COCONUT RESEARCH INSTITUTE - REPORT FOR 1996

COCONUT RESEARCH BOARD

COCONUT RESEARCH INSTITUTE OF SRI LANKA

REPORT FOR 1996

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REPORT OF THE

COCONUT RESEARCH INSTITUTE

FOR 1996

Editors

M de S Liyanage, Ph D, M I Biol (S L)

C Jayasekera, Ph D

Printed at Coconut Research Institute, Lunuwila, Sri Lanka

THE COCONUT RESEARCH BOARD
as at 31 December, 1996

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N A Tennakoon, B Sc Agric;
M Phil (Kelaniya);
Ph D (Aberdeen); M I Biol
L P Vidhanaarachchi, B Sc Agric,
M Sc (Malaysia)**; M I Biol

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B Sc Agric**
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Biochemist

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Clerk/Typist

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H S Herath - SLAS II/I

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P Daluwatta

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P Premaratne, B A

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Mrs W S R Fernando
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N M H Wijewardena

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Mrs W J M D M A Dias

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Accountant

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Resident Engineer

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M D Bernard Praxidus

Foreman (Mechanical)

M J M D S Jayawardena

Foreman (Buildings)

R M Dayaratne

Motor Mechanic

R M S G Ratnayake
R Vithanage

Mason

W M Dhanapala

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K D T K Liyanage

Work Superintendent

A L D K Amarasinghe

Draughtsperson

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Mrs A R S Hettiarachchi

Clerks/Typists

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M Somasiri

Senior Electrician

D W J Jayakody

Carpenter

A A K Amarasinghe

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Assistant Manager (Farms)

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D E V R Wijetunga

Senior Clerk

K P W Perera

Technical Assistant (E)

D M Pathirage

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W P R R Fernando

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A N Eknaligoda

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G B A Wijesekara

Senior Field Assistant

W L B Silva

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M A Sunil Fernando
W W A P R Fernando

Senior Clerk/Typist

H H J E Appuhamy

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Superintendent

M R L A Perera

Senior Estates Clerk

R P Victor

Supervisors

S Alahakoon
T M Keerthiratne

Isolated Seed Garden

Actg. Superintendent

D M Pathirage

Field Officer

D L J Nettasinghe

Clerk/Typist

J A R Reginold

Supervisor

M P W Fernando

Lab & Field Assistant

U V M Fernando

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Makandura Estate

Superintendent

P D Benat Silvan

Maduruoya Seed Garden

Superindentent

R B Attanayake

Supervisors

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R A Suwarnathilake
W A H Upali
M G D Placidus

AGRICULTURAL RESEARCH PROJECT

Project Coordinator

D T Mathes, F I S (Lond); B Sc; Dip Stat (Vid); Dip. Bio (Reading)

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* When more than one officer is listed under a designation, the names appear in alphabetical order. Unless otherwise stated, all Bachelor's degrees indicated in the staff list are from Universities in Sri Lanka.

** On study leave.

*** On overseas no-pay leave.

REPORT OF THE DIRECTOR

M de S Liyanage, PhD

1. GENERAL

The national coconut production showed a downward trend in 1996 with a total annual production of 2546 Mln. nuts indicating a marginal decrease of 8 percent over the previous year. This decline was mainly attributed to the adverse effect of moisture stress on the palm caused by insufficient rainfall received during the last quarter of 1995 and first quarter of 1996. Despite the lower export volume for most kernel products, especially desiccated coconut and fibre products, the total foreign exchange earnings from the coconut industry rose to Rs. 8293 Mln, showing a marginal increase of 7 percent, over the 1995 earnings. This is a reflection of the favourable prices offered to coconut products in the international market.

The three seed gardens maintained by the Coconut Research Institute (CRI) continued to make steady progress and produced 1.15 Mln. seed nuts during the year, which represent a 20 percent reduction over the previous year. This was mainly due to the severe drought experienced during January to April 1996. Of the total quantity of seednuts, as much as 98 percent was supplied to the Coconut Cultivation Board (CCB).

The project on Land Suitability Mapping for coconut supported by the Cess Fund made good progress and the preparation of soil maps for Southern coconut growing region was completed during the year. In addition, several extension and training programmes launched by the CRI during the year were supported by the Cess Fund, amounting to a total sum of Rs. 11.0 Mln.

The Research Committee met twice during the year to monitor the implementation of the new research programme. The Committee also approved several new recommendations arising from the previous five year programme, in broad areas of fertilizer application, pest management and intercropping. Having recognised the urgent need to strengthen coconut processing research at CRI, for developing new products and adding value, the Coconut Research Board (CRB) appointed a Committee to prepare an agenda for processing research and development strategies and implementation programmes for coconut. During the year, the research cadre was re-structured creating several positions to strengthen processing research activities.

After several years of negotiation, CRI was able to convince the National Plant Quarantine Committee to allow importation of limited quantities of embryos and pollen of exotic germplasm, to be used in the coconut breeding programme in

the future. This decision will no doubt provide an impetus to coconut breeders for developing new cultivars with a potential for high yields and wide ecological adaptability.

Following an outbreak of Ganoderma Root and Bole Rot Disease of coconut in the Hambantota District, a decision was taken to set up a temporary laboratory at the Agricultural Research Station at Angunakolapelessa, in order to develop control measures and to check further spread of the disease. In addition, a field survey was conducted jointly by CRI and CCB staff to assess the severity of damage to coconut palms caused by the disease and to develop an effective control programme for the entire District.

The Agricultural Research Project (ARP) funded by the World Bank continued to provide assistance to the Institute for the development of manpower and infrastructural facilities for research. The assistance provided by the ARP during the past nine years was discontinued with the termination of project activities in December. The Institute benefitted most from the project for strengthening the infrastructure facilities for research and upgrading the professional skills of research and support staff.

The CRI continued to provide technical assistance and advisory services to the Estate and Smallholder sector, particularly with regard to the differential fertilizer recommendations (DFR) and management of coconut pests and diseases. In addition, the persuasive extension programme (PEP) began to gather momentum as it proved to be an effective extension tool for convincing coconut land owners, in particular absentee landlords, to increase productivity of their land by the application of CRI technology. These services have enabled the Institute to maintain a regular and closer interaction with the coconut farming community.

During the year, nine in-house research seminars were conducted on several themes with a focus on biotechnology, soil physics, plant physiology, Ganoderma disease, economics and biometrical aspects of coconut. In addition, two research and extension dialogues were held with active participation of extension staff of the CCB. On the initiative of the Chairman, CRB, a Biotechnology Working Group was formed comprising of Biotechnologists, representing various Research Organizations in the country, to provide a common forum to discuss and exchange views of biotechnology related issues in the Agriculture sector.

The CRI estates were maintained in good order, despite the fact that an overall reduction of 15.7% in coconut production was recorded due to low rainfall experienced during the year.

The CRB appointed a sub-committee to prepare a Code of Conduct for

Research and Non-Research Executive staff of the CRI, which will serve as a useful guide in day to day administrative and management decisions.

In view of the dearth of coconut pickers' in the country a pilot project was launched by the CRI, to train unemployed youths' for this vocation with assistance of the Pannala Divisional Secretariat.

The Hon. Minister of Public Administration, Home Affairs, Plantation Industries and Parliamentary Affairs was invited as the Chief Guest for the Ceremony held at the CRI Auditorium, to award certificates of competency for forty trainees who successfully completed the training programme.

2. THE COCONUT RESEARCH BOARD

During the year, the Board functioned under the Chairmanship of Dr U P de S Waidyanatha and held seven meetings (275th to 281st).

The members of the Board of Management tendered their resignation in September on a directive issued by the Ministry of Public Administration, Home Affairs, Plantation Industries and Parliamentary Affairs. The membership of the Board and attendance at meetings upto September were as follows:

Dr U P de S Waidyanatha (Chairman)	(5/5)
Dr S B Senaratne	(3/5)
Mr P S Karunasena	(4/5)
Ms K M D L Jayatilake	(5/5)
Ms G D S C Sudasinghe	(3/5)
Mrs W T Y S Fernando	(3/5)
Mr M S M Naseem	(5/5)
Mrs P C Ratnayake (Treasury Representative)	(1/5)
Dr K S Jayasekera (Observer Member)	(2/5)
Dr M de S Liyanage (Director/CRI)	(4/5)

The new Board of Management was re-constituted by the Hon. Minister of Public Administration, Home Affairs, Plantation Industries and Parliamentary Affairs with effect from October 1996 and comprised the following members. Their attendance at the two meetings held during the fourth quarter of the year was as follows:

Dr U P de S Waidyanatha (Chairman)	(1/2)
Dr D A Nethsinghe	(2/2)
Dr P Nugawela	(1/2)
Mr T Asoka Peiris	(1/2)

Mr S Mallikarachchi	(2/2)
Mr D Guruge (Ministry Representative)	(2/2)
Mrs P C Ratnayake (Treasury Representative)	(2/2)
Dr K S Jayasekera (Observer Member)	(2/2)
Dr M de S Liyanage (Director/CRI)	(2/2)

Dr D A Nethsinghe functioned as the Protem Chairman for the 281st meeting as Dr U P de S Waidyanatha, Chairman/CRB was on overseas leave.

Dr (Mrs) C Jayasekera, Deputy Director (Research) attended the 275th meeting in her capacity as the Acting Director, in place of Dr M de S Liyanage, Director, CRI who was on overseas leave.

Mr H S Herath, Deputy Director (Adm. & Fin.) functioned as the Secretary to the Board at all meetings.

3. COMMITTEES OF THE COCONUT RESEARCH INSTITUTE

3.1 The Research Committee

During the year, Research Committee held four meetings (43rd - 46th) to review the progress of implementation of the new research programme and to approve new recommendations to the industry, based on findings of the previous research programme.

The membership of the Research Committee and attendance at meetings were as follows:

Dr U P de S Waidyanatha (Chairman)	(3/4)
Dr M de S Liyanage	(4/4)
Dr D A Nethsinghe	(4/4)
Dr K S Jayasekera	(4/4)
Mr P A S Fernando	(3/4)
Mr B R T de Tissera	(3/4)
Vidya Jyothi Dr C R Panabokke	(3/4)
Dr I V S Fernando	(2/4)
Dr N E M Jayasekera	(2/4)
Vidya Jyothi Dr R Wijewardena	(2/4)
Dr H B Kotagama	(1/4)
Dr (Mrs) C Jayasekera (Convenor)	(4/4)

The Committee recommended the appointment of following members to a sub-committee to study coconut processing research needs and prepare a

comprehensive research programme to cater to the future development of the coconut industry.

Dr M de S Liyanage (Chairman)
Dr R L Wickramasinghe
Dr (Mrs) N Ediriweera
Mr H A Thilakaratne
Mr S B Ratnayake
Prof U Samarajeewa
Dr P B T Wijeratne
Mr Gorden de Silva
Mr T K G Ranasinghe
Dr (Mrs) C Jayasekera (Convenor)

3.2 Administrative Committee

The Administrative Committee met once during the year to discuss administrative matters and advise the Board. The membership of the Committee and attendance at the meeting were as follows:

Dr U P de S Waidyanatha (Chairman)	(1/1)
Mr G Bambaradeniya	(0/1)
Mr D B J Ranatunga	(0/1)
Mrs P C Ratnayake (Treasury Representative)	(1/1)
Mrs I Sugathadasa (Ministry Representative)	(1/1)
Dr M de S Liyanage, Director/CRI	(1/1)

Mr H S Herath, Deputy Director (Adm. & Fin.) functioned as the Convenor of the Committee.

3.3 Estates Committee

The Estates Committee met twice during their field visits to CRB properties to review the progress and recommend further improvements to the estates and seed gardens.

The membership of the Committee and attendance at meetings were as follows:

Dr (Mrs) C Jayasekera (Chairperson)	(2/3)
Dr M N Fernandopulle (Member)	(3/3)
Dr R R A Peiris (Member)	(2/3)
Mrs C N K Rajapakse (Member)	(3/3)

Mr A Kurukulasooriya (Convenor)	(3/3)

3.4 Other Standing Committees

3.4.1 Provident Fund Committee

The Provident Fund Committee met regularly to attend to matters related to the administration of staff provident fund and approval of loans. Messrs D T Mathes and A H Norman were the member representation in the Committee while Mr R C M Handalage functioned as the Board's nominee. The membership of the Committee and attendance at meetings were as follows:

Dr U P de S Waidyanatha (Chairman)	(7/7)
Dr M de S Liyanage, Director/CRI	(5/7)
Mr D T Mathes	(7/7)
Mr A H Norman	(6/7)
Mr R C M Handalage	(4/7)
Mr H S Herath (Secretary)	(7/7)

An interest rate of 14.25% against the Provident Fund savings was declared for members for the year 1995.

3.4.2 Board of Trustees - Medical Aid Scheme

The Board of Trustees met regularly to attend to matters relating to the administration of the Medical Aid Scheme, which continued to provide health facilities to the staff. Mrs A de Alwis and Mr A I F Fernando were member nominees in the Board of Trustees. The Board's contribution to the scheme was Rs. 1,373,631.84.

