polonnaruwa, for purposes of cross-breeding the Sinhala breed, at Ratmalagara Estate.

#### Yield Particulars

	No. of Cows in Milk		Pints/Cow/Month		Pints per Cow per Day	
	B/E	R/E	B/E	R/E	B/E	R/E
January	14.67	8	128	167	4.15	5.40
February	13.82	8	114	134	3.96	4.70
March	10.45	8	141	121	4.58	3.90
April	9.56	6.3	159	141	5.30	4.70
May	14.80	10.8	184	145	5.95	4.70
June	21.40	12	165	154	5.53	5.16
July	21.90	11.4	172	53	5.57	4.96
August	22.00	16.20	141	147	4.57	4.75
September	21.70	20.00	119	135	3.98	4.50
October	20.00	23.17	110	134	3.57	4.33
November	19.76	23.00	108	120	3.62	4.02
December	13.60	23.70	111	124	3.60	4.01
Average	15.19	14.21	137.67	139.58	4.53	4.59

#### Milk Distribution

The Milk at both stations was supplied to the Staff. The surplus at both stations was sent to the Milk Board — but towards the middle of the year, the surplus milk at Ratmalagara was separated to Dhcc.

#### Water Supplies to the Dairy

The quality of the water to the dairy is very poor. Though repeated requests to look into this have been made, no suitable remedial measures have been taken so far.

#### Animal Health

During the whole year there has been no serious outbreak of any disease. However, a number of cases of rumen impaction was recorded at Bandirippuwa. The animals affected were mainly young stock. Animals affected were in all plots and not confined to any one grass. All cattle have been vaccinated against H.S. and wormed regularly with either Coopane; or Copper Sulphate and Nicotinesulphate. Cow No. R.8 died of snake bite.

(Miss) N. RAMALINGAM,  
Acting Agrostologist.

# REPORT OF THE OFFICER-IN-CHARGE BIOMETRY

The Biometrician (Mr. V. Abeywardene) left in July 1960 for a Course of studies at the Indian Statistical Institute, Calcutta and the Research Assistant (Statistics) was Officer-in-Charge.

## Statistical Work

As in other years this Division was engaged mainly in catering to the Statistical needs of the Research Divisions. The most noteworthy of the work done was the preparation of Selection Indices for the Botanist on the lines laid out by Dr. I. Sakai, an expert on 'Population Statistics', who was here for a short span of three weeks. The fitting of growth curves (exponentials and polynomials) on the data of the Pot Culture Experiment of the Chemist, was another piece of work done for the Research Divisions. A summary of the work done for the Research Divisions is given below.

### (a) Botanist:

(i) Tests of significance were done to test whether the differences in the yield of the progenies of block nuts and heap nuts are Statistically significant.

(ii) Genetic Correlations between the following characters of the Marandawila Progeny Trial were evaluated; Weight of husked nuts, weight per nut, nuts per year, bunches per year, nuts per bunch, plant height, stem girth, internode length and flowering period.

(iii) Selection Indices were worked out with the following characters from the Marandawila Progeny Trial.

(1) Weight of husked nuts, weight per nut, buncher per year, nuts per bunch and plant height.

(2) Nuts per year, weight per nut and flowering period.

Heritability values and Genetic Gains were calculated for the above Selection Indices.

### (b) Chemist:

(i) An analysis of the data of the Pot Culture Experiment was carried out with a view to determine whether there is a Statistically significant effect on different seedling characters (viz. Plant height, Stem girth and Leaf counts) due to the lack of major nutrients and Trace Elements.

(ii) Growth Curves were fitted to various seedling characters in the above experiment.

(iii) A large volume of Graphs were drawn for the Chemist.

### (c) Soil Chemist:

Routine Statistical Analysis of field experimental data.

### (d) Acting Agrostologist:

Routine Statistical Analysis of the data of Glass House Experiments.

### Agri-Meteorological Stations

The Agri-Meteorological Stations at Bandirippuwa, Ratmalagara, and Ambekelle were maintained satisfactorily.

### Agri-Meteorological Studies

(i) The studies on the incidence of Dry Spells were commenced and the number of Dry Spells during the last 25 years, of 2 to 34 weeks duration, and ranging from one to four inches of rain were counted for different representative rainfall stations.

(ii) Correlations were worked out with different combinations of 25 to 36 fort nightly rainfall cycles with the Crops at Bandirippuwa Estate.

### The Weather Report

The rainfall in five stations representative of certain important coconut growing areas is given below:

Rainfall — 1960 and Crop Prospects — 1961 — Rainfall in Representative Areas

Area	Rainfall			Effective Rainfall			Distribution Indices		
	1960	1959	Average 1953-58	1960	1959	Average 1953-58	1960	1959	Average 1953-58
Lunuwila ..	88.45	71.08	78.96	83.11	71.08	74.14	(i) 1.14	1.39	1.71
							(ii) 1.83	1.96	2.94
Chilaw ..	75.71	70.19	61.92	74.34	60.69	59.85	(i) 1.03	0.84	1.38
							(ii) 1.90	1.44	1.87
Kurunegala ..	72.18	97.15	85.51	70.35	94.12	80.23	(i) 1.21	1.72	1.69
							(ii) 1.92	2.92	2.42
Puttalam ..	52.53	48.74	45.60	44.82	48.74	43.33	(i) 0.90	0.98	1.15
							(ii) 1.41	1.19	1.41
Ratmalagara Estate	73.09	64.37	65.33	72.20	64.37	64.81	(i) 1.02	1.39	1.52
							(ii) 1.73	1.83	2.25

Except for areas around Kurunegala, most Coconut growing areas have recorded a higher total rainfall during 1960 as compared with the previous year's rainfall or the average rainfall during recent years for the respective areas. The effective rainfall too had been higher in 1960 except for areas around Kurunegala and Puttalam. The effective rainfall in Puttalam area, though lower than 1959, is slightly higher than the average during the recent years.

The rainfall distribution showed an improvement only in Chilaw, and is almost the same in Puttalam, as compared with the previous year. In Lunuwila, Kurunegala and Madampe areas the distribution had been poorer, although the total as well as the effective rainfall had been higher.

Since there had been a very good total as well as effective rainfall, although the distribution had been poorer than 1959, on the whole there is an indication of improved Crop prospects in most Coconut growing areas, and specially the Chilaw area. Kurunegala area however is unlikely to reflect improved crop prospects.

J.K.T. FERNANDO,  
Officer-in-Charge/Biometry.

# ANNUAL REPORT OF OFFICER IN CHARGE CROP PROTECTION DIVISION

## INTRODUCTION

With the increase in service on Crop Protection by, way of advice and actual control operations under our supervision, more and more such assistance were in constant demand. The call for advisory service by correspondence and visits, curtailed experimental work.

The Crop Protection Officer was engaged in post-graduate studies at Rutgers University, in the United States of America.

A large number of diseased and pest affected specimens were received for identification and advice on control measures. These were examined and attended to. A few specimens were sent to the Plant Pathologist, Department of Agriculture, Peradeniya, for further examination.

The most serious pest, whose bionomics and control was studied, was the Red Weevil (*Rhyncophorus ferrugineus*). But rot on palms occurred extensively and demanded attention. Other pests and diseases, although they did not assume serious proportions, were dealt with promptly, whose effective control measures are known. These pests have been brought under control; thus their importance have not got focused into public views.

An unusual condition of palms located principally, in some estates in the Southern Province, demanded much effort to investigate the cause which is yet unknown. The palms die pre-maturely. It is a sort of die-back as growth gets restricted, crowns thin out, nuts become smaller in size and reduce in number. The trunks taper, and the diminished small crowns, fall off from the trunks of palms. An attempt was made to look for nematodes that could be associated with these palms.

### 1. Bionomics and Control of the Red Weevil (*Rhyncophorus ferrugineus*)

#### (i) Laboratory Work

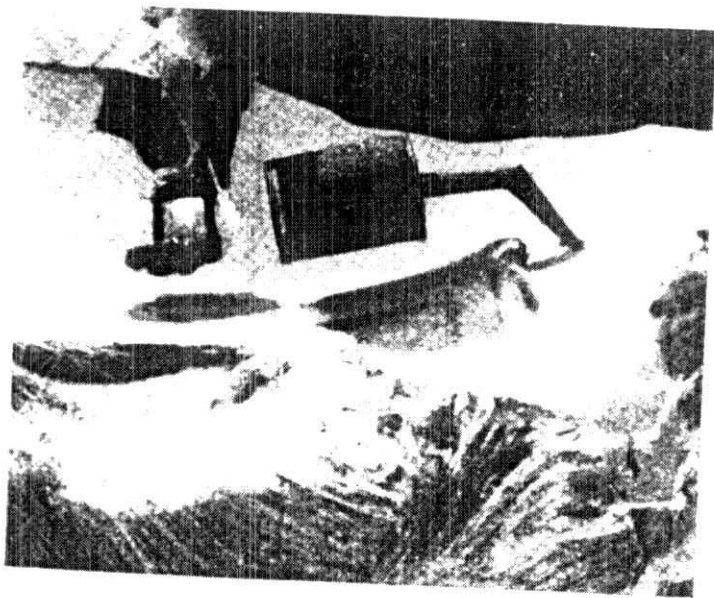
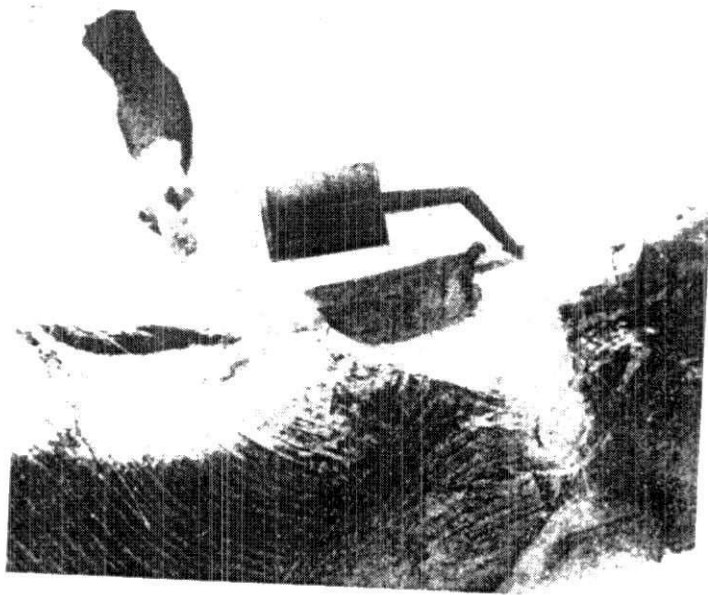
The maintenance of Red Weevil cultures was an important pre-requisite in Red Weevil control experiments. Hitherto, grubs were bred on coconut cabbage. As this material is not readily available, other breeding materials were tried out. At the conclusion of these trials, it was found that potatoes are a good breeding material for grub cultures.

Adults were provided with pieces of coconut leaf petiole, with the outer rind removed, for egg laying. By these means sufficient cultures were maintained.

The Insecticide trials were not conducted in the laboratory; instead, it was found to be more satisfactory to do field tests straightaway.

#### (ii) Field Trials

The systemic insecticide injection technique was developed further. The supply of Systox on a large scale in glass ampules was found to be impracticable, though satisfactory. Therefore, the chemical has to be measured with a teaspoon and poured direct into the funnel. The use of a pair of rubber gloves has become necessary (vide photographs next page).



Metasystox was tried out on several infested palms. On palms where the infestations were advanced, the effects were not satisfactory. This chemical has to be tried out further.

## 2. Bionomics and Control of the Coconut Caterpillar. (*Nephantis serinopa*)

### (i) Field Observations

In Ganawatte-Nikadalupotha (Kurunegala district), where an outbreak occurred in 1959, observations were kept to look for re-infestations. No re-infestations occurred.

The parasite breeding field laboratory, established in the area, supplied the required parasites. The castor garden attached to this field laboratory was extended. The services of a temporary Attendant to work in the field laboratory was recruited.

The Entomologist, Department of Agriculture, Peradeniya, visited the area and the parasite breeding field laboratory, on several occasions.

In October, a final survey of the whole area was done and as it was seen that the pest was well under control, the field laboratory was closed down on 31st October, 1960.

### (ii) A Project to control the pest in Batticaloa

During the visit of Dr. Simmonds, Director, Commonwealth Institute of Biological Control, in September, 1959, a project for the supply of parasites was planned out. Dr. V.P. Rao, Head of the Indian Station of the Commonwealth Institute of Biological Control in Bangalore who visited in December, 1959—Jan. 1960, made an extensive survey in the Batticaloa district and other areas. At that time the outbreak in Nikadalupotha, was under control. His report appeared as a circulation paper—C.P. 6/60.

### (iii) Infestations in other districts

Estates having infestations in other coconut growing districts were supplied with parasites from the Insectary at Headquarters.

## 3. Bud-rot and its Control. (*Phytophthora palmivora*)

The incidence of Bud-rot was observed to be very heavy again in the Kurunegala district. In one estate where observations were kept throughout the year, the toll of death of palms was as many as 73. There may be other estates where the incidence was heavier.

Several attempts to culture and isolate the fungus ended in failure. It was difficult to sample out portions of affected palms where the disease was in the incipient stage.

Hitherto, an application of copper fungicide has been recommended as a prophylactic measure on palms, neighbouring affected ones. But when affected palms were mapped out, it was observed that the distribution of these affected palms was so much scattered that treating neighbouring palms was not satisfactory. Therefore, this recommendation was withdrawn.

### (i) Field Trial with fungicides

In one estate, where young palms were being affected, a small scale field trial was done with the following fungicide samples.

- (1) Thylate
- (2) Mangan Curit
- (3) Blitox

- dilution — 1 oz. in 1 gal. water.  
dosage — dilution poured down 'cabbage' of palm, with a tin, until the 'cabbage' region is thoroughly wet.  
Frequency — Once a fortnight for 2 months and thereafter once a month for 4 months.  
Fields — 5-10 acres in one block were treated with each fungicide.  
Results — In all the treated blocks palms got affected after treatment.

(ii) *Further Work*

As much data as possible was collected from field observations. The Plant Pathologist, Department of Agriculture, Peradeniya, was studying the effects of some fungicides.

It was considered that more intensive work has to be done with the co-operation of the Plant Pathologist of the Department of Agriculture, after the Crop Protection Officer returns from post graduate studies.

4. **Pest Infestation and Disease Infection Records**

(i) *Red Weevil*

Red Weevil damage on palms was reported from all coconut growing districts. Heavy infestations were reported from Land Development Colony allotments. The complaints were also frequent from small holdings. It was observed that in small holdings, particularly, the incidence was heavier, because of negligence in allowing infested palms to remain unattended. When the incidence of weevil attack is heavy, it is the small holders themselves who are unable to use chemicals. Thus there is a pressing need to urge small holders to practise good sanitation by preventing breeding in neglected palms.

(ii) *Bud-rot*

From the Kurunegala district, many reports of bud-rot were received. It was observed, during field trips, that bud-rot occurs in other areas too, but reliable reports are not yet available.

(iii) *Coconut Caterpillar*

The coconut caterpillar pest made its appearance in Kurunegala, Chilaw, and Hambantota districts. In Batticaloa, some estates which were heavily infested, last year, were almost free of the pest, this year, indicating, a periodicity in the population fluctuations.

(iv) *Coconut Scale*

This pest appeared in infestations of 8-10 acres, mainly in the Chilaw district. The infestations were brought under control by spraying Kerosene oil emulsion.

(v) *Termites*

Termites were a pest on seedlings and prompt control measures were required in some newly planted areas. The insecticide Aldrin was recommended.

(vi) *Black Beetle*

Fairly serious black beetle damage was observed in a small part of the coconut area in Gal Oya. The affected palms put out distorted growth. Other reports did not reveal extensive damage. Estate Sanitation and an application of Dieldrin on Young Palms was recommended.

There is no reason why beetle populations could be reduced, cheaply and effectively, by destroying breeding places; but yet sufficient care is not forthcoming, especially among small-holders.

(vii) *Bats*

The loss of tender nuts by bat damage was found to be very heavy in Lancigama, near Marawila and in Pitipana, near Negombo. In both places, the bats come from roosting places about 4 to 5 miles away. One method of controlling the pest is by shooting the bats, in their roosting places *en masse*.

(viii) *Nettle Grub*

One report of a nettle grub infestation was reported from Rambodagalle. The timely action taken in cutting and burning the infested fronds, arrested the spread of the pest.

(ix) *Other pests*

Other pests that were reported of minor occurrence, were locuts, rats, porcupines and bag worm.

(x) *Leaf blights*

Grey blight caused by *Pestalotiopsis palmarum* and Heavy leaf blight caused by *Helminthosporium incurvatum* were commonly found in some Land Development Colony Allotment plantations. These diseases were present mostly in heavily intercropped lands, unmanured and not watered during droughts. Manuring of these palms was recommended.

(xi) *Stem bleeding*

Stem bleeding was reported from five estates; but many more were detected on field inspections. The application of Bordeaux paste was recommended.

5. An unusual condition of Palms, which may be an unknown disease

When palms exhibit unusual symptoms and pre-mature decline, an unknown disease may be suspected. Such was the condition of some palms in the Southern Province.

The history of these palms revealed that at one time they were in good healthy condition, well bearing; but suddenly they began to decline resulting in death of palms within about 2 to 3 years time.

In the incipient stage, the margins of leaflets, of the older fronds, turn brown and dry off. Later the new fronds diminish in size. The nuts too get smaller and fewer in the bunch. In general, the whole crown of the palms thin out. Simultaneously, the trunk tapers and eventually the small crown fall off from its trunk.

These palms are about 30-50 years old, scattered about in plantations, standing on good as well as hard soil. They are found on well manured and also in unmanured lands. It was observed that the number of symptoms of palms in such were on the increase.

(i) *Early attempts towards control*

Some attempts to arrest this decline were made by the following treatments.

(a) Liming the soil.

(b) Cutting off affected fronds.

(c) Heavy application of fertilizers.

These treatments did not yield any beneficial results.

(ii) *Present investigations*

A number of soil samples taken near affected and healthy palms were examined for Nematodes by Dr. M.T. Hutchinson, Nematologist of the Tea Research Institute (Ceylon). He discovered the presence of some plant parasitic nematodes, in the samples, but they were not yet associated with the declining palms as more samples have to be examined.

## 6. Parasite Breeding

### *Parasites of the Coconut Caterpillar*

Until February (1960), only *Trichospilus pupivora*, a pupal parasite was bred in the insectary. In spite of careful handling, its population numbers fluctuated greatly, with a low emergence in warm climate.

The supply of Castor leaves, which was required for the breeding of *Prodenia litura* (host insect) was in short supply. A castor garden was raised in a five-acre plot, but during droughts the plants got stunted. However, it was maintained with careful attention.

Dr. V.P. Rao, Head of the Indian Station of the Commonwealth Institute of Biological Control, on his visit here, introduced *Tetrastichus israeli*. This is a pupal parasite. *Prodenia litura* was used as its laboratory host.

The Indian Station of the Commonwealth Institute of Biological Control in Bangalore supplied the following parasites:

- |                                    |                     |
|------------------------------------|---------------------|
| (1) <i>Microbracon brevicornis</i> | } larval parasites. |
| (2) <i>Perisierola nephantidis</i> |                     |
| (3) <i>Elasmus nephantidis</i>     |                     |
| (4) <i>Stomatomiya bezziana</i>    |                     |

Cultures of (1) and (2) were maintained and later mass production was begun. It was not possible to maintain *Elasmus nephantidis* and *Stomatomiya bezziana* as their host material viz. *Nephantis serinopa* was not available.

Cultures of *Stomatomiya bezziana* was made available after several breeding experiments done in Bangalore. Dr. Rao has made attempts to search for exotic parasites in India and elsewhere.

The parasites that were mass bred in the Insectary here, were despatched to estates in small consignments at a time, for field liberation.

## 7. Coconut Caterpillar Control Project in Batticaloa

In July a detailed programme of the project including estimates was accepted. The report was published as circulation paper C.P. 63/60. In November, Mr. Edwin Dharmaraju, M.Sc., F.R.E.S., Entomologist, Department of Agriculture, Andhra Pradesh, India, came on a Colombo Plan assignment. He took over the project work.

After the preliminary work was over, Mr. Dharmaraju established a parasite breeding station, in Batticaloa, at No. 8 Dias Road, Batticaloa Town.

Supplies of the nucleus material of parasites and host insects were supplied, periodically, to the Parasite Breeding Station, in Batticaloa, from the Insectary at Headquarters.

## 8. Training

The Officer-in-Charge of the Division, obtained a training in Parasite Breeding and Biological Control techniques at the Indian Station of the Commonwealth Institute of Biological Control, Bangalore, under Dr. V.P. Rao and his staff. His report after training was circulated as a Circulation Paper.

A number of students, studying general coconut cultivation, received instructions in the laboratory and field, on methods of crop protection.

#### 9. Leaflets and Articles

The following leaflets were revised.

No. 31 Control of Insect pests of the Coconut Palm.

No. 32 Diseases of the Coconut Palm.

No. 33 Stem Bleeding in Coconut.

An article, under the caption 'Coconut Caterpillar Pest New Project for its Control' was prepared for the Ceylon Coconut Planters Review Vol. 1, No. 1.

An article on the Red Weevil and its Control was prepared for the Ceylon Coconut Planters' Review Vol. 1, No. 2.

#### 10. Research Conferences

The Officer-in-Charge, gave an address on Parasite Breeding at a Research Conference. A discussion followed.

Dr. M.T. Hutchinson delivered a lecture on Plant Nematodes with reference to declining palms at Gonapinawela. The address was illustrated with slides. A discussion followed.

#### 11. Pest Control Service

The Pest control service, unit was in demand for spraying operations, mostly against the Coconut Scale pest. Kerosene oil emulsion proved to be quite satisfactory in controlling this pest. Estates in the Chilaw and Kurunegala districts were helped to spray tall palms. At one time, the demand was so much that the estates that required assistance, had to be listed out in order of the intensity of infestation.

One estate was helped to spray the ground with Aldrex 2, 1 gal. per acre, against Black beetle grubs, breeding in the soil. The populations of these grubs declined in the first month after spraying, but later rains interfered with further operations.

Some palms in the Botanist's Block were saved from the ravages of the Red Weevil by Systox treatment. In several estates, palms were treated, against Red Weevil. These treatments were experimental, but it was a service to those estates where the palms were saved from further damage by the pest.

#### 12. Office Routine, Correspondence and Field Trips

Interviews with visitors and matters dealing with the administration of the Division, were unknowingly time consuming. A large number of letters, mainly advisory were received and answered. A number of Field trips were necessary in connection with Advisory and Experimental work.

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

# REPORT OF THE SOIL SURVEY UNIT-1960

Three major Soil Surveys were undertaken in the year 1960.

The soil survey of Ambalama Estate Vanatavillu was taken up in the first quarter. This stretch of land is about 300 acres in extent and divided into East and West Segments by a central uncultivated land, which had a xerophytic vegetation and calcareous soils. This central area is called a Vembu and is unsuitable for coconuts.

In the east and west the soil was good though there were occasional patches of Vembu area in the east.

## 2. Reconnaissance Soil Survey of Battulu Oya (One inch sheet)

This is an area of 180 square miles in the North Western Province. The soils were grouped into series by their morphology and chemical properties, and the mapping was done by aerial photo interpretation and on results of ground survey.

The results of mechanical analysis showed the accuracy of field texturing. Chemical analysis showed that the total exchangeable bases averaged in the range of 3 Me./100 gms. soil.

## 3. The Reconnaissance Soil Survey of the Puttalam one inch sheet was completed

### *Laboratory Investigations*

Laboratory work in support of Field Work was carried out and included besides mechanical analysis, determination of the heavy mineral fractions.

Mr. Camillus Silva, Senior Technical Assistant resigned in October, 1960.

K.S.O. PERERA,  
*Technical Assistant, Soil Survey Unit.*

# ANNUAL REPORT OF PUBLICATIONS OFFICER

Mr. M.D.H. Seneviratne was appointed Publications Officer with effect from 2nd May, 1960.

## Publications

The following leaflets which were out of stock were translated into Sinhalese and arrangements made for their printing. Leaflets No. 4, 12, 17, 21, 22, 27 and 33. Two new leaflets No. 36 on 'Manuring of Adult Coconut Palms' and No. 37 on 'Red Weevil and its Control' were brought out in the course of the year.

### 'Ceylon Coconut Quarterly'

It was decided to bring the Ceylon Coconut Quarterly up to date by the printing of all issues from Vol. IX, Nos. 1/2. According to this Vol. IX, Nos. 3/4 was printed and distributed. Vol. X, Nos. 1/2 and 3/4 were sent to the Printers and articles for Vol. XI, Nos. 1/2 are being prepared.

### 'Ceylon Coconut Planters Review'

According to the decision of the Editorial Committee a new publication known by the above name was started.

The first number of this Journal was printed and distributed. The second number is with the printers while arrangements for bringing out the third number are being made.

### 'Pol Pawath'

The first number of the new series was printed and distributed. It is interesting to note that this publication has been reviewed favourably in the Press. The second number is with the Printers. Articles for the third number are being translated.

## Issue of Free Publications

About 1,000 sets of Advisory leaflets have been despatched to the public.

## Translations

A major portion of the Institute's Translation work was done by the Publications Officer. This includes Circulars, Correspondence and Routine Translations such as vacancy advertisements, notices, general Forms, etc.

One of the major documents translated by the Publications Officer is the Annual Report of 1959. This is probably the first attempt made in this country to translate a Research Report including details of Scientific Experiments.

M.D.H. SENEVIRATNE,  
*Publications Officer.*

## ADVISORY DIVISION ANNUAL REPORT FOR 1960

The Field Staff have during the period under review assisted a number of coconut growers by advice and demonstration on methods of planting new-clearings, replanting old and uneconomic coconut lands, after care of seedlings, moisture conservation by husk burying, prevention of soil erosion by constructing contour drains and bunds, draining low-lying land, control of pests and diseases, value of fertilizers and their application. Considerable attention has been devoted in particular to demonstrations of lining for planting on the triangular and square systems and tracing for contour drains and bunds to prevent soil erosion and harness 'run-off' water, on coconut lands.

In addition to the above the Field Staff have also visited a number of holdings in connection with pre-planting and follow-up service. They have also assisted owners of coconut lands by distributing and filling application forms to enable coconut growers especially the small-holders to obtain manure under the Fertilizer Subsidy Scheme. The Field Staff attended meetings and delivered talks on improved methods of coconut cultivation.

It is gratifying to note that there has been a greater inclination than has been noticed in the past for owners of coconut lands to adopt improved methods.

In addition to the normal work the Field Staff assisted the Subsidy Scheme for growing coconuts in Citronella lands in the Matara and Hambantota districts.

In the early part of the year the Field Staff helped to carry out the pre-planting service of the Scheme, and later in the inspections for the payment of the Cash Subsidy to applicants who were supplied with free seedlings and fertilizer, during May/June and October/November, 1960. In all 20 officers of this division have been posted, in batches, for this work at different times of the year. As a result a good portion of their time, which they would have otherwise devoted for Advisory work on coconut holdings in other ranges, have been spent on this work.

In September, 1960, the Division participated in the Ceylon Economic Development Exhibition held in Colombo.

The work done during the year included the following:

### General Advisory Visits to Small-holdings and Estates:

#### A. SMALL-HOLDINGS:

(a) No. of holdings visited for general advisory work	7,059
(b) No. of holdings visited for soil conservation work	499
(c) Extent of drains traced for soil conservation work	5,174 chains
(d) No. of holdings visited for advice on draining low-lying land	86
(e) Extent of drains pegged in these holdings	615 chains

**B. LARGE-HOLDINGS:**

(a) No. of holdings visited for general advisory work .. .. .	730
(b) No. of holdings visited for soil conservation work .. .. .	78
(c) Extent of drains traced for soil conservation work .. .. .	1,719 chains
(d) No. of holdings visited for advice on draining low-lying land .. .. .	15
(e) Extent of drains pegged in these holdings .. .. .	401 chains

**C. INSPECTIONS UNDER THE FERTILIZER SUBSIDY SCHEME:**

(a) No. of small-holdings visited .. .. .	628
(b) No. of manure application forms distributed to small-holdings .. .. .	1,422
(c) No. of manure application forms distributed to large-holdings .. .. .	177

**Pests and Diseases:**

**NO. OF HOLDINGS VISITED TO ADVICE ON THE FOLLOWING PESTS AND DISEASES:**

	<i>Seedlings under 5 years</i>		<i>Adult Palms</i>	
	<i>Small-holdings</i>	<i>Large-holdings</i>	<i>Small-holdings</i>	<i>Large-holdings</i>
(a) Termite .. .. .	544	146	59	09
(b) Black Beetle .. .. .	513	123	220	77
(c) Coconut Caterpillar .. .. .	12	01	12	31
(d) Red Weevil .. .. .	106	32	165	53
(e) Grey Blight .. .. .	65	32	87	30
(f) Scale Insects .. .. .	28	01	02	05
(g) Other Pests and Diseases .. .. .	145	36	65	55

**Pre-planting and Follow-up Service:**

**A. PRE-PLANTING:**

**1. SMALL-HOLDINGS:**

(a) No. of holdings lined for planting .. .. .	541
(b) Extent lined for planting .. .. .	749 acres
(c) No. of holdings visited for soil conservation work .. .. .	59
(d) Extent of drains traced for soil conservation work .. .. .	1,293 chains
(e) No. of holdings visited for advice on draining low-lying land .. .. .	10
(f) Extent of drains pegged in these lands .. .. .	64 chains

**2. LARGE-HOLDINGS:**

(a) No. of holdings lined for planting .. .. .	112
(b) Extent lined for planting .. .. .	328 acres
(c) No. of holdings visited for soil conservation work .. .. .	18
(d) Extent of drains traced for soil conservation work .. .. .	188 chains
(e) No. of holdings visited for advice on draining low-lying land .. .. .	01
(f) Extent of drains pegged in these lands .. .. .	07 chains

**B. FOLLOW-UP:**

**(a) SMALL-HOLDINGS:**

(a) No. of visits for follow-up service	922
(b) No. of holdings visited for soil conservation work	19
(c) Extent of soil conservation drains traced	353 chains
(d) No. of holdings visited for advice on draining low-lying land	09
(e) Extent of drains pegged in these holdings	97 chains

**(b) LARGE-HOLDINGS:**

(a) No. of visits for follow-up service	147
(b) No. of holdings visited for soil conservation work	03
(c) Extent of soil conservation drains traced	20 chains

**Meetings and Talks:**

(a) No. of meetings attended by the Field Staff	164
(b) No. of talks delivered by the Field Staff	88

**Demonstration Plots:**

These were continued to be maintained during the year. At Mundelwatte two acres were replanted on the triangular and square systems, while a 3rd acre was planted with artificially pollinated Tall  $\times$  Dwarf seedlings. At Ratmalagara and Hettipola the palms were manured with General Coconut Fertilizer Mixture. At Vannankerney Estate, Pallai, 10 acres were under-planted on the triangular system, and the mature palms have been manured with General Coconut Fertilizer Mixture. At Koggala, the land was divided up into a number of blocks for the purpose of demonstrating thinning, systems of underplanting and manuring.  $2\frac{1}{2}$  acres of the old stand in each of the blocks A and B were uprooted and lined on the square and triangular systems respectively, and in Block D half the old stand was uprooted.

C.A. WICKRAMASURIYA,  
*Chief Advisory Officer, Coconut Research Institute.*

# CITRONELLA SUBSIDY SCHEME

## Staff

<i>Cadre</i>	<i>Estimated</i>	<i>Posts filled</i>
District Coconut Instructor ..	1	1
Coconut Instructors ..	9	4
Field Attendants ..	18	18
Clerk/Typists ..	6	5
Office Attendants ..	2	2

Mr. Malcolm Goonawardena, Advisory Field Officer of the Advisory Division who was posted at Vitharandeniya for work in the Citronella Subsidy Scheme resigned and Mr. J.B. Herath was appointed in his place.

Mr. J.B. Herath, Coconut Instructor, Vitharandeniya resigned on 15th December, 1961, and his work was temporarily handed over to Mr. Wijeratne, Field Attendant, Vitharandeniya Range. Messrs. C.A. Fernando and W. Weeraratne, Coconut Instructors of the Advisory Division were temporarily in charge of Hakmana and Katuwana Ranges. They were later relieved by Messrs. B.K.S. Jayasekera and J.B. Galagedera, Coconut Instructors (Temporary) and Messrs. C.A. Fernando and W. Weeraratne were posted for inspections under the Subsidy Scheme.

Mr. W.J.P.M. Lowe, Coconut Instructor, Advisory Division was temporarily transferred for work in Walasmulla Range with Mr. Gamen de Silva newly appointed Coconut Instructor (Temporary) to work under him. Later Mr. Gamen Silva was placed in charge of the range and Mr. Lowe reverted back to his normal duties in the Advisory Division.

Messrs. S.A. Swamy, S.B. Karunaratne and P.D. Wijesinghe, Advisory Field Officers of the Advisory Division, assisted in the distribution of Seedlings and Fertilizer for May/June 1960 Planting Season.

The work done during the year included the following:

### 1. May/June 1960 Planting Season:

(a) No. of permits issued .. .. .	2,118
(b) No. of applicants who took delivery of Seedlings and Fertilizer .. .. .	1,954
(c) No. of Seedlings issued .. .. .	139,713
(d) Tonage of fertilizer issued .. .. .	46 tons 12 cwts. 56 lbs.
(e) Acreage planted .. .. .	1,864 acres

The Seedlings for May/June 1960 Planting were supplied from Mapalana Nursery, Kamburupitiya.

### 2. Oct./November 1960 Planting Season:

(a) No. of permits issued .. .. .	2,053
(b) No. of applicants who took delivery of Seedlings and Fertilizer .. .. .	1,966

(c) No. of seedlings issued	247,232
(d) Tonnage of fertilizer issued	82 tons 10 cwts. 14 lbs.
(e) Acreage planted	3,295 acres.

The Seedlings for Oct./November 1960 Planting were supplied from Medamulana Nursery, Weeraketiya.

The Field Staff have during the year visited the Citronella lands of the applicants to demonstrate lining and to advice on holding filling up of holes and planting seedlings. Owing to the large number of applicants group demonstrations had to be resorted to in the majority of cases to cope up with the work in time for the planting. The Field Officers also carried out the distribution of Seedlings and Fertilizer to the applicants at central points. The Seedlings were supplied by the Planting Officer and the Fertilizer by the Commissioner of Coconut Rehabilitation. The issues of Seedlings and Fertilizer were done free of cost to applicants on a blue permit which had already been issued to them in advance.

### CASH SUBSIDY INSPECTIONS MAY/JUNE AND OCT./NOV. 1960 — PLANTING SEASONS

Sixteen officers of the Advisory Division were released to carry out inspections for the payment of cash subsidy to applicants. Eight of them for inspections of lands planted in May/June 1960 and the other eight for those planted in October/November, 1960.

As quite a number of applicants had not planted the seedlings issued to them in May/June 1960 owing to the failure of the monsoon, a second inspection of these lands was begun in December, 1960.

#### 3. Cash Subsidy Inspections:

##### A. MAY/JUNE 1960 PLANTING SEASON.

Cash Subsidy Inspection report forms on six hundred and thirty-two (632) lands were sent to the Commissioner of Coconut Rehabilitation for the payment of the first instalment for seedlings planted in May/June 1960. Reinspection on rest of the lands for which seedlings had been issued during May/June 1960, is in progress.

##### B. OCT./NOVEMBER 1960 PLANTING SEASON

Eight Advisory Field Officers, to carry out inspections on lands planted in Oct./November 1960 were posted in the Matara and Hambantota districts in December, 1960.

C.A. WICKRAMASURIYA,  
Chief Advisory Officer, Coconut Research Institute.

# ANNUAL REPORT OF THE PLANTING DIVISION FOR THE YEAR 1960

## 1. Nurseries

(Seednuts) — 2,101,845 seednuts were planted in the nurseries during the year.

The distribution of seednuts in the nurseries is as follows:—

<i>Name of Nursery</i>	<i>Seednuts planted for 1960</i>
Ratmalagara ..	401,850
Eraminigolla ..	68,000
Carmel ..	335,440
Walpita ..	192,256
Nakkala ..	30,000
Hettipola ..	65,000
Handapangala ..	102,484
Mylambavelly ..	80,340
Kalawewa ..	100,000
Damatawela ..	82,450
Wilpotha ..	324,225
Kilinochchi ..	100,500
Alampil ..	100,000
Koggala ..	119,300
<b>Total ..</b>	<b><u>2,101,845</u></b>

### Citronella Subsidy Scheme

Medamulana Nursery ..	556,650
Mapalana Nursery ..	129,000
	<b><u>685,650</u></b>

### Seedlings

Orders for 1,325,229 seedlings accepted for both planting seasons, i.e. May/June and October/November 1960.

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>
Ratmalagara ..	73,884	189,275	263,159
Hettipola ..	18,303	24,168	42,471
Walpita ..	72,471	44,644	117,115
Carmel ..	58,382	127,745	186,127
Wilpotha ..	61,535	152,095	213,630
Dematawela ..	23,180	50,465	73,645
Koggala ..	20,165	45,853	66,018
Alampil ..	—	62,520	62,520
Kilinochchi ..	—	66,386	66,386
Mylambavelly ..	—	44,705	44,705
Eraminigolla ..	11,850	24,697	36,547
Kalawewa ..	—	64,698	64,698
Handapangala ..	—	69,555	69,555
Nakkala ..	—	18,653	18,653
			<u>1,325,229</u>

## 2. 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 ..	6	3	9
Kalawewa — Karawaddena Mylambavelly ..	6	3	11
Kilinochchi — Alampil ..	3	4	6
Koggala — Dematawela — Handapangala ..	6	4	7
Walpita — Eraminigolla ..	4	5	9

P.D.L. FERNANDO,  
Planting Officer.

## REPORT OF THE WELFARE OFFICER FOR 1960

The staff position was as follows:

	<i>Senior</i>	<i>Inter- mediate</i>	<i>Assistant</i>	<i>Minor</i>
At the end of 1959	8	7	102	71
New appointments in 1960	—	—	25	32
	8	7	127	103
Less Resignations and retirements in 1960	—	—	10	—
Deaths	—	—	1	—
	8	7	116	103
Promotions	—	—	6	3
Confirmations	—	—	9	26
Position as at 31-12-1960	8	7	116	103

The appointment of Mr. E. Dharamaraju, Colombo Plan Entomologist who is on a short-term assignment under the Colombo Plan Technical Co-operation scheme is not shown above. The cadre of the entire staff at the end of 1960 was 234 as compared with 189 last year. 4 Assistant Staff Grade II officers were promoted during the year to the Assistant Staff Grade I; one as District Coconut Instructor, two as Senior Technical Assistants and the other as Field Officer of the Botanist Division. A Clerk Typist and a Field Assistant were also promoted as Additional Book-Keeper and a Senior Field Assistant respectively during this period. All these promotions were within the same grade. An Office Attendant and a Nursery Attendant were promoted as Clerk-Typist and Field Assistant respectively. These appointments were from the Minor Staff to the Assistant Staff Grade II. There were 2 promotions to the Selection Grade of the Minor Staff. Except in the case of the 2 Minor Staff appointments to the Assistant Staff Grade II, all other promotions were within the same grade. It is with deep regret that we have to record the death of Mr. J.E.A. Bede Fernando, Advisory Field Officer who died while in service during this year. He joined the Institute on 15-2-1951. Mr. K. Santhirasegaram, Agrostologist, proceeded to Australia on a Colombo Plan Scholarship for higher studies. Mr. V. Abeywardena, Biometrician, proceeded to India for a course of training at the International Statistical Education Centre, Calcutta, under a Colombo Plan Scholarship.

In my report for 1959 I had specifically pointed out that with the implementation of the new rules and regulations since 1st January 1957 the promotion of Minor grade officers to the Assistant Staff grade has decreased as the minimum qualifications laid down for the higher grade was applied. On a request from the Assistant and Minor Staff Union the Coconut Research Board laid down for internal

applicants a period of 5 years service in the Institute as the minimum qualifications for eligibility to the higher grade. This was a reasonable concession granted for the Minor Staff officers and presumably as a result of it there was not a single resignation during this year as compared to eight resignations from this grade last year. Similar concessions in the minimum qualifications for appointments from the Assistant Staff Grade I and II to the Intermediate Grade and from the latter to the Senior Staff grade should make the entire staff more persevering and enthusiastic in their work.

*Labour Force.*—According to the Provident Fund Register who are members of the Employees Provident Fund the labour force as at 31-12-60 was 590 distributed as follows: on monthly pay 29, daily pay 561. Labourers were encouraged to apply for monthly paid appointments in the Labour Grades and the Minor Staff as an incentive for persevering workers. Four were appointed on trial to the Non-Staff monthly paid appointments and two were selected from the labour force to the Minor Staff during this year.

Recommendations have been made to the Board for an increase in the rate of batta and the granting of full pay for absence as a result of accidents while on duty during the first seven days. Industrial accidents have been on the increase during the last few years and in 1960 alone sixteen accidents have been reported to us. All these were temporary disablement cases and a sum of Rs. 226.25 have been paid by the Insurance Company during this period.

*Housing.*—Twenty-one labour cottages; six at Bandirippuwa Estate, four at Ratmalagara Estate, two at Ibbagamuwa, Koggala, Alampil and Chenkaladi Nurseries and Mundel Demonstration centre and one at Walpita Demonstration centre to accommodate twenty-one families were built during the year. The cost of each cottage was estimated at Rs. 3,000/-. A Minor staff cottage was also converted to an Assistant Staff bungalow at the Isolated Seed Garden at an estimated cost of Rs. 5,000/-. Welfare service was extended to all employees as far as possible without any distinction between any category of workers. The number of applications awaiting for quarters are gradually getting increased. A sum of Rs. 1,000/- was estimated for supply of additional furniture to the Rest Room and a sum of Rs. 10,000/- for the construction of a Rest Room at Bandirippuwa Estate and Ratmalagara Estate for the Labourers have also been approved by the Board. 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. A Permanent Housing Committee consisting of the Chief Administrative Officer and a representative each from the C.R.I., Research and Extension Staff Officers Association and C.R.I., Employees Union, with Welfare Officer as Secretary was appointed during the year to recommend applications for allocation of quarters.

*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. 65,900/- on transport loans have been granted during this period. A sum of Rs. 100/- per head to the monthly paid employees and a sum of Rs. 50/- per head to the daily paid employees were allowed as festival advances during the year and the total amounts involved were Rs. 15,880/- and Rs. 19,470/- respectively.

*Medical Aid.*—Special concessions to members have been obtained from doctors in the panel. The amount lying to the credit of members on 1st January 1960 in the Medical Aid Fund was Rs. 25,933.68 to 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. 19,359.43 was paid to members on Medical Aid claims approved at 10 meetings held during the year.

*Thrift, Savings and Food Supplies.*—The C.R.I. 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 currysutuffs and other essential requirements at competitive rates while the canteen was in progress 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/-.

The employees Provident Fund contributions during the year in respect of the Labourers were Rs. 30,987.44, viz. Rs. 12,530.77 from the labourers, and Rs. 18,456.67 from the Board. A Gratuity is payable to labourers for their past services, viz. prior to 1st June 1959, the date of operation of the E.P.F. Act to employees of this Institute.

The Staff contributions during the year to the Provident Fund under the approved Scheme were Rs. 864,899.84 viz. Rs. 434,549.58 from the staff, and Rs. 430,350.26 from the Board. Interest is payable at 4½ per cent.

With the amendment of the Provident Fund Act and the provision for loans and Insurance embodied therein a sum of Rs. 10,000/- has been granted during the year for purchase of land for a building site for the construction of a residential house and/or construction of a residential house. A further sum of Rs. 14,946.47 has been paid on annual insurance premia in respect of eighty officers who have taken an Insurance policy from their Provident Fund monies.

*Recreation and Cultural Activities.*—Every encouragement and assistance have been given for recreational and cultural activities during the year. The 'D' Division Cricket Team of the C.R.I. Recreation Club participated in the Government Service Cricket Tournament and came up to Semi-finals. The Health Dept., Gal Oya Development Board, and the Police Dept. were defeated by a comfortable margin and in the Semi-finals the C.R.I. Team lost to the Excise Dept. Our team had to face the last two matches for 6 days consecutively and the strain they had to bear up was too much to do more than they did to face the opponents. The Board granted a sum of Rs. 65/- for each tournament match and the remaining expenses were met from the Funds of the Club.

A friendly game of cricket with the Rubber Research Institute was played on their grounds in Kalutara and ended in a victory for the home team. The C.R.I. Recreation Club for the first time entered the Government Service Indoor Games tournament and participated in Table Tennis, Carrom, Draughts and Contract bridge competitions. Our team was not selected for the finals. The Recreation Club held its club days and Christmas Party during the year. The party was mainly organised for the benefit of the officers and labourers' children and over 250 gifts and food bags were distributed among them. A sports meet and a variety entertainment were among the important features of the party. The Board's annual grant is Rs. 500/-.

The Coconut Research Board recognised the Coconut Research Institute Art Circle organised mainly for the promotion of cultural activities of the Institute's employees. In its first year of activities the Art Circle made a very satisfactory progress and displayed a number of Sinhalese concerts and participated in matters pertaining to cultural affairs.

*Industrial Relations.*—In the field of industrial relations the employees of the Institute have still further advanced in the development of Trade Unionism as a means of securing their legitimate rights. During the year 1960 the unions have largely been engaged in pursuing their primary objective of promoting and assisting the general interests of the Coconut Research Institute with respect to work and personnel. The Coconut Research Board recognised the Lanka Estate Workers Union which represents a number of Institute's labourers at Bandirippuwa, Rathmalagara and in a few nurseries as from October 1960. The Institute joined the Ceylon Estates Employers' Federation to represent the interests of the Coconut Research Board. Complaints regarding minor labour disputes have been inquired into and amicably settled. Liaison between the Institute and its social and welfare organisations have been maintained as far as possible in the role of promoting sound industrial relationships within employees of the Institute.

F.H.B. FELIX SILVA,  
Welfare Officer, Coconut Research Institute of Ceylon.

# ANNUAL REPORT 1960

## BANDIRIPPUWA ESTATE

### Acreage

	ESTATE SECTION		
	A.	R.	P.
B/E (1)			
" (2) A	153	0	00
" " B	118	0	38
" " C	59	3	26
	34	3	07
<b>Total</b>	<b>365</b>	<b>3</b>	<b>31</b>

The above acreage comprises as follows:—

Research Section (Res. a/c.)	75	2	04
" " (Est. W/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
<b>Total</b>	<b>365</b>	<b>3</b>	<b>31</b>

Total Estate Working Account Acreage ... 267 2 15

### Census

Census of palms as at February, 1960 is as follows:—

Particulars	Research Section	Estate Section				Grand Total
		Pasture Plots	Response Curve	N.P.K. Gd. Rows	Estate	
Full Bearing	1047	867	1569	380	5936	9799
Partial Bearing	618	1189	1872	278	3459	7416
Duds	120	360	720	65	2737	4002
In Flower	109	14	6	2	88	219
With Stem	108	12	12	1	124	257
Established Plants	41	10	—	1	77	129
Supplies	15	1	—	—	5	21
Vacancies	33	139	326	25	400	923
<b>Total</b>	<b>2091</b>	<b>2592</b>	<b>4505</b>	<b>752</b>	<b>12826</b>	<b>22766</b>
Left out for the playing field						462
Unplantable vacancies and palms uprooted for buildings etc.						627
						<b>23855</b>

### Underplanted Area

Established plants	162	—	—	—	104	266
Supplies	427	—	—	—	100	527
Vacancies	—	—	—	—	7	7
<b>Total</b>	<b>589</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>211</b>	<b>800</b>
<b>Grand Total</b>						<b>24655</b>

On the above census palms uprooted for new planting for the year effected after the census was taken in February, 1960. About 125 palms were uprooted for the year. The vacancies on the estate section are not filled owing to the fact that underplanting is undertaken gradually.

### Field Notes

*Weeding.*—The whole estate was freed of heavy growths by frequent disc-harrowing for the year.

*Drains.*—Altogether 3579 fathoms drains were cut in the new acquisition estates on the contour and 2767 fathoms 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) C.

*Streams.*—2111 fathoms streams in B/E (1) and B/E (2) B have been deepened and cleaned twice for the year. The frequent cleaning of the streams have helped all palms in the low lying area to be healthy looking.

*Husk Pits.*—654 husk pits have been done for the year in No. 6 and B/E (2) B and C.

*Pests and Diseases.*—The incidence of beetle attack on young palms have been very much less as frequent observation work is undertaken.

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

*Ploughing.*—A few acres in gravel area of B/E (2) C has been ploughed.

*Rainfall.*—This compares with the previous year as follows:—

Average 1934/50	Months	1959		1960	
		Inches	Wet Days	Inches	Wet Days
2.20	January	0.93	1	0.57	3
2.17	February	0.59	3	0.03	—
5.38	March	2.28	1	2.02	4
8.40	April	8.88	14	17.59	18
10.31	May	10.76	24	14.10	19
7.42	June	5.96	18	3.50	8
2.82	July	9.72	17	15.58	16
3.45	August	3.40	13	0.91	3
4.28	September	4.90	13	2.15	5
12.56	October	11.04	18	14.07	9
12.92	November	11.49	13	12.64	17
4.81	December	1.13	5	1.02	4
<b>76.72</b>	<b>Total</b>	<b>71.08</b>	<b>140</b>	<b>84.18</b>	<b>106</b>

There was very little rain in the first three months as the drought had set in since December, 1959. The first two crops have been very badly effected.

Crops.—These compares as follows:—

Pick	1956	1957	1958	1959	1960	5 Years Average
B/E (1) 1	51,187	74,720	43,996	74,787	34,374	67,959
2	76,300	95,564	65,862	122,447	94,034	96,553
3	106,571	105,526	107,669	97,380	105,134	108,103
4	107,980	101,281	112,139	89,864	102,947	107,533
5	76,448	85,069	68,850	63,412	61,539	75,863
6	55,398	49,779	45,825	29,892	57,584	48,314
Total	473,884	511,939	444,341	477,782	455,612	504,325
Resear.	67,253	83,030	73,464	86,362	83,041	79,247
Est. Total	406,631	428,909	370,877	391,420	372,571	425,078
B/E (2) 1	—	—	—	78,036	37,850	—
2	—	—	—	94,414	71,581	—
3	—	—	—	96,406	97,677	—
4	—	—	54,163	88,332	103,747	—
5	—	—	48,462	66,884	75,473	—
6	—	—	51,541	46,466	62,166	—
Total	—	—	154,166	472,538	448,494	—
Gr. Total	473,884	511,939	598,507	950,320	904,106	—

The total crop realised for 1960 on both estates was 904,106 nuts from 17,205 palms equivalent to 52.5 nuts per palm and 3311.7 nuts per acre.

The disposal of crops is as follows:—

Sold on Contract	Nuts
Sold to Plant: Division	88,873
Sold to Research	210,484
Sold to Staff	2,177
Research Nurseries	680
Allowance to Staff	2,001
Cured	27,592
Empties	559,176
Total	13,123 1.5%
	904,106

The 559,176 nuts cured into copra obtained 441 candies 335 lbs. on an out-turn of 1266 nuts to a candy. The nuts per candy of copra has been good owing to the fact that the new acquisition estates have shown a remarkable improvement of the quality of nuts after the heavy dose of manuring in 1959. It would have further improved in the out-turns if the nuts sold to Planting Division were converted to copra.

## Manuring

The following palms have been manured for 1960:—

B/E (1)	No. 1	Field	1,649 palms	}	=	3 lbs. Sulphate of Ammonia 4 lbs. Saphos Phosphate 3 lbs. Muriate of Potash
"	2	"	569 "			
"	3	"	581 "			
"	4	"	383 "			
"	6	"	212 "			
"	BB	"	126 "			
B/E (2)	A	"	1,558 "	}	=	10 lbs.
	B	"	456 "			
		Total	5,534 "			

All palms were manured by cutting circular trenches round palms and 2134 palms received a supply of husks. 262 young palms have been manured for the year.

## Expenditure

The estate expenditure for the year as follows:—

General Charges	Rs. 31,689.02	@	Rs. 38/60	Estimated	..	Rs. 36,510.00	@	Rs. 31/71
Upkeep	.. .. 18,476.78	"	" 22/50	"	..	" 24,090.00	"	" 21/22
Cultivation	.. .. 16,623.82	"	" 20/25	"	..	" 29,830.00	"	" 26/29
Collection	.. .. 12,409.63	"	" 15/11	"	..	" 12,625.00	"	" 11/12
Total	.. .. 79,199.25	"	" 96/46	"	..	" 103,055.00	"	" 90/34

## General

It was possible to complete the programme of work for the year with the availability of labour without seriously effecting the work, although preference being given to Research Work in the estate.

W.F. WITHANA,  
Superintendent, Bandirippuwa Estate.

# REPORT ON THE ESTATES

## RATMALAGARA ESTATE

### Ratmalagara Estate and Research Station

This estate is approximately 273 acres in extent. The whole estate has been fenced right round. There is a three acre block of clonal rubber originally planted by the Rubber Research Institute as a clonal seed garden but now under the Estate Management.

*Rainfall.*—The rainfall during 1960 compared to that of 1958 and 1959.

	1958		1959		1960	
	Days	Inches	Days	Inches	Days	Inches
January	3	1.25	1	1.86	6	.29
February	4	.95	1	1.11	8	4.13
March	11	6.61	1	2.47	3	1.65
April	17	10.78	10	8.86	14	10.60
May	19	12.86	19	12.09	21	14.68
June	15	5.34	16	4.39	9	2.37
July	8	1.13	11	4.35	16	13.91
August	12	1.36	5	2.74	4	.50
September	4	.78	16	4.31	3	.25
October	14	6.00	15	10.53	9	9.81
November	21	8.38	20	9.74	21	14.21
December	7	6.17	6	1.92	3	.72
	135	58.61	121	60.06	117	73.12

The total rainfall for the year 1960 was 73.12 inches thus showing an increase of 13.06 inches above that of the year 1959.

*Crops.*—The Crop for the year 1960 has been extremely good. The Crop of the Research and Estate Divisions total 754,615 nuts as against 652,662 nuts in 1959. This shows an all-round increase of 101,953 nuts over 1959. The total Crop is made up as follows:—

Estate and Pasture Plots	528,181
Research II and III	226,434
Total	754,615

*Crops.*—The Crops were disposed of as follows:—

Cured into Copra .. .. .	533,230 Nuts
Sold on Credit .. .. .	. 140
Sold to Planting Division .. .. .	94,500
Sold to Research .. .. .	3,870
Issued to Staff .. .. .	10,788
Rejections .. .. .	10,980
Balance on 31-12-60 .. .. .	101,107
Grand Total .. .. .	<u>754,615</u>

The 533,230 nuts cured into copra produced 417 candys of grades I, II and III giving an average out-turn of 1279 nuts per candy. It will be of interest to mention here that this out-turn was obtained although the best nuts amounting to 945,000 were selected by the Planting Division for Seedlings. There has been a marked decrease of 688 nuts per candy compared to last year which was 1967 npc.

*Field Work.*—All field works have been carried out according to Programme.

*Manuring.*—All palms in the Estate Section have been manured this year, 2,547 being palms and 478 young palms.

*Labour.*—A set of 10 labourers were taken on the Check Roll this year. There was no trouble with labour.

*Buildings.*—These are all in order. Electricity and water supply were supplied to the Minor Staff bungalows in the Nursery. A new 2 bay extension was built to the Copra Kiln.

*Fence.*—The boundary fence is in order and is maintained in good condition.

S.T. BRAINE,  
Superintendent.