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Annual Report of the Coconut Research Board of the Coconut Research Institute for 1956

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ANNUAL REPORT OF THE COCONUT RESEARH BOARD OF THE COCONUT RESEARCH INSTITUTE FOR 1956

THE present report is the 28th Annual Report of the Coconut Research Institute which was established by Ordinance No. 29 of 1928, dated December, 1928.

REPORT OF THE CHAIRMAN

ON 1st January, 1956, the Coconut Research Board consisted of the following members:—

Chairman: The Director of Agriculture—Dr. A. W. R. Joachim, O.B.E., Ph.D., B.Sc. (Lond.)

Treasury Representative: Mr. E. B. Wiratunga.

Chairman, Low Country Products' Association: Senator E. W. Kannangara, C.B.E., J.P., B.A. (Lond.)

Senators and Members of the Parliament nominated by the Honourable Minister: Mr. N. H. Keerthiratne, M.P., and Mr. R. Singleton-Salmon, M.P., C.B.E.

Representatives of the Low Country Products' Association: Mr. R. H. de Mel, Mr. Wace de Niese.

Representatives of the Planters' Association of Ceylon: Mr. A. W. Warburton-Gray, Mr. C. T. Van Geyzel, J.P.

Representatives of the Small-holders nominated by the Honourable Minister: Mr. E. Muttukumaru, J.P., Mrs. L. J. de S. Seneviratne.

Director, Coconut Research Institute of Ceylon: Mr. F. C. Cooke, A.R.C.S., B.Sc. (Lond.), A.M.I.Chem.E., E.D.

Messrs. R. Singleton-Salmon, M.P., C.B.E., and N. H. Keerthiratne, M.P., who represented Parliament on the Coconut Research Board ceased to be members on dissolution of Parliament, and were succeeded by Messrs. W. I. Hugh Fernando, M.P., and J. C. W. Munasinha, M.P., with effect from 15th and 30th May respectively.

Dr. A. W. R. Joachim. O.B.E. on retirement as Director of Agriculture in August ceased to be ex-officio Chairman of the Coconut Research Board and was succeeded by Dr. W. R. C. Paul, M.A. (Cantab.), Acting Director of Agriculture, and subsequently by Dr. M. F. Chandraratne, Director of Agriculture.

Mr F. C. Cooke, Director, Coconut Research Institute, on leaving the Island on 19th June on furlough, prior to retirement ceased to be a member of the Board and was replaced by Dr. M. L. M. Salgado, Acting Director, till the arrival on 8th November of Prof. S. C. Harland, F.R.S. as Director (Interim).

Meetings

Nine meetings of the Coconut Research Board were held during the year—on 9th March, 11th April, 4th June, 23rd June, 9th July, 21st September, 2nd November, 2nd December and 10th December, 1956.

Committees

Administration Committee (Personnel at January 1):

(1) Dr. A. W. R. Joachim (Chairman)
(2) Mr. E. B. Wiratunga
(3) Senator E. W. Kannangara, O.B.E.
(4) Mr. R. Singleton-Salmon, M.P.
(5) Mr. R. H. de Mel
(6) Director, Coconut Research Institute

the 16th and 17th meetings were held on 30th April and 13th September.

Research Committee (Personnel at January 1):

(1) Mr. R. H. de Mel (Chairman)
(2) Dr. A. W. R. Joachim
(3) Mr. E. Muttukumaru, J.P.
(4) Mr. C. T. Van Geyzel, J.P.
(5) Mr. Wace de Niese
(6) Director, Coconut Research Institute

the 16th, 17, 18th and 19th meetings were held on 5th May, 30th June, 15th August, and 1st October.

Extension Committee (Personnel at January 1):

(1) Mr. C. T. Van Geyzel (Chairman)
(2) Mr. A. W. Warburton-Gray
(3) Mr. N. H. Keerthiratne, M.P.
(4) Mr. E. Muttukumaru, J.P.
(5) Mrs. L. J. de S. Seneviratne
(6) Director, Coconut Research Institute

the 15th and 16th meetings were held on 30th April and 27th August.

Salaries Sub-Committee (Personnel appointed in June):

(1) Senator E. W. Kannangara (Chairman)
(2) Mr. E. B. Wiratunga
(3) Mr. W. I. Hugh Fernando, M.P.
(4) Mr. J. C. W. Munasingha, M.P.
(5) Mr. R. H. de Mel
(6) Director, Coconut Research Institute
Mr. B. Mahadeva (co-opted).

M. F. CHANDRARATNE,
Chairman, Coconut Research Board.

REPORT OF THE DIRECTOR (1956)

THE staff of the Coconut Research Institute at the end of 1956 was as follows:—

Director: Prof. S. C. Harland, F.R.S. (Lond.), D.Sc.

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

ADMINISTRATION DIVISION

Secretary-Accountant: Mr. S. C. Kahawita, B.Com. (Lond.)
Accounting Assistant: Mr. K. C. de Pinto.

SOIL CHEMISTRY DIVISION

Soil Chemist: Dr. M. L. M. Salgado, B.Sc. (Lond.), Ph.D. (Cantab.), Dip. Agric. (Cantab.).

Research Assistant to Soil Chemist: Mr. D. A. Nethsinghe, B.Sc. (Ceylon), A.R.I.C. (on overseas study leave).

CHEMISTRY DIVISION

Chemist: Mr. W. R. N. Nathanael, B.Sc. (Lond.). ✓
Research Assistant: Mr. T. S. Balakrishnamurti B.Sc. (Ceylon).

BOTANISTS' DIVISION

Botanist: Dr. D. V. Liyanage, B.Sc. (Lond.), Ph. D. (Manch.). ✓
Research Assistant: Mr. C. A. Wickramasooriya, B.Sc. (Ceylon).

AGRONOMY DIVISION

Agronomist: Mr. T. B. Paltridge, B.Sc. (Lond.), Colombo-Plan.
Research Assistant: Mr. K. Santhiresegaram, B.Sc. (Hons.) (Ceylon).
Animal Husbandry Officer: Mr. G. C. M. Goonesekera.

PLANTING AND ADVISORY DIVISION

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

CROP PROTECTION

Crop Protection Officer: Mr. H. F. Goonewardene.

PUBLIC RELATIONS

Public Relations Officer: Mr. L. R. N. H. Perera.

BIOMETRY

Biometrician: Mr. V. Abeywardene. ✓

ESTATES

Superintendent, Bandirippuwa Estate: Mr. D. F. Withana.
Superintendent, Ratmalagara Estate: Mr. H. J. F. Peiris.

MECHANICAL

Senior Mechanic: Mr. R. Weeraperumall.

Mr. F. C. Cooke, B.Sc. (Lond.), A.M.I.Chem.E., Director, retired from the services of the Institute on the expiry of his contract and left the Island on Tuesday, 19th June. Dr. M. L. M. Salgado was appointed Acting Director as from this date.

Prof. S. C. Harland, F.R.S. of the Manchester University was appointed Director (interim) as from 9th November, 1956. Dr. Salgado was appointed as Deputy Director (interim) as from this date.

Mr. D. A. Nethsinghe, B.Sc. (Ceylon), A.R.I.C. (Lond.), Research Assistant to Soil Chemist left the Island on a Colombo Plan Scholarship for a course of postgraduate studies at the Department of Agriculture, University of Oxford.

Mr. G. C. M. Goonesekere, Animal Husbandry Officer, who was away in Australia on a Colombo Plan Scholarship returned to the Island and has resumed duties at Ratmalgara Research Station, Madampe.

Exhibitions and Conferences

The Coconut Research Institute was represented at the Royal Agricultural and Food Exhibition held during the beginning of the year. All Officers were on duty on rotation during the entire period at the stall jointly organised by the Institute and the Ceylon Coconut Board.

Three staff Conferences were held during the year. A Conference of the Publications Sub-Committee comprising Acting Director and Heads of Divisions was also held.

Two Conferences of Research Officers were held.

Training Course

A training course in Coconut Cultivation for the Advisory Field Officers of the Coconut Research Institute, Coconut Inspectors of the Coconut Rehabilitation Department and Supervisors and Overseers of the Land Commissioner's Department was held from July to September, 1956.

The following new appointments were made during the year:

Mr. J. H. Hanisdeen, Field Assistant to the Planting Officer as from 1st March, 1956.

Mr. F. R. de Alwis, Field Assistant to the Soil Chemist as from 1st March.

Mr. W. B. A. de Silva, Field Assistant to the Botanist as from 1st March.

Mr. E. R. Chelliah, Technical Assistant to the Chemist as from 1st April.

Mr. W. A. Wijeratne, Clerk/Typist, Grade II, as from 1st March.

Mr. F. Milton Silva, Clerk/Typist, Grade II, as from 1st March.

Mr. G. Richard Appuhamy, Clerk/Typist, Grade II, as from 1st March.

Messrs. H. M. R. B. Wewalpola, Y. V. Surasena, S. L. Sumanasiri, K. W. Kirthisiri and K. B. Cyril Fernando as nursery attendants to the Planting Officer.

Mr. Reinzil de Almeida as Attendant to the Biometrician.

Messrs. H. Samaranayake and R. M. Gunarathamy as Attendants to the Secretary/Accountant.

Mr. P. D. Ariyasena as Attendant to the Public Relations Officer.

Messrs. L. D. Thambugala, C. Iddawela and P. Mahindapala as Advisory Field Officers with effect from 1.5.56.

Mr. Hilary F. Gunawardene, Crop Protection Officer, as from 12.4.56.

Mr. J. G. Pinto as Laboratory Attendant to the Crop Protection Officer as from 3.5.56.

Misses M. W. Ginger and B. M. Salmond as Laboratory Assistants to the Agronomist as from 18th July and 2nd May respectively.

Messrs. A. P. Jayawansa and H. W. Tillakeratne as Field Assistants to Botanist and Soil Chemist respectively with effect from 20th August and 5th September respectively.

Messrs. S. Mahesan, P. D. Wijesinghe, P. A. Gomes, P. K. Somawansa, W. L. H. M. Wijegunaratne, T. D. J. R. D. Peiris, and S. A. Swami as Advisory Field Officers as from December, 1956.

Messrs. S. Muthuchamy and M. S. Velu as Field Assistants to Animal Husbandry Officer and Crop Protection Officer respectively as from 1st December.

Resignations

The following officers left the service of the Institute during this year:

Mr. A. Maheswara, Industrial Research Assistant.

Mr. J. W. Fernando, Field Attendant (Pollination).

Mr. D. M. Kiribanda, Office Attendant.

Mr. W. B. A. de Silva, Field Assistant to the Botanist as from June, 1956.

Promotions

The following were promoted during the year:

Mr. Vincent de Paul Fernando, Nursery Attendant as Field Assistant to the Planting Officer as from 1st June.

Mr. D. T. Van de Bona, from Clerk/Typist, Grade II, to the Grade I Service.

Mr. George Jayawardena, from Clerk/Typist, Grade II, to the Grade I Service.

Meetings and Articles

The Acting Director and the Technical Staff attended the Annual Sessions of the Ceylon Association for the Advancement of Science.

The following papers were read at the Sessions:—

(*a*) The phosphate content of coconut water in relation to phosphate availability and response to phosphate manuring by Dr. M. L. M. Salgado, Mr. D. A. Nethsinghe and Mr. V. Nalliah.

(*b*) A mineralogical approach to soil studies with special reference to coconut soils in Ceylon by Dr. M. L. M. Salgado.

(*c*) Land use and soil and water relations with reference to coconut cultivation by Dr. M. L. M. Salgado.

Publications

The following were published and made available for issue during the year:

Leaflets Nos. 24, 25 and Bulletin No. 7 in English.
Leaflets Nos. 26, 27 and 28 and Bulletin Nos. 8 and 9 in English.
Sinhalese reprints of Leaflets Nos. 1, 2, 5 and 8.
Sinhalese reprints of Leaflets Nos. 2, 3 and 4.
Ceylon Coconut Quarterly, Vol. 6, No. 2, and Pol Pawath, Vol. 1, No. 3.
Ceylon Coconut Quarterly, Vol. 6, Nos. 3 and 4.

Welfare

The following committees of management have been actively engaged in the development of welfare of the staff of the Institute which has considerably increased.

Medical Aid Fund

Personnel at the end of 1956:

Dr. M. L. M. Salgado, Acting Chairman.
Mr. S. C. Kahawita, Secretary-Accountant.
Mr. W. R. N. Nathanael.
Mr. M. M. Perera.
Mr. F. H. B. Felix Silva, Secretary to the Committee.

The main functions of this Committee have been to approve medical bills incurred by members in terms of the rules governing the Medical Aid Fund. Eleven meetings of the Committee of management have been held during the year and 243 applications for aid have been approved for payment. Special arrangements have always been made at the discretion of the Secretary wherever possible in consultation with the respective panel of doctors when members find difficult to settle hospitalisation bills owing to lack of funds, lying to the credit of members. The proposal to increase rates of contribution are under consideration by the Coconut Research Board.

Coconut Research Institute Co-operative Welfare Society, Ltd.

Managing Committee: Personnel at the end of 1956:
Mr. S. C. Kahawita, President.
Mr. C. W. S. de Silva, Vice-President.
Mr. K. C. de Pinto, Vice-President.
Mr. F. H. B. Felix Silva, Honorary Secretary.
Mr. M. B. S. Kurera, Honorary Treasurer.
Messrs. G. W. M. Wijetunge, V. Abeywardene, O. D. J. Wanasinghe and D. R. Withana, Committee members.

The main functions of this Committee have been to encourage thrift and savings by providing means whereby such savings may receive a reasonable interest and to afford relief to members in need by enabling them to obtain loans for useful or really necessary purposes at reasonable interest and with easy terms of repayment and to supply consumer goods at cheap rates. The establishment of the stores and canteen sections of the Society during the year has been one of the principal achievements of the Society in the furtherance of its objects and the response to it has been very encouraging and exceeded all expectations. A general meeting, one special committee meeting and twelve general committee meetings were held during the course of the year. Among other important purposes for which loans have been granted, the Society has on record of having assisted in the purchase of lands and the building, repairing and redeeming of dwelling houses of members, and also in agricultural and educational matters.

The salary of the Canteen and Stores Manageress and the cost of altering and renovating the building allocated to the Society and further the cost of a refrigerator have been met from a grant given by the Coconut Research Board.

Recreation Club

Personnel at the end of 1956—

GENERAL COMMITTEE

President:	(Vacant)
Vice-President:	Mr. C. A. Wickramasooriya
General Secretary:	Mr. F. H. B. Felix Silva
General Treasurer:	Mr. G. W. M. Wijetunga
Tennis Secretary:	Dr. D. V. Liyanage
Cricket Secretary:	Mr. V. Abeywardene
Indoor Games:	Mr. T. S. Balakrishnamurti
Library Secretary:	Mr. J. K. F. Kirthisinghe
Volley Ball Secretary:	Mr. O. D. J. Wanasinghe.

One general meeting, one extraordinary meeting and six Committee meetings have been held during the course of the year. The Recreation Club provides recreation facilities to all members and the necessary equipment is supplied from funds of the Club and also from a grant given by the Coconut Research Board. Cricket was popular again as the club entered the Government Services tournament for the second time and was qualified to participate until the third round—a step ahead than last year. Tennis, Volley Ball and Indoor games matches were also arranged and several members participated in an excursion to the Wilpattu Game Sanctuary. At the end of the year, there was a very successful social, sports meet, Christmas tree and a variety entertainment which was attended by the Officers and their families; all the children of all those employed in the office and estate were given gifts. A ball room dance was organised by the CRI Recreation Club and a profit of Rs. 320 was donated to the Deaf and Blind School, Seeduwa.

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

SUMMARY OF ANNUAL REPORTS

Botanical Division

Work on intra-specific hybridisation has been continued.

The yield of the first generation (F^1) palms of the *Typica* × *Nana* (i.e., Tall × Dwarf) varieties have been very satisfactory. The hybrids appear to be as hardy as the *typica* parent and were not affected by the severe drought, although the dwarf palms in the same block were affected.

Twenty acres of the isolated seed garden were planted up with seedlings of the tall × tall crosses.

Seedlings from four other inter-varietal crosses were transplanted at Ratmalagara and Bandirippuwa.

The analysis of the data of the Progeny trial planted in 1934 at Marandawila indicate that there is no correlation between the yield of another palm and its offspring under open pollination.

An examination of the data of the Selection Experiment at Ratmalagara, planted in 1939, has confirmed the value of seedling selection.

A new system of planting—Hedge Planting—where more seedlings than are necessary are planted and subsequently selectively thinned to the required density is being tested at Ratmalagara Estate. The rows were spaced 26 feet apart and within the row the seedlings were planted 18 feet apart.

A study of insects commonly visiting coconut inflorescences has been made. Out of 13 species of insects the honey bee was the commonest visitor.

Spraying 2-4 Dicho rophenoxyacetic acid (2-4D) to the female flowers did not result in a significant increase in fruit setting.

Crop Protection

With the appointment of the Crop Protection Officer in April, 1956, a detailed programme of research and proposals for a Pest Control Service have been approved by the Board.

The main item of research is directed towards the control of Black Beetle. Field experiments were commenced to determine the role of insecticides as repellants of Black Beetle and in the control of Termite damage to seedlings.

Soil Chemistry Division

The long range manurial experiments have been continued.

In the course of the year, there have been several reports from estates in the Kelani Valley, Gampaha, Peliyandala and Galle regarding an increasing incidence of yellowing of palms. Preliminary investigations by using the nut water technique do not indicate a deficiency of major nutrients, and two trials using dolomite and magnesium sulphate have been commenced.

A quick technique for the determination of phosphate in coconut water has been worked out. Application of this method to assessment of phosphate availability in soils appears to be promising.

A detailed Soil Survey of 4,000 acres of Wilpothakelle Reserve Forest, in the Chilaw District and a reconnaissance Soil Survey of the Crown Jungles in Karativu-Vannatavillu area of the Puttalam Districts were carried out.

Technological Chemistry

Experiments carried out by the ' Generator ' process using ' low wines ' from fermented toddy show that a fairly high strength spirit vinegar could be prepared under certain favourable conditions.

In studies on the recovery of dried yeast from toddy it was found possible to recover at least a pound of yeast containing 50 per cent. protein from every 100 gallons. These studies reveal the importance of recovering the valuable toddy

yeast (about 200-250 lb. of dry yeast per day) which is being run to waste with the effluents in Ceylon's distilleries and vinegar factories. Even in the crude form of a ' fodder yeast ', it would provide a valuable protein concentrate for farm stock.

Bleaching experiments on ' Drain Oil ' have been successful in producing a refined oil water white in colour and perfectly clear in appearance.

Plant Chemistry

In connection with the projected experiments on the growing of indicator plants and coconut seedlings in sand cultures the nutrient solution recommended by the Long Ashton Research Station was found to give the most satisfactory results with a variety of plants.

Division of Agronomy

The new division of Agronomy which was initiated in September, 1956 has initiated a programme of research in the nutrient status selected coconut soils and on pasture trials.

During 1956, the new Division of Agronomy has been firmly established as an effective unit within the Coconut Research Institute. Essential equipment including such items as a carefully designed plant house or ' phytosolarium ', dehydrator (imported from Australia) and general laboratory apparatus has been purchased and installed. Farm implements for the work at Ratmalagara Estate have also been supplied. A small but effective staff has been recruited.

During this formative period the work of the Division has been centred on two important types of soil, the lateritic gravel and the Cinnamon sands. About 30 factorial pot experiments have been commenced with a view to determining the nutrient status of these two soils. Some fifteen of these experiments have been carried through to completion and the data are now being analysed.

Results to date suggest that plants grown on the lateritic soils do not suffer from any deficiency of trace elements, but the demand for major nutrients, N. P. K. Ca. and Mg. is complicated by a number of complex interactions and some change in nutrient status which takes place over a period of time. In many cases it has been necessary to continue individual experiments for approximately six months in order to follow those changes to stability.