The membership of the Committee and attendance at meetings were as follows:

Dr M de S Liyanage (Chairman)	(10/12)
Mr H S Herath	(09/12)
Mrs A de Alwis	(12/12)
Mr A I F Fernando	(11/12)
Mr P Daluwatta (Secretary)	(12/12)

Rs. 1,546,976/- was reimbursed as medical expenses during this year and the total membership at the end of the year was 375. Out of the interest received on the investment of medical aid fund, Rs. 251,850/- was disbursed among members and each received Rs. 730/-.

4. THE COCONUT RESEARCH INSTITUTE

A brief account of the research and development (R & D) activities of the Coconut Research Institute is given below.

4.1 Agronomy Division

During the year, twenty new field experiments and two new crop/farm models were set up and over thirty on-going field experiments and fourteen crop models were managed by the division. Much emphasis was given to the nutritional aspect of livestock management under coconut. In one experiment, cattle were fed with mixtures of rice straw, gliricidia and urea-treated straw as alternative feed sources. In another experiment, it has been demonstrated that *Brachiaria mutica* (grass with low nutritive quality) can be fed to goats to achieve satisfactory weight gains. Results obtained so far have indicated that a mixture of *B. mutica* and fresh gliricidia fodder gave the best weight gains (47.2%) while free grazing of *B. mutica* (control) gave 32.6% over the initial weight of goats.

In experiments conducted at five locations, cashew performed well in the fifth year of planting and did not show any adverse effects on coconut. Over 80% of the cashew trees came into flowing and produced over 1 kg of cashew nuts per tree per year. Coconut yields of other crop/farm models improved significantly over the control.

Various treatments applied to induce new root formation in Leaf Scorch Decline (LSD) palms did not show a significant improvement in nut production.

In the weed management programme, several experiments were set up to assess the effect of weeds on yield of adult palms and growth of young palms.

Application of 30-35 kg of gliricidia green matter per year has been able to supplement the total annual nitrogen requirement of coconut palm, for a continuous period of seven years. In locations with sandy loam soils, gliricidia produced over 8 kg of green matter per tree but its performance on lateritic soil was poor producing only around 2 kg per tree per year. Several new experiments were commenced to study the competitive effects of high density planting of Gliricidia and Acacia in situ on coconut yield and to estimate green matter production.

In laboratory experiments conducted to study the recovery of nitrogen from various green matter subject to composting, the highest N recovery (3.56%) was obtained from a combination of grass and gliricidia and the lowest (2.23%) from a combination of grass and cattle manure. The highest P (0.5%) and K (4.34%) levels were also found in grass and gliricidia combination.

Experiments were also conducted on the effect of micronutrients (molybdenum) and phosphate on nodule formation of grain legumes. Results of this experiment illustrated that phosphorus (60 mg $P_2 O_5$/plant) and molybdenum (1ppm Mo/plant) had a greater influence on vegetative growth and nodulation of *Vigna radiata* (mungbean) than on *Vigna unguiculata* (cowpea). In another experiment pigeon pea (*Cajanus cajan L.*) ICPL 2 (indeterminate) and ICPL-87 (determinate) were grown under 45 years and 04 years. In another study to determine growth and yield response of pigeon pea to reduced solar radiation and phosphate levels, it was found that despite possible competive effects from coconut, the recommended P level ($P_2 O_5$ - 62 kg/ha) was sufficient to produce a seed yield of 295-321 kg ha^{-1} of coconut for both varieties. Furthermore, seed yield under 45 year old plantations transmitting 65% light was reduced by 20% (ICPL-87) and 24% (ICPL-2) compared with those obtained under 04 year old plantation providing 95% light to the understorey.

Economic investigations on the performance of smallholder livestock farming under coconut revealed that the majority of farmers managed cattle as a primary activity and those having less than 2 ha of land gained an additional income of Rs. 4090 from livestock.

4.2 Genetics and Plant Breeding Division

The Genetics and Plant Breeding Division organised the "Regional Training Course on Coconut Breeding Research Techniques" during 16-28 June 1996 for six participants from Bangladesh, Myanmar, Pakistan and India, funded by the Coconut Genetic Resources Network (COGENT).

Total of 100 palms at the Isolated Seed Garden (ISG), Ambakelle, selected on the basis of progeny testing (field 11A, ISG) and long term yield stability, were used in controlled crossing programme, in order to raise planting material for the 4th seed garden to be established at Margaret Estate, Pallama.

The results of cultivar evaluation trials at Bandirippuwa and Thammenna during the year 1996 reiterated the superiority of DG x T among all crosses and stressed the importance of site specific cultivar selection for different agro-climatic regions.

Progenies arising from crossing of putative drought tolerant germplasm with Ambakelle tall evaluated at 3 sites in representative agro-climatic areas. After one year of planting Ambakelle special and Debarayaya x Ambakelle tall out performed the others. Comparison of the progenies of the three crosses Tall x Tall, Tall x Dwarf Green and Tall x San Ramon with different fertilizer treatments revealed that there was a mean increase of 8 nuts/palm/yr irrespective of the cultivar, between

the two levels of fertilizer, (half and one and a half the recommended dosage) at Ratmalagara, after 4 years of application. However, no significant interaction was observed between varieties and fertilizer levels. Fruit component studies of the 3 crosses revealed an estimated copra content of 265 g/nut, 217 g/nut and 192 g/nut in Tall x San Ramon, Tall x Tall and Tall x Dwarf green, respectively.

In the ongoing germplasm conservation programme funded by the Asian Development Bank,planting material were raised for establishing another germplasm repository at Lenawa Model Garden of the Coconut Cultivation Board. Following long years of negotiations, license for importation of coconut germplasm was issued by the Department of Agriculture Sri Lanka and arrangement will be made to import coconut pollen and embryos from safe areas of Indonesia.

The isozyme methodology has been successfully established for two enzyme systems, but realizing the restrictions in the use of isozymes, new methods have been identified through the use of DNA markers. The Council for Agricultural Research Policy has pledged its support to this programme by granting a sum of Rs. 1 110 000 for the project "Evaluation of the extent of genetic variation in the coconut germplasm using RAPD markers".

4.3 Soils and Plant Nutrition Division

The Division conducted seventeen field experiments to investigate the nutritional status of coconut, soil biology and water management in coconut lands. Four miscellaneous short-term green house and laboratory studies on soil biology and soil chemistry were also carried out to complement the data from on-going field experiments.

Experiments on nutritional studies revealed that the level of two micro nutrients, Cu and Zn were marginal in two major coconut soils viz. Kuliyapitiya and Kurunegala series, covering 83000 ha in the Kurunegala District. The occurrence of potassium and magnesium deficiencies was mainly observed on lands which had not been manured regularly. Analyses showed that the substitution of local Rock Phosphate (Eppawala Appatite) for Imported Rock Phosphate in coconut fertilizer did not significantly affect phosphate nutrition status within a four year period. Chemcial analysis of coconut sap/toddy revealed that the removal of potasium for sap production in tapping palms was five times higher than that of nitrogen and eighteen times that of phosphorus. In contrast, removal of potassium by nuts is only marginally less than nitrogen and six times higher than phosphorus.

The seasonal fluctuation in nitrate concentration of ground water in CRI estates remained within the safety limits (0-10 μg/1). But, the concentrations were

higher (4-6 μg/1) during the period October to December. It showed that the residual nitrogen in coconut lands could be leached in to ground water and get accumulated as nitrate.

Field experiments on the effect of quality and decomposition rate of organic manure on coconut yield, and different fertilizer application techniques, were continued. To prepare a biological database of coconut soils, 20 soil series of the major coconut growing area were sampled. Soil microbiological activity and microbial population were found to be low on marginal lands compared with that of productive land, suggesting that there is a need for improving the biological properties of marginal lands by the application of organic manures.

Studies on water relations revealed that coconut palm could effectively utilize water stored up to 150 cm depth in the soil. These studies further showed that water deficiency in soil would cause malfunctioning of the coconut roots leading to decline of palms. Preliminary studies revealed that placement of four drippers at a distance of 100 cm from the bole of the palm with equal distance between drippers was sufficient for wetting the entire area of the manure circle by drip irrigation. Studies on soil aeration revealed that the soil oxygen concentration less than 15% would restrict the root growth of coconut. In another study, it has been demonstrated that planting of *Acacia* and *Gliricidia* between coconut rows could loosen the hard and compact gravelly layers of marginal coconut soils. This may be used as a technique of rehabilitation of low yielding coconut lands.

Preparation of both soil maps and land suitability maps for coconut of the southern coconut growing area was completed. Compilation of a composite soil map of the entire coconut triangle and the southern coconut growing area on 1:250.000 scale was also completed. Preparation of composite land suitability maps of southern coconut growing area on the scale of 1:100,000 and composite soil map on the scale of 1:250,000 for the same region is in progress.

4.4 Crop Protection Division

Incidence of root and bole rot disease of coconut has been reported at epidemic levels from the Southern Province. Affected area was surveyed, demarcated and mapped. Disease incidence was estimated to be 10%. A temporary laboratory was set up at the Agricultural Research Station, Angunakolapelessa to work on the disease. The causative fungus of the disease has been identified as *Ganoderma sp.* and a rapid isolation technique was established. Control measures were recommended to check further spread of the disease.

A new and inexpensive trap lured with Ferrugineol (4-methyl-5-nonanone), the synthetic analogue of the aggregation pheromone of red palm weevil, was

recommended for coconut growers. This method controlled the pest effectively.

Chemically synthesized aggregation pheromone (ethyl-4-methyloctanoate) of black beetle has been tested in infested plantations and found to be of high efficacy as an attractant for both sexes of the beetle.

Studies on activity patterns of the parasitoids of coconut caterpillar indicated that in the absence of a sugar diet, fecundity and longevity of parasitoids reduce significantly. This information can be used to enhance the parasitism rate in the field by providing optimum conditions for parasitoids. Field studies have reconfirmed that the females of coconut caterpillar produce a sex pheromone which can be used in forecasting pest outbreaks.

The translocation and distribution pattern of the systemic insecticide 'monocrotophos' in the crown of mature palms revealed that the insecticide is translocated to the crown within 6 hours and a higher concentration was found in mature fronds.

Investigations on the viral pathogen of black beetle, *Baculovirus oryctes*, were continued in the laboratory and in the field. It was found that the viability of the virus in a fresh suspension and in faecal matter of infected larvae lasts for 4 hrs and 12 days respectively. Release of infected larvae to the natural breeding sites significantly reduced the damage over time.

Establishment of Turmeric and Allocacia plants in coconut nurseries had neither repellent nor toxicological effects on termites.

Assistance was provided to growers on the identification and control of pest and diseases of coconut. Over one million adult parasitoids were released to coconut caterpillar infested areas under the bio control programme of the pest. Chemical control service against coconut caterpillar was provided to 13 estates and 37 small holdings and covered 15, 487 infested palms.

4.5 Plant Physiology Division

The research programme of the Division was adjusted to accommodate studies on post-harvest storage techniques and new tapping techniques.

Preliminary research was carried out to develop a proper post-harvest storage technique to maintain the chemical composition and flavor of nut water and preserve the cosmetic appearance of king coconut to cater to the overseas market demands. The studies revealed that the perianth fall and discoloration of the skin could be reduced when king coconuts were wrapped with cling film and stored at

low temperatures (14° C - 16° C). Further experiments are in progress to confirm the above temperature regimes, to test cheap wrapping material and to select the best maturity stage for harvesting.

Selection of cultivars with a potential for high yield of toddy continued with satisfactory progress. Out of the four cultivars tested (TxT, DxT, Bodiri and Nawasi), the indigenous cultivar "Nawasi" was apparently the best sap yielder producing two liter per day, followed by D X T. High Performance Liquid Chromatography (HPLC) analysis showed that there was no significant difference in sucrose content of the sap among the four cultivars. Three new experiments were commenced at Bandirippuwa Estate to develop a biochemical technique to select high sap yielders, to elucidate the possibility of using yield stimulants that would increase flow of sap without harming the sap quality and, to improve the profitability of coconut plantations through sequential toddy tapping and nut production from the same palm.

Studies on morphology, anatomy, growth and regeneration of root system in different varieties of coconut at different ages and under different soil types were continued. Root samples were collected from adult palms. Seedlings were planted in S_1, S_2, S_3 and S_4 soil types at BE, RE, WE and ISG.

Five new experiments were commenced to determine the cellular and biochemical mechanisms, sap flow rate and production of stress hormones in Leaf Scorch Decline (LSD) palms. In studies of sap flow, whilst there was a clear reduction in sap volume and duration of sap flow per inflorescence in palms showing moderate symptoms, the total polyphenol content in sap was apparently increased.

Experiment to study the physiological and biochemical variations among different cultivars of coconut revealed that there are differences in net assimilation rate, transpiration rate, stomatal density, leaf wax content, chlorophyll content and nitrate reductase enzyme activity among the cultivars.

4.6 Tissue Culture Division

Experiments on vegetative propagation of coconut through in vitro culture of immature embryo, floral meristem, tender leaf and root explants were continued during the year. Culture of immature embryo explants gave encouraging results. The culture media were refined further to increase the incidence of somatic embryo formation and their subsequent germination. Profuse shoot proliferation was observed in several cultures. Further development of some shoots led to the production of a few plantlets.

Some of the cultured-leaf explants produced somatic embryos. However,

germination of these embryos was incomplete and inconsistent. Most of the germinated embryos gave rise to roots while a few produced calli. Embryogenic calli were obtained from cultured-floral explants. Some flower meristems produced shoot-like structures in culture.

Activated charcoal is one of the components of coconut tissue culture media. however, it is a strong adsorbent which causes undefined conditions concerning the availability of supplements in the medium. The use of activated charcoal introduces a further source of variability in culturing. Therefore, experiments were initiated to develop a charcoal-free protocol for coconut tissue culture.

Propagation of *dikiri pol* using embryo culture technology was continued. As a result of improved soil establishment, the number of *dikiri* seedlings produced during the year was significantly increased. Five of the *in vitro*-raised seedlings were planted in the field and the rest will be planted in the field early next year.

The investigations on *in vitro* screening of drought-tolerant coconut germplasm using polyethylene glycol (PEG) in culture medium were continued. Forty three seedlings (developed from zygotic embryos of Ambakelle special palms) that survived the stress conditions caused by different concentrations of PEG were hardened and are ready to be planted in the field.

Several experiments to reduce the cost of production of embryo-cultured seedlings were commenced. Attempts were made to develop suitable culture media for medium-term preservation of mature zygotic embryos of coconut.

4.7 Biometry Division

The Division continued to assist the research divisions in designing field experiments, statistical analyses, interpretation of results, use of computers and software packages, and in database management.

The palms in the calibration trial at Walpita Estate to study seasonal variation in yield parameters recorded a 6.0 % decrease in the total number of bunches and 9.1% reduction in number of nuts per palm over that of 1995. The copra yield was 2548.5 kg/ha as against 2844.5 kg/ha, recorded for 1995.

The monthly harvesting, showed 13.4% increase in number of bunches and 18.4% increase in the number of nuts as compared to two monthly harvesting. The increase for copra weight was 21.7%. The percentage fallen nuts for monthly and two monthly harvesting were 16 and 35 respectively.

Preliminary arrangements were made to commence three experiments to

compare and estimate coconut yields under four frequency levels of harvesting and two yield levels. The frequency of harvesting are; monthly, two monthly, four monthly and no harvesting but collecting fallen nuts. The yield levels of the palms were classified into low (3705 to 4940 nuts/ha/yr) and high (9880 to 12,350 nuts/ha/yr).

A survey was conducted to assess "The impact of subsidy on the Coconut Industry and Subsidy Recipients". The districts covered in the survey were Puttalam, Kurunegala, Gampaha, Kalutara, Galle, Matara and Hambantota. The distribution of subsidy materials found to be highly variable among subsidy recipients. The dropout ratio of the subsidy recipients was as high as 90 percent irrespective of the holding size, region and the period. The full benefit of the subsidy scheme was achieved only by 9% of the farmers irrespective of the scheme and holding size. The benefits with respect to new planting and under/re planting programmes were 12 and 8% respectively.

The Agri-meteorological stations at Bandirippuwa Estate, Ratmalagara Estate, Isolated Seed Garden, and Maduru Oya Seed Garden were maintained satisfactorily. A reduction of 10 to 35 percent in rainfall was observed in all four stations for the year, compared to 1995.

4.8 Extension Services Division

Under the Persuasive Extension Progrmme, seventy coconut estate development plans were prepared covering an extent of 2100 ha. Over 60% of owners of these estates have already started the implementation of development plans. Three Farm Development Officers were recruited to advise and monitor the implementation of this programme.

In order improve the knowledge and skills of coconut growers and the management staff of coconut estates, a series of one day training programme was conducted. The Division also co-ordinated training programmes for coconut growers at the request of the National Institute of Plantation Management. Attachment training and familiarization programmes were also organized for students from various educational institutions.

Two research and extension dialogues were conducted with the participation of extension staff of the Coconut Cultivation Board. To demonstrate the technology developed, the Institute participated in three exhibitions in different coconut growing areas.

Coconut Bulletin Vol 10 Nos 1/2, Pol Pawath Vol 16 ,Cocos Vol 10 and Annual Reports for 1993 and 1994 were published.

The printing section of the Institute was reorganized to function under this Division with the addition of necessary equipment. This section now cater the most of the printing requirements of the Institute. In addition to the requirements of the Institute, the Division supplied colour slides and photographs to the Regional Staff of the Coconut Cultivation Board.

4.9 Library and Coconut Information Centre

Routine services were provided throughout the year. Users were supplied with necessary information from resources within and outside the library. The staff actively participated in external networks and inter-library co-operation. Computerization of the journal holdings in the Library was commenced during the latter part of the year. The library continued to be an active member of the agricultural information network (AGRINET) with a view of sharing of resources.

4.10 Estates Management Division

The two main functions of the Division, namely production of improved quality seednuts and providing facilities for research activities were continued satisfactorily. General agronomic practices in all properties were carried out following the CRI recommendations. Due to the severe drought experienced during January to April, much emphasis was placed on soil moisture conservation practices particularly on land suitability classes 3 and 4.

All seed gardens and estates received fertilizer in accordance with the Differential Fertilizer Recommendations (DFR) based on foliar and soil analysis. Introduction of cattle for weed management in estates and seed gardens was found to be effective and economical showing a 50% reduction in weeding cost.

Cumulative coconut yield of all properties was 3,372, 579 and showed 15.7% reduction compared to yield recorded in 1995, due to low rainfall and reduced number of wet days experienced during the year. The reduction in rainfall ranged from 10% to 35% except in Maduru Oya Seed Garden. Coconut yields in Maduru Oya Seed garden and Poththukulama estate were increased by 11% and 06% respectively, as a result of the progressive addition of immature palms to mature palm stand.

During the year, 1.15 Mln seed nuts were produced from the three seed garden, out of which 98.6% was supplied to the CCB and 0.7% to the private sector. In keeping with the Government policy, food production programme was launched in all estates aimed at supplying vegetables, fruits and other food products for employees at a reasonable prices.

4.11 Administration Division

The budget allocations for the year was Rs. 71.4 million, made up of Rs. 49.8 million as Recurrent and Rs. 21.6 million as Capital Expenditure. The total revenue (excluding transport) for the year was 16.5 million. The Government grant was Rs. 48.5 million.

The Board's contribution to the Medical Aid Scheme was Rs. 1,496,659.00.

During the year, 09 Executive and 53 non-executive positions were filled. At the end of 1996, there were 364 employees in the CRI permanent staff. Regular staff meetings were held to discuss the implementation of the work programme for the year 1996. Every attempt was made to maintain good employer-employee relationship and as usual the Division continued to assist in all welfare activities.

The Board continued to extend financial assistance to the Seva Vanitha Unit, Co-operative Society, Recreation Club and Art Circle of the Institute and for conducting an English class with the assistance of the Official Language Department, for the benefit of the support staff.

Maintenance work of buildings, electricity, vehicles and machinery was carried out by the Engineering Unit.

The Institute conducted an auction of condemned articles and collected a sum of Rs. 762,920/- from the sales.

5. OUTSIDE FUNDED PROJECTS

5.1 Agricultural Research Project

The Agricultural Research Project (ARP) funded by the World Bank and administered by the Ministry of Agriculture, Land and Forestry continued its activities on strengthening manpower development for research and support staff, and providing infrastructural facilities to the Institute.

Construction of fertilizer stores and water supply and distribution installation system at Maduru Oya and over-head tank and water distribution system at Makandura were completed.

The project continued to provide financial assistance to the staff for post-graduate training. In addition, three short-term training fellowships were offered in the field of germplasm conservation, pest management and pasture management. Mr D T Mathes, Head Biometry continued to function as the acting Project Co-

Project Co-ordinator on a voluntary basis, in addition to his normal duties.

The activities of the project were terminated in December. The Project Manager and staff of the ARP should be congratulated for their continued support, and maintaining a good rapport with the Institute during this period.

5.2 Other Projects

The International Atomic Energy Agency (IAEA) extended financial support for a further period of one year, to study biological nitrogen fixation (BNF) in Gliricidia and Leucaena under the Contract Research Programme.

The Overseas Development Administration (ODA) in collaboration with the Natural Resources Institute (NRI) in U.K. continued to support the project entitled "Investigation of lethal coconut diseases of unknown etiology"

The International Plant Genetic Resources Institute (IPGRI) with assistance from the Asian Development bank continued to support the project entitled "Acceleration of collection and conservation of coconut biodiversity at risk, and evaluating existing coconut population for physiological characterization".

The Sri Lanka Council of Agricultural Research Policy (CARP) awarded a research grant in support of the project " Evaluation of genetic variation in coconut germplasm using RAPD markers".

6. ACKNOWLEDGEMENTS

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The valuable contribution made by the Chairman and Members of the Board and those who served at various committees are acknowledged with deep appreciation.

The continued support given by following organizations is also acknowledged.

* Ministry of Public Administration, Home Affairs, Plantation Industries and Parliamentary Affairs
* The Agricultural Research Project of the Ministry of Agriculture, Lands and Forestry
* Coconut Development Authority

* Sri Lanka Council for Agricultural Research Policy
* GTZ/CARP Project
* International Atomic Energy Agency
* National Institute of Plantation Management
* Natural Resources, Energy and Science Authority of Sri Lanka
* The Coconut Genetic Resource Network (COGNET)/Asian Development Bank
* Coconut Cultivation Board
* Overseas Development Administration and Natural Resources Institute, UK.
* Asia and Pacific Coconut Community (APCC)
* National Livestock Development Board
* Wayamba Plantations (Pvt) Ltd.,
* Kurunegala Plantations (Pvt) Ltd.,
* Department of Agriculture
* Pannala Divisional Secretariat

REPORT OF THE AGRONOMY DIVISION

Head - D N S Fernando, Ph.D

1. GENERAL

Priority was given for studies on animal (i.e. cattle and goats) and pasture management under coconut and evaluation of alternative feeding materials for cattle and goats. Experiments on management of in-situ grown leguminous tree species to be used as green manure for replacement of inorganic nitrogen for coconut were continued with inclusion of several new experiments in major soil classes and climatic zones in major coconut growing areas. These new experiments were especially designed to study the competitive effect of inter-planted leguminous trees (ie. *Gliricidia* and *Acacia*) on coconut when planted at higher densities.

Specially designed experiments to study soil and soil moisture conservation representing major soil classes and climatic zones were also commenced with an emphasis to give the locational specific recommendations.

Several laboratory and field experiments were conducted on composting green matter of different leguminous as well as non leguminous species abundantly available in coconut lands, effect of micro and macro nutrients on nodulation of grain legumes grown on coconut soils, and effect of reduced solar radiation available under coconut on grain legumes (ie. Pigeon pea).

Further, several aspects of socio-economic studies on management of livestock by growers in the coconut triangle and on the adaptability of fertilizer application by coconut growers were considered.

2. RESEARCH PROJECTS

PROJECT 2: REHABILITATION OF LOW-YIELDING PLANTATION

Experiment 2.2.3: Effect of cultural operations designed to induce root formation on rehabilitation of low yielding palms, Rathmalagara Estate, Madampe - 1993

During the year nut number and the female flower number of the treated palms were counted at every pick. The nut number had 11% increase with top soil at 30 cm., 27% increase with *Gliricidia* + top soil at 30 cm, 26% increase with cattle manure + top soil at 60 cm, over the control. Rest of the treatments had no effect on nut production. The female flower number was increased only in palms treated at 60 cm away with cattle manure + top soil by 11%, top soil only by 3%

and coir dust+top soil by 20%. Other treatments had no effect on flower production

Roots of coconut palms were excavated down to 2 feet at respective distances where treatments were applied, and roots were separated to primary, secondary and tertiary orders based on branching of roots. The number of roots in each root order have been compared with similar data collected in 1994 (Table 2).

D N S Fernando, K B Dassanayake & W S M A Fernando

Experiment 2.3.4: Study the effect of root pruning on palms showing drastic yield reduction due to heavy root mat formation, Madurankuliya - 1995

During the year coconut palms were fertilized with 3.0 kg of APM and 1.0 Kg of Dolomite except those in T_1 (control) and T_3 (root pruning)treatments. Harrowing was done in T2 (root pruning + harrowing once a year) and T3 (root pruning once a year only) treatments once during the year.

There were no significant yield variation among treatments.

H A J Gunathilake, D N S Fernando & I Dupathi

Experiment 1.1.3: Study the effect of root pruning on palms showing drastic yield reduction due to heavy root mat formation, Palavi - 1996

The experiment was established during the year at Palavi and the following treatments were applied.

T_1	-	Control
T_2	-	Root pruning once a year + recommended fertilizer
T_3	-	Root pruning once a year only
T_4	-	Fertilizer application only

H A J Gunathilake, D N S Fernando & I Dupathi

PROJECT NO 2: DEVELOPMENT OF LOW COST WEED MANAGEMENT SYSTEMS FOR COCONUT LANDS

Experiment 2.1.1: Identification of most economical management methods of most abundant weed species in coconut plantations and to assess the effect of weed species on yield of coconut. Isolated Seed Garden, Ambakele - 1996

The objectives of the proposed studies are to select the most economical control method(s) for weeds available under coconut and to assess the reduction of yields and effects on performance of bearing and young palms respectively.

Treatments imposed are:

T_1 - Slashing of weeds and mulching palms with slash 2 times/year
T_2 - Slashing and removing slash. 2 times/year
T_3 - Application of glyphosate 1.42 Kg of a.i/ha (Counter 4 lit/ha)
T_4 - Application of glyphosate 2.85 a.i/ha (Counter 8 lit/ha)
T_5 - Establishment of *Pueraria* as a cover
T_6 - Control (unweeded)

Treatments were applied twice during the year and growth parameters of young palms and the yield of adult palms were recorded.

D N S Fernando, A Samarajeewa, S Samarajeewa & I Costa

Experiment 2.1.2: Identification of most economical management methods of most abundant weed species in young coconut plantations and to assess the effect of weeds on growth performance of young coconut palms. Isolated Seed Garden, Ambakelle -1996

Treatments imposed are:

T_1 - Slashing of weeds and mulching palms with slash 2 times/year
T_2 - Slashing and removing slash. 2 times/year
T_3 - Application of glyphosate 1.42 kg of a.i/ha (Counter 4 lit/ha)
T_4 - Application of glyphosate 2.85 a.i/ha(Counter 8 lit/ha)
T_5 - Establishment of *Pueraria* as a cover
T_6 - Control (unweeded)

Treatments were applied twice during the year and growth parameters of young palms and the yield of adult palms were recorded.

D N S Fernando, A Samarajeewa, S Samarajeewa & I Costa

Experiment 2.1.3: Identification of most economical management methods of most abundant weed species in young coconut plantations and to assess the effect of weeds on growth

performance of young coconut plantation. Rathmalagara Research Station, Madampe - 1996

Treatments imposed are:

T_1	-	Slashing of weeds and mulching palms with slash 2 times/year
T_2	-	Slashing and removing slash. 2 times/year
T_3	-	Application of glyphosate 1.42 Kg of a.i/ha (Counter 4 lit/ha)
T_4	-	Application of glyphosate 2.85 a.i/ha (Counter 8 lit/ha)
T_5	-	Establishment of *Pueraria* as a cover
T_6	-	Control (unweeded)

Treatments were applied twice during the year and growth parameters of young palms and the yield of adult palms were recorded.

Experiment is in progress.

D N S Fernando, A Samarajeewa, S Samarajeewa & I Costa

Experiment 2.2.1: Identification of most economical and effective control method(s) for Illuk (*Impereta cylindrica*) in adult coconut plantations. Mangala Eliya Estate, Mundel - 1996

Illuk (*Impereta cylindrica*) is a perennial weed found in coconut lands mainly on sandy and sandy loam soils in Intermediate and Dry Zones of Sri Lanka. Illuk is considered as one of the most competitive weed found in coconut lands.
An experiment was initiated to identify the most economical control method(s) for Illuk, suitable for different situations and also to asses the yield losses of adult coconut palms due to the competitive effects of Illuk on coconut.

Treatments were as follows:

T_1	-	Harrowing twice a year
T_2	-	Slashing twice a year
T_3	-	Application of glyphosate at recommended rate (2.85 a.i/ha)
T_4	-	Application of glyphosate at 50% of the recommended rate
T_5	-	Application of glyphosate in the manure circle at recommended rate + slashing of the rest of the square
T_6	-	Control (Illuk uncontrolled)

All treatments were applied and yield records of coconut palms were

collected during the year. The experiment is in progress.

D N S Fernando, A Samarajeewa, S Samarajeewa & K C P Perera

Experiment 2.3.1: Identification of the most economical control method(s) for Pupala (*Vernonia zelenica*) in coconut plantations, Nimalka Estate, Welipennagahamulla - 1996

Pupula (Hin-botiya or Wal-pupula) has been reported by many growers recently as a threatening weed in coconut plantations. This has been reported earlier mainly in the most dry areas of Vauniya and Hambantota Districts. Papula is difficult to control particularly in lands with hard gravel soils and also in lands subjected to over grazing. Due to the deep root system and resistance to transpiration the weed to survive and regenerate quickly after dry periods.
An experiment was commenced to identify a successful chemical control method for the weed.

Treatments are as follows:

T_1	-	Application of paraquat (560 g a.i/ha)
T_2	-	Application of glyphosate (2.85 Kg a.i/ha)
T_3	-	Application of glyphosate (4.2 kg a.i/ha)
T_4	-	Application of 2.4 D (0.76 kg of a.i/ha)
T_5	-	Application of paraquat (280 g a.i/ha) + 2.4 D (0.76 kg of a.i/ha)
T_6	-	Application of glyphosate (2.85 kg a.i/ha) + 2.4 D (0.38 kg of a.i/ha)

D N S Fernando, A Samarajeewa S Samarajeewa & W S M A Fernando

PROJECT 3: DEVELOPMENT OF AN IMPROVED PACKAGE OF SOIL MOISTURE CONSERVATION PRACTICES FOR SOIL CLASSES 3, 4 & 5 TO INCREASE YIELD OF COCONUT BY 25%

Experiment 3.1.1 Effect of three methods of management practices on the performance of *Pueraria phasioloides* and their effects on coconut production. Saddhatissa Estate, Divulapitiya - 1992

Repeated application of treatments on the cover crop were made during the year and coconut palms were fertilized with a DFR mixture. Nut production had no significant improvement over the control (no cover crop) and several observations

made on soil parameters are presented (Table 2).

D N S Fernando, W E Tissera & I N Hemasiri

Experiment 3.2.1: Demonstration on the use of cover crops and Gliriicidia in coconut lands. Ratmalagara Research Station - 1988

Experiment 3.2.2: Demonstration on the use of cover crops and Gliricidia in coconut lands. Walpita Research Station -1988

During this year too, *Pueraria* performed poorly but *Gliricidia* produced sufficient green matter to provide the total N requirement for coconut palms. *Gliricidia* was pruned 3 times during the year. Coconut yields of palms treated with *Gliricidia* still maintained their production in par with the palms treated with inorganic fertilizer mixture (APM).

D N S Fernando M N Fernandopulle & M A Dayawansa

Experiment 3.3: Improvement of water storage capacity of soil - 1995

Of the proposed six locations, experiment was established in four locations; Minuwangoda(3.3.1), Hettipola(3.3.2), Kumarakattuwa(3.3.3) and Madampe(3.3.4). Of the established four sites, site at Madampe had to abandoned due to sudden fragmentation of the land. The other two sites (at Bingiriya and Kurunagala) will be established in 1997.

Nut yield records of existing three sites did not show any significant difference due to treatments.

H A J Gunathilake, D N S Fernando & S D J N Subasinghe

PROJECT 4: Development of a low cost manuring system for coconut utilizing organic/green manure

Experiment 4.1.1: Effect of tree management on BNF in Gliricidia and Leucaena grown under coconut - 1992

Of the two species of Nitrogen Fixing Trees (NFT), *G. sepium* was found to be a better nitrogen fixer than *L. leucocephala*, as shown by a higher amount of nitrogen fixation in whole prunings (46 g N $Plant^{-1}$) compared with 21g N $Plant^{-1}$ in Leucaena, during the year (ie. 3 years after initial pruning). However, the amount of nitrogen fixation in both species decreased over the previous year, probably as a result of nitrogen enrichment in the soil due to litter fall and sloughing of root and

nodule biomass. Percentage of nitrogen derived from the atomosphere varied from 55% - 65% in both species. Pruning of trees for increasing biomass production and nitrogen yield was found to be more effective than unpruned trees for both species, four monthly period being superior to six monthly intervals. Among two species total DM and nitrogen yield in prunings was significantly higher in *G. sepium* than in *L. leucocephals*. These results suggest that tree management practices such as frequency of pruning has a positive effect on BNF capacity in NFTS.

The experiment is in progress

M de S Liyanage, D N S Fernando & H A Abeysoma

Experiment 4.2.1: Substitution of inorganic nitrogen for coconut palms with two different sources of organic matter. Ratmalagara Research Station - 1991

Treatments have not shown significant difference over the control(no fertilizer but soils of the manure circles turned to the depth of 6"). Nut productions with *Gliricidia* treatments had slight increase (about 4%) over the control. The female flower production had a significant increase (64% over control) probably indicating the future trends in nut production with in-situ grown *Gliricidia* (Table 4). The control(no fertilizer) palms were able to maintain their yields comparable with the same of other fertilizer treatments would be an indication of the effect of residual nutrients as a result of long term manuring in the past.

The *Gliricidia* production was over 9 kg of green matter per tree and the total production of *Gliricidia* was sufficient to provide over 50 kg per palm, where as the required rate was only 30-35 kg/palm/year.

The experiment is in progress.

D N S Fernando, M N Fernandupulle & W S M A Fernando

Experiment 4.2.2: Substitution of inorganic nitrogen for coconut palms with two different source of organic matter, Sirigapatha Estate, Badalgama - 1992

Gliricidia production(in-situ) was not satisfactory during the year. The hard lateritic soil at this site affects the growth and the green matter production and which was limited to 4 kg/tree. This level of production will supply only 20 kg per palm and the balance 15 kg(recommended rate of *Gliricidia* is 30-35 Kg/palm/year) was provided from outside. However it is expected that the green matter production of *Gliricidia* would reach the required production levels before long.

Table 1. *Effect of cultural practices on nut and female flower production of low yielding palms*

Treatments	Number of nuts/palm Nuts/palm	No of female flowers/palm
1. Control	31.3	75
2. Cattle manure+Top soil at 30 cm	31.6	66(-12%)
3. Top soil only at 30 cm	35.3(11%)	60(-20%)
4. Coir dust+Top soil at 30 cm	29.3	60(-20%)
5. Gliricidia+Top soil at 30 cm	39.8(27%)	60(-20%)
6. Cattle manure+Top soil at 60 cm	39.3(26%)	83(11%)
7. Top soil only at 60 cm	32.75	77(3%)
8. Coir dust+Top soil at 60 cm	33.34(6%)	90(20%)

(Figures shown within the parentheses are the percentage difference over the control of the same column).

Table 2. *Effect of cultural practices on new root formation of low yielding palms*

Treatments	0 - 30 cm						31 - 60 cm					
	Primary		Secondary		Tertiary		Primary		Secondary		Tertiary	
	1994	1996	1994	1996	1994	1996	1994	1996	1994	1996	1994	1996
Control	245	231	84	112	312	282	173	190	90	115	189	220
Cattle manure+top soil at 30 cm	302	331	171	210	315	590	160	320	205	280	426	320
Top soil only at 30 cm	221	350	175	272	1046	994	166	161	143	301	856	690
Coir dust+top soil at 30 cm	281	245	187	181	964	781	235	202	220	165	897	512
Gliricidia+top soil at 30 cm	141	260	78	168	867	762	182	290	223	145	324	623
Cattle manure+top soil at 60 cm	91	186	127	362	673	890	85	169	81	220	533	820
Top soil only at 60 cm	112	173	61	97	399	621	286	309	118	242	609	1206
Coir dust+top soil at 60 cm	93	141	148	162	555	612	136	120	79	120	661	723

Table 3. *Effect of different management practices of Pueraria on certain physical and chemical parameters of the soil*

Treatment	Soil depth (cm)	Organic matter (%)	Soil pH (1:5)	Water holding capacity (meg/g of dry soil)	C:N ratio	Cation exchange capacity (meg/100 g of soil)
Pueraria						
Cut and add	0-30	1.58	5.2	15.81	14.3	3.90
	31-60	0.62	5.7	17.30	15.1	3.11
	61-90	0.60	5.7	16.1	16.1	2.80
	91-120	0.54	5.4	16.2	18.3	2.70
Slashing	0-30	1.68	5.4	17.21	14.0	3.70
	31-60	1.22	5.4	16.3	14.1	3.61
	01.90	0.78	5.0	16.6	15.5	2.70
	91.120	0.62	5.2	16.1	14.1	2.10
Light harrowing	0-30	1.62	5.3	16.58	12.8	3.93
	31-60	1.42	5.8	51.00	13.3	2.70
	61.90	0.60	5.8	17.00	9.6	2.23
	91-120	0.46	5.4	17.00	9.6	2.23
Control	0-30	1.12	5.0	15.30	15.6	3.26
	31.60	0.84	5.4	16.01	13.4	2.86
	61.90	0.75	5.2	16.30	19.2	2.30
	91.120	0.71	5.1	16.10	18.9	1.96

Table 4. *Effect of fertilizer and manure on yield components of coconut during 1996*

Treatments	Female flower production		Yield		Husked nut weight	
	FF/Palm	% over APM	Nuts/ Palm	% over APM	kg/nut	% over APM
Control (No fertilizer)	97.9	-	59.0	-	0.60	-
APM	101.6	4.1	61.73	4.4	0.63	5.0
Gliricidia in-situ	160.6	64.0	61.30	8.9	0.59	1.6
Gliricidia ex-situ	96.3	1.63	61.53	4.3	0.64	6.6
Cattle manure	70.5	27.9	58.3	1.19	0.56	6.6

Table 5. *Effect of fertilizer and manure on yield components of coconut*

Treatments	Female flower production		Yield		Husked nut weight	
	FF/Palm APM	% over Palm	Nuts/ APM	% over APM	kg/nut	% over
APM	109.10	-	59.3	-	0.60	-
Gliricidia in-situ	122.80	12.60	50.3	15.68	0.61	1.67
Gliricidia ex-situ	64.62	40.8	54.4	8.26	0.60	0.0
Cattle manure	127.3	16.68	60.7	2.36	0.59	1.67

Apart from a 12% increase in female flower production of *Gliricidia* treated palms over the control(APM application), treatments had no significant influence on other yield parameters so far(Table 5).

The experiment is in progress.

D N S Fernando, M N Fernandopulle, W E Tissera & K J S Perera

Experiment 4.2.3: Substitution of inorganic nitrogen for coconut seedlings with two different sources of organic matter, Bandirippuwa Estate - 1992

Treatments of the experiment are the application of YPM fertilizer, in-situ grown *Gliricidia* and cattle manure and the control had no fertilizer. The quantities of *Gliricidia* and cattle manure(dried) applied in equivalent to the nitrogen content in the YPM mixture and P and K requirements were supplemented with Saphos Phosphate and Muriate of Potash. All seedlings were provided with 500 g of Dolomite during the year.

Observations made during the year on growth performance indicated that growth up to the age of 4 years, would be more beneficial with chemical fertilizers, than *Gliricidia* and cattle manure (Table 6).

D N S Fernando, M N Fernandopulle, W E Tissera & N Hemasiri

Experiment 4.3.1. Study the effect of high density of *Gliricidia* and *Acacia* under coconut for substitution of inorganic nitrogen of coconut palms on sandy loam soil in the Intermediate Dry Zone (IL_3). Pothukkulama Research Station, Pallama - 1995

Experiment 4.3.2. Study the effect of high density of *Gliricidia* and *Acacia* under coconut for substitution of inorganic nitrogen of coconut palms on clay loamy soil in the Intermediate Dry Zone (IL_3). Bernarth Estate, Horombawa - 1995.

Two experiments were continued successfully and growth of *Gliricidia* and *Acacia* was satisfactory during the year. Collection of nut records were continued and statistical analysis have shown that non of the treatments have significant effect on coconut production so far.

Two more experiments were commenced at two other locations with the same treatments.

Experiment 4.3.3: **Study the effect of high density planted *Gliricidia* and *Acacia* under coconut for substitution of inorganic nitrogen of coconut palms an clay loam soil in the Intermediate Wet Zone (IW_3). Nilpanagoda, Minuwangoda - 1996**

Experiment 4.3.4: **Study the effect of high density planted *Gliricidia* and *Acacia* under coconut for substitution of inorganic nitrogen of coconut palms on shallow gravel (S_4) soil in the Intermediate Wet Zone (IW_3). Badalgama - 1996**

Two experiments were commenced with the following treatments.

1. Mulch with coconut fronds
2. *Gliricidia* - density 1 (16 trees/coconut square)
3. *Gliricidia* - density 2 (24 trees/coconut square)
4. *Gliricidia* - density 2 (loppings buried in 1/4 circle trenches)
5. *Acacia* - density 1 (16 trees/coconut square)
6. *Acacia* - density 2 (24 trees/coconut square)

D N S Fernando, M Bastian & M J I Costa

PROJECT 4.5: **Recovery of N nutrient from several types of green manures**

Extensive studies conducted on the use of *Gliricidia* as a green manure for coconut have proven its advantages, i.e. replacement of inorganic N provides economic benefits and improvement of soil by means of organic matter which are required in many coconut growing soils to increase the productivity . However, *Gliricidia* has not performed equally well in all coconut growing soils in different agro-climatic regions. Several other nitrogen fixing tree species (eg. *Acacia* and *Calliandra*) have shown encouraging performance under wide range of conditions. However the usefulness of these species will depend on the rate of decomposition of green matter and the rate of recovery of N in the soil. Those factors eventually decide the performance of coconut.

Composting is known to be the process which facilitates decomposition of many organic materials found in agricultural systems and adoption of this practice has several advantages over other manuring practices, especially the application of chemical fertilizers.

Two experiments were completed during the year to study the efficiency of composting on different plant materials.

Experiment 4.5.1: Study the effect of composting on N release of different green material. Bandirippuwa Estate, 1996

Green matter of four leguminous and four non leguminous plants were subjected to composting using cattle manure as a microbial medium. At the end of three months, all composted materials were subjected to laboratory analysis for available nitrogen and the following recoveries were found. The highest recovery of N was found in *Calliandra* (3.84%) and fresh coconut leaves (3.05%) and the lowest in grasses (1.72%), *Casuarina*(2.23) and *Acacia* (2.00%)(Table 7).

The experiment will be repeated to asses the availability of other nutrients (eg. P.K) as well in composted materials.

D N S Fernando, K C P Perera & P A B A Caldera

Experiment 4.5.2: Evaluation of different types of organic materials available in the coconut growing areas for composting. Bandirippuwa Estate - 1996

Many types of plant and organic materials, suitable for composting are available in the coconut triangle. Some of these materials are produced throughout (eg. grasses and legumes) and some are in seasons (eg. rice straw) and most of them are not used as manures. However all these materials are not equally suitable as manures or same are not suitable to be used in compost preparation as they have either higher or low C: N ratios. For quick and easy decomposing, plant materials should have a C:N ratio around 30. These materials can be mixed to get a required C:N ratios and several combinations of those materials were subjected to composting and at the end of the required period, the changes were observed in composted materials as shown in Table 8.

D N S Fernando, W A M D Fernando & A D Samarajeewa

PROJECT 10: Development of improved fertilizer application techniques for coconut to improve efficiency of uptake and to minimize cost

Experiment 10.1 Studies on the localized application of fertilizer in coconut on lateritic gravel soil. Rathmalagara Estate, Madampe - 1993

Localized application of APM fertilizer mixture for coconut palms was repeated during the year. Records on growth and yield parameters were maintained

Table 6. *Effect of fertilizer on growth performance of coconut seedlings during 1996*

Treatments	Girth in cm	% increase over control	Fronds number	% increase over control
1. YPM mixture	132.92	28.90	15.95	38.70
2. *Gliricidia* in-situ	117.99	14.53	13.22	14.96
3. Cattle manure	129.31	25.52	12.07	4.96
4. Control No. fertilizer	103.02	-	11.50	-

Table 7. *Percentage N in the different materials subjected to composting*

	Material used	Recovery of N(%)
Legume species		
1. *Pueraria*	Green leaves + stems	1.73
2. *Gliricidia*	Green leaves + tender stems	2.86
3. *Acacia*	Green leaves + tender stems	2.00
4. *Calliandra*	Green leaves + tender stems	3.84
Non legume species		
5. Fresh coconut leaves	Green leaves with out midribs	3.05
6. Weeds	Mixture of 4 weeds	2.71
7. *Casuarina*	Spikelets	2.23
8. Grass (*B.brizantha*)	Leaves + stems	1.72

Table 8. *Effect of composting on availability of plant nutrients of several combinations of green matter and crop residues*

Treatment	C:N ratio		Available N%		Available P%		Available K%	
	Initial	after	initial	after	initial	after	initial	after
1. Straw+ *Pueraria*	34	16	1.84	3.01	0.23	0.26	1.02	2.58
2. Straw+ Gliricidia	35	34	1.98	3.51	0.20	0.30	1.12	2.68
3. Straw+cattle manure	39	19	1.09	2.60	0.27	0.32	0.81	1.39
4. Guinea-B+ Pueraria	38	17	2.33	2.91	0.25	0.51	1.73	4.82
5. Guinea-B *Gliricidia*	33	14	2.77	3.56	0.27	0.51	2.24	4.36
6. Guinea-B cattle manure	34	20	1.69	2.23	0.39	0.44	1.58	1.97

Table 9. *Coconut yield in difference crop/farm models*

Site	Agro ecological zone	Crop/farm model	Coconut/crop/ animal combination Intercrops	Coconut yield nuts/palm Yield of 1995 With Intercrops	No Intercrops	Yield of 1996 With Intercrops	No Intercrops
Divulapitiya	WL_3	Crop	Coconut+coffee+ pepper	70	47	65	56
Walpita-A	WL_3	Crop	Coconut+pepper+coffee	84	85	67	58
Walpita-B	WL_3	Crop	Coconut+pineapple+ banana	99	55		
Udulla	WL_3	Crop	Coconut+yam	34	28	33	30
Kandanegedara	WL_3	Crop	Coconut+cashew+ cassava	61	39	44	35
Kahatawila-I	IL_1	Crop	Coconut+pepper+coffee+ ginger	63	42	38	26
Kahatawila-II	IL_1	Crop	Coconut+pineapple+ ginger	39	36	56	43
Rathmalagara	IL_1	Farm	Coconut+pasture+ NFT's+goat	82	74	57	49
Deegalla	IL_1	Crop	Coconut+cashew+ lime+NFT's	36	35	34	30
Divulwewa	IL_1	Crop	Coconut+mango+ lime	59	41	36	48
Madurupitiya	WL_3	Farm	Coconut+pepper+ pasture+NFT's+cattle	59	41	36	48
Katuneriya	IL_3	Farm	Coconut+coffee+ pasture+NFT/s+cattle	72	66	51	44
Gaspe	WL_3	Farm	Coconut+pasture NFT/s+cattle	66	54	60	43
				78	66	55	39

Table 10. *Performance of Intercrops at on-farm models in the Wet & Intermediate Zone - year 1996*

Location	Agro-ecological Zone	Size of the Model	Crops	Yield of Intercrops	
Divulapitya	WL_3	0.2 ha	Coconut+pepper+coffee	Pepper Coffee	337 kg/ha 21 kg/ha
Walpita	WL_3	0.1 ha	Coconut+pepper+banana	Pepper Banana	1400 kg/ha 1000 kg/ha
Kahatawila-I	IL_1	0.4 ha	Coconut+pepper+coffee+ ginger	Pepper Coffee	247 kg/ha 40 kg/ha
Kahatawila-II	IL_1	0.4 ha	Coconut+pineapple+ ginger	Pineapple	9500 fruits/ha
Kihulwala	WL_3	0.4 ha	Coconut+banana+ ginger+colacacia	Colacacia	565 kg/ha
Kandanegedara	WL_3	0.3 ha	Coconut+cashew	Cashew	125 nuts/tree (3 years old)
Deegalla	IL_1	0.4 ha	Coconut+cashew+ lime+NFT's	Cashew NFT's	175 nuts/tree 2166 kg/ha
Divulwewa	IL_1	0.4 ha	Coconut+mango+lime+ Banana	Mango	1500 fruits/ha

Table 11. *Performance of Animals & Intercrops on-farm models in the Wet and Intermediate Zone - 1996*

Location	Agro-ecological Zone	Size of the Model	Crops/Animals	Yield of Milk & Intercrops	
Madurupitiya (S_3)	WL_3	0.8 ha	Coconut+pepper+coffee+ pasture+cattle	Pepper Coffee Milk	235 kg/ha 22 kg/ha 2266 l/year
Gaspe (S_4)	WL_3	0.4 ha	Coconut+pasture+cattle	Milk	4900 l/year
Katuneriya (S_1)	IL_1	0.5 ha	Coconut+coffee+pasture+NFT's	Coffee Milk	35 kg/ha 1500 l/year

during the year. There were no significant differences in growth performance in nut production of palms due to the treatments. Generally, growth performance of whole plantation of the experimental field is deteriorating rapidly. The hard lateritic gravelly nature of the soil and the effects of recurrent droughts are the possible reasons for this condition.

However, coconut roots were found to be significantly greater in pits(treated with organic materials) than in untreated palms.

The experiment will be terminated soon.

D N S Fernando, M N Fernandopulle & R Marasinghe

PROJECT 18: **Improvement of small holder coconut farming systems with annual/perennial crops in the wet zoneaiming at maximizing farm income and sustainable production.**

Experiment 18.1 **On farm cropping models in the Wet and Wet Intermediate Zone of coconut - 1987**

Collection of the agronomic and economic data from seventeen existing models is being continued. This year too, nut yield records indicated that there was beneficial effect on coconut with high intensive cropping/farming under moderate management (Table 9). However, general nut production declined in this year compared to those of 1995 except in the crop model at Kahatawila II (Coconut+pineapple+ginger). This may be due to conservation of moisture by coir dust which was used for pineapple. Further none of the other models had coir dust for moisture conservation.

During the year, pepper performed remarkably well and produced over 1.0 kg/vine/year in those crop/farm models at Dulapitiya, Walpita and Madurupitiya. Yield performance of coffee in Dulapitiya and Kahatawila was continuously poor and the maximum yield per plant was 150 g/year. Cashew was introduced to crop models (3 rd year onward) at Kadanegedara and Deegalla, and showed promising good yield (Table 10).

Generally farmers prefer banana which produced over 150 fruits/bunch. However, the spread of Panama disease was found in some places. The highest rate of return was given by pineapple as 11.5 at Kahatawila-2 model. The economic benefits of high density planting (21000 suckers/coconut ha) of pineapple over the traditional planting density of 10500 suckers per coconut hectare was observed. There was a reduction of production cost per fruit, and a reduction of diseases incidence due to short cultivation cycle(i.e. 2 year) (Table 11). Among other crops,

cassava and ginger were more popular particularly in crop models at Urapola where those crops were planted with Rambutan and replanted coconut.

Amongst the farm models integrated with milking cattle, the model at Gaspe produced the highest milk yield of 4900 lit/year from 6 cattle. The extent of the farm model was extended by the farmer by increasing the number of animals.

H A J Gunathilake, S D J N Subasinghe & K D D Appuhamy

Experiment 18.2: Intercropping coconut with selected medicinal plants, Walpita Research Station, Walpita (a collaborative trial with CISIR).

During this year the effect of nitrogen and potassium fertilizers on growth and yield of Komarika (*Aloe vera*), Ratnetol (*Plumbago indica*) and Tippili (*Piper longum*) grown under coconut was studied. The study was composite with four levels of nitrogen (0, 20, 40 & 100 kg N/ha and two levels of potassium (0 & 60 kg K_2O/ha). All plants were established in a Randomized Complete Block Design with three replicates.

Results showed that N_2K_1 fertilizer level was the best for growth of *Alove vera, Plumbago indica* responded positively for potassium (60 kg K_2O/ha) but not for any levels of Nitrogen, while *Piper longum* produced the highest number of pods/plant in N_2K_1 fertilizer level.

H A J Gunathilake, I Duipathi & M A Dayawansa

PROJECT 19: Improvement of small holder coconut farming systems with annual/perennial crops in the Intermediate & Dry Zone aiming at maximizing farm income and sustainable production.

Experiment 19.1 Study the suitability of coconut/cashew mixed cropping in the dry zone. Kamandaluwa Estate, Andigama - 1991.

So far, canopies of coconut and cashew in all four planting systems do not overlap each other. *Acacia* and *Gliricidia* trees established as a source of green manure and ground cover of the ground to control Illuk were maintained . All cashew trees came into flower during this year and gave a mean yield of 2.5 kg of cashew nuts per tree/year.

The experiment is in progress.

H A J Gunathilake, S D J N Subasinghe & E M G Banda

Experiment 19.3: Performance of grafted cashew under coconut. Rathmalagara Estate, Madampe - 1995

Air layered cashew plants showed 100 percent flowering within a year of establishment (height is 60 cm) however none of the plants produced nuts. Twenty five percent of the bud-grafted cashew plants also came into bearing within a year and produced few nuts. Cashew seedlings raised from nuts did not flower yet.

H A J Gunathilake & S D J N Subasinghe

PROJECT 20: Development of small holder coconut farming system with livestock(cattle) integration in the wet zone

Experiment 20.1 Utilization of animal husbandry to improve the productivity of coconut lands (small farmers). Rathmalagara Research Station, Madampe - 1996

Feed scarcity especially in dry season adversely affects the productivity of animals and the income of the farmer. Natural pastures found in coconut lands have a very low productivity and their nutritive value is low. Therefore it is important to investigate the possibilities of improving pasture productivity within limited land extent. Experiments conducted earlier (Liyanage et. al., 1993) have shown that integration of high productive grasses and legumes under coconut increases the carrying capacity of the land, but the pasture productivity declined during dry weather. Therefore, improvement of such systems with inclusion of more leguminous tree species, which are able to continue green matter production through out under proper management practices are proposed.

Treatments:
- T_1 - Establishment of fodder (*P.maximum*) and legume (*Gliricidia*) trees at high density)
- T_2 - Rotational grazing with cattle (2 heads/ac).

Six blocks, each with 24 adult coconut palms, were planted with above species and after successful establishment, rotational grazing will be adopted.

D N S Fernando, R Marasinghe & M D V Saparamadu

Experiment No. 20.2: To study the competitive effects of improved pastures on coconuts and to find a suitable fertilizer recommendation

for pastures grown under coconut. Pothukkulama Research Station, Pallama - 1996

Integration of improved pastures in coconut lands is a primary requirement to increase the animal productivity in coconut/livestock systems. However, improved, high productive grasses and fodder species would affect the coconut production imposing competitive effects on coconut for soil moisture and nutrients. However, this situation could be avoided through proper soil moisture conservation practices and adaption of balance fertilizer mixtures for coconut and pasture. The requirements of nutrients would vary with the pasture species and also with the soil and climatic factors.

Therefore, experiments were designed to study the fertilizer requirements of improved pastures grown under coconut in major soil classes under the main agro-climatic conditions. Further experimentation will be done on the findings of this experiments to study the effect of different grass species on the performance of coconut.

Treatments:

T_1	-	3 pasture species (*B. milliformis/B.ruziziensis, B. brizantha, P.maximum*)
T_2	-	3 levels of N fertilizer
T_3	-	3 levels of P fertilizer
T_4	-	3 levels of K fertilizer
T_5	-	3 levels of Mg fertilizer

The experiment was commenced during the year with land preparations and soil testing etc. and will be planted during yala 1997.

D N S Fernando, R Marasinghe & W R O Fernando

Experiment 20.3: Growth performance of cattle fed on alternative feeding materials for grasses. Rathmalagara Research Station - 1996

Pasture productivity follows a seasonal pattern in Sri Lanka especially in the Dry and Dry Intermediate Zones due to the bimodal rainfall pattern. In addition, most of the coconut growing soils are mainly sandy in nature and has a poor water holding capacity. As a result, pasture productivity under coconut decreases considerably and affect the animal productivity and maintaining a continuous production will be difficult. As a possible solution, alternative feeding materials have

been introduced (eg. urea treated straw). The most important factors of such introduction would be the availability, cost and their effect on animal performance.

A series of experiments was proposed to study the effect of several alternative feeding materials on growth performance of cattle managed under coconut.

Adopted treatments were as follows:

T_1 - *Gliricidia* 50% + improved pasture 50% (cut and feed)
T_2 - *Gliricidia* 50% + urea treated straw 50%
T_3 - Pasture 50% + urea treated straw 50%
T_4 - Free grazing on improved pastures

The improved pasture species in this experiment was a mixture of *B.milliiformis* and *B.brizantha* and 3 months old (approximately) bull calves (Jersy x Local) were used in the experiment replicated for 3 times. The amount of feeding materials was increased with the increasing intake. The first experiment was continued for six months as an initial study and following results were observed (Table 13).

D N S Fernando, R Marasinghe & W A Hemawardana

PROJECT 21: Development of small holder coconut farming system with livestock(cattle and small ruminants)integration in the intermediate and dry zone

Experiment 21.1: Selection and evaluation adopted, stable, high yielding and high quality cultivars of pasture grass species of *B.* brizantha, P maximum and P. purperium, 1991 (Inter Institutional Research Project)

Cultivated all twelve genotypes of *B. brizantha*(with high dry matter digestibility and in-vitro organic matter digestibility) and produced sufficient planting material to be transplanted under coconut.

However the funding for the project(IIRP) is over and those materials will be distributed among the selected farmers for further multiplication.

S G J N Senanayake & D N S Fernando

Experiment 21.3.1: Improvement of dry matter production of *B.mutica* grown in abandoned paddy fields in the coconut triangle through a balanced fertilizer mixture. Pothukkulama Research Station - 1996

B.mutica is a perennial grass grown under tropical climatic conditions. Performance of the grass is better under high soil moisture conditions, and even on stagnated water this species performed well and has been successfully adapted to such conditions. Abandoned paddy fields and shallow water bodies in the coconut triangle are already infested with this grass. Currently, a considerable extent of paddy fields in the Wet and Wet Intermediate Zones are not cultivated due to low profitability. On the other hand, the demand for animal products in the country is steadily increasing. However due to limited land availability for pasture cultivation, expansion of animal productions has become difficult. Therefore the conservation of abandoned, paddy fields for pasture cultivation would be useful. *B.mutica* has a greater potential under such conditions but proper management practices such as balanced fertilizer mixtures have to be introduced.

An experiment was initiated with the following fertilizer treatments, in an abandoned paddy field, already having heavy growth of *B. mutica*, at the Poththukkulama Research Station.

T_1	-	Control (no fertilizer)
T_2	-	51 (N) + 31 (P_2O_5) + 77 (K_2O)
T_3	-	102 (N) + 31 (P_2O_5) + 77 (K_2O)
T_4	-	153 (N) + 31 (P_2O_5) + 77 (K_2O)
T_5	-	51 (N) + 31 (P_2O_5) + 77 (K_2O)
T_6	-	102 (N) + 31 (P_2O_5) + 77 (K_2O)
T_7	-	153 (N) + 31 (P_2O_5) + 77 (K_2O)

Nitrogen for T_2 T_4 treatments were applied as urea and for T_5 T_7 were applied with goat manure, and P_2O_5 and K_2O requirements were supplemented with Sapos Phosphate and Muriate of Potash.

The grass was sampled at monthly intervals for dry matter assessment.

D N S Fernando, R Marasinghe & W R O Fernando

Experiment 21.3.2: Improvement of dry matter production of *B.mutica*, grown under coconut on Madampe series soil. Bandirippuwa Estate (1996)

Naturally grown *B.mutica* under coconut were fertilized with 4 levels of N fertilizer to evaluate the dry matter production. Phosphorus and potassium fertilizers were applied at recommended rates for *B.mutica* grown under coconut. During the year only 3 samples were collected as dry conditions affected the growth of the grass and the experiment will be recommended with rains.

Table 12. *Effect of different levels of N and K on the yield of Aloe vera, Plumbago indica and Piper longum*

Fertilizer Treatment	*Aloe vera* (Number of levels/plant)	*Plumbago indica* Weight of dry zones (kg/ha)	*Piper longum* Number of pods/plant
N_0K_0	14 a	888 b	40 a
N_0K_1	18 a	2556 a	55 ab
N_1K_0	20 a	2039 ab	53 ab
N_1K_1	25 a	2432 a	70 ab
N_2K_0	26 a	2166 ab	99 b
N_2K_1	35 b	2533 a	141 c
N_3K_0	34 b	1619 ab	70 ab
N_3K_1	31 b	1780 ab	79 ab

(Within each column, values showing a common letter do not differ significantly at P = 0.05)

Table 13. *Effect of different feeding treatments on performance of bull calves*

Treatments	Feed intake Animal/day(kg) 1 Three months	2 Three months	Total weight gain/animal/ 6 months(kg)	Weight gain per animal/ day (kg)
1. *Gliricidia* 50% + pasture 50%	15.82	23.09	121.3	0.88
2. *Gliricidia* 50% + treated straw 50%	10.09	16.62	33.0	0.24
3. Urea treated straw + pasture 50%	12.25	18.09	57.3	0.41
4. Free grazing (*B.milliiformis* + *B.brizantha*)	-	-	84.3	0.61

T_1	-	Control 0 (N) + 50 (P_2O_5) + 100 (K_2O)
T_2	-	50 (N) + 100 (P_2O_5) + 50 (K_2O)
T_3	-	100 (N) + 50 (P_2O_5) + 100 (K_2O)
T_4	-	150 (N) + 50 (P_2O_5) + 100 (K_2O)
T_5	-	200 (N) + 50 (P_2O_5) + 100 (K_2O)

D N S Fernando, R Marasinghe & Y M Chandrasiri

Experiment 21.4.1: Growth performance of goats fed on *B.mutica* pasture. Pothukkulama Research Station - 1996.

Green matter of *B. mutica* contain more moisture than in any other introduced grasses to Sri Lanka. Earlier observations made on goats fed with only *B.mutica* showed that their performance were poor. The main reason for this would be the higher intake of water and lack of sufficient nutrients, and if the grass is mixed with another grass (hay or straw would also be useful) with less moisture, the live weight gain of animals would be better. Under free grazing systems such a mixing takes place unintentionally and the live weight gain is satisfactory.

Experiment was initiated on goats with the following treatments.

T_1	-	Free grazing on *B. mutica* and other grasses (*B. brizantha* and *B. milliiformis*)
T_2	-	*B. mutica* with *Gliricidia* (in a ratio to balance the feed requirement according to the body weight)
T_3	-	*B. mutica* with straw (as at T_2)
T_4	-	*B. mutica* with grasses (as at T_2)
T_5	-	*B. mutica* (dried overnight) + *Gliricidia*

Results produced so far are presented in the Table 14.

D N S Fernando, R Marasinghe & W R O Fernando

PROJECT 23.0 (17): PREMATURE DECLINE OF PALMS

Experiment 17.4 (23.0.4): Studies on effect of root pruning and incorporation of organic manure on LSD palms. Walpita Research Station - 1989

During the year nut yield records were maintained and also measurements on kernel thickness of nuts were recorded at three alternative picks. A palm by palm

survey was carried out to estimate the scorching effect of fronds. The survey results showed that scorching of leaflets had no significant effect from the treatments. However nut production of palms at incipient stage of symptoms have shown some recovery due the treatments. This effect was more prominent in palms grown on sandy loam and clay loam soils.The similar effect was found only in palms grown on gravel soils treated with cow dung. Palms at mild and moderate stages on other soil types had favourable effects with coir dust treatment. Further, treatments of *Gliricidia* and cow dung favourably affected the moderate palms (Table 15).

Palms at mild and moderate stages in gravel soil had favourable effects in weight of copra and nut number per palm due to *Gliricidia* application, but coir dust affected only on palms at mild stage (Table 16).

Except cattle manure and same soil treatments, kernel thickness was increased over the control as a result of other treatments in incipient stages. This effect was hardly visible in other stages of scorching (Table 17).

Results indicated that if palms could be diagnosed early for LSD symptoms and treated with organic manure a greater, recovery would be possible.

D N S Fernando, A Ninanayake, M Bastian & W P Peiris

3. MISCELLANEOUS STUDIES

Experiment M-1. Effect of different soil types on early growth and nodulation of *Gliricidia sepium*

Gliricidia seedlings were grown in pots with four different soil types (i.e. sandy, sandy loam, gravel and clay loam) and were treated with urea (0.5 g/plant) and saphos phosphate (1.0 g/plant), to study the effect of N and P nutrients on growth and nodulation of *Gliricidia*. Growth performance of gliricidia seedlings was higher in sandy loam and clay loam soils, than other soil types. *Gliricidia* grown on clay loam soil had greater effect of N fertilizer than any other soil type. The response to N and P fertilizers in sandy and gravel soils was not clear. Application of N and P at early stage showed a significant increase in nodulation in sandy loam soil but this effect was not found in other soil type.

D N S Fernando, V Jayamanna, I Vipulasena & W P Peiris

Experiment M-2. Effect of in-situ grown *Gliricidia* and goat manure on yield of coconut grown on sandy loam soil in the Dry Intermediate low country (IL_3). C.S. Estate, Mundal - 1994

Table 14. *Effect of different feeding mixtures of B mutica on growth of goats*

Treatments	Initial body weight(kg)/ animal	Total weight gain 1st 3 months	2nd 3 months	Dung production(kg)/animal 1st 3 months	2nd 3 months
Free grazing	23.0	3.0	4.50	25.00	69.90
B.mutica + *Gliricidia*	21.0	1.20	6.90	47.60	97.30
B.mutica + straw	22.8	3.45	7.50	39.30	91.70
B. mutica + grasses	19.7	4.90	4.40	19.0	47.0
B. mutica(dried overnight) + *Gliricidia*	17.0	7.00	5.50	18.10	57.50

Table 15. *Effect of organic matter on nut production(nuts/palm) during the year*

Treatments	Healthy		Incipient		Mild		Moderate	
	Gravel	Other	Gravel	Other	Gravel	Other	Gravel	Other
Control	43.33	52.00	33.00	54.33	32.50	18.83	36.66	27.58
Gliricidia	61.33	59.54	51.00	65.33	8.50	25.33	23.00	21.32
Cattle manure	43.00	59.66	42.67	38.67	22.00	28.67	29.75	16.59
Coir dust	66.33	42.00	37.67	60.67	30.00	53.00	9.00	34.89
Same soil	55.67	46.77	40.33	47.33	24.00	51.50	23.00	19.10

Table 16. *Effect of organic matter on copra production (kg/palm) during the year*

Treatments	Healthy		Incipient		Mild		Moderate	
	Gravel	Other	Gravel	Other	Gravel	Other	Gravel	Other
Control	8.23	9.36	7.26	9.77	4.88	2.25	4.40	4.41
Gliricidia	11.65	11.31	7.14	10.45	0.68	3.29	1.84	2.34
Cattle manure	7.74	9.55	7.68	6.96	1.54	3.15	4.46	0.99
Coir dust	12.60	7.98	4.52	12.94	4.80	9.01	0.45	3.83
Same soil	9.46	8.36	7.26	7.00	2.88	9.27	2.07	2.29

Table 17. *Effect of organic matter on kernel thickness (cm) during the year*

Treatments	Healthy		Incipient		Mild		Moderate	
	Gravel	Other	Gravel	Other	Gravel	Other	Gravel	Other
Control	1.22	1.12	1.34	1.26	1.20	1.10	1.11	1.05
Gliricidia	1.27	1.27	1.15	1.26	1.23	1.10	1.07	1.02
Cattle manure	1.19	1.23	1.24	1.26	-	1.18	1.24	1.11
Coir dust	1.28	1.25	1.27	1.37	1.16	1.30	1.23	1.05
Same soil	1.23	1.28	1.25	1.19	1.19	1.26	1.03	1.12

Table 18. *Effect of different mulching materials on properties of sandy loam soils*

Treatments	Available N(NHN+NON) (micro g/g)		Soil pH (1:5)		CO_2 evolution (Mg/g/hr)		Fungal colonies x 10^3/g		Bacterial colonies x 10^5/g	
	1 month	4 month	1 month	4 month	1 month	4 month	1 month	4 month	1 month	4 month
Control	5.185	3.051	5.93	5.68	1.886	1.988	8	11	6	9
Straw	20.967	30.381	4.64	4.44	5.354	8.104	18	62	15	54
Casuarina	22.631	27.663	4.78	4.65	4.174	4.046	23	42	47	48
Calliandra	21.574	20.172	4.81	4.89	2.944	7.663	17	49	11	39
Coconut leaves	17.949	26.961	4.76	4.56	2.335	4.886	17	26	13	25
Acacia	17.286	27.836	4.82	4.80	2.335	4.852	15	27	16	35
Grass	13.601	22.905	4.65	4.34	3.896	7.070	21	47	14	49
Gliricidia	23.681	35.602	4.43	4.26	3.390	7.511	20	58	15	63
White polythene	30.961	36.731	5.70	5.62	2.171	2.725	15	13	14	13
Black polythene	31.731	34.449	5.52	5.37	2.052	2.271	12	14	11	15
Rubber + coir	26.232	29.203	5.28	5.12	2.513	4.015	18	17	6	13

Table 19. *Effect of solar radiation and P_2O_5 levels on seed production of 2 pigeon pea varieties*

Variety	Under 5 year old plantation (65% solar radiation)			Under 45 year old (90% solar radiation)		
	P_2O_5 0kg/ha	P_2O_5 62.1kg/ha	P_2O_5 124.2kg/ha	P_2O_5 0kg/ha	P_2O_5 62.1kg/ha	P_2O_5 124.2kg/ha
ICPL-2	303	422	424	221	321	337
ICPL-87	181	368	356	150	295	341

Variety ICPL-2 produced the highest yield under both light regimes and the production of ICPL-2 was 16% greater under higher light level than under low light level. Variety ICPL 87 had only 9% yield increase under higher light level.

The study was commenced as a non replicated trial and treatments were:

T_1 - Application of *Gliricidia* in-situ grown
T_2 - Application of *Gliricidia* from ex-situ
T_3 - Application of *Gliricidia* goat dung
T_4 - Application of *Gliricidia* APM

All organic treatments were supplemented with P and K fertilizers. Experiment is in the early stages and treatments had no effect sofar. Experiment is in progress.

D N S Fernando & W R O Fernando

Experiment M-3 **Study on the effect of different mulching materials on properties of sandy loam soils. Bandirippuwa Estate - 1996**

Study was conducted to evaluate the effect of ten different materials on soil qualities when used as a ground mulch. Materials were, green matter of *Casuarina, Calliandra, Acacia, Gliricidia,* grasses (Guinea B), dried coconut leaves, white and black polythene and rubber-coir mat (thickness of 2.5 cm). Except, polythene and rubber coir mat, other materials were used in equal quantities per unit area (4 kg/sq.m). Soil was analyzed at the begin and at the end of 4 month period and results are summarised in Table 18.

D N S Fernando, N A Tennakoon & H L A P Liyanage

Experiment M-4 **Constraints and possibilities for livestock production under coconut cultivation at Chilaw region - 1996**

Majority of farmers do not practice animal husbandry in the coconut triangle despite the economic benefits achieved through increasing efficiency of land use. The existing programmes to develop the coconut small holder sector has not been successful and it is important to study the constraints and possibilities available to improve the livestock production under the coconut cultivation. Hundred livestock farmers were selected from three villages in the Chilaw region and data were collected through a questionnaire.

All farmers interviewed owned coconut lands. The average highland per head was about 0.4 ha and about 12% had paddy fields of 0.4 ha on average. All farmers reared cattle for milk and 25% of the farmers were engaged in poultry. About 9.3% reared goats of local breeds. At the time of survey twenty seven farmers had 3-4 cows, and 5 hand 2 cows, and about 26 had 1-2 heifers. The

majority of farmers had over 5 years of experience in livestock and over 60% had European cross breeds (Jersey, Ayrshire and Friesian) and 26% had Indian crosses (eg. Sahiwal). Over 30% of cattle were fed by stall feeding and about 10% were only on grazing, the rest were on both systems. The majority of farmers (75%) used artificial insemination (AI) for superior progeny and the rest were natural breeding. Majority of cows gave 1-3 litres of milk and 14% gave 3-5 litres. Only 7% gave over 10 litres per day. The major constraints for dairy farming was high feed cost (47%) seasonal pasture availability (38%) and shortage of land for pasture cultivation (15%).

S A D W Priyankara, D N S Fernando & S Samarajeewa

Experiment M-5: Economic performance of small holder livestock farming under coconut

Most coconut lands are cultivated as monoculture. Although favourable climate & other resources are available growers do not wish to practice either intercropping or livestock farming. These practices have been proven as one of the two most profitable activities to increase the productivity of coconut lands. The existing programmes to develop specially the coconut small holder sector include a package of farming activities. Pasture production & cattle farming under coconut plays an important role in meeting the country's milk & protein needs.

A study was carried out with the objectives of;

- to identify existing livestock farming situations around CRI
- to identify constraints & potentials for livestock farming & to assess the adoption of technical know now generated at the CRI.

For the purpose two boundary villages of the CRI (Haldanduwana & Bandirippuwa) were selected to do a sample survey. A sample of 24 farmers were selected, who were registered at the milk collection centre at Lunuwila. A detailed questionnaire was used to collect information by making multiple visits to each farmer.

This study revealed that the small holder farmers have a potential to integrate livestock to enable successful use of coconut lands. But due to the lack of technical knowledge on improved management practices they are not getting optimum benefits. Therefore further measures should be taken to assist these farmers to upgrade their farming activities.

L A N P Liyanaarachchi, D N S Fernando & S Samarajeewa

Experiment M-6: An economic Investigation of fertilizer use in coconut sector

Among the many factors fertilizer input plays an important role in increasing the productivity of coconut. Currently fertilizer application on coconut is in a declining trend.

Therefore, this study was carried out to determine the adoption rate of fertilizer application & to find out socio-economic factors responsible for not applying fertilizer. For the study a random sample of 60 coconut growers were selected from two coconut growing areas; Lunuwila in Puttalam District & Weeraketiya in Hambantota District. A pretested structured questionnaire was used to collect information by visiting each coconut grower.

This study revealed that communication channel between extension & the target group (grower) is not up to satisfactory levels in both areas considered. Specially this is a problem in small holdings. Therefore a proper information dissemination system must be introduced, to get the maximum benefits of research recommendation on coconut.

S D Rajapksha, D N S Fernando & W P Peiris

Experiment M-7: Growth and yield of selected food legumes under coconut. Bandirippuwa Estate - 1996

Pulse crops have the ability to thrive under a wide range of soils and climatic conditions, and with their rapid growth and early maturity, food legumes fit in well to the rainfall pattern in the intermediate and wet zone of Sri Lanka where coconut is cultivated.

A study was conducted with two mungbean (*Vigna radiata*) varieties (MI 5 and Harsha) and two cowpea (*Vigna unguiculate*) varieties (Hawari and Polon ma), cultivating them under coconut (solar radiation was 58% of total) and in the open. Fertilizer (NPK mixture) was applied at recommended and 1 1/2 times the recommended dosage and growth and yield parameters were collected for a period of 4 months.

Compare with yields under total sunlight *V.unguiculata* and *V. radiata* had 40% and 60% yield reductions respectively under coconut.This indicates that *V.unguiculata* has greater potential as a intercrop with coconut than *V. radiata.* However the yield reduction in variety Harsha of V. radiata was less compared to the same of MI 5 under coconut, indicating selection of suitable varieties for such conditions have a potential.

D N S Fernando, I Wijebandara & I A N Hemasiri

Experiment M-8: **Effect of Eppawala Rock Phosphate on early growth performance of *Acacia auriculiformis* and *Panicum maximum* grown on loamy and sandy soils. Bandirippuwa Estate - 1996**

Due to the availability of better soils, climate and infrastructure, coconut triangle can play a major role in animal husbandry.In these areas, one of the major constraints faced by the farmers is scarcity of animal feed. Although several species of grass and legumes suitable for animal feeding have been introduced, their productivity under coconut seems to be unsatisfactory, due to lack of application of required nutrients to fodder as well as for coconut. The main reason for this is the high cost of fertilizer, which are almost totally imported to the country. However, phosphate is available in the country as a rock phosphate, which has not been considered as a suitable material mealy due to its low solubility. However, sufficient research work has not been with local rock phosphate, and therefore a pot experiment was conducted to evaluate its suitability on grasses and legumes. Two major soil types were used in the study with three levels of triple super phosphate(TSP) and Eppawala rock phosphate(ERP).

Results have shown that initial dry matter productions of species in both soil types were significantly grater(approximately 55% in both species) in plants with TSP, than with ERP. However, at the final harvest(after four months) the reductions in dry matter production of plants with in ERP were only 35% in *P. maximum*(Green panic) and 30% in *Acacia*, indicating a possibility of replacing TSP with ERP for fodder production possibly with a booster dose(ie. TSP) at planting.

W G C W de Silva, D N S Fernando & P A B A Caldera

Experiment M-9: **Performance of pigeon pea (*Cajanus cajan*) under coconut. Rathmalagara Research Station - 1996**

Pigeon pea (*Cajanus cajan*.L) is one of the major grain legume crops of the tropics and sub tropics. Endowed with several unique characteristics, it finds an important place in the farming systems adopted by small holder farmers in large number of developing countries. Besides its main use as dhall, its tender, green seeds are used as a vegetable, crushed dry seeds(contain 25% protein) as animal feed, green leaves as fodder stems as fuel wood and to make baskets etc. Pigeon pea has a deep and laterally spreading system which incidentally enables it to tolerate drought. This can be adopted to a wide range of soil types from gravel to clay loam. Pigeon pea is most sensitive to low irradiance during the period of pod formation.

Study was conducted to evaluate the effect of low light intensity on pigeon pea grown under coconut plantation. Two shade levels were selected in two coconut

plantations, planted with ordinary tall variety, planted at a spacing of 7.5 m 7.5 m, in Andigama soil series at Rathmalagara Research Station.

Three levels of phosphate were applied as 0, 62.1 recommended dose and 124.2 kg per ha with recommended levels of nitrogen (16.1 kg/ha) as urea and potassium (45 kg/ha of K_2O) as muriate of potash (Table 19).

All growth parameters measured (i.e. plant height leaf number, leaf area) and the yield indicated that reduced solar radiation up to 65% under 45 years old coconut plantation had significant reduction than under 90% solar radiation under 5 years old plantation.

D C Siribanddana, D N S Fernando & W R O Fernando

Experiment M-10: The influence of phosphorus and molybdenum on vegetative growth and nodulation in mungbean (*Vigna radiata* (L.) and cowpea (*Vigna inguiculata* (L.) grown on sandy loam soils. Bandirippuwa Estate - 1996.

Legumes are an important component of tropical farming systems. Their value is enhanced due to the biological nitrogen fixing capacity. However in most tropical soils, nodulation of legumes in poor. This could be overcome by addition of required nutrients. Molybdenum and phosphorus have been found to have direct effect on nodulation. Thus a pot experiment was conducted to evaluate the influence of three(03) elements on vegetative growth and nodulation of two tropical food legumes (mung bean and cowpea) grown on sandy loam (Madampe series) soil and plants were applied with 2 levels of P and 3 levels of molybdenum. Results have shown that the most effective rates of phosphorus and molybdenum were 60 mg and 1 ppm per plant respectively and it also found that the effect of phosphorus and molybdenum was more pronounced in terms of nodulation rather than vegetative growth.

H A A Jayamini, D N S Fernando & Y M Chandrasiri

4. TRAINING AND EXTENSION ACTIVITIES

The following lectures/demonstration were conducted.

Dr. D N S Fernando on soil and soil moisture conservation in coconut lands, management of pasture and cattle under coconut, and cover cropping and green manuring in coconut lands, Dr. H A J Gunathilake on intercropping, farming systems and soil moisture conservation Mrs. S Samarajeewa on Economics of Intercropping under coconut, Mr. A Samarajeewa on weed management in coconut

lands delivered lectures and also conducted demonstrations to officers from, Coconut Development Authority, Talawakele Plantations Divisional Secretariat of Pannala, Students from Peradeniya, Kelaniya and Colombo Universities, Technical Colleges of Kuliyapitya, Matale and Gampaha and from National Institute of Plantation Management at various times during the year.

Dr. D N S Fernando supervised six students from the Faculty of Agriculture, University of Peradeniya and three students from the Faculty of Agriculture, University of Ruhuna during their final year projects on areas of Agronomy, Animal husbandry and Agric. Economics.

Dr. H A J Gunathilake, Supervised two students from the Faculty of Agriculture, University of Peradeniya on Intercropping and Animal husbandry.

Dr. D N S Fernando and Dr. H A J Gunathilake, trained several students from National Institute of Plantation Management, Aquinas College of Agriculture, Technical Colleges of Kuliyapitiya and Gampaha on Agronomy, Intercropping and Animal husbandry.

Dr. D N S Fernando visited Nikawaratiya Area Estates, of Wayamba Plantation on a advisory visit on 10.7.96 and Dr. D N S Fernando and Dr. H A J Gunathilake, attended on field day organized by the Metropolitan Plantations at Pitiyakanda estate, Mawathagama to deliver lectures on Soil Moisture Conservation and Management of Intercropping.

Dr. H A J Gunathilake, Dr. D N S Fernando, Mrs. S Samarajeewa, Mr. A Samarajeewa and Mr. Ivan Appuhamy of the Division visited number of coconut estates on Persuasive Extension Activities. This programme was conducted jointly with the Extension Division of the Institute.

5. ACKNOWLEDGEMENT

The cooperation and assistance of the staff of the Agronomy Division in conducting the experiments, demonstrations and training programmes during the year are gratefully acknowledged.

My thanks are due to Mr. D T Mathes/Head Biometry and Mr. T S G Peiris, Principal Biometrician and the staff of the Biometry Division for continuous assistance with designing of experiments and collecting and analysis of data, and Dr(Mrs) M N Fernandopulle, Head and staff of Soils and Plant Nutrition Division for chemical analysis and to Mr. A A D N Athauda for typing the manuscript.

REPORT OF THE GENETICS AND PLANT BREEDING DIVISION

Head - W M U Fernando, Ph D

1. GENERAL

The Genetics and Plant Breeding Division was responsible for organizing and conducting the Regional Training Course on Standard Coconut Breeding Research Techniques for seven participants from India, Pakistan, Bangladesh and Myanmar during 16-28 June 1996 funded by the Coconut Genetic Resources Network (COGENT).

Following ten years of progeny testing in multilocational trials, the cross Tall x San Ramon has been identified as a promising cultivar and a programme to mass produce this cross has already been initiated. Systematic crossing programmes are in progress at the Isolated Seed Garden Ambakelle and Bandirippuwa Estate in order to produce Tall and San Ramon planting material respectively for the fourth seed garden proposed to be established at the Margaret Estate, Pallama.

With supplementary financial assistance from the Asian Development Bank, planting material was raised for establishing another germplasm repository at the Lenawa model garden of the Coconut Cultivation Board. After several years of negotiations, permission to import exotic coconut germplasm was granted by the National Plant Quarantine Committee of Sri Lanka in the form of pollen and embryos.

The Council for Agricultural Research Policy pledged its support to the ongoing Biotechnology programme by granting a sum of Rs. 1 110 000 for the project entitled "Evaluation of the extent of genetic variation in the coconut germplasm using RAPD markers".

2. RESEARCH PROJECTS

PROJECT: Evaluation of existing cultivars

Experiment 12.1: Evaluation of five improved cultivars (1983-86)

Design: Randomized block with 4 replicates
Plot size: 20 palms/plot
Treatments:

The five cultivars evaluated were used as treatments

V_1 Dwarf green x Tall (DG x T) (CRIC 65)

V_2	Dwarf yellow x Tall (DY x T) (CRIC 65)
V_3	Tall x Tall (TT) (CRIC 60)
V_4	Moorock Tall (MT)
V_5	Ordinary Tall (from plus palms) (PPT)

Expt. No	Location	Year of establishment	Soil type	Agroecological region
12.1	Bandirippuwa	1983	Loamy sand	Wet intermediate zone
12.2	Thammenna	1983	Latasol	Dry zone
12.3	Palugaswewa	1985	Sandy clay loam	Dry intermediate zone
12.4	Suriyapura	1986	Lateritic gravel/ clayey	Wet zone

The results of Bandirippuwa and Thammenna trials revealed that the cultivars have now attained stability in nut production (Tables 1 and 3). The DG x T hybrid has shown the potential of producing 15 kg of copra/palm/yr, 13 years after establishment under favourable soil conditions in the dry zone. Amongst the tall cultivars, Moorock tall showed promise as a good copra source performing similar to Tall x Tall (CRIC 60) (Tables 2 and 4).

Despite the set-back caused by severe black beetle and cattle damage at Palugaswewa Estate and management problems experienced at Suriyapura site during the establishment phase, these palms have attained full bearing at both locations and results indicated that hybrid cultivars are superior in nut production compared to tall cultivars.

R R A Peries, W M U Fernando, W B S Fernando, M H L Padmasiri & S Mallawarachchi

Table 1. *Yield data of each cultivar during the current (11th year) and previous year, in the evaluation of cultivars trial at Bandirippuwa Estate, Lunuwila*

Cultivar	Number of palms harvested		Number of nuts harvested		Nuts/palm	
	95	96	95	96	95	96
DG x T	74	75	5201	5019	70	67
DY x T	79	79	4828	5128	61	65
T x T	78	80	3697	3801	47	48
M.T	75	75	3367	3138	45	42
P.P.T	77	79	3815	3489	50	44

(Note: 80 palms per treatment in 04 blocks).

Table 2. *Fruit component analyses of the evaluation of cultivars trial at Bandirippuwa. (mean of six picks in 1996).*

FRUIT COMPONENT	CULTIVAR									
	DG x T		DY x T		T x T		MT		PPT	
	A	B	A	B	A	B	A	B	A	B
Fresh nut weight (g)	1068	12.3	1164	11.0	1335	11.8	1487	8.1	1316	7.7
Dehusked weight (g)	605	13.8	635	11.6	707	9.2	766	9.7	683	9.1
Split nut weight (g)	470	10.5	473	10.4	550	8.9	580	7.8	532	7.4
Kernel weight per nut (g)	305	9.9	310	10.5	345	9.5	375	8.9	341	8.5
Estimated copra weight (g/nut)	194	na	203	na	226	na	245	na	219	na
Estimated copra weight (kg/palm)	13.0	na	13.2	na	10.8	na	10.3	na	9.6	na

(na = not analyzed; A = weight in grams; B = CV)

Table 3. *Yield data of each cultivar during the current year (11th year and previous year, in the evaluation of cultivars trial at Thammenna Estate, Puttalam)*

	Number of palms harvested		Number of nuts harvested		Nuts/palm	
	95	96	95	96	95	96
DG x T	78	78	6253	5699	80	73
DY x T	76	76	4798	4975	63	65
T x T	75	76	3442	3895	46	51
M.T	70	74	2439	2696	35	36
P.P.T	77	77	3634	3802	47	49

(Note: 80 palms per treatment in 4 blocks)

Table 4. *Fruit component analysis of the evaluation of cultivars trial at Thammenna. (mean of six picks in 1995).*

FRUIT COMPONENT	CULTIVAR									
	DG x T		DY x T		T x T		MT		PPT	
	A	B	A	B	A	B	A	B	A	B
Fresh nut weight (g)	1243	11.4	1212	10.1	1400	9.6	1444	7.6	1406	7.4
Dehusked weight (g)	654	8.7	654	15.0	719	10.8	717	9.3	712	8.8
Split nut weight (g)	487	7.2	474	10.3	554	8.7	549	8.6	550	6.7
Kernel weight per nut (g)	315	7.0	308	13.3	355	8.2	356	9.5	357	7.8
Estimated copra weight (g/nut)	209	na	209	na	230	na	229	na	228	na
Estimated copra weight (kg/palm)	15.3	na	13.6	na	11.7	na	8.2	na	11.1	na

(na = not analyzed; A = weight in grams; B = CV)

Table 5. *Percent palms in flower (A) and number of nuts/palm (B) in the evaluation of cultivars trials at Suriyapura Estate and Palugaswewa Estate*

Cultivar	Suriyapura		Palugaswewa	
	A	B*	A	B
DG x T	100	26	80	45
DY x T	100	17	87	34
T x T	98	10	90	32
M.T	100	11	94	18
P.P.T	100	12	89	24

(* nuts/palm for 5 picks of 1995; yield data could be obtained only for 5 picks)

PROJECT: IDENTIFICATION OF PARENT PALMS FOR THE USE IN THE BREEDING PROGRAMME. RESPONSE OF GENOTYPES TO YEARLY CHANGES IN WEATHER AT ISG, AMBAKELLE

Experiment 12.2.1a: Programme for the improvement in nut size and nut number in the Isolated Seed Garden (1993)

The progeny obtained by crossing palms selected for sustained high nut weights during adverse climatic conditions in 1991, planted in field No. 14, ISG (151 progeny families) and field No. 3B, Maduru Oya Seed Garden (95 progeny families) were maintained satisfactorily. The growth measurements recorded on seedlings at ISG indicated an average of 4.5 new leaves/palm during the year.

R R A Peries, A A L Perera & M H L Padmasiri

Experiment 12.2.1b: Selection of parent palms for raising planting material for the new seed garden (1995)

A set of 100 elite palms from field Nos. 1, 2 and 4 of ISG, selected on the basis of long term yield data and on progeny testing (CRI 1995) were hand pollinated according to a systematic crossing programme commencing from March 1996. A total of 18,000 female flowers from 994 inflorescences were pollinated upto December and an average of 7200 female flowers are estimated to be set after 3 months from pollinations (setting percentage was assumed as 40). Approximately 5400 seednuts sufficient for planting 50 Ac from