The work on cinnamon sands has shown that these soils are very deficient in calcium, which seems to exert a major control on the effectiveness of all other nutrients. They are also deficient in sulphur and in boron. It is a matter of considerable importance that very heavy doses of the major elements are required for satisfactory growth of soil improving plants, and the economics of effective fertilizer practice are being closely studied.

Experimental pastures of *Brachiaria brizantha, Brachiaria miliformis* guinea grass (*Panicum maximum*) and *paspalum commersonii* have been established and they are being used to maintain small herds of Sinhala cattle. Their fertilizer requirements and their effect on coconut trees, soil structure and soil water status are being recorded as part of a comparatively long-term programme of research on the use and management of pastures on Coconut Estates.

Planting Division

1,312,437 seednuts were planted in 17 nurseries during the year. The demand for seedlings exceeded the supply and 833,238 seedlings were issued during the two planting seasons.

At the end of 1956, there were 17 Advisory Field Officers, 10 of whom were in charge of ranges, while 7 newly recruited officers were undergoing a course of training at Headquarters.

REPORT OF THE SOIL CHEMIST

I. Field Experiments

(i) 3 × 3 × 3 N. P. K. EXPERIMENT (BANDIRIPPUWA ESTATE)

The 21st year of this experiment was completed in November, 1956. As in the ninth manuring the stepped-up potash levels remained the same since the manuring in November, 1951.

K_0	is	K_1	0·75 lb.	K_2O
K_1	is	K_2	1·50 lb.	K_2O
K_2	is	K_3	2·25 lb.	K_2O

The manuring of the Guard Row palms was done in June, 1956. The next biennial manuring of the plot palms is due in 1957. For the nitrogen comparison (i.e. comparison of sulphate of ammonia, calcium cyanamide, and oil cake), sediment poonac containing 6 per cent. nitrogen was used as groundnut cake was not available.

The yield data for the main effects for 1956 are given below:

Nitrogen	*Lb. Copra per acre*	*Calculated percentage*	*Difference in lb.*	*Copra out-turn, nuts per candy*
N^0	1,672	100	—	1,125
N_1	1,672	100	—	1,148
N_2	1,601	96	—71	1,192
Phosphoric Acid				
P_0	1,650	100	—	1,132
P_1	1,643	100	—7	1,157
P_2	1,653	100	+3	1,174
Potash				
K_0 (uow K_1)	1,406	100	—	1,211
K_3 (now K_2)	1,318	122	+312	1,138
K_2 (now K_1)	1,823	130	+417	1,126

Significant difference P.05 = 136 lbs./acre.

The potash response alone continues to be significant.

Potash response for the manurial years 15-21 are given below:—

Manurial Year	*Year*	*LBS./COPRA/ACRE* $K_1—K_0$	$K_2—K_0$
15	1950	543	711
16	1951	664	846
17	1952	547	799
18	1953	321	437
19	1954	511	714
20	1955	321	431
21	1956	312	417

Note.—Potash doses were stepped-up during the manuring in November, 1951.

The drop in response shown by the K_2—K_0 and K_1—K^0 columns, continuously from 1951, even after the stepping-up of the potash levels of manuring, is due to the fact that the K_0 plots (now K_1) have shown significant improvement in yield as shown below:—

Year	Yields : Lb. Copra per acre			Yield data for 300 palm block of the Botanist
	K_0 (K_1 after 1951)	K_1 (K_2 after 1951)	K_2 (K_3 after 1951)	(Nuts/acre)
1950	1,204	1,747	1,915	4,603
1951	1,398	2,062	2,244	4,416
1952	1,195	1,742	1,994	4,571
1953	1,267	1,588	1,704	3,856
1954	1,326	1,837	2,040	4,117
1955	1,851	2,172	2,282	4,841
1956	1,406	1,718	1,823	3,595

Note.—The year 1956 is a poor year regarding yield as is shown by the Yield Records given above for the 300 palm block of the Botanist, where normal manuring and cultivation have been carried out.

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

	N_0	N_1	N_2	K—*Total*
K_0	1,474	1,419	1,321	1,406
K_1	1,758	1,759	1,638	1,718
K_2	1,784	1,837	1,846	1,823
N—Total	1,672	1,672	1,601	1,648

	P_0	P_1	P_2	K—*Total*
K_0	1 440	1,369	1,407	1,406
K_1	1,742	1,698	1,715	1,718
K_3	1,767	1,861	1,839	1,823
P—Total	1,650	1,643	1,653	1,648

	P_0	P_1	P_2	N—*Total*
N_0	1,665	1,711	1,640	1,672
N_1	1,406	1,596	1,737	1,672
N_3	1,602	1,621	1,581	1,601
P—Total	1,650	1,643	1,653	1,648

(II) K.P.C. MANURIAL × CULTIVATION EXPERIMENT—(RATMALAGARA ESTATE)

The 7th biennial application of manures of this experiment is to be carried out in 1957.

This factorial experiment includes combinations of the following treatment and is of the 3 × 2 × 2 type and consists of 6 blocks of 6 plots each. The interactions P.C. and K.P.C. are partially confounded with block differences.

$\left\{\begin{array}{l} K_0 = \text{No potash} \\ K_1 = \text{1 lb. } K_2O \text{ per palm} \\ K_2 = \text{2 lb } K_2O \text{ per palm} \end{array}\right\} \times \left\{\begin{array}{l} P_0 = \text{No phosphoric acid} \\ P_1 = \text{1 lb. } P_2O_5 \text{ per palm} \end{array}\right\} \times \left\{\begin{array}{l} C_0 = \text{No ploughing} \\ C = \text{Ploughing once in two years at the time of manuring} \end{array}\right\}$

All plots are given a basic application of 3 lbs. sulphate of ammonia per palm. The first biennial application of manures was carried out in June, 1943. The yield data for the main effects from the second year (1944-1945) up to the thirteenth year are summarised in Table below:

K. P. C. Manurial × Cultivation Experiment—Ratmalagara Estate

(*Lb. per acre*)

Treatment	*1944–45* 2nd year	*1945–46* 3rd year	*1946–47* 4th year	*1947–48* 5th year	*1948–49* 6th year	*1949–50* 7th year	*1950–51* 8th year	*1951–52* 9th year	*1952–53* 10th year	*1953–54* 11th year	*1954–55* 12th year	*1955–56* 13th year
K_0	1,771	1,691	1,415	1,841	1,438	1,342	1,631	1,978	1,663	1,827	1,883	1,664
K_1	1,935	1,674	1,395	1,842	1,466	1,327	1,677	1,957	1,684	1,924	2,011	1,726
K_2	1,893	1,738	1,492	1,975	1,589	1,449	1,760	2,167	1,813	2,006	2,044	1,886
Significant difference (P·05)	194	152	181	215	161	173	202	123	200	264	185	197
P_0	1,792	1,625	1,276	1,711	1,353	1,095	1,487	1,798	1,434	1,574	1,582	1,505
P_1	1,938	1,777	1,592†	2,061†	1,643*	1,651†	1,891†	2,270†	2,006†	2,264†	2,377†	2,012†
C_0	1,783	1,615	1,372	1,851	1,450	1,320	1,654	2,020	1,708	1,942	1,977	1,744
C	1,949*	1,787†	1,496	1,921	1,547	1,426	1,725	2,048	1,732	1,896	1,981	1,773
*Significant difference (P·05)	158	123	149	176	131	145	165	151	163	216	151	241

†Significant at P·01

As before phosphate response alone continued to be marked and significant but has now dropped to 507 lb. per acre per annum from the peak value of 795 lb. per acre for 1954-1955.

Year	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*	*10th*	*11th*	*12th*	*13th*
Lbs./Acre	144	152	316	350	290	556	404	472	572	690	795	507

(III) 3 × 3 × 3 N.P.K. MANURIAL EXPERIMENT ON YOUNG PALMS (RATMALAGARA)

The eighth annual manuring was carried out in October-November 1956. The manures were broadcast for the first time in the square followed by turning of the soil with mammoties.

The basic rates of manuring remained the same as during the previous year, viz.—

Nitrogen (N_1): Sulphate of Ammonia 1 lb. per palm.
Phosphoric Acid (P_1): Saphos Phosphate 1 lb. per palm.
Potash (K_1): Muriate of Potash 1 lb. per palm.

(*a*) *Palms in Flower.* Up to the end of December 1956, there were 740 palms in flower. The distribution is shown below according to the main effects—

Palms in Flower

N_0	239	P_0	166	K_0	239
N_1	255	P_1	287	K_1	236
N_2	246	P_2	287	K_2	265

Phosphate manuring has a marked effect on flowering.

(*b*) *Yield of Nuts.* The distribution of nuts of the plot palms are shown below according to the main effects—

N_0	1,641	P_0	375	K_0	1,863
N_1	2,370	P_1	2,814	K_1	2,019
N_2	2,719	P_2	3,049	K_2	2,356

Here again the effect of phosphate is particularly striking.

(*c*) *Leaf Counts.* Two leaf counts were done during the year 1956, in January and July. The extra leaves that emerged during the year are shown below—

	Total Leaves	*Calculated as per cent.*	*Leaves per palm*
N_0	3,898	100	12·0
N_1	3,975	102	12·3
N_2	3,763	97	11·6
P_0	3,595	100	11·1
P_1	3,983	111	12·3
P_2	4,058	113	12·5
K_0	3,790	100	11·7
K_1	3,787	100	11·7
K_2	4,059	107	12·5

On leaf development too phosphate alone continues to produce a significant response.

II. Co-operative Manurial Experiments

(I) MANURIAL EXPERIMENT ON UNDERPLANTED YOUNG PALMS (LETCHEMY ESTATE, NATTANDIYA)

This experiment was commenced in 1940, on underplanted palms put out in October 1939. The treatments are (*a*) Cover *vs.* No Cover (*b*) O, NK and NPK in five randomised blocks of six plots each.

The first palm came into bearing in 1945, in the sixth year after planting. By 1952, the entire old stand was removed.

At the end of 1956, there were 476 palms in flower as compared to 467 at the end of 1955. The total number of experimental palms being 540, making the percentage in flower at the end of 1956, 88 per cent.

The following is the distribution of palms in flower according to treatments:—

	O	*N.K.*	*N.P.K.*
No Cover ..	81	77	85
Cover ..	78	73	82
	159	150	167

Total—476 palms

The following tables give data concerning (*a*) Palms in Flower, (*b*) The Yield of Nuts, (*c*) Yield of Copra, (*d*) Copra out-turns for years 1945 to 1956 :—

(*a*)

Palms in Flower
(Totals of 10 plots of 18 palms)
Treatments

Year	*O*	*N.K.*	*N.P.K.*	*Total*
1945 ..	—	—	1	1
1946 ..	12	16	12	40
1947 ..	43	49	41	133
1948 ..	68	77	75	220
1949 ..	99	97	117	313
1950 ..	119	120	135	374
1951 ..	132	124	146	402
1952 ..	136	130	154	418
1953 ..	148	136	161	445
1954 ..	153	141	164	458
1955 ..	157	145	165	467
1956 ..	159	150	167	476

(*b*)

Yield of Nuts
(Totals of 10 plots of 18 palms)
Treatments

O	*N.K.*	*N.P.K.*	*Total*
—	—	—	—
—	—	15	15
92	87	191	370
325	628	656	1,649
864	1,030	1,785	4,279
976	1,638	2,091	4,705
1,618	2,559	3,379	7,556
2,424	3,526	4,556	10,506
2,661	4,302	5,876	12,830
4,822	6,976	10,345	22,143
6,847	8,373	11,719	26,939
6,979	7,594	10,744	25,317

(*c*)

Yield of Copra (lb.)
(Totals of 10 plots of 18 palms)
Treatments

Year	*O*	*N.K.*	*N.P.K.*	*Total*
1945 ..	—	—	—	—
1946 ..	—	—	11	11
1947 ..	44	45	120	209
1948 ..	111	281	272	664
1949 ..	269	497	605	1,371
1950 ..	501	878	1,158	2,537
1951 ..	819	1,417	1,912	4,148
1952 ..	1,117	1,846	2,519	5,482
1953 ..	1,262	2,159	3,030	6,451
1954 ..	2,465	5,771	5,852	12,088
1955 ..	3,494	4,496	6,627	14,617
1956 ..	3,802	4,168	6,156	14,126

(*d*)

Copra out-turn (nuts/candy)
(Totals of 10 plots of 18 palms)
Treatments

O	*N.K.*	*N.P.K.*
—	—	—
—	—	764
1,171	1,083	821
1,175	1,158	945
1,122	1,084	1,051
1,091	1,045	1,011
1,106	1,011	990
1,215	1,070	1,013
1,181	1,116	1,086
1,096	1,035	990
1,097	1,043	990
1,028	1,020	997

It will be noticed that the highest yield and the best out-turn are obtained for the N.P.K. treated palms.

(II) MANURIAL EXPERIMENT ON METHODS OF APPLICATION OF MANURES (MARANDAWILA GROUP, BINGIRIYA)

This experiment is of the unreplicated 3 × 3 × 3 factorial design and consists of all combinations of N.P.K. applied in the following ways:—

No—No nitrogen
Nc—Nitrogen applied in circular trenches
NB—Nitrogen broadcast and ploughed

Po—No phosphoric acid
Pc—Phosphoric acid applied in circular trenches
PB—Phosphoric broadcast and ploughed

Ko—No potash
Kc—Potash applied in circular trenches
PB—Potash broadcast and ploughed

The first biennial application of manures was done in June 1949. The yield data distributed according to treatments are given below for the various years commencing MII (Viz. 1950-51)—

Lb. Copra per Acre
(Yields adjusted by Covariance Analysis)

	M-II 1950–51 2nd year	*M-III 1951–52 3rd year*	*M-IV 1952–53 4th year*	*M-V 1953–54 5th year*	*M-VI 1954–55 6th year*	*M-VII 1955–56 7th year*
No	1,917	1,493	1,436	1,337	1,934	1,958
Nc	1,929	1,561	1,563	1,496	2,145	2,091
NB	1,835	1,538	1,500	1,476	2,064	2,135
Po	1,833	1,416	1,400	1,343	1,901	1,851
Pc	1,907	1,575	1,560	1,491	2,132	2,163
PB	1,941	1,600	1,539	1,476	2,111	2,170
Ko	1,814	1,482	1,401	1,408	1,874	1,913
Kc	1,938	1,472	1,528	1,418	2,116	2,099
KB	1,929	1,639	1,570	1,484	2,154	2,171
(Significant difference P ·05)	83	217	141	403	342	220

Significant Responses

M-II		*M-III*	*M-IV*	*M-V M-VI M-VII*
Nitrogen	Nc > NB	None of the responses are significant	Nil	None of the responses are significant
Phos. Acid	PB > Po		Pc > Po	
Potash	Kc > Ko		Kc > Ko	
	KB > Ko		KB > Kc	

(III) YELLOWING OF PALMS:

Recently, particularly in the course of this year there have been several reports from estates of the Kelani Valley, Gampaha, Meegoda, Aturugiriya, Homagama, Piliyandala, Horana, Ingiriya and further south in Galle, regarding an increasing incidence of yellowing of palms.

To study this problem two estates were chosen:

(*a*) Walgama Estate in the village of Rukmale on the Aturugiriya Road.

(*b*) Mattegoda Estate in the village of Polgasowita.

On both these estates the yellowing is not restricted to any particular area of the estate and is distributed and scattered on the upper regions of the estate as well as the low lying areas so that it can be inferred that it is not the usual type of yellowing which is associated with water logging. Neither is there evidence to suspect lack of cultivation and systematic manuring on these estates for the past few years: in fact the two estates mentioned above have been systematically manured.

The main soils of the area in which the estates are situated are of the typical lateritic soil type. The rainfall is fairly heavy, ranging from 90-120'' annually and well distributed.

Ad hoc trials were therefore commenced on these estates with the suspicion that the yellowing may be due to deficiencies in these soils of either Calcium or

Magnesium or both, as analysis of nuts water samples collected from the estates failed to indicate any deficiencies of the major nutrients as shown in table below:—

Estimation of Phosphoric Acid and Potash contents of nut water samples from Walgama Estate

Date of Sampling—October 15, 1956

Samples No. (Composite)	P_2O_5 *content (affected)*	*Mgm/litre (unaffected)*	*Potash content (affected)*	*gm/litre (unaffected)*
1	169 ..	204 ..	1·585 ..	1·568
2	199 ..	217 ..	2·016 ..	2·273
3	215 ..	197 ..	2·331 ..	2·389
4	204 ..	211 ..	2·281 ..	2·115
5	184 ..	186 ..	2·207 ..	2·265
	971 ..	1,015 ..	10·693 ..	10·610
Mean.. ..	194 ..	204 ..	2·139 ..	2·122
	95·1* ..	100* ..	100·8* ..	100*

Estimation of Phosphoric Acid and Potash contents of nut water samples from Walgama Estate

Date of Sampling— December 18, 1956.

Sample No. (Composite)	P_2O_5 *content (affected)*	*Mgm/litre (unaffected)*	*Potash content (affected)*	*gm/litre (unaffected)*
1	151 ..	187 ..	2·223 ..	1·941
2	194 ..	260 ..	1·867 ..	2·182
3	152 ..	212 ..	2·323 ..	1·999
4	205 ..	200 ..	2·472 ..	2·240
5	206 ..	197 ..	2·132 ..	2·522
	908 ..	1,056 ..	11·017 ..	10·884
Mean.. ..	181·6 ..	211·2 ..	2·203 ..	2·177
	85·9* ..	100* ..	101·2* ..	100*

* Unaffected palm figures expressed as 100.

Estimation of Phosphoric Acid and Potash contents of nut water samples from Mattegoda Estate (North)

Date of Sampling— December 19, 1956.

Composite of Palm group	*Remarks*	P_2O_5 *content mgm/litre*	*Potash content gm/litre*
Gr. A		203 ..	2·016
Gr. B.	Yellowed	226 ..	2·140
Gr. C	Palms	218 ..	2·115
Gr. D		224 ..	2·132
Gr. E		203 ..	1·991
	Mean	215 ..	2·079
201–210		198 ..	1·891
211–220	Unaffected	233 ..	2·257
221–230	Palms	179 ..	1·833
231–240		235 ..	1·983
	Mean	211 ..	1·991

Records of picks are being systematically maintained. Premanurial photographic records (in colour) are being kept of crowns of experimental palms. It is premature to make any conclusion regarding the trials. The first manuring at Walgama with N.P.K., supplemented with Dolomite and Epsom salts is to be carried out in early 1957.

III. Soil Surveys

A number of soil surveys were undertaken by the Soil Chemist's Division for the various highland colonization schemes sponsored by the Government. Based on these surveys virgin jungle lands were recommended in suitable areas for

2—J. N. R 22303 (3/58).

opening up under coconuts as follows: (1) Pilot schemes for the landless peasants. (2) Colonization schemes under village expansion. (3) Middle class colonization schemes and co-operative development schemes.

Of these surveys, those in the Wellawaya area and the one at Wilpotha-Kele in the Chilaw District deserve mention. In the latter instance a detailed survey lasting about a month under difficult conditions was carried out for the dereservation of 2,000 acres out of 4,000 acres of forest reserve.

A land utilization and underground water survey of the Karaitivu-Vannativillu area was undertaken jointly by the Government Mineralogist and the Soil Chemist.

Analyses of some of the soil samples collected, from areas undertaken for survey, are given in tables below:

Mechanical and Chemical Analysis of Soil Samples from Wellawaya and Karativu

Locality	*Mechanical Analysis* Coarse sand	Fine sand	Silt	Clay	*pH*	*Exchangeable bases in m.e. %* Total	Ca	Mg	*Available* K_2O	P_2O_5 (*p.p.m.*)	*HCl Soluble* K_2O %	P_2O_5 (*p.p.m.*)
1. Veherayaya (Top) ..	42·6	24·4	1·0	30·2	7·79	7·85	5·95	1·22	0·459	35·0	0·283	295
2. Veherayaya (Sub) ..	48·7	21·0	2·1	25·3	7·95	8·54	6·36	1·49	0·571	12·5	0·293	95
3. Dumbakotayara (Pit 2 top)	42·2	32·8	3·3	20·2	7·97	14·03	10·52	2·81	0·582	138·0	0·343	399
4. Anapallama .. (4th M.P. LHS. Top)	48·1	24·3	4·2	22·3	8·2	13·89	8·62	1·86	1·365	25·0	0·444	210
5. Harathgamuwa (Top)	47·2	21·3	1·5	26·0	7·57	13·44	7·72	3·93	0·426	22·5	0·258	165
6. Karaitivu ..	66·5	12·3	3·6	17·5	7·15	3·116	1·65	—	0·091	20·0	0·054	127

Mechanical and Chemical Analysis of Marichchukkaddi Soil Samples

(*a*) *Mechanical Analysis :*

Sample	*Coarse sand%*	*Fine sand%*	*Silt %*	*Clay %*	*Total %*
1. Marichchukkaddi (Top) ..	77·6 ..	4·32 ..	1·5 ..	13·6 ..	97·02
2. Marichchukkaddi (Sub) ..	63·5 ..	9·21 ..	3·1 ..	24·1 ..	99·91

(*b*) *Chemical Analysis :*

Sample	*pH*	*Total Exchangeable bases m.e.%*	*Exchangeable K_2O m.e.%*	*Phosphoric Acid (p.p.m.)*
1. Marichchukkaddi (Top) ..	7·22 ..	1·1833 ..	0·079 ..	25·0
2. Marichchukkaddi (Sub) ..	6·40 ..	1·334 ..	0·099 ..	17·5

Profile studies carried out at the Coconut Research Institute Seed Garden at Ambakelle in the Ambanmukkalana forest reserve shows that the canopy of soil overlies a dried up river bed, and that the latter overlies pegmatite.

Training Course. During 1956, two batches of Advisory Field Officers, Coconut Inspectors and Overseers were trained. The training course included lectures on coconut soils and the manuring and cultivation of coconuts, followed by tours arranged to various coconut areas of Ceylon.

LABORATORY INVESTIGATIONS

(*a*) *Studies on potash content of coconut water.* The determination of the potash content of coconut water samples from the N.P.K. manurial experiment

at Bandirippuwa Estate, which was recommenced in January, 1954, in order to study the effect of stepping up of the levels of potash applied to the palm since November, 1951, has been continued.

The figures for the concentration of potash in nut water for 1956 are given in the table below along with those for 1947, 1954, and 1955.

N.P.K. Experiment Bandirippuwa Estate—Grammes K_2O/litre of Nut Water

Pick	1947			1954			1955			1956		
	K_0	$K_{0\cdot75}$	$K_{1\cdot50}$	$K_{0\cdot75}$	$K_{1\cdot50}$	$K_{2\cdot25}$	$K_{0\cdot75}$	$K_{1\cdot50}$	$K_{2\cdot25}$	$K_{0\cdot75}$	$K_{1\cdot50}$	$K_{2\cdot25}$
1	1.06	1.56	1.95	0.97	1.55	1.93	1.27	1.80	1.99	1.06	1.67	2.04
2	1.08	1.64	2.07	0.98	1.51	1.94	1.29	1.75	1.96	1.11	1.62	2.01
3	0.99	1.47	1.82	1.0	1.55	1.90	1.02	1.56	1.93	0.96	1.38	1.77
4	0.92	1.51	1.90	1.02	1.53	1.92	1.05	1.49	1.80	1.12	1.63	1.90
5	1.06	1.59	1.98	1.06	1.55	1.89	1.11	1.62	2.04	1.05	1.62	1.98
6	1.04	1.59	2.05	1.09	1.61	1.98	1.05	1.48	1.88	0.98	1.48	1.84
Mean	**1.03**	**1.56**	**1.96**	**1.02**	**1.55**	**1.93**	**1.13**	**1.62**	**1.93**	**1.05**	**1.57**	**1.92**

The statistical analysis of this data has not been completed, and further comments will be made in next year's report.

(*b*) *Phosphate studies in nut water.* The new quick method, for determining inorganic phosphate using the vanadomolybdate-complex, which has been perfected in our laboratory for use with nut water was applied for studying the phosphate content of nut water from samples collected from the manurial experiments of the Soil Chemist with a view to studying the possibilities of using the method for diagnosing soil deficiencies with respect to phosphorus.

The phosphate concentrations in nut water from the experiments grouped according to treatments are summarised in tables below:—

Mean values for P_2O_5 in Coconut Water in (mg) P_2O_5 per litre for the year M XXI (N. P. K. Experiment at Bandirippuwa Estate)

	Treatments		
Pick	P_0	P_1	P_2
1	173.7	184.7	197.0
2	215.5	232.7	240.5
3	223.3	245.0	244.9
4	162.5	169.3	178.4
5	181.3	194.2	202.9
6	168.0	171.0	183.0
Total	1124.4	1196.9	1246.7
Mean	187.4	199.5	207.8

Mean values for P_2O_5 in Coconut Water in (mg) P_2O_5 per litre for the year M VII Marandawila Estate

	Treatments		
Pick	P_O	P_C	P_B
3	121.7	168.3	155.2
4	153.0	145.0	129.0
5	165.1	211.7	207.2
Total	439.8	525.0	491.5
Mean	146.6	175.0	163.8

Mean values for P_2O_5 in Coconut Water in (mg) P_2O_5 per litre for the year M XIII (K. P. C. Experiment at Ratmalagara Estate)

Pick	*Tratments*	P_0	P_1
3	.. .. ..	116.0	176.0
4	.. .. ..	107.8	176.4
5	.. .. ..	119.4	198.1
	Total ..	343.2	550.5
	Mean ..	114.4	183.5

The low phosphate content of the Ratmalagara soil, where a marked response to phosphate manuring is obtained is shown by the very low content of phosphoric acid in the nut water compared to the corresponding soils at Bandirippuwa.

(*c*) *pH Determinations*. A large number of pH determinations were done (*a*) some for the Crop Protection Division, (*b*) some for the Agronomist, of pot soils from his experiments, (*c*) others in connection with the soil surveys and soil studies.

(*d*) *Soil Nitrogen Studies*. In continuation of the work already done at Bandirippuwa and elsewhere further studies of soil nitrogen, as both ammonical and nitrate nitrogen, were carried out. Tables below confirm the view that there is considerable amount of ammonical nitrogen in the top and sub-soil.

It will be noted that the virgin soils are richer in nitrogen status compared to cultivated soils under coconuts. (Refer to values for NH_4—and NO_3 nitrogen for Wellawaya and Puttalam Soils).

Nitrogen in Wellawaya and Puttalam Soils (Virgin Jungles)

	Locality	*Layer*	*Total Nitrogen %*	*—NO_3 Nitrogen (p.p.m.)*	*Ammonical Nitrogen in p.p.m.*
1.	Veherayaya	Top ..	0·0624 ..	12·5 ..	24·9
2.	Veherayaya	Sub ..	0·0123 ..	7·5 ..	22·4
3.	Dambakotayrara Pit No. 2 ..	Top ..	0·1101 ..	12·5 ..	30·7
4.	Anapallama (4 M.P. Left hand side) ..	Top ..	0·1204 ..	13·8 ..	38·6
5.	Harathgamuwa	Top ..	0·0782 ..	22·0 ..	34·4
6.	Karaitivu	Top ..	0·1289 ..	3·0 ..	21·7
7.	Marichchukkaddi	Top ..	— ..	2·5 ..	—
8.	Marichchukkaddi	Sub ..	— ..	5·0 ..	—

Ammonical and Nitrate Nitrogen in Samples of Soil taken from the Botanist's Plot of Bandirippuwa Estate

Date of Sampling: 23-10-56.

Sample No.	*Series No. and layer*	*NH_4 Nitrogen (p.p.m.) in air dry Sample*	*NO_3 Nitrogen (p.p.m.) in air Dry Sample*	*NH_3 Nitrogen (p.p.m.) oven Dry Sample*	*NO_3 Nitrogen (p.p.m.) oven Dry Sample*
	Series No. 1				
1 ..	0—9″ T ..	16·97 ..	8·5 ..	18·1 ..	9·1
2 ..	9″—18″ S_1 ..	8·2 ..	7·5 ..	8·6 ..	7·9
3 ..	18″—27″ S_2 ..	11·6 ..	8·5 ..	12·4 ..	9·1
	Series No. 2				
4 ..	0—9″ T ..	13·7 ..	7·0 ..	14·3 ..	7·4
5 ..	9″—18″ S_1 ..	14·8 ..	6·5 ..	15·6 ..	6·9
6 ..	18″—27″ S_2 ..	9·4 ..	7·0 ..	10·1 ..	7·5
	Series No. 3				
7 ..	0—9″ T ..	13·7 ..	8·0 ..	14·3 ..	8·4
8 ..	9″—18″ S_1 ..	8·9 ..	7·0 ..	9·7 ..	7·6
9 ..	18″—27″ S_2 ..	9·5 ..	7·5 ..	10·4 ..	8·2

(*e*) *Soil Analysis in connection with Land Utilisation Surveys*. Date on mechanical and chemical analysis of the soils of Wellawaya and Puttalam areas which were undertaken for surveys are given under the head '*Soil Surveys*'.

V. NALLIAH,
Officer-in-Charge, Soil Chemistry Division.

10th July, 1957.

REPORT OF THE CHEMIST

Chemical Division

1. EXPERIMENTS ON THE PREPARATION OF SPIRIT VINEGAR USING THE ' GENERATOR ' PROCESS

In continuation of the work on the ' generator ' process of vinegar manufacture, experiments were carried out to ascertain the possibility of making an aromatic high strength vinegar ' low wines ' (i.e. the strong alcoholic distillate or ' high wines ' after dilution) from fermented toddy.

The experimental laboratory generator was packed with fresh maize cob cores and seeded with vinegar bacteria in the usual way using eight litres of unpasteurized vinegar in active acetification. After seeding, various experimental charges of low wines were put through the generator quantitatively.

In order to accumulate stocks of ' high wines ', various composite samples of fermented toddy were distilled and one-fifth of the distillate (high wines) was collected. Table I shows the composition of seven samples of high wines prepared for these studies.

TABLE I

Composition of High Wines

Sample No.	% *Acidity (as acetic) G/100 ml.*	% *Alcohol (V/V)*
1	0·32	34·3
2	0·28	35·1
3	0·28	35·6
4	0·21	35·8
5	0·35	32·9
6	0·33	34·5
7	0·28	36·7
Mean (7 samples)	0·29	35·0

Before passing through the generator the ' high wines ' were reduced to ' low wines ' by diluting with distilled water so that the alcohol strength was lowered from 35 per cent. to between 8-11 per cent. A small proportion (10-20 per cent.) of unsterilized vinegar was then added, in order to raise the initial acidity of the charge to about 1-2 per cent. Two 8.5 litre charges of this composition were put through the generator with the results shown in Table II.

TABLE II

Composition of samples before and after passing through generator

	Composition of Low Wines Mixture used			*Composition of Spirit Vinegar produced*				
Charge No.	% *Acidity (as acetic) G/100ml.*	% *Alcohol (V/V)*	% *Total solids G/100ml.*	% *Maximum acidity recorded (as acetic) G/100 ml.*	% *Residual unoxidised alcohol (V/V)*	% *Total solids G/100 ml.*	*No. of hours taken to reach maximum acidity*	*Fermentation efficiency at maximum acidity* %
1	1·09	*8·5	0·33	5·62	3·2	0·64	96	52·3
2	1·85	8·9	0·56	4·83	5·1	0·95	144	32·9

(* 1 ml. of absolute alcohol weighs 0.78075 gm. at 30°C).

It will be seen from the above figures that the two samples did not acetify completely. The fermentation efficiencies being only 56.9 per cent. and 32.9 per cent. of the theoretical respectively on the basis of the stoichiometrical yield 1 gramme ethyl alcohol = 1.30355 grammes of acetic acid. The fact that acetification in both samples did not proceed beyond a certain point showed that the bacteria deteriorated and became inactive probably owing to the depletion of microbial nutrients in the stock. In this connection it should be mentioned that it was also observed in a separate empirical trial that the bacteria were completely inactivated when the alcohol strength of the stock used was in excess of 12-13 per cent. by volume.

The question of fortifying the low wines with mineral nutrients before passing through the generator was next investigated. Two different nutrient formulations were tried out:—

Concentrated Nutrient Solution (A)
(Based on Czapek's medium-Industrial Microbiology, Prescott and Dunn, p. 557)

	Grammes
KH_2PO_4 ..	.. — 1.0
$NaNO_3$ ..	.. — 2.0
$MgSO_4.7H_2O$	.. — 0.5
KCl ..	.. — 0.5
$FeSO_4.7H_2O$	.. — 0.01

(Made up to 1 litre in low wines diluted to 10 per cent. V/V alcohol content)

Note.—Solution A was diluted 5 times with the spirit-vinegar stock, during use.

Concentrated Nutrient Solution (B)
(Based on recent work in Belgium—Food Engineering 27, No. 2, 175, 1955)

	Grammes
Glucose ..	.. 3.000
$(NH_4)_2HPO_4$	.. 0.3660
$NaH_2PO_4.2H_2O$	.. 0.5535
$MgSO_4.7H_2O$	.. 0.2535
KCl ..	.. 0.1430
$FeSO_4.7H_2O$	.. 0.0100

(Made up to 1 litre in low wines diluted to 10 per cent. alcohol content)

Note.—(1) Solution B was diluted 5 times with the spirit-vinegar stock during use.
(2) The vinegar stock when fortified this way, will contain:—0·6 gm. glucose, 0·020 gm. NH_4, 0·120 gm. PO_4, 0·005 gm. Mg and 0·015 gm. K per litre, as recommended by the above workers.

Four 8.5 litre charges of spirit vinegar stock prepared from low wines and fortified with the above nutrient solutions and mixed with a small proportion of the spirit vinegar prepared in the earlier experiments (to raise the initial acidity) were next put through the laboratory generator with the following results:

TABLE III

Composition of samples before and after passing through generator

Composition of Low Wines Mixture used				*Composition of Spirit Vinegar produced*						
Charge No.	*% Acidity (as acetic) G/100 ml*	*% Alcohol V/V*	*% Total Solids G/100 ml.*	*% Acidity (as acetic) G/100 ml. at 192 hours*	*% Acidity (as acetic) G/100 ml. Highest recorded (192 hrs. or more)*	*% Residual unoxidised alcohol V/V*	*% Total solids G/100 ml.*	*No. of hours taken to reach highest acidity*	*Acetification efficiency at 192 hrs. %*	*Remarks*
1	1·26	9·2	0·23	5·52	7·31	2·6	0·68	288	45·5	Solution A
2	1·90	9·8	0·35	5·50	6·93	4·1	0·70	264	36·1	Solution A
3	1·19	9·4	0·22	6·66	6·66	3·4	0·61	192	57·2	Solution B
4	1·86	9·6	0·34	6·42	6·42	4·5	0·67	192	46·6	Solution B

The analytical results show that the acetification in all four samples were unsatisfactory. The following observations could however be made:—

(1) In the previous experiment when no nutrients were used, acetification reached a maximum value and then stopped. In these samples, however, acetification was extremely slow at the highest acidities recorded but had not ceased altogether.

(2) Of the two nutrient solutions A and B, the latter is definitely better. Comparatively the rate of acetification was faster and the acetification efficiency higher with solution B.

(3) It is likely that the glucose in solution B is responsible for the differences in efficiency.

(4) It is also likely that the particular dominant Acetobacter species involved cannot be grown in chemically defined media with ethyl alcohol as the sole source of carbon.

With these observations in mind the growth promoting activity of certain organic microbial nutrients (other than glucose) and activity stimulants like fructose, mannitol and glycerol and certain biological materials like yeast autolysate and peptone were tried out non-quantitatively. In each trial the glucose in solution B was merely substituted by one of the above nutrients listed above. With the exception of peptone, all the other empirical nutrient mixtures proved to be less beneficial than glucose. Peptone however at concentrations of about 0.3 per cent. (in the spirit vinegar stock) gave very promising results. It was found to accelerate the rate of acetification and also increase the yield of acetic acid (i.e. acetification efficiency). Trace amounts of peptone and high concentrations of it however had no favourable effects.

Five quantitative charges of spirit vinegar stock prepared from low wines fortified with solution B containing 0.3 per cent. Bacto-peptone in place of glucose, were put through the laboratory generator with the following results:—

TABLE IV

Composition of samples before and after passing through generator

	COMPOSITION OF LOW WINES MIXTURE USED			*COMPOSITION OF SPIRIT-VINEGAR PRODUCED*				
Charge No.	% *Acidity (as acetic) G/100 ml.*	% *Alcohol (V/V)*	% *Total solids G/100 ml.*	% *Acidity (as acetic) G/100 ml.*	% *Residual unoxidised alcohol (V/V)*	% *Total solids G/100 ml.*	*No. of hours taken to reach highest acidity*	*Acetification efficiency at maximum acidity* %
1	1·03	8·7	0·55	8·70	0·0	0·96	216	86·7
2	1·72	8·5	0·92	9·09	0·0	1·19	192	85·1
3	1·26	9·4	0·67	9·33	0·0	1·04	216	84·3
4	2·02	9·3	1·08	9·77	0·0	1·25	240	81·9
5	1·58	10·1	0·84	9·61	0·0	1·08	264	78·0
Mean	1·52	9·2	0·81	9·30	0·0	1·10	216 (9 days)	83·2
RANGE	1·03 to 2·02	8·5 to 10·1	0·55 to 1·08	8·70 to 9·77	0·0	0·96 to 1·25	192 to 264	78·0 to 86·7

Though the above experiments were not exhaustive or conclusive the results show that a fairly high strength spirit vinegar could be prepared by the 'Generator' process under certain favourable conditions. The vinegar produced was clear and highly aromatic (as should be expected) and perhaps best suited for the preparation of pickles.

Though among the activity stimulants tried out peptone proved the most promising, giving complete acetification, yet it cannot be regarded as being altogether satisfactory. The progressive decrease in fermentation efficiency coupled with a slowing down of the rate of acetification in the five experimental charges indicate that certain other growth and activity factors stimulating the bacteria may be in operation. Owing to the limited alcohol and acid tolerance of the species of Acetobacter involved, the acid strength of the spirit vinegar produced could not be expected to be much higher than 9 per cent.

To obtain optimum acetification, more studies would be required on empirically developed nutrient mixtures and growth stimulants and their critical concentrations, in relation to the activity of the dominant species of Acetobacter, which develop in the generator during the production of spirit vinegar from toddy low wines.

Dried Yeast from Coconut Toddy

In Ceylon distilling and brewing practice, the yeasts that are present in the raw material (fermented toddy) are just run to waste with the effluents. As it was felt that this valuable food adjunct could be economically recovered certain quantitative laboratory studies were made to estimate the probable yields of yeast and also the composition of the dried product.

When yeast is actually grown for commercial purposes, it is known that yields would depend on a number of factors such as total amount of assimilable carbon in the raw material, the content of necessary inorganic materials, presence of nutrilites (organic growth promoting factors) and fermentation conditions (air supply, temperature, etc.). In the present context however, we are only concerned with obtaining a rough average estimate of what is recoverable as a by-product from the existing fermentation industries.

For the laboratory studies, 3 litre samples of the sap collected in accordance with the methods (T), (ST), and (STV) were allowed to ferment naturally :

T. Toddy collected in unsterilized pots (usual method).

ST. Sweet toddy collected, in sterilized pots, *without* the addition of ' Hal ' bark.

STV. Sweet toddy collected in sterilized pots, with the addition of ' Hal ' bark (Vateria acuminata), in 3 litre pyrex r.b. flasks.

On completion of alcoholic fermentation the yeast that had settled out at the bottom was filtered through worsted flannel, washed with a limited quantity of water, transferred to weighed clock glasses and the dry matter present estimated by dehydrating to constant weight in an electric oven at 102°C.

The use of suction filtration with a Buchner funnel and tough Whatman 50 filter paper recommended for quantitative yeast separations (accurate to 1 per cent.) by some observers was found to be unsuitable for toddy. Unlike most other media used in industrial fermentations, coconut toddy is an intractable material in filtration, clogging up the pores of filter paper of sintered glass with utmost readiness.

The results obtained on ten samples each, recovered from (T), (ST), and (STV) are presented in Table V.

TABLE V

Results of the quantitative studies on the recovery of dried yeast from the fermented sap

1	*2*			*3*		
	Dried Yeast (grams per 100 ml. of sap)			*Dried Yeast (grams per gallon of sap) calculated*		
Sample No.	*T*	*ST*	*STV*	*T*	*ST*	*STV*
1	0·153	0·163	0·133	6·96	7·41	6·05
2	0·148	0·122	0·168	6·73	5·55	7·64
3	0·127	0·129	0·123	5·77	5·86	5·59
4	0·144	0·141	0·136	6·55	6·41	6·18
5	0·143	0·153	0·132	6·50	6·96	6·00
6	0·136	0·108	0·144	6·18	4·91	6·55
7	0·139	0·124	0·147	6·32	5·64	6·68
8	0·126	0·153	0·163	5·73	6·96	7·41
9	0·138	0·133	0·163	6·27	6·05	7·41
10	0·149	0·127	0·164	6·77	5·77	7·46
Average	0·140	0·135	0·147	6·38	6·15	6·70
RANGE	0·126 to 0·153	0·108 to 0·163	0·123 to 0·168	5·73 to 6·96	4·91 to 7·41	5·59 to 7·64

TABLE VI

Composition of Dried Yeast from the Fermented Sap

1 Constituent (Per Cent.)	2 T — Wet Basis T_1	T_2	T_3	Mean	Dry Basis T_1	T_2	T_3	Mean
Moisture	10·69	10·22	12·70	11·20	—	—	—	—
Mineral Matter (Tot. ash-sulphated)	4·26	4·65	4·65	4·52	4·77	5·18	5·33	5·09
Nitrogen (as N) ..	7·74	6·32	6·54	6·87	8·67	7·04	7·49	7·73
Protein (Nx6·25) ..	48·4	39·5	40·9	42·9	54·2	44·0	46·8	48·3
Phosphate (as P_2O_5) ..	2·76	2·26	2·34	2·45	3·09	2·52	2·68	2·76
Potash (as K_2O) ..	1·18	1·19	1·12	1·16	1·32	1·33	1·28	1·31
Calcium (as CaO) ..	0·02	0·02	0·04	0·03	0·02	0·02	0·05	0·03
Magnesium (as MgO) ..	0·12	0·13	0·14	0·13	0·13	0·14	0·16	0·14

1 Constituent (Per Cent.)	3 ST — Wet Basis ST_1	ST_2	ST_3	Mean	Dry Basis ST_1	ST_2	ST_3	Mean
Moisture	10·52	12·79	11·53	11·61	—	—	—	—
Mineral Matter (Tot. ash-sulphated)	4·56	5·20	4·93	4·90	5·10	5·96	5·57	5·54
Nitrogen (as N) ..	7·51	5·47	6·02	6·33	8·39	6·27	6·80	7·15
Protein (Nx6·25) ..	46·9	34·2	37·6	39·6	52·4	39·2	42·5	44·7
Phosphate (as P_2O_5) ..	2·78	1·93	2·08	2·26	3·11	2·21	2·35	2·56
Potash (as K_2O) ..	1·22	1·03	1·07	1·11	1·36	1·18	1·21	1·25
Calcium (as CaO) ..	0·02	0·03	0·02	0·02	0·02	0·03	0·02	0·02
Magnesium (as MgO) ..	0·13	0·12	0·14	0·13	0·15	0·14	0·16	0·15

1 Constituent (Per Cent.)	4 STV — Wet Basis STV_1	STV_2	STV_3	Mean	Dry Basis STV_1	STV_2	STV_3	Mean
Moisture	10·86	12·58	10·83	11·42	—	—	—	—
Mineral Matter (Tot. ash-sulphated)	5·08	4·88	4·83	4·93	5·70	5·58	5·42	5·57
Nitrogen (as N) ..	7·82	6·93	6·63	7·13	8·77	7·93	7·44	8·05
Protein (Nx6·25) ..	48·9	43·3	41·4	44·5	54·9	49·5	46·5	50·3
Phosphate (as P_2O_5) ..	2·83	2·58	2·37	2·59	3·17	2·95	2·66	2·93
Potash (as K_2O) ..	1·23	1·27	1·19	1·23	1·38	1·45	1·33	1·39
Calcium (as CaO) ..	0·03	0·03	0·02	0·03	0·03	0·03	0·02	0·03
Magnesium (as MgO) ..	0·15	0·14	0·13	0·14	0·17	0·16	0·15	0·16

1 Constituent (Per Cent.)	5 General Averages (T, ST and STV) — Wet Basis: 3 Vacuum dried Samples	6 Sun-dried Samples	Overall average (all 9 Samples)	Dry Basis: 3 Vacuum dried Samples	6 Sun-dried Samples	Overall average (all 9 Samples)
Moisture	10·69	11·78	11·41	—	—	—
Mineral Matter (Tot. ash-sulphated)	4·63	4·86	4·78	5·19	5·51	5·40
Nitrogen (as N) ..	7·69	6·32	6·78	8·61	7·16	7·64
Protein (Nx6·25) ..	48·1	39·5	42·3	53·8	44·8	47·8
Phosphate (as P_2O_5) ..	2·79	2·26	2·43	3·12	2·56	2·75
Potash (as K_2O) ..	1·21	1·14	1·17	1·35	1·30	1·32
Calcium (as CaO) ..	0·03	0·02	0·03	0·02	0·03	0·03
Magnesium (as MgO) ..	0·13	0·13	0·13	0·15	0·15	0·15

Note—Samples T_1, ST_1, and STV_1, were dried in vacuum desiccator.
Samples T_2, T_3, ST_2, ST_3, STV_2 and STV_3 were sundried.

The figures show that there are no significant differences in the yield of dried yeast from (T), (ST) and (STV) and the overall average recoveries from them will be found to work out to 6.41 grammes dried yeast per gallon or 641 grammes (1.41 lb.) per 100 gallons of sap. As an overall generalization therefore it appears to be legitimate to assume that it should be possible to recover at least a pound of dried yeast from every 100 gallons of sap fermented. Whether or not under factory conditions the recoveries will be widely different from these laboratory figures is a matter for investigation.

As scorched and overheated samples of yeast which had been dried in the oven at 102°C were reckoned to be unsuitable for analytical determinations, separate samples were used for studies on the composition of the yeast. The fresh samples after filtration through worsted flannel (or felt) were transferred to clock glasses and were either dried to constant weight in a vacuum desiccator or were dried by exposure to solar heat. The analytical results obtained on three samples each recovered from (T), (ST), and (STV) are presented in TABLE VI.

It will be seen that the notable feature of all the samples is the large proportion of nitrogenous substances they contain. Though the quantity could vary apparently, according to the conditions of nutrition under which the yeast has been grown, yet it will be seen that in general, almost one half of the dry substance consists of proteins and other nitrogenous bodies.

It is interesting to note that the three samples dried under vacuum have on the dry basis protein contents above 50 per cent., indicating that this method of recovery is to be preferred in industrial practice. The comparative average values for protein and mineral matter in (T), (ST), and (STV) are as follows:—

	(T)	*(ST)*	*(STV)*
% Protein (dry basis)	48·3	44·7	50·3
% Mineral Matter (dry basis) ..	5·09	5·54	5·57

Though there are no appreciable differences, the protein content in (ST) shows a tendency to be lower than in (T) or (STV).

The present studies reveal the importance of recovering the fairly considerable quantity of valuable toddy yeast (about 200-250 lb. of dry yeast per day) which is being run to waste with the effluents in Ceylon's distilleries and vinegar factories. If it is recovered and dried it could doubtless enrich the diet of man and his domestic animals to a certain extent in proteins and vitamins of the B group. Even if it is recovered in the crude form of ' fodder yeast ' it would provide a protein concentrate most valuable as food for farm stock, especially when mixed with other feeding stuffs such as grain or oil cake.

The best and most efficient method of recovering this yeast in the factories appears to be by continuous centrifugal separation followed by vacuum drying. This method should offer dual advantages, because in addition to ensuring a satisfactory recovery of the yeast, it would also give a cleaner yeast-free toddy for the distillation of a better quality arrack.

In the actual preparation of the dried yeast, vacuum drying is to be preferred to solar or oven drying, because the analytical data reveal higher recoveries of protein material when employing the former method. The lower figures obtained with the latter method are probably due to losses from decomposition in the form of ammonia on overheating.

Isolation and Identification of Mannitol from Fermented Coconut Toddy

After many attempts using various organic solvents, a method has been evolved for the isolation of the product formed which is responsible for the increase (particularly in ST) of the non-saccharine organic matter, during the spontaneous

fermentation of the sap. 2,250 ml., samples of (T), (ST) and (STV) were allowed to ferment naturally in 2 litre measuring cylinders. After 168 hours (7 days), when changes due to alcoholization could be regarded as being complete, the samples were analysed. The analytical results on the samples before and after fermentation are charted in Table VII,

TABLE VII

Analytical characteristics of samples used for experiment (before and after fermentation)

(*a*) Initial Analysis at time of Collection

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Sample	% *Total Solids G/100 ml.*	% *Sulphated Ash G/100 ml.*	% *Total Organic Solids G/100 ml.*	% *Reducing Sugars as invert Sugar G/100 ml.*	% *Non-reducing Sugars as sucrose G/100 ml.*	% *Total Sugars G/100 ml.*	% *Alcohol V/V*	% *Acidity (as acetic) G/100 ml.*	% *Non-fermentable organic Solids G/100 ml.*
(T)	9·28	0·46	8·82	1·72	4·47	6·19	4·7	0·53	2·63
(ST)	18·62	0·47	18·15	0·97	14·76	15·73	0·0	0·28	2·42
(STV)	18·86	0·44	18·42	0·98	15·31	16·29	0·0	0·07	2·13

(*b*) Final Analysis after 168 hours when fermentation was complete

(T)	3·46	0·42	3·04	0·12	0·10	0·22	6·9	1·03	2·82
(ST)	5·84	0·49	5·35	0·16	0·26	0·42	4·4	1·12	4·93
(STV)	2·81	0·47	2·34	0·14	trace	0·14	9·7	0·27	2·20

Though fermentation in (T) and (STV.) is usually complete within 72 hours, the final analyses in this particular instance were done after 168 hours to make sure that any slow changes in the solids (associated with alcoholic fermentation) which are known to take place in (ST) even after 72 hours have almost ceased.

Though there appear to be indications that at least small quantities of the non-fermentable organic matter under investigation are produced even at the time of collection during the incipient stages of alcoholization (especially where bacterial activity is pronounced), yet for purposes of isolation doubtless the fermented liquor proved best. Unlike at the initial or intermediate stages where the presence of sugars make separations difficult the fermented liquor was found to be the ideal medium for these investigations. The experimental procedure adopted for the isolation of the product in question was as follows :—

200 ml. of the filtered fermented liquor from each of the samples (T), (ST) and (STV) were evaporated down to dryness and the solids were boiled under reflux with 90 per cent. alcohol for 2 hours. The extracts were filtered off hot and the insoluble residues were refluxed a second and third time using half the volume of 90 per cent. alcohol employed previously.

On standing overnight, it was found that feathery off-white crystal separated only from the alcohol extracts from (ST). None of the other filtrates showed any signs of depositing weighable quantities of crystals, even at lower temperatures or on concentration.

Melting points were done on all batches of crystals obtained with the following results :—

Filtrate	*Crop*	*Weight (grams)*	*Melting Point*
ST_1	1	2·82	163–165°C
ST^1	2	0·13	153–160°C
ST^2	1	0·41	162–164°C

The 3.23 grammes of crystals from ST_1 crop 1, and ST_2 were combined and recrystallised twice with charcoal treatment from 90 per cent. alcohol and were found to have a melting point of 165°-166°C. The crystals were identified to be mannitol CH_2OH $(CHOH)_4$ CH_2OH, and confirmed by doing mixed melting points with pure recrystallised B.D.H., mannitol.

It will be seen that the total weight of crystalline mannitol recovered from (ST) in the form of three crops is 3.36 grammes. On the basis of the analytical results obtained, the fermented liquor from (ST) contained 4.93 per cent. of non-fermentable organic solids. In other words the 200 ml. of this liquor taken for the present experiment would have contained 9.86 grammes of total residual non-fermentable organic solids. If we deduct from this $2 \times 2.63 = 5.26$ grammes, the amount of non-fermentable solids in 200 ml. of the unfermented sap, we will have 4.60 grammes as the hypothetical amount of mannitol produced in 200 ml. of (ST) during alcoholization. Thus barring the mannitol remaining in solution in the filtrates the actual recovery of crystalline mannitol expressed as a percentage of the calculated hypothetical yield is 73.0 per cent. Thus on the basis of the present experiment it can be safely claimed that of the (4.93-2-63) = 2-30 per cent. of non-fermentable organic matter produced during alcoholization, over 1.68 per cent. is mannitol.

On the basis of the observations made in these studies, it seems most likely that mannitol is not a normal constituent of the *perfectly fresh* coconut sap, but is formed by the bacterial reduction of glucose and fructose. Due to the activity of heterofermentative bacteria and fungi, it is most probable that the fermentable hexose sugars present undergo side reactions other than conversion to alcohol and carbon dioxide and it is most probable that reduction to mannitol is one of these.

Bleaching Experiments on ' Drain Oil '

About fifteen years ago some bleaching experiments were carried out in this laboratory on ' Red Oil ' or ' Drain Oil ' which is recovered from desiccated coconut factories. The bleaching agents tried out included, activated carbon, kieselguhr standard fullers earth and hydrogen peroxide, under various concentrations and at different temperatures. Only negative results were obtained in these trials.

The present studies carried out on the problem have yielded very promising results. Various grades of activated Fulmonts produced by the Fuller's Earth Union Limited were tried out and Fulmont No. 237, has been found a suitable grade for treating ' Drain Oil '.

It was found that about 27 per cent. W/V of Fulmont 237 was required to get a strong bleach giving an *almost* colourless oil, when the mixture was heated for 2 hours at 80°C. The trace of colour still left could not be removed by subsequent treatments with any of the Fulmonts, but it was found that it was readily bleached with 10 per cent. (W/V) of activated charcoal. The oil after charcoal treatment was water white in colour and perfectly clear in appearance.

It would thus appear that the complete bleaching of ' Red Oil ' is not an insuperable problem, and the above method could be readily adopted by refiners who face the bleaching problem. Though experiments have not been done, it is felt that lower concentrations of the earth and charcoal could be employed if the free fatty acids in the original oil are partly neutralized by alkali treatment prior to bleaching operations.

Further work is required to evolve a bleaching technique (employing Fulmont 237 and charcoal) which could be economically applied to industry.

Nutrient Formulation for Sand Pot Cultures

In connection with projected experiments on the growing of indicator plants and coconut seedlings in sand cultures, various nutrient formulations were tried out. Using the technique of intermittent flowing cultures, the following standard complete nutrient solution (recommended by the Long Ashton Research Station, Bristol) was found to give the most satisfactory results with a variety of plants.

Salt	*Weight in Grammes (for 100 litres of diluted nutrient)*
KNO_3	20·2
$Ca(NO_3)_2$—anhydrous ..	65·6
$NaH_2PO_4{\cdot}2H_2O$ ..	20·8
$MgSO_4{\cdot}7H_2O$ ..	36·9
Ferric citrate ..	2·45
$MnSO_4{\cdot}4H_2O$ ..	0·223
$CuSO_4{\cdot}5H_2O$ ..	0·024
$ZnSO_4{\cdot}7H_2O$ ..	0·029
H_3BO_3	0·186
$(NH_4)_6Mo_7O_{24}{\cdot}4H_2O$ ..	0·0035

This gives the following concentrations of ions as milligram-equivalents per litre :—

	m.eq./L		*m.eq./L*
NO_3'	10	Na +	1·33
PO_4'''	4	Fe +++	0·33
SO_4''	3	Mn ++	0·02
Ca ++	8	Cu ++	0·002
Mg ++	3	Zn ++	0·002
K +	2		
		Milli Mols	
		B	0·033
		Mo	0·0002

It will be seen that the nutrient solutions are based on nitrate as a source of nitrogen. Ammonium compounds are not normally included, partly in order to avoid the possibility of toxic effects, and also because of the complication produced in relation to experiments on the availability of iron, where it may be necessary to study the effects of other types of nitrogen supply. The method of using ammonium compounds to control pH variations in the nutrient solutions is thus precluded. It is felt that where pH control is required constant flowing cultures are the proper approach to the problem.

The following plants were grown very satisfactorily using the above complete nutrient solution:—

Green Gram (Phaseolus aureus).
Maize (Zea Mays).
Tomato (Lycopersicon esculentum).
Kurakkan (Eleusine coracana).
Canna (Canna indica).
Capsicum (Capsicum grossum).

All the plants completed their vegetative and reproductive cycles with optimum results. It is now proposed to employ this nutrient formulation for growing coconut seedlings in sand cultures using giant size pots, employing an intermittent flowing technique.

Examination of Hybrid Palm Copra

Six samples of hybrid palm copra sent by the Botanist were examined for moisture and oil. The results are summarised in Table VIII.

TABLE VIII

Analytical Data on Hybrid Palm Copra

Palm No.	No. of Cups	Weight of Copra (Grams)	% Moisture	% OIL	
				Wet Basis	Dry Basis
103	27	3,614	5·61	63·06	66·78
118	13	3,568	5·72	62·75	66·51
120	30	3,845	6·03	62·68	66·45
144	30	2,818	6·03	62·82	66·45
K.C. × T.	15	1,960	6·44	64·28	68·70
T × K. C.	24	2,698	6·95	63·06	67·74
Average	23	3,084	6·13	63·11	67·10
RANGE	13 to 30	1,960 to 3,845	5·61 to 6·95	62·68 to 64·28	66·45 to 68·70

The overall average of 67.10 per cent. (dry basis) for the oil content is about one per cent. lower than the normal figure for good quality Ceylon estate copra.

In general it may be said that the oil contents of the copra from hybrid palms, examined so far, have shown this tendency for lower figures.

Miscellaneous Work

This included analyses and reports on various samples of copra, poonac and coconut oil sent mostly by mill owners seeking advice.

Certain analytical investigations were also carried out for the Agronomist on samples of soil and plant tissue.

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1957.

REPORT OF THE BOTANIST

1. Intra-specific Hybridisation

Typica x *Nana*. A detailed report of the performance of the first generation (F_1) palms of this cross (i.e. Tall × Dwarf varieties) during the early stages of growth relative to vigour, leaf-production, flowering, etc., was given in the annual report for 1955. In the year under review, all the palms except two were in bearing and the number of nuts harvested and their husked-nut weights are given in Table I.

TABLE I

Yield of Typica × Nana F_1 Palms in 1956

Cross	No. of Progenies	No. of Harvests	Mean No. of Nuts/ progeny	Mean Weight of Nuts/ progeny (lb.)
360 × 1713	5	5	68	100·6
218 × 1713	5	6	86	148·3
360 × 1712	5	6	89	143·7
273 × 2646	1	6	82	118·8
139 × 2646	4	4	38	52·8
778 × Dwarf	3	6	75	99·1
Mean	—	—	68	106·0

The yield of the F_1 palms has been very satisfactory, considering that the data are for the 6th year after planting and that in some palms only 4 to 5 harvests have been gathered. The general mean of 68 nuts per palm for 1956 includes two palms that were not in bearing during the year. The mean weight per husked-nut for all the progenies is 1.56 lbs. If these means are calculated on an acre basis, say on a modest density of 60 palms to the acre, the equivalent yield is 4,080 nuts or 18.17 cwt. of copra per acre.

The hybrids appear to be as hardy as the *typica* parent. They were not affected by the severe drought experienced between July to October, although the dwarf palms in the same block were affected.

Typica x *Typica*. During the year, paired crosses were continued on 146 selected mother palms of the tall variety and nearly 26,500 female flowers have been pollinated. 3,555 nuts harvested from the paired crosses done in 1955 were planted in the nursery.

Twenty acres of the *Isolated Coconut Seed Garden* were planted up with seedlings from the crosses done in 1954 and a part of 1955. The area planted to date in the Seed Garden is about 25 acres.

Other Crosses. Out of the seednuts collected from the other inter-varietal crosses done in 1955, the following seedlings were transplanted at Ratmalagara and Bandirippuwa stations in November 1956.

Dwarf × San Ramon	Reciprocal
1731 × 1870—13 seedlings	1870 × 1731—5 seedlings
1713 × 1904—4 seedlings	—
King Coconut × San Ramon	Reciprocal
1717 × 1733—27 seedlings	1733 × 1717—3 seedlings
2050 × 1873—15 seedlings	1873 × 2050—7 seedlings
1495 × 1870—10 seedlings	
King Coconut × Tall	Reciprocal
2665 × 428—6 seedlings	428 × 2665—2 seedlings
502 × 148—11 seedlings	148 × 502—6 seedlings
—	185 × 139—5 seedlings
—	184 × 2664—6 seedlings
Tall × San Ramon	
196 × 1733—23 seedlings	
931 × 1904—11 seedlings	

More seednuts of these crosses were harvested towards the latter part of the year and their seedlings would be ready for transplantation next year. The main purpose of these crosses is to ascertain how far hybrid vigour is expressed in the first generation progenies.

2. Progeny Trials

In a progeny trial that was planted in 1934 at Marandawila, 281 offspring of 9 high-yielding mother palms have been tested. The mean yield of nuts per year of the offspring for the period 15th to the 19th year after transplantation is given in Table II.

TABLE II

Frequency distribution of progenies according to mean yield of nuts per year (1949-53)

Mean of yield class	*Mother Palm Number*									
	IV	*XLIII*	*I*	*XXII*	*XVII*	*VI*	*XXIII*	*XXVI*	*XVI*	*Total*
4·5 ..	—	—	2	—	—	—	1	—	—	3
14·5 ..	—	—	—	—	—	—	1	1	2	4
24·5 ..	—	—	3	—	3	—	3	2	1	12
34·5 ..	—	—	1	1	8	—	4	4	4	22
44·5 ..	—	—	4	1	4	5	3	8	6	31
54·5 ..	2	2	10	3	18	9	7	7	5	63
64·5 ..	1	3	12	2	12	4	13	11	—	58
74·5 ..	4	2	12	3	11	3	4	8	1	48
84·5 ..	2	1	8	1	—	—	4	—	—	16
94·5 ..	1	—	4	1	4	1	1	1	—	13
104·5 ..	—	1	3	—	3	—	1	—	—	8
114·5 ..	1	—	—	—	1	—	—	—	—	2
124·5 ..	—	1	—	—	—	—	—	—	—	1
No. of progenies ..	11	10	59	12	64	22	42	42	19	281
Progeny mean ..	77·4	76·6	65·7	63·9	61·7	58·3	57·6	56·9	43·7	61·0
S. E. of mean ± ..	5·44	6·98	2·80	4·55	2·48	2·61	3·30	2·37	3·25	1·19
Mean yield of Mother Palm ..	119	105	151	86	126	99	109	115	99	—

The mean yield of the nine mother palms has varied between 151 and 86 nuts per year. There is no correlation between the yield of a mother palm and its offspring under open pollination. The range of the progeny means varies between 44 and 77 nuts per year with a general mean for all progenies of 61 nuts per year. Variation in yield between offspring of a single family is considerable, but two families, viz. IV and XLIII show considerably less variation than the others and they have given the highest progeny means. It is significant from the yield pattern of the offspring, that these two mother palms are apparently less heterozygous for the character yield than the other palms.

In another field experiment planted in 1939, there are 125 progenies derived from 20 mother palms and here again there are considerable differences in the yield of nuts between the families (Table III). Only the mother palms with at least five offspring have been considered.

TABLE III

Yield of nuts of mother palms and their progenies (1955-1956)

Mother Palm		*Offspring*		
Number	*Mean yield per year*	*Number available*	*Mean yield per year*	*Yield Range*
B 1	132	5	89·8	73–116
25	120	6	83·4	68–119
11	137	5	81·2	65–128
21	96	6	76·1	48–115
24	129	5	74·7	18–111
B 23	118	6	74·7	41–101
27	119	6	73·3	15–98
2	126	15	70·9	16–116
16	126	6	65·2	50–84
28	198	6	62·1	20–107
8	80	6	60·1	2–104
9	107	12	58·3	27–82
6	85	10	56·5	17–98
B 2	109	5	55·1	38–100
3	88	7	55·0	33–75
12	135	12	51·8	22–136
1	101	10	48·1	21–77
7	—	6	46·4	3–105
14	84	5	46·3	57–116
10	91	5	31·2	18–45

The data of the offspring presented in Table III has been extracted from a field trial (Latin Square) designed to compare methods of mass selection. The palms are now seventeen years old and from the yield pattern of the entire block it can be considered that they have reached a reasonably full bearing capacity. Here again the same conclusions can be drawn as from the previous table; variation in yield between families and within certain families is considerable, but yet mother palms B1, 25 and 11 have given considerably higher progeny means than the others. Their mean yield is 30 per cent. above the general mean of 62 nuts per year.

3. A Selection Experiment

The Latin Square experiment referred to in detail in the annual report for 1953 (pp. 27-28) and in previous reports was planted in 1939 to study three methods of seed selection and two methods of seedling selection. The design of the experiment is a 6 × 6 Latin Square with 16 palms per plot. The yield of nuts and copra obtained from the sixth year (1945) to the seventeenth year (1956) have been statistically analysed and the summarised results are presented below.

TABLE IV

Mean yield of nuts and copra (in cwt.) per acre per year

Treatment	*Period 1945–49*		*1950–54*		*1955–56*	
	Nuts	*Copra*	*Nuts*	*Copra*	*Nuts*	*Copra*
Selected seedling of						
1. high-yielding mother palms	895	3·31	2,866	12·28	3,862	17·25
2. low-yielding palms	819	3·13	2,857	12·88	3,952	17·81
3. heap nuts	799	3·08	2,711	12·25	3,743	17·46
Unselected seedlings of						
4. high-yielding mother palms	485	1·77	2,165	9·13	3,041	13·31
5. low-yielding palms	814	3·01	2,897	12·74	3,901	17·55
6. heap nuts	682	2·57	2,464	11·31	3,370	15·62
Critical difference	261	1·12	516	2·57	495	2·63

During the first five years of bearing (1945-1949) the differences between the treatments and the interaction of years × treatments have been significant at the 5 per cent. and 1 per cent. levels respectively with respect to yield of nuts. The significant interaction indicates that the relative superiority of treatments differed in different years. This is largely due to the fact that all the palms were not bearing in 1945, every year a number of palms came into bearing and by virtue of this fact the treatment pattern differed. As such this interaction is only incidental and does not mean a seasonal change in the treatment effect. It is however observed that within a year, the differences in treatments between the three types of seed selection were not significant but there were significant differences between the two methods of seedling selection; selected seedlings have given higher yields than unselected seedlings. With regard to yield of copra the differences between treatments have shown no significant differences. The yield from the selected and unselected seedlings of low-yielding palms have been practically the same.

During the second five-year cycle of bearing (1950-1954) there were significant differences, only in yield of nuts at the 5 per cent. level. The differences in yield of copra and the interactions years × treatments were not significant. The absence of the interaction in the second five-year cycle shows that the effect of new palms coming into bearing has got gradually eliminated. Even with regard to the significant difference in the yield of nuts, the differences were only between selected and unselected seedlings and there again the two types of seedlings from the low-yielding palms, have given practically the same yields.

The differences between treatments in yield of nuts and copra during 1955 and 1956 have been significant at the 1 per cent. and 5 per cent. levels respectively. The unselected seedlings of high-yielding mother palms have given 821 nuts or 3.92 cwt. of copra per acre per year less than the selected seedlings from the same type of seed selection and the difference is statistically significant. The differences between any of the other treatments, have failed to reach a significant level.

This plantation is now seventeen years old. In 1955, that is the 16th year, the palms from the selected groups of seedlings gave 4,066 nuts per acre. Considering the density of the plantation (55 palms to the acre) and the environment it is likely that the palms have reached a reasonably full bearing capacity. In the following year, the yield of the same group of palms dropped to 3,637 nuts per acre; the decrease was mainly due to adverse climatic conditions.

Correlations. 43 correlations have been worked out between the following characters collected during various stages of this experiment; weight of seednuts, volume of seednut, sprouting-period of seedling, weight of seedling, leaf number of seedling, root number of seedling, seedling height, flowering period of palm and the yield of nuts and copra when the palms were 16 and 17 years old.

It is not possible to enumerate all the correlation coefficients here, however, the significant coefficients and the more important ones are given in Table V. The other correlation coefficients are either not significant or are only suggestive.

Generally, the weight and volume of a seed-nut, the weight, root number, leaf number, and height of a seedling have shown no influence on the flowering period or the yield of copra of the adult palm.

As far as the economic factors of these correlations are concerned, the seednut weight and volume are negatively correlated with yield of nuts for ' between ' parents and not for ' within ' parents. Thus the progenies of palms with heavy or large nuts have a lower yield (i.e. fewer number of nuts), and that for a particular parent, weight and volume of seednut have no bearing on yield between its progenies. These two seednut characters apparently have no influence on the yield of copra.

Sprouting-period of a seednut is positively correlated with the flowering-period of the palms and this correlation is restricted only to ' between ' parents. Palms that have a lower period of germination for their progenies will have a lower period of flowering for the same progenies.

The period taken for flowering of a palm is negatively correlated with yield of nuts and copra, and both the ' between ' parents and ' within ' parents coefficients are highly significant. This means that generally a palm that takes a shorter period to flower will yield more nuts and copra than a palm that flowers late.

TABLE V

Correlation coefficients between seednut, seedling and adult palm characters

	Between Parents	*Within Parents*
Weight of seednut × Volume of seednut	+ 0·8094**	+ 0·9851**
Weight of seednut × Weight of seedling	+ 0·8565**	+ 0·5310**
Weight of seednut × Yield of palm (nuts)	— 0·5482**	— 0·0411
Weight of seednut × Yield of palm (copra)	— 0·3210	+ 0·0331
Volume of seednut × Weight of seedling	+ 0·8546**	+ 0·4853**
Volume of seednut × Yield of palm (nuts)	— 0·5605**	— 0·0872
Volume of seednut × Yield of palm (copra)	— 0·3496	— 0·0833
Leaf number of seedling × Root number of seedling	+ 0·6675**	+ 0·5774**
Sprouting period of seednut × Flowering-period of palm	+ 0·5348*	— 0·0273
Sprouting period of seednut × Yield of palm (nuts)	— 0·0072	— 0·1537
Sprouting period of seednut × Yield of palm (copra)	— 0·1810	— 0·1393
Flowering period of palm × Yield of palm (nuts)	— 0·5027*	— 0·5724**
Flowering period of palm × Yield of palm (copra)	— 0·6282**	— 0·5520**

* Significant at 5 per cent. level.
**Significant at 1 per cent. level.

4. Planting Techniques

Hedge Planting. The orthodox method of planting coconut seedlings is at the corners of a geometrical figure—either a square, a rectangle or a triangle. This system is not very conducive to thinning, as any young palm rejected has to be replaced with another seedling whose growth would be considerably retarded by the already established stand.

A new system of planting—Hedge Planting—where more seedlings than are necessary are planted and subsequently, selectively thinned to the required density is being tried out. Four observation plots, each approximately 1 acre was planted in November, 1956; two plots with Hedge Planting and the other two with the orthodox method for comparative purposes. In Hedge Planting the rows were spaced 26 feet apart, and within the row the seedlings were planted 18 feet apart. This spacing has given 98 palms (approx.) per acre. Within the first eight years, it is proposed to reduce the stand to 74 palms to the acre by selective thinning.

Depth of Planting. A field trial was initiated in November 1956 to study the relationships, if any, between the depth of planting of a coconut seedling and its subsequent growth and yield. Four treatments 6, 12, 18 and 24 inches deep planting were replicated five times with 9 plants per plot. Selected seedlings derived by crossing Tall × Tall palms were transplanted.

5. Insects on Coconut Inflorescences

Coconut flowers are said to be insect and wind pollinated. A trial initiated to study the relative efficiency of each agent is in progress. In the course of this study, a census of winged and wingless insects commonly visiting coconut inflorescences was taken to ascertain the types that help pollination. Altogether 13 species of insects were collected from the inflorescences. The Commonwealth Institute of Entomology, London, has very kindly identified them as follows:

Coleoptera	Curculionidae	1. *Derelomus* sp.
Hymenoptera	Apidae	2. *Apis indica* Fab.
		3. *Halictus* sp.
		4. *Nomiodes* sp.
	Vespidae	5. *Ropalidia marginata* Lep.
	Formicidae	6. *Camponotus* sp.
		7. *Camponotus* (*Orthontomyrmex*) *Sericeus* Fab. ssp. *Opaciventris* M.
		8. *Pheidole* sp.
	Braconidae	9. *Triaspis* sp.
Diptera	Culcidae	10. *Armigeres obturbans* Walk.
	Calliphoridae	11. *Lucilia* (*Hemipyrellia*) *Ligurriens* Wied.
	Muscidae	12. *Musca* (*Eumusca*) sp.
Dermaptera	Forficuliadae	13. *Chelisoches morio* (F).

Our observations indicated that the honey bee (*Apis indica*) was the commonest and the most frequent winged visitor to the male and female flowers, and by far, perhaps the only insect of any economic importance in pollination. The bees appeared on the inflorescences about 6 a.m., thereafter the frequency of visits increased and by 4-00 p.m. they were less frequent. The minimum number of bees on an inflorescence was recorded about 6-00 p.m. The small black ants (*Pheidole* sp.) were frequently found on the inflorescence. They were not found on the stigmatic surfaces and their field of movement was limited. It is very likely that they are only foraging insects and serve no useful purpose in pollination. *Derelomus* sp. was found though not so frequently as the black ant and was particularly common on the male flowers. According to information received from the Commonwealth Institute of Entomology, this species frequent male flowers of various palms and are doubtfully injurious, but may help fertilization. Another common insect not mentioned in the above list is the mite. These have been referred to in the Annual Report for 1953.

The female flower at receptivity shows a trifurcated stigma with a glistening viscous fluid in its centre. About the same time nectar is found to exude from three longitudinal slits, lower down in the ovary, at the corners of a more or less equilateral triangle. During this time the large black ant (*Camponotus sericeus* ssp. *opaciventris*) was found to feed on the nectar and drive away any honey bees by running towards them, should the latter chance to settle near or on the stigmatic surface. This species may be considered a possible limiting factor for bee pollination.

6. Miscellaneous

2-4 *D and Fruit Setting.* An experiment to study the effect of 2-4 Dichlorophenoxyacetic acid (2-4 D) as an aid to setting of female flowers was initiated in late 1955 and completed during the following year. Forty palms that have given a yield of 60 to 70 nuts each per year during the previous five years were selected for the trial. 30 p.p.m. 2-4 D either in water, coconut water or cattle urine were sprayed on to the female flowers with an atomiser at weekly intervals, commencing from the date of receptivity. Four applications were done. Each treatment was repeated on 10 palms and for the control an equal number of palms was left untreated.

The results were analysed using the ' t ' test and there were no significant differences between the treatments; mean percentage of setting of female flowers varied between 37.4 to 49.5 per cent. The application of 2-4 D at 30 p.p.m. either in water, nut water or urine to the female flowers of palms in the above yield group did not result in a significant increase in fruit setting.

Routine observations on the size of seed-hole and replantation experiments were continued during the year.

Further attempts to induce polyploidy in coconut seedlings were not successful. In all cases various concentrations of colchicine solutions were either applied on to the meristematic tissues of young seedlings or injected into the nuts. Chromosome counts were done on a number of F_1 hybrid palms and all of them had the somatic complement of $2n = 32$.

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REPORT OF THE AGRONOMIST

1. Agronomy

A. STUDIES ON THE NUTRIENT STATUS OF SELECTED COCONUT SOILS:

During the first three months of the year, apparatus and equipment ordered from Overseas firms was received and installed and the research programme was initiated in March.

The primary objective has been to determine the nutrient status of selected soils typical of comparatively large areas in Ceylon, with a view to more effective use of fertilizers on coconuts, and to correction of nutrient deficiencies that might be a limiting factor in the growth and selection of desirable pasture plants. Preliminary studies have been confined to important soils in the immediate vicinity of the Coconut Research Institute (Bandirippuwa Estate) Lunuwila.

The investigation uses a technique of bio-assay (popularly known as the ' pot technique ') whereby species known to require soils of high fertility are grown in pots with and without mineral nutrients, or combinations of nutrients, and their effect is measured in terms of the yield (dry weight) of plants in every pot. The test plants are all perennial pasture grasses or legumes: they are being used deliberately to obtain some basic information in reasonable time.

While all plants (including coconuts) do not require the same nutrients in the same proportions, these experiments should give a general picture of local soil fertility problems, and it is at least highly probable that if a rapidly growing plant with high fertility requirements shows no deficiency of any nutrient, then that nutrient is unlikely to be a limiting factor in the growth of coconuts.

Three species, one a grass (*Paspalum commersonii* Lam.) and two legumes (*Phaseolus lathyroides* L.) and lucerne (*Medicago sativa* L.) are being used. They were selected primarily for their known demand for all essential nutrients and because the Agronomist is familiar with deficiency symptoms in these species. In all experiments using legumes the soils are inoculated with specially imported strains of *Rhizobium*.

These experiments are generally of a factorial nature, and the nutrients are applied singly and in all possible combinations. Any comparison of treatments is made on the basis of mean values for a large number (normally thirty-two pots or multiples of that number) to which a particular nutrient has been applied

and for the same number of pots without that nutrient. Interactions (the combined effect of two or more nutrients) are measured on the basis of mean values for groups of 16 or 18 pots, or multiples of those numbers. This technique has some advantage over any direct comparison, because each treatment is evaluated over a whole range of conditions with respect to presence or absence of other nutrients.

The plants are grown in a special ' Phytosolarium ' which is a building 20 feet × 60 feet made with all-aluminium frame work and covered with an envelope of ' cascalite ' (fritted glass in plastic). The sides of this building, above bench height, are hinged to allow free ventilation and temperatures have ranged from a mean maximum of 108° F in April and May to 104° F in August: minimum temperatures from 79° F in May to 77° F in August. Light is dicuse and remarkably even, and the plants have shown no symptoms of inadequate illumination.

(*a*) *Studies on the lateritic gravel.* Fifteen experiments have been initiated, of which 10 have been completed and the results written up for publication as a Coconut Research Institute Bulletin. They may be summarised as follows:—

(1) The data show that this soil is deficient in nitrogen, phosphate and potash, and that there is a consistent pattern of responses with some change in nutrient status over a period of time. There is also a deficiency of calcium, which may be resultant on natural leaching of the surface soil.

(2) There was no apparent deficiency of magnesium, and application of magnesium to this soil is not recommended.

(3) There was no deficiency of sulphur, or of trace elements:—copper, zinc, manganese, iron and boron. Molybdenum had no effect on plant growth, but its delayed effect on symbiotic legume bacteria (*Rhyzobium*) needs further investigation.

(4) Nitrogen was at all times an important limiting factor in plant growth, and on the basis of 100 per cent. for plants receiving N, P and K, relative yields for the grass *Paspalum commersonii*—grown without any application of nitrogenous fertilizer—decreased steadily from an initial value of 50 per cent. in the first harvest, to 15 per cent. in all subsequent harvests. The sub-soil contains even less available nitrogen, and yields decreased steadily to a consistent value of less than 10 per cent. Yields of a legume (*Phaseolus lathyroides*) rose steadily to an asymptote at 100 per cent. indicating effective nodulation.

(5) The amount of nitrogen required for satisfactory plant growth has not been determined, but in pot experiments doses of 5-15 cwt. $(NH_4)_2SO_4$ were used to maintain satisfactory growth over a period of six months. Excess nitrogen (+ phosphate). in absence of sufficient K, gave unsatisfactory yields, and was responsible for the death of some plants.

Under field conditions, plants of *Paspalum commersonii* did not show the same *acute* nitrogen deficiency, and it is likely that frequent, small doses would be more economic and equally effective. Use of green manures, or of highly productive grass pastures—(whereon the animals were fed a supplementary ration of protein—poonac) would seem to be obvious alternatives: both would require optimal dressings of potash, phosphate and calcium.

(6) In the early stages of growth there was an acute deficiency of Phosphate, and relative yields for plants grown in surface and in sub-soil were as low as 20 per cent. and 9 per cent., respectively. However, there

was a general trend towards increasing yields, (without any application of phosphate fertilizer) and in subsequent harvests relative yields of 70 per cent and 45 per cent were recorded.

In pot experiments, applications of 3 cwt./acre of $NaH_2PO_4.^2H_2O$ were sufficient to maintain satisfactory growth of both grass and legume.

(7) A deficiency of potash has been established, and it is a point of peculiar interest that in the absence of potassic fertilizers relative yields did not tend towards an asymptote, and plants of *Paspalum commersonii* eventually died. The data suggest that available potash in this soil is gradually fixed, and this is supported by chemical evidence, and by experiments wherein the soil was aerated and dried. Following that simple treatment, soil whereon most plants of *Paspalum* had died, was replanted and gave relative yields of more than 80 per cent.

With no application of potassic fertilizer, the sub-soil gave initial yields of 60 per cent, but after 114 days all plants of *Paspalum* were dead. The surface soil initially gave relative yields of over 90 per cent, and after 150 days most plants were dead.

The capacity of this soil to fix available potash is apparently limited, and applications of 4½ cwt. K_2SO_4 per acre were sufficient to maintain plant growth. Doses up to 10 cwt./acre gave no further increase in yield. That rate of application was in respect to soil sampled to a depth of nine inches, and it is possible that under field conditions, and in time, some further application would be required.

(8) A deficiency of calcium was recorded only in surface soil, where applications of 10 cwt. $CaCO_3$ per acre were sufficient to meet all requirements. It is possible that a smaller dose would be equally effective.

(*b*) *Studies on the Lateritic Loam.* Five experiments have been started—2 are completed. The data so far suggest that this soil differs from the Lateritic gravel only in the degree of deficiency of similar nutrients.

(*c*) *Studies on the Lateritic Sand.* To date two experiments have been initiated. Both are incomplete.

(*d*) *Studies on the Cinnamon Sand on Horrekelly Estate.* This soil was selected as one of the poorest coconut soils in Ceylon, typical of quite large areas along the Western Coast. It is essentially a leached sand, developed through emergence of sub-coastal lagoons, or possibly in low-lying areas that were not necessarily submerged at any time. There is generally a 'hard-pan' or clay layer occurring at a depth of approximately five feet. Drainage is poor, and in wet seasons free water rises to within six inches of the surface.

Ten experiments have been started and 5 completed. The data show that this soil is deficient in both major and minor nutrients and in particular that there is very little response to any form of fertilizer which does not include a liberal amount of calcium. There is also an acute deficiency of sulphur and of some minor elements. A deficiency of boron has been established and other deficiencies are suspected, or in part confirmed.

B. PASTURE TRIALS

As a preliminary measure, pending more exact information on the nutrient status of soils, the requirements for local cattle, and some experience of stock and pasture husbandry on Coconut Estates, a number of small experimental pastures have been established and are being used to maintain individual small herds of Sinhala cattle. To that end, one acre plots of each of three grasses, *Brachiaria*

brizantha, *Brachiaria milliformis* and *Paspalum commersonii* have been established and a small herd of two 12 months old Sinhala heifers has been allocated to each plot. These animals will be maintained continuously, mated, and milked on the one plot.

The immediate objectives are to obtain some data on live weight, milk yields, and economic returns in relation to expenditure on establishment and use of fertilizers calculated to maintain these pastures at an optimum level of production. To date no legumes have been sown but the animals are given a daily supplement of poonac as a source of protein and of nitrogen which is returned to the soil in urine and faeces. Yield data are being recorded for individual coconut trees, in each plot.

These experiments are necessarily exploratory and the general form of management is subject to modification in the light of accumulating data and experience. Any effect on the yield of coconuts, or on the general level of soil fertility can only be recorded over a period of some 5-10 years.

A similar one-acre plot of guinea grass (*Panicum maximum*) is being tried and managed as a fodder crop, sub-divided into 8 smaller paddocks which are grazed in rotation by a larger herd of 9 cattle. Returns will be calculated in terms of cattle-days-grazing. The ultimate objective is to determine the economics of combined feeding, using such a fodder crop as reserve feed and in association with perennial pastures.

Another comparatively long term experiment has been laid out to measure the response to sub-soiling and to different ways of applying fertilizer to the coconut trees in a pasture; and to assess the need for such additional fertilizer application to trees growing in association with a well managed pasture that is itself fertilized. To that end fertilizer is being applied in rings and in narrow strips of equivalent area, and at equivalent dosage. In each case, the experiment uses split plots to compare the effectiveness of fertilizer laid on surface of the ground with that of fertilizer buried in shallow trenches. These treatments are being applied to one acre pastures of *Brachiaria milliformis* and *Paspalum commersonii* at Bandirippuwa Estate, and to one acre pastures of *Brachiaria brizantha* and *Paspalum commersonii* at Ratmalagara Estate. All pastures will be continuously grazed by individual herds of two Sinhala Cows.

An experiment to study the soil moisture status of Bandirippuwa soils has been laid down as a series of randomized blocks with three replications. There are four treatment, viz. (1) Fallow, (2) Weeds, (3) *Brachiaria brizantha* and (4) *Paspulum commersonii*. In each plot boujoucos blocks have been buried at a depth of 6 inches, 1, 2, 3 and 4 feet and the amount of available soil moisture is being recorded electrometically at regular monthly intervals; or at such other intermediate times as may be desirable (e.g. after any rainfall). These data should provide some general record of seasonal soil moisture status, and of the effect thereon of the differing ground cover.

2. Animal Husbandry

A. PASTURE EXPERIMENT AT RATMALAGARA ESTATE

This experiment has been designed to answer 3 fundamental questions:—

1. What is the effect of pasture? } on the yield and production
2. What is the effect of grazing? } from coconut trees.
3. What is the order of economic return from pasture on Coconut Estates?

The experiment has now been laid out as a serious of 28 separately fenced plots, all of equal area and each with its own stock watering facilities. During the first year, those plots will be grazed uniformly at the rate of 1 beast/2 acres, and basic data on the yield of individual coconut trees will be recorded.

Grass nurseries have been established, and in September 1957, 14 plots will be planted with each of two grasses (*Brachiaria brizantha* and *Paspalum commersonii*) and the plots combined in groups of 2, 3 and 4 to give major plots that will be grazed at 3 intensities, viz:—1 beast to 1 acre, 1 beast to 1½ acres and 1 beast to 2 acres of each pasture. In addition there will be 3 plots of each pasture that are completely ungrazed. All pastures will receive regular applications of fertilizer in accordance with the results of current experiments on the nutrient status of this soil.

Management and the intensity of grazing is flexible and subject to modification in the light of progressive knowledge and experience. All animals will be given a supplementary ration of approximately 2 lb. poonac per day.

On each plot the yield (dry weight) of grass, legume and weeds will be separately recorded from 12 quadrads at bi-monthly intervals and the yield from selected palms will be recorded at the same time.

B. SUPPLEMENTARY FEEDING TRIAL

This experiment has been designed to determine the optimum quantity of supplementary feed (poonac) necessary for production in Sinhala cattle. It uses 12 first-lactation heifers that were pre-selected for uniformity of weight and conformation, and after rating grouped as 3 replicates of each of four treatments. The treatments are:—

½ lb. Morlac × 2 oz. Mineral mixture/day
1 lb. Morlac + 2 oz. Mineral mixture/day
2 lb. Morlac + 2 oz. Mineral mixture/day
4 lb. Morlac + 2 oz. Mineral mixture/day
} + Roughage *ad lib.*

Records of milk yield, body weight; rectal temperatures and general observations are being maintained.

Data for the first few months suggest that 1 lb. poonac per head per day may be sufficient to maintain production in these cattle.

C. NUT WATER AND WHOLE MILK FEEDING OF POULTRY

This experiment was carried out at the request of Professor S. C. Harland. It was designed to measure the effect of mature nut water and whole milk on the growth rate of chickens.

For this purpose, 3 groups each of 10 one-day old R.I.R. chickens were placed in separate cages and fed a daily ration of standard mash + green herbage (guinea grass and *Stylosanthes guyanesis* on alternate days), both supplied *ad lib.* In addition one group was supplied with pure water, and one with nut water and the third with whole milk.

The experiment is incomplete but the preliminary data show a much better rate of growth in chickens that were given milk. Those that were given coconut water showed a tendency to earlier development of mature feathers.

D. GENERAL

(1) *Cattle.* The herds at Ratmalagara and at Bandirippuwa continue to do well, and dehorning of young steers is now a matter of routine. All excess bull calves and culled animals were sold by Auction in July. Forty-six of a total herd of 78 Sinhala cattle are now being used on experiments. Production figures for this year are as follows:—

Milk Production in Pints	*Ghee in Pints*	*Cattle Sold*
20,448	15	20

(2) *Pigs.* During this year, 27 pigs have been raised and 50 piglings were sold. They realized a sum of Rs. 1,632/-.

(3) *Poultry.* 324 day-old chickens were brought in November/December and of those, 298 were brought to maturity. 3,429 eggs and 52 table birds were sold.

(4) *Farmyard Manure.* 172 cwt. cattle manure has been conserved in manure pits and that from Bandirippuwa Cattle has been analysed at intervals of six months. All has been issued and used on coconuts or on pasture plots at both Bandirippura and Ratmalagara. Cattle and poultry manure has all been returned to the ground in areas where those animals were grazed.

T. B. PALTRIDGE,
Agronomist, Colombo Plan, C.R.

REPORT OF THE BIOMETRICIAN

Statistics and Agri-Meteorology

STATISTICS

(*a*) *Routine Work.* This division co-operated with all the Research divisions of the Institute in the design of experiments and the analysis and interpretation of experimental data.

(*b*) *Special Work.* (1) During the month of August, the Biometrician was posted to the Department of Coconut Rehabilitation in order to study the response of the small holder to the manure subsidy scheme.

(2) The Biometrician was assigned (full-time) during November and December to work with Prof. S. C. Harland, in the study of special aspects of the experiments conducted by the Institute.

AGRI-METEOROLOGY

(*a*) *Routine Work.* Meteorological records continued to be taken twice daily (at 0830 hours and 1730 hours) throughout the year.

(*b*) *Expansion Work.* On the approval of the Coconut Research Board, preliminary arrangements were made to install an agri-meteorological sub-station at Ratmalagra Research Station.

(*c*) *Special Work.* (1) A statistical investigation was carried out into the inter-relationships between the different stages of development of a bunch of coconuts—the purpose being to ascertain the extent of which each stage of development controls a succeeding stage and also the final crop.

(2) An analysis of past meteorological records was carried out with a view to defining the normal atmospheric environment and its probable range of variation at Bandirippuwa Estate.

(3) An analysis of rainfall records was commenced in order to study the incidence of dry spells at Bandirippuwa Estate—the length of dry spells and their frequencies, etc.

The definition attached to ' dry spell ' in synoptic meteorology (world meteorological organization) does not seem to offer much meaning when applied to agricultural problems. In fact the definition of ' dry spell ' is necessarily specific to each variety of plants. The purpose of this investigation is therefore to ascertain what really constitutes a dry spell from the point of view of the coconut palm. This investigation is still proceeding.

(4) A further statistical investigation is in progress with a view to working out a reasonable ' effective rainfall ' for coconuts.

The preliminary work done suggests that for the soil type, environment, and the rainfall distribution of Bandirippuwa Estate, coconut crops do not respond to any rain exceeding 14-15 inches for a month. This work too is proceeding.

The above statistical investigations constitute a few out of a series of investigations contemplated as a preliminary to initiating a programme of Agri-Meteorological Research.

V. ABEYWARDENA,
Biometrician, Coconut Research Institute.

REPORT OF THE CROP PROTECTION OFFICER

Personnel

(1) Crop Protection Officer (since April 1956).
(2) Crop Protection Assistant (since inception of division).
(3) Field Assistant (since 1st December, 1956).
(4) Attendant (since May 1956).

General

From September 1955 to early April 1956, the work in this division was looked after by the Crop Protection Assistant—Mr. F. Kirthisinghe. The work was mainly of an advisory nature, i.e., helping growers to overcome their pest problems. Information already available on pest and diseases of coconuts was made use of in this work. Some equipment required for the new Division was ordered and collected. Further field experience on the common pests and diseases of the palm was acquired through visits to plantations. A Crop Protection Officer was to be appointed shortly and in anticipation of this appointment a programme of work was drawn up and an estimate of expenditure for the work of the Division was submitted to the Board of Management for approval. This was approved.

After the appointment of the Crop Protection Officer in April 1956, a detailed research programme was submitted to the Board of Management. The chief items of work detailed in this programme were directed towards the control of *Oryctes rhinoceros* L. (Black beetle), Termites and minor pests. New estimates were drawn up which were also approved by the Board of Management.

A plan for the organisation of a Pest Control Service for the growers was drawn up and submitted to the Board for its approval. This service is designed to help the grower with his pest and disease problems. The grower will be able to count on the services of personnel trained under the supervision of this Division to tackle his pest and disease problems. The grower is expected to bear the cost of chemicals, labour and transport. This service met with the approval of the Board. A vote for costs associated with the setting up of this service was approved by the Board.

One of the vehicles (a Colombo Plan gift from Canada) to be used in the Pest Control Service is now on hand but the equipment required for fitting the vehicle up has yet to be delivered from overseas. It is to be hoped that before long there will be a fully equipped Pest Control Unit for use in the control of pests and diseases which can be made available to the grower.

Pests and Disease Control Projects

An incidence of *Aspidiotus destructor* (Coconut Scale) was met with in an estate in the Kurunegala District. All the palms in a five acre block were found seriously affected. The leaves had turned yellow. Although the predator *Chilocorus nigritus* (Lady Bird Beetle) was present, yet the infectation had got out of hand. The proprietor was willing to bear the cost of chemical treatment. This was the first pest control spraying project undertaken by the Coconut Research Institute. Spraying was carried out under our supervision, with a kerosene oil emulsion, using the Hypermicrover power sprayer which was specially adapted for our needs. The pest was brought under control. The cost of the chemical and the labour borne by the proprietor amounted to nearly 13½ cents per treated palm.

The Botanist had a pest control problem in the nursery when his experimental seednuts were attacked by ants. The pest was brought under control by wetting the soil with Chlordane and dusting the nuts with 5 per cent B.H.C. dust. This latter measure was necessary as the ants were found in the husks of the seednut.

An out-break of *Parasa Lepida* (stinging caterpillar) occurred on 2 to 3 year palms on an estate in the Negombo District. This pest was brought under control by using 2 per cent Toxaphene as a spray. On a subsequent inspection of the plantation it was found that the pest was parasitised by a Hymenopterous parasite which was identified as *Euplectromorpha* sp. near *artonae*. Ferr. (Eulophidae). It was also found that a Cockchafer beetle (yet unidentified) fed on the leaf margins.

The grass plots belonging to the Agronomist both at Bandirippuwa and at Ratmalagara had pest problems. The plots at Bandirippuwa were invaded by *Leptocorisa varicornis* and this was controlled by dusting with 6.5 per cent g B.H.C. At Ratmalagara the plots were attacked by *Heliothes* sp. and this was brought under control by using a 2 per cent solution of Aldrex 2 (24 per cent Aldrin ex Shell Co.). The plants in the Phytosolarium were infested by White fly (F. Aleurodidae). A. 0.5 per cent solution of Gammalin was used as a spray in this instance.

Pestalotia palmarum together with *Helminthosporiun* sp. broke out on an estate in the Negombo district. The diseases were widespread. The predisposing factor to the outbreak of the diseases was unbalanced manuring over the years, hence this factor had to be taken into consideration in any control programme that was to be recommended. pH determinations of samples of soil collected from the estate were carried out and on these findings appropriate recommendations were made. Together with these recommendations it was suggested that the older leaves of infected palms be cut and burnt and that the remaining younger foliage be sprayed with Perenox (1 oz. in 1 gal.). On an experimental basis, these recommendations were carried out on four acres and it was found that the freshly emerging leaves were protected from fungal attack. It is understood that the rest of the estate was later sprayed using a Helicopter. No data has been furnished to us from this aerial spraying project.

Advisory Visits

During the months January to April, several pest inspections were done and control measures were recommended.

A severe out-break of stem bleeding was reported from an estate in the Chilaw district. Investigations revealed that the cause of this out-break was not due to the associated pathogenic parasite, *Ceratostomella paradoxa* but was due to a physiological cause. A contributing factor may be the heavy clay sub-soil and water logging. It was recommended that drains be opened and the soil conditions improved.

This Division undertakes visits only when correspondence alone cannot help and if the Advisory Officers to whom problems are initially referred to for inspection and advice require the assistance of this Division.

In our inspections we came across a leaf-eating caterpillar *Elymnias fraterna* attacking leaves of transplanted seedlings. Previous records of this pest do not indicate it to have caused any damage to transplanted seedlings.

Other pests and diseases besides those mentioned above that occurred and were reported during the year under review were:—

Phytophthora palmivora (Bud rot)
Ceratostomella paradoxa (Stem-bleeding)
Rhyncophorus ferrugineus (Red Weevil)
Oryctes rhinoceros (Black Beetle)
Aularchis milliaris (Yellow-spotted locust).

The Agricultural Officer, Trincomalee, sent us some specimens of a plant bug found on coconut leaves. This bug has been identified as *Leptocoris* sp. (F. Coreidae).

Experimental Work

(1) *Laboratory*. It is interesting to note that the larvae of a dipterous fly *Megaselia scalaris* loew (phoridae) were found to provide a small degree of control of Red Weevil. Cultures kept in the laboratory indicated that it was possible to get a very small percentage of 3rd instar larvae parasitised. Further observations will be carried out when detail work on the Red Weevil is commenced.

The detailed life cycle of *Oryctes rhinoceros* is being studied under laboratory conditions.

(2) *Field*. Field experiments were commenced on 12-9-1956 so as to determine the role of insecticides as repellants of Black Beetle and in the control of Termites. The adult Black Beetle experiment is being conducted at Bandirippuwa estate in the replanted block. With the Botanist's kind permission this block was treated with various insecticidal formulations, placed in the uppermost leaf axils. The experiment is still in progress and the results will be published elsewhere when the experiment is concluded.

The termite control experiments are being conducted in the nurseries at Walpita and Kurunegala. The chemical treatments consisted of applications of emulsifiable concentrates and dusts in the trenches immediately prior to the placement of seednuts in the trenches. The experiment is to be conducted over three stages:—

(1) Pre-planting treatment for control of termites.
(2) Post emergence treatment for control of termites.
(3) Control of termite damage in transplanted seedlings.

A summary of the findings of stage 1 of the termite trials conducted at Walpita nursery is given here below:—

N.B.—These results are from Stage 1 of the Termite control trials that were set up at Walpita Nursery on 27-8-1956. Stage 1 represents the pre-planting treatment for the control of Termites.

Parallel trials have been set up at Carmel Nursery, Ibbagamuwa, but these results are not yet to hand and therefore they cannot be included in this report.

The trials in both Nurseries have been designed so as to fit in with the present routine cultural practices being carried out at the Nurseries.

(1) Damage to seedlings was caused by the following species of Termites:—

(*a*) *Odontotermes horni* var. *hutsoni* Kemner.
(*b*) *Odontotermes redemanni* (Wasmann).

Other insects that were responsible for any damage being caused to the seedlings was a cockchafer beetle larva. It was not possible to identify this pest. Damage caused by this pest was very slight. An ant *Dorylus* (*Alaopone*) *orientalis* West also caused some slight damage.

(2) Observations revealed that there was surface and deep running of termites soon after the experiment was set up. No damage to seednuts was evident during the early period, i.e. prior to germination, although termites were seen in the treated area. This indicated that damage to seedlings is caused by the above mentioned species of termites and that these termites attack or damage the emerged shoot.

(3) Damage to seedlings commenced after germination had proceeded 3 to 4 weeks. Germination was first observed on 25-10-56, i.e. approximately 8 weeks after laying down. Germination was well advanced by 10-12-56. Damage to seedlings was not observed until 5-1-57, i.e. approximately 13 weeks after laying down.

(4) In most cases over 70 per cent of the non-germinations was due to Termite damage.

(5) Independent observations revealed the presence of termites on every bed of the experimental area. Since seedling damage took place only in early January, it could be said that chemical treatment offered 8 weeks of protection after germination. If these preliminary findings are correct then it would be necessary to repeat chemical treatment every 8 to 10 weeks.

(6) Our findings reveal that the damage was more frequent on the end rows. This is probably due to the fact that the termites already present and foraging in the drains bordering each bed readily attack seedlings once the effect of the insecticide treatment has worn off due to environmental conditions.

(7) From our preliminary findings in one set of trials the results of which have not been analysed thoroughly, it is not possible to recommend any specific insecticide for the pre-planting control of termites. Our results show that all insecticides used in the experiment gave some degree of control over the experimental period. Our recommendations therefore will when they are made take into consideration the following factors:

(*a*) The cost of the insecticide.
(*b*) The availability of the insecticide.
(*c*) The ease of application.

(8) Our present findings indicate that such insecticides as Gammexane dust 0.65 per cent g B.H.C. (I.C.I.), Aldrin 30 per cent M.O. (Mackwoods), Psylortox 25 per cent D.D.T. (Mackwoods), Chlordox 10 per cent Chlordane (Mackwoods), Intox 8.70 per cent Chlordane (Baurs), in that order have given better protection to seedlings over the experimental period than the other insecticides tried out.

From these preliminary findings it could be said that in the pre-planting chemical treatment of beds to prevent seedling damage from termites it would be necessary:—

(*a*) To treat not only the actual area of the bed on which planting is to be carried out, but also a strip around the periphery of the bed. This strip would then act as a barrier and so prevent termite infiltration from outside the bed.

(*b*) Over the period the seedlings are in situ in the bed, it will be necessary to repeat the chemical treatments at intervals. The interval depending on the particular insecticide being used and the environmental conditions prevailing during this period.

A complete and detailed report of the whole trial and our findings will be reported elsewhere when the experiments are duly completed.

Various rodenticides have been used at Carmel nursery to reduce the depredation of seedlings by rats. The following rodenticides—

Warfarin (Lee Hedges)
Tomorin (Baur & Co.)
Muritan (Chatham House)
Silmurin (Baur & Co.)

have proved useful.

The role of systemic insecticides in the control of Red Weevil was tried out at Walahapitiya. A 1 per cent solution of Systox gave a 40 per cent kill. It is proposed to use higher concentrations of the systemic insecticides and so study the effect of the insecticide on the plant as well as the insect. Systemic insecticides were given as trunk injections or root transfusions. Trunk injections appear to be most suitable.

Visitors and Correspondence

Several overseas and local visitors called at the laboratory. Firms dealing with chemicals have sent their representatives to discuss the use of their chemicals. We have discussed our policies and stated that the policy of this Division will be to thoroughly test every chemical that is recommended for a particular pest or disease. After comprehensive tests, the grower will be made aware of as to which of the large array of chemicals he could use to control his particular pest or disease.

Correspondence has been of an advisory nature. Much time has been devoted to indenting for equipment and also attending to connected correspondence. Three articles have been written for the *Ceylon Coconut Quarterly* and a couple of Advisory leaflets.

Summary

The year under review was essentially a period of organisation for the commencement of work in this new Division. The few experiments were set up. The research programme for 1957 has wider scope and this has been approved. It is hoped that we will have our Insectary-cum-Plant Pathology room by early next year. When this building is completed we hope to commence in the Insectary Section a programme of parasite breeding, mainly the various Hymenopterous parasites for the control of *Nephantis serinopa* (Coconut caterpillar). 1956 Estimates for this Division provide us with funds for fitting out one of the two Canadian gift International vans as a Crop Protection Unit. This work will be started shortly.

Our thanks are due to Messrs. Mackwoods, Chatham House, Baur & Co., Imperial Chemical Industries for supplying us with samples of chemicals for our various experiments and for the co-operation extended to us.

Identification of specimens were carried out by the Commonwealth Institute of Entomology. It is therefore opportune for me to express my sincere thanks for the trouble they have gone through in this regard.

It is my hope that on the basis of our experimental findings we will soon be in a position to recommend to the growers a specific chemical or chemicals for a particular pest or disease.

HILARY F. GOONEWARDENA,
Crop Protection Officer.

REPORT OF THE PLANTING OFFICER FOR THE YEAR 1956

Nurseries

Seednuts The following quantities of seednuts were planted in the nurseries during the year 1956.

Name of Nursery	*Quantity*
Ratmalagara	156,000
Carmel	30,000
Karawaddena	175,000
Walpita	85,250
Hettipola	60,000
Wilpotha	200,000
Labuduwa	30,000
Eraminigolla	30,000
St. Anne's	70,000
Dematawala	124,122
Koggala	63,100
Mylambavelly	30,000
Batticaloa	11,000
Killinochchi	75,000
Mullativu	52,000
Kalawewa	90,000
Wennappuwa	30,865
	1,312,437 nuts

Seedlings. The demand for seedlings exceeded the supply and orders for 833,238 were issued for the two planting seasons, namely May/June and October/November.

The following quantities of seedlings were issued during the year 1956.

Ratmalagara	114,575
Hettipola	47,433
Wilpotha	148,511
Labuduwa	18,782
Dematawala	91,658
Dunagaha	21,599
Walpita	63,675
Carmel	112,893
St. Anne's	31,697
Kalawewa	51,260
Killinochchi	43,883
Wennappuwa	21,102
Batticaloa	8,114
Chenkaladi	19,200
Mullativu	38,857
	833,238 s'lings

Expenditure. The details of expenditure for the year 1956 are as follows:—

Depreciation reserve ..	..	18,809 81
Rent allowances ..	..	4,060 81
D/A and Special allowances	..	32,879 33
Salaries (GL/73) ..	..	46,474 86
Bonus and Interest (GL/73)	..	9,151 4
M. A. Fund Contribution ..	..	903 15
Workmen's Comp. Interest	..	422 37
Seednuts purchases ..	..	215,397 11
Nur. Mint Rent and Trans.	..	170,749 53
Nurseries Travelling ..	..	23,930 16
Nurseries Office ..	..	4,898 60
Buildings Upkeep ..	..	729 89
		538,404 31

Advisory Service. At the end of 1956, there were 17 Advisory Field Officers, 10 of whom were in charge of ranges in the Field, while the other newly recruited 7 Officers were undergoing a course of training at Headquarters.

The ranges covered by the 10 Officers are as follows:—

Name of Officer	*Range*	*Province*
H. L. L. Perera	Katugampola Hatpattu North	N. W. P.
T. Ganarajah	Weudavili Hatpattu	N. W. P.
Dunstan Fernando	Chilaw/Puttalam Districts	N. W. P.
L. D. Thambugala	Katugampola Hatpattu South	N. W. P.
Bede Fernando	A. K. K. North "A" and South	W. P.
K. M. Francis	Hapitigam Korale	W. P.
C. Iddawela	Siyanekorale East	W. P.
P. Mahindapala	Hewagam, Salpiti, Raigam Korales	W. P.
W. V. Fernando	Galle, Matara and Hambantota Districts	S. P.
V. Vennayagam	Batticaloa and Trincomalee Districts	E. P.

It is proposed to station the other seven Officers after the training in the following Ranges:—

1. Dambadeni Hatpattu
2. Matara and Hambantota Districts
3. P. K. North
4. Devamedi Hatpattu
5. Puttalam District
6. Siyanekorale Medapattu and Adikarapattu.

One Officer will be attached to the Headquarters as a relieving Officer.

P. D. LAURENCE FERNANDO.
Planting Officer, Planting and Advisory Division.

REPORT OF THE PUBLIC RELATIONS OFFICER

Exhibitions

The Institute participated in the Royal Agricultural and Food Exhibition held at Colombo in January 1956, and all the Officers of the Institute were on duty in rotation during its entire period.

Conferences

A conference of Research, Technical and Field Officers of the Institute was held on 20th April, 1956.

A conference of the Publications Sub-Committee was held on 20th August, 1956, with Public Relations Officer as Secretary.

A conference of Research Officers was held on Monday, 29th October. It was decided that monthly conferences of Research Officers should be held on the 4th Monday of every month in accordance with a directive of the Coconut Research Board.

Meetings

The Director and the Public Relations Officer attended the 6th Annual General Meeting of the Nattandiya Coconut Producers' Co-operative Society at D. C. and Oil Mills, Kirimetiyana. At this meeting, the Director delivered a talk on Copra and it was interpreted by the Public Relations Officer.

4—J. N. R 22393 (3/58).

Publications

Volume V, No. 4 of the *Ceylon Coconut Quarterly* was published in March this year.

Volume VI, Nos. 1/2 was published as a combined double number in order to complete the arrears, and bring the publication to date. Volume VI, Nos. 3/4 was also published as a combined double number.

Pol Pawath

Pol Pawath, the Sinhalese Publication of the Institute was published up to the 7th Number of the 1st Volume during this year. This publication that is becoming very popular with the Sinhalese reading smallholders has a circulation of 8,000 copies at present and the demand is daily increasing. Leaflets Nos. 24, 25, 26, 27 and 28 were printed during this year.

Reprints of leaflets Nos. 1, 2, 5, 8, 23 and 24 were done during the year.

Bulletins that were printed during this year were:—

No. 7 on Intra Specific Hybrids in Coconuts by Dr. D. V. Liyanage, Botanist.
No. 8 on The Manufacture of Coconut Toddy Vinegar by Mr. W. R. N. Nathanael, Chemist.
No. 9 on The Smallhoder's Copra Kiln by Mr. F. C. Cooke, Director.
No. 10 on Toddy Yields from Coconut Palms in Ceylon by Mr. W. R. N. Nathanael, Chemist.

A Museum of Coconut Products

A museum of coconut products was presented to the Institute by Sir Wilfred de Soysa on Thursday, 8th March. The gift was received by Dr. A. W. R. Joachim Chairman of the Coconut Research Board. Members of the Coconut Research Board and several prominent Coconut Planters were present on this occasion.

Training Courses

A training course in Coconut Cultivation for newly appointed Advisory Field Officers of the Coconut Research Institute, Coconut Inspectors of the Coconut Rehabilitation Department and Supervisors and Overseers of the Land Commissioner's Department was conducted at the Coconut Research Institute in July and August this year.

Besides lectures and practical work a number of Field Excursions undertaken during this training course included visits to the main coconut growing regions and to a number of Pilot Colonization Schemes.

At the termination of the Training Course the trainees were examined by their respective lecturers.

Training Course No. 2

Seven newly appointed Advisory Field Officers of the Coconut Research Institute, three Coconut Inspectors of the Coconut Rehabilitation Department, and one Supervisor of the Land Commissioner's Department were given a course of training for six weeks commencing from 19th December, 1956. The programme followed was similar to that of Training Course No. 1.

Visitors

Hon. Mr. D. P. R. Gunawardena, Minister of Agriculture and Food, visited the Institute on 4-8-56.

He also visited the Sub-Station at Ratmalagara Estate, and the Isolated Seed Garden at Ambakelle on the same day in the company of the Acting Director and the Botanist.

Photography

The majority of Research Photographs prepared this year were for the Agronomist, Chemist and Soil Chemist.

Work is in progress with regard to preparing a few Film Strips which would be completed shortly.

L. R. N. H. PERERA,
Public Relations Officer, Coconut Research Institute.

REPORT ON THE ESTATES, 1956

Bandirippuwa Estate

Crops Hervested during 1956

Crops	*Nuts from Estate Area*	*Nuts from Research Area*	*Total*	*Average 1931 to 1955*	*1956 above or below Average*
I	42,912	8,275	51,187	68,930	— 25·7
II	66,430	9,870	76,300	108,939	— 30·0
III	92,308	14,263	106,571	131,359	— 18·9
IV	92,682	15,298	107,980	117,992	— 8·5
V	65,534	10,914	76,448	81,135	— 5·8
VI	46,765	8,633	55,398	63,427	— 12·6
	406,631	67,253	473,884	571,782	— 17.1

The nuts were disposed of as follows:—

	Nuts	
Sold on contract	96,852	
Sold to Planting Division	12,500	
Sold for Research	1,123	
Research Nurseries	850	
Cured into Copra	340,670	
Allowance to Staff	17,519	
Empties	4,370	0·9 per cent.
Total	473,884	

The 340,670 nuts cured gave 272 candies 542 lb. of copra and an out-turn of 1,248 nuts to a candy.

The revenue from Bandirippuwa Estate actually accruing in 1956 was—

	Revenue from Estate Management. Crops in 1955			*Revenue from Research Management. Crops in 1955*		
	Rs.	*c.*	*Rs.* *c.*		*Rs.*	*c.*	*Rs.* *c.*
Sale of nuts	4,762	58		Sale of nuts	232	95	
Sale of copra	3,996	36		Sale of copra	5,997	71	
Sale of sundries	4,144	79		Sale of sundries	9	35	
			12,903 73				6,240 01
	Crops in 1956			*Crops in 1956*			
Sale of nuts	13,175	74		Sale of nuts	312	25	
Sale of copra	33,725	87		Sale of copra	7,996	99	
Sale of sundries	4,281	68		Sale of sundries	25	70	
			51,183 29				8,334 94
			64,087 2				14,574 95

The total revenue for 1956 was Rs. 78,661.97.

Sundry Debtors and Creditors Account

Of the income accruing in 1956, and included in the above statement is Rs. 12,903.73 (Estate) and Rs. 6,240.01 (Research) from 1955 crops had been credited to the Estate working account for 1955 through sundry debtors account. The Estate working account for 1956 does not therefore include this sum.

The following accounts have been credited to the Estate working account on account of 1956 crops lying unsold at the end of the year:—

1956 Crops (Estate)	*Rs.*	*c.*	*1956 Crops (Research)*	*Rs.*	*c.*
Sale of nuts	6,459	93	Sale of nuts	—	
Sale of copra	739	78	Sale of copra	1,275	10
Sale of sundries	695	70	Sale of sundries	9	40
	7,895	41		1,284	50

The expenditure for the year totalled, including depreciation of kiln to Rs. 32,769.75. The cost of production of nuts in the Estate area (including) the depreciation of kiln is Rs. 80.58 per 1,000 nuts.

The Bandirippuwa Estate working account for the year 1956 thus shows a balance of Rs. 35,928.39.

D. F. WITHANA,
Superintendent, Bandirippuwa Estate.

Ratmalagara Estate

CROPS HARVESTED DURING 1956

Crops	*Nuts from Estate Area*	*Nuts from Research Area*	*Total*	*Average 1951 to 1955*	*1956 above or below Average*
I	37,328	22,569	59,897	59,685	+ 3
II	67,770	31,975	99,745	87,630	+ 1
III	71,904	33,106	105,010	102,085	+ 2
IV	67,136	35,382	102,518	96,974	+ 5
V	56,758	31,723	88,481	83,987	+ 5
VI	43,945	23,981	67,926	66,222	+ 2
Total	344,841	178,736	523,577	496,583	+ 5

The crops were disposed of as follows:—

Sold on contract	101,181
Sold to Research	4,054
Cured into copra	404,315
Allowed to staff	6,105
Empties and Rej.	7,922
	523,577

The 404,315 nuts cured into copra produced 327 candies 237 pounds copra equivalent to an outturn of 1,265 nuts to a candy.

The revenue from Ratmalagara Estate in 1956 was:—

Revenue from Estate Management. Crops in 1955

	Rs. c.	Rs. c.
Sale of nuts	4,923 15	
Sale of Copra	407 0	
Sale of sundries	2,024 40	
Rubber garden	139 26	
		7,493 81

Revenue from Research Management. Crops in 1955

	Rs. c.	Rs. c.
Sale of nuts	—	
Sale of Copra	4,880 7	
Sale of sundries	851 96	
—	—	
		5,732 3

Crops in 1956

Sale of nuts	6,777 84	
Sale of copra	22,875 95	
Sale of sundries	5,406 35	
Rubber garden	789 38	
		35,849 52
		43,343 33

Crops in 1956

Sale of nuts	207 0	
Sale of copra	12,026 59	
—	—	
—	—	
		12,233 39
		17,965 42

The total revenue for 1956 was thus Rs. 61,308.75.

(—— J.N.R 22393 (3/58).

Sundry Debtors and Creditors Account

Of the income accruing in 1956 and included in the above statement is Rs. 7,493.81 (Estate) and Rs. 5,732.03 (Research) from 1955 crops that had been credited to the estate working account in 1956 through sundry debtors account. The estate working account for 1956 does not include this sum.

The following accounts have been credited to the estate working account on account of 1956 crops lying unsold at the end of the year:

1956 Crops (Estate)	Rs. c.	*1956 Crops (Research)*	Rs. c.
Sale of nuts	9,808 87	Sale of nuts	783 22
Sale of copra	9,975 17	Sale of copra	7,114 30
Sale of sundries	426 42	—	—
Rubber garden	126 62	—	—
	20,337 8		7,897 52

The expenditure for the year including depreciation of kilns totalled Rs. 26,355.92. The cost of production of nuts in the estate area (including the depreciation of kilns Rs. 568.50) was Rs. 76.42 per 1,000.

Ratmalagara Estate working account for 1956 thus shows a balance of Rs. 49,933.68.

HENRY J. F. PEIRIS,
Superintendent, Ratmalagara Estate, Madampe.

9th July, 1957.

COCONUT RESEARCH INSTITUTE—COCONUT RESEARCH BOARD

My No.P-2(3)13
AUDIT OFFICE,
Colombo 7: 4th March, 1958.

The Chairman,
Coconut Research Board,
Peradeniya.

Accounts of the Coconut Research Institute for the year ended 31st December, 1956

The accounts of the Coconut Research Institute for the year 1956 were audited under my direction. The Balance Sheet as at December 31, 1956, and connected financial statements as detailed below were rendered for audit on 6th June, 1957 :

(i) Revenue Account,

(ii) Working Accounts of—

- (*a*) Bandirippuwa Estate,
- (*b*) Ratmalagara Estate,
- (*c*) Planting Division,
- (*d*) Animal Husbandry Division,
- (*e*) Provident Fund,
- (*f*) Medical Aid Fund, and

(iii) Capital Expenditure Accounts.

These were returned for amendment on 8.11.57 and the amended statements of accounts were received on 9th January, 1958.

These have been examined and compared with the books kept by the Institute and found to be in order. The Balance Sheet has been certified by me subject to the observations in this report and is returned herewith along with the connected statements.

Revenue Account

2. (*a*) *Cess Collections : Rs. 1,377,979,62.* The cess revenue for the year under review was Rs. 1,377,979.62 as compared with Rs. 1,482,001.22 in the previous year. The decrease of Rs. 104,021.60 reflects the decrease in export volume of coconut products in 1956.

(*b*) *Interest on Investments : Rs. 74,728.87.* The interest on investments for the previous year was Rs. 40,669.89. The increase of Rs. 34,058.98 was due to the following additional investments made in December 1955 and during the year under review.

	Rs.
(1) 3¼% Ceylon Government Loan 1975/80 (15-12-55)	750,000
(2) 3¼% National Housing Debentures 1976/81 (1.12.56) ...	350,000
(3) 3% National Housing Debentures 1969/71 (16.1.56) ...	100,000

3. *Estate Working Accounts — Profits from Estates : Rs. 78,667.35 (Bandirippuwa Rs. 37,111.82, Ratmalagara Rs. 50,555.53).* The working accounts of the Estates show a profit of Rs. 87,667.35 as compared with the profit of Rs. 88,323.72 for the previous year. The decrease of Rs. 656.37 despite more favourable selling prices in 1956, (the average local selling price of coconuts per 1,000 in 1956 being Rs. 132.00 as compared with Rs. 115.00 in 1955) was mainly due to the comparatively poor yield in 1956 as shown below :

Name of Estate	*Yields—Number of Nuts*	
	1955	*1956*
(*a*) Bandirippuwa Estate	613,680 ..	473,884
(*b*) Ratmalagara Estate	567,654 ..	523,577

The short-fall of crop was attributed to the continuous drought that prevailed during 1956.

4. *Planting Division Working Account Deficit : Rs. 19,707.89.* The account shows as income the grant of Rs. 350,000 given in August 1956 by the Director of Agriculture from the provision under Head 82, Vote 1, Sub-head 15 and Rs. 155,374.94 being the proceeds of sale of seedlings. The expenditure incurred on the Planting Division amounted to Rs. 525,082.83 which exceeded the income for the year by Rs. 19,707.89. The deficit was met from the accumulated net revenue of this Division brought forward from the previous year.

The total number of seednuts planted during the year was 1,312,437 out of which 833,238 were sold during the year under review and the balance 479,199

rejected as unsuitable and destroyed. The average cost of raising seedlings by the Institute during the year under review was 63 cents each as ompared with 69 cents during 1955. The seedlings were sold at a subsidised rate of 30 cents each as in the previous year.

5. *Animal Husbandry Division : Loss Rs. 17,431.04.* The loss in this Division was Rs. 17,431.04 compared to the loss of Rs. 3,858.86 in the previous year. This activity is primarily concerned with research, and the produce (e.g. Milk, Ghee, Eggs, &c.) is sold to the staff at nominal rates. Losses therefore are not unusual.

The increase in the loss during 1956 as shown in this account is attributable mainly to expenditure incurred on pasture experiments which is a new feature, as also to a change in the accounting procedure whereby salaries and wages of staff employed in this Division (except those of the Animal Husbandry Officer and his Assistants) have been charged to this account for the first time instead of to the main Revenue Account of the Institute as in previous years. This change in the accounting procedure follows a recommendation made in para 5 of the Audit Report on the accounts for 1955.

Balance Sheet

ASSETS

6. *Fixed Assets : Rs. 2,620,277.92.* The value of fixed assets is overstated by reason of the fact that there was no proper procedure for the writing off of assets which are no longer in existence, having been sold or scrapped. Neither was a Fixed Assets Register maintained showing particulars of the date and cost of acquisition of each item of asset, depreciation written off year by year, date scrapped or sold etc. The importance of maintaining such a register cannot be overstressed and it is suggested that early steps be taken to rectify this defect.

In addition to maintaining a Register of Fixed Assets it is also equally important to have the assets verified by a Board of Survey at the end of the year so as to furnish evidence of their existence on the date of the Balance Sheet.

LIABILITIES

7. *Depreciation Fund : Rs. 274,775.24.* The balance to the credit of this account is overstated as no adjustment has been made in respect of assets sold or scrapped.

8. *Provident Fund : Rs. 453,015.54.* In terms of section 4 (1) of the Provident Fund Rules "Every member should contribute to the Fund in respect of each month a sum equivalent to 15% of his salary for that month." However, in the case of officers who were on no-pay leave for a part of a month the practice had been to recover as Provident Fund contribution 15% of the monthly salary and not 15% of the salaries actually earned for that month. This has been pointed out to the Director.

9. *Medical Aid Fund : Rs. 10,400.15.* The absence of provision in the Coconut Research Ordinance for the establishment of a Medical Aid Fund was commented on in the Audit Report on the Accounts for 1954. As far as I am aware action to regularise its establishment has so far not been taken.

10. *Unauthorised Expenditure.* The expenditure exceeded the sanctioned estimates in respect of several items as indicated below:

Statement of Excess Expenditure

Item	*Estimate*	*Supplementary Provision*	*Total Provision*	*Expenditure*	*Excess*
	Rs. c.	*Rs. c.*	*Rs.*	*Rs. c.*	*Rs. c.*
1. Improvements to Isolated Seed Garden	62,820 0	9,500 0	72,320	73,856 74	1,536 74
2. Photographic equipment	2,165 0	—	2,165	5,050 20	2,885 20
3. Lab. and Library Chemicals and Glassware	28,050 0	2,100 0	30,150	36,827 81	6,677 81
4. Running Expenses, Electrical Plant	14,150 0	—	14,150	17,542 0	3,392 0
5. Vehicles	6,500 0	—	6,500	11,110 12	4,610 12
6. Passage	1,000 0	—	1,000	6,076 79	5,076 79
7. Depreciation	19,405 0	—	19,405	66,106 26	46,701 26
8. Industrial Research	10 0	—	10	178 13	168 13
9. Overseas Training	10 0	—	10	509 12	499 12

It has been repeatedly pointed out in Audit Reports that the practice of incurring expentiture in excess of the approved provisions in the Annual Estimates without prior approval of the Board is irregular.

11. The desirability of early rendering of the Annual Accounts for audit free from errors, should receive the attention of the Board.

D. S. DE SILVA,
for Auditor-General.

Revenue Account, 1956

	Rs. c.	Rs. c.	Rs. c.
Personal Emoluments :			
Institute's salaries		231,144 66	
Living allowances		112,839 67	
Rent allowances		7,786 89	
Provident Fund bonus and interest ..		43,773 88	
Medical Aid Fund		2,740 33	
Coconut allowance		2,670 63	
Recreation and Co-operative Society ..		2,000 00	
			402,956 06
Other Charges :			
Travelling—Board Members		5,861 05	
Travelling—Staff		48,457 60	
			54,318 65
Office :			
Stationery		9,716 23	
Postage		3,809 92	
Printing and advertising		7,370 47	
Audit fees		7,000 00	
Telephone rental		723 00	
Entertainment allowance		185 30	
Incidental expenses		731 49	
Workmen's Compensation Insurance ..		453 85	
Office upkeep		782 50	
Publicity and Ceylon Coconut :			
Quarterly	17,927 25		
Less credit	1,365 00		
		16,562 25	
Co-operative canteen ..		30 00	
			47,365 01
Laboratory and Library :			
Books and periodicals		6,764 34	
Laboratory upkeep		39,022 02	
			45,786 36

	Rs. c.	Rs. c.	Rs. c.
Government Grant			30,000 00
Cess collections			1,377,979 62
Interest on investment			74,728 87
Charges to staff for electricity			1,941 75
Sale of publications			581 28
Sale of Ceylon Coconut Quarterly ..			2,148 56
Sundry receipts			1,962 51
Working Accounts :			
Bandirippuwa	37,111 82		
Rathmalagara	50,555 53		
	87,667 35		
Less loss on Animal Husbandry Working Account	17,431 04		
			70,236 31

Research :

Chemist		8,288 44	
Botanist	26,501 60		
Less sale of seedlings ..	457 80		
		26,043 80	
Soil chemist	..	8,253 42	
Agronomist	..	9,371 41	
Crop protection ..	..	699 01	
Industrial research ..	..	178 13	
Animal husbandry pasture ..	..	1,839 95	
			54,674 16

Reserves :

Depreciation	..	45,779 72	
Passage	..	6,076 79	
Overseas training ..	..	509 12	
			52,365 63

Upkeep :

Buildings and machinery ..	..	15,391 01	
Insurance	..	3,383 47	
Electric plant	..	17,822 41*	
Vehicles	..	11,080 32	
			47,677 21
			705,143 08
Excess of Revenue over Expenditure ..		..	854,435 82
			1,559,578 90
			1,559,578 90

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute.

* This includes Rs. 5,584·90 paid to the Department of Government Electrical Undertakings for supply of A. C. current to the office and laboratories.

Bandirippuwa Estate Working Account, 1956

Expenditure	Rs. c.	Rs. c.	Income	Rs. c.	Rs. c.
Estate :			*Estate area :*		
General Charges	16,147 60		By sale of nuts	19,635 67	
Upkeep	6,633 14		By sale of copra	34,465 65	
Cultivation	3,859 11		By sale of sundries	4,977 38	
Collection	4,707 21				59,078 70
		31,347 06			
Depreciation	..	239 26	*Research area :*		
Transferred to Revenue Account ..	..	37,111 82	By sale of nuts	312 25	
			By sale of copra	9,272 09	
			By sale of sundries	35 10	
					9,619 44
		68,698 14			68,698 14

Certified correct.

S. C. KAHAWITA,
Secretary-Accountant.

Ratmalagara Estate Working Account, 1956

Expenditure	Rs. c.	Rs. c.	Income	Rs. c.	Rs. c.
Estate :			*Estate Area :*		
General charges	12,483 65		By sale of nuts	16,586 71	
Upkeep	5,050 21		By sale of copra	32,851 12	
Cultivation	3,952 93		By sale of sundries	5,771 62	
Collection	3,617 63				55,209 45
		25,104 42	*Research Area :*		
Food crops	..	27 91	By sale of nuts	990 22	
Depreciation	..	568 50	By sale of copra	19,140 69	
Transferred to Revenue Account ..	..	50,555 53			20,130 91
			Rubber Seed Garden :		
			Income	1,614 80	
			Less Expenditure ..	698 80	
					916 00
		76,256 36			76,256 36

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute.

Planting Division Working Account, 1956

Expenditure	Rs. c.	Rs. c.	Rs. c.
Seednuts Account :			
Cost of seednuts ..			215,397 11
Nurseries :			
Maintenance, rent and transport	171,152 91		
Less recoveries ..	3,718 36		
		167,434 55	
Workmen's Compensation Insurance ..		422 37	
Buildings upkeep		729 89	
Nurseries office		4,896 60	
Depreciation		18,809 81	
			192,293 22
Personal Emoluments :			
Salaries	46,474 86		
Dearness allowance and special allowance	32,879 33		
Rent allowance ..	4,060 46		
Provident Fund Bonus and Interest	9,151 04		
Medical Aid Fund contributions	896 65		
			93,462 34
Travelling :			
Staff travelling			23,930 16
			525,082 83

Income	Rs. c.
Planting Division grant	350,000 00
Sale of seedlings	155,374 94
Deficit transferred to Net Revenue Account	19,707 89
	525,082 83

Certified correct.

S. C. Kahawita,
Administrative Secretary,
Coconut Research Institute.

Animal Husbandry Division Working Account, 1956

Expenditure	Rs. c.	Rs. c.	Income	Rs. c.
Upkeep of :				
Cattle	14,814 67		Sale of milk, &c.	6,302 44
Poultry	3,790 84		Sale of eggs and birds	1,006 91
Pigs	2,531 51		Sale of pigs	1,577 50
		21,137 02	Transferred to Revenue Account	17,431 04
Cattle Shows and Sheds, &c.		1,639 71		
Depreciation		708 97		
Personal Emoluments :				
Salaries	1,073 80			
Dearness allowance and special allowance ..	1,525 32			
Provident Fund contributions ..	161 07			
Medical Aid Fund contributions ..	72 00			
		2,832 19		
		26,317 89		26,317 89

(*Note.*—Salaries of Animal Husbandry Officer and his assistants are not included above.)

Certified correct.

S. C. Kahawita,
Administrative Secretary,
Coconut Research Institute.

Provident Fund Working Account for the Year ended December 31, 1956

	Rs. c.		Rs. c.
To payments	772 44	By balance brought forward from 1955	359,713 19
Balance carried forward to 1957	453,015 54	Board's bonus for 1956	39,181 73
		Interest on Board's bonus	7,335 35
		Officers' contributions during 1956	39,486 23
		Interest on officers' contributions	8,071 48
	453,787 98		453,787 98

Certified correct.

S. C. Kahawita,
Administrative Secretary,
Coconut Research Institute.

Medical Aid Fund Working Account, 1956

	Rs. c.	Rs. c.		Rs. c.	Rs. c.
Bills paid	5,658 62		Officers' contributions	3,852 98	
Less refunds	479 47		Board's contributions	3,852 98	
		5,179 15			7,705 96
Transferred to reserve		114 85			
Refund to members leaving		114 85			
Balance		2,297 11			
		7,705 96			7,705 96

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute of Ceylon.

Lunuwila, March 12, 1958.

Planting Division Capital Expenditure Account, 1956

	Rs. c.		Rs. c.
Buildings	62,073 59	Contributions from Net Revenue Account	72,964 96
Improvements to Estates	272 46		
Land	795 20		
Nursery fittings and equipment ..	9,823 71		
	72,964 96		72,964 96

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute.

Institute Capital Expenditure Account, 1956

CAPITAL EXPENDITURE:	Rs. c.	Rs. c.		Rs. c.
Laboratory :				
Equipment	129,897 90		Contributions from Net Revenue	564,600 47
Photographic equipment	5,275 20			
Animal Husbandry equipment ..	104 50			
		135,277 60		
Buildings		233,841 12		
Furniture and Fittings :				
Bungalows	17,796 11			
Office	14,381 60			
		32,177 71		
Improvements to Estates :				
Bandirippuwa	3,501 90			
Ratmalagara	11,791 90			
Isolated Seed Garden	73,856 74			
		89,150 54		
Electricity and Water Supply :				
Electricity and water supply—				
Ratmalagara Estate	2,908 45			
Bandirippuwa Estate	27,947 50			
New well—Bandirippuwa Estate ..	858 00			
		31,713 95		
Machinery and Vehicles :				
Vehicles		41,824 80		
Books and Periodicals—Token		10 00		
Land		604 75		
		564,600 47		564,600 47

Certified correct.

Lunuwila, March 12, 1958.

S. C. KAHAWITA,
Administrative Secretary.
Coconut Research Institute.

Coconut Research Institute—Balance Sheet as at December 31, 1956

LIABILITIES	Rs. c.	Rs. c.	Rs. c.	ASSETS	Rs. c.	Rs. c.	Rs. c.
Capital Outlay :				*Fixed assets at Cost :*			
Institute as at December 31, 1955 ..		1,684,699 27		Buildings	1,341,841 08		
Contribution during 1956		564,600 47		Estates	484,108 08		
			2,249,299 74	Estate kilns	15,604 90		
Planting Division as at December 31, 1955 ..		298,013 22		Animal husbandry equipment	7,888 07		
Contributions during 1956		72,964 96		Laboratory equipment	336,661 29		
			370,978 18	Photographic equipment	5,275 20		
Research Reserve :				Power plant	88,043 38		
Balance as at December 31, 1955 ..		715,000 00		Fence and wells	4,225 20		
Additions during year		250,000 00		Gas Plant	8,221 77		
			965,000 00	Museum	3,276 20		
Staff—Funds :				Furniture—Bungalows	69,248 12		
Provident Fund ..	Rs. c.			Furniture—Office	55,515 49		
Officers contributions and interest ..	227,444 43			Machinery	43,551 90		
Institute's bonus and interest ..	225,571 11			Tools	13,362 08		
		453,015 54		Vehicles	112,589 15		
Medical Aid Fund :				Electricity and water supply	30,855 95		
Balance as at December 31, 1956 ..	10,198 30			Library books (token)	10 00		
Reserve under Rule 14 (2)	201 85					2,620,277 92	
		10,400 15		*Current Assets :*			
			463,415 69	Cess collections due in 1956	81,213 28		
Depreciation Fund :				Sundry debtors	162,774 42		
Balance as at December 31, 1955 ..		208,668 98		Accrued interest on investments ..	15,813 42		
Additions during year—				Transport loans	40,566 15		
Institute	47,296 45			General Stores Advance	917 73		
Planting Division	18,809 81			Travelling Advance	766 75		
		66,106 26				302,051 75	
			274,775 24	*Investments at Cost :*			
Current Provision and Liabilities :				*Government and Government Guaranteed stock ..	2,332,000 00		
Sundry creditors		78,301 29		Savings Bank	1,204 88		
Amounts due on Fertiliser account ..		473 06		Savings Certificates	25,000 00		
			78,774 35	Fixed deposits	550,000 00		
Net Revenue Account :						2,908,204 88	
Institute		1,015,468 73		*Cash Balance :*			
Planting Division		629,738 07		Cash in Bank	206,914 95		
			1,645,206 80	Cash in Hand	10,000 50		
						216,915 45	
			6,047,450 00			6,047,450 00	

* Statement showing face value and the Middle Market Value is annexed.

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute.

The accounts of the Coconut Research Institute for the year ended December 31, 1956, have been audited under my direction. Subject to the observations contained in my report No. P—2 (3) 13 dated March 4, 1958, made to the Chairman, Board of Management of the Coconuut Research Institute, I am of opinion, that the Balance Sheet and Financial Statements above set forth have been drawn up so as to present fairly the financial position of the Institute as at December 31, 1956, and the results of its operation for the year ended on that date.

Audit Office,
Colombo 7, March 4, 1958.

D. S. DE SILVA,
for Auditor-General.

Investments

Investments	*Cost*	*Face Value*	*Middle Market Rate*	*Middle market Value as at December 31, 1956*
	Rs. c.	*Rs. c.*		*Rs. c.*
3 % Sri Lanka Government Loan, 1969–1974	2,000 00	2,000 00	98 11/16	1,973 75
3½% National Housing Debentures, 1969–1971	450,000 00	450,000 00	105 1/2	474,750 00
3 % National Housing Debentures, 1969–1971	100,000 00	100,000 00	100	100,000 00
3½% National Housing Debentures, 1976–1981	350,000 00	350,000 00	100	350,000 00
2½% Ceylon Government National Development Loan, 1962—1967	125,000 00	125,000 00	93 11/16	117,109 38
2½% Ceylon Government National Development Loan, 1962—1967	250,000 00	250,000 00	93 11/16	234,218 75
3½% Ceylon Government Loan, 1975–1980	750,000 00	750,000 00	100 3/16	751,406 25
3 % Ceylon State Mortgage Bank, 1965–1968	150,000 00	150,000 00	100 6/16	150,562 50
3 % State Mortgage Bank (3) ..	5,000 00	5,000 00	100	5,000 00
3 % Ceylon Government Loan 1966–1971	150,000 00	150,000 00	100	150,000 00
	2,332,000 00	2,332,000 00		2,335,020 63

Certified correct.

S. C. KAHAWITA,
Administrative Secretary,
Coconut Research Institute.

Institute Net Revenue Account, 1956

	Rs. c.		Rs. c.
		Balance brought forward from 1955	980,118 34
Adjustments :		*Adjustments :*	
Amount charged to 1955	4,849 89	Accrued Interest understated in 1955	138 00
Balance carried forward	975,633 38	Uncashed cheques of 1955 now cancelled	44 00
		Overpayments of 1955 recovered	182 93
	980,483 27		980,483 27
Contributions to capital outlay	564,600 47	Adjusted balance brought down	975,633 38
Research Reserve	250,000 00	Excess of Revenue over Expenditure for 1956 transferred	
Balance carried forward	1,015,468 73	from Revenue Account	854,435 82
	1,830,069 20		1,830,069 20

Planting Division Net Revenue Account, 1956

	Rs. c.		Rs. c.
Deficit on Working Accounts 1956	19,707 89	Balance brought forward from 1955	722,732 92
Contributions to Capital outlay	72,964 96		
Loss on sale of building materials	322 00		
Balance carried forward	629,738 07		
	722,732 92		722,732 92

Certified correct.

Lunuwila, March 12, 1958.

S. C. KAHAWITA,
Administrative Secretary.
Coconut Research Institute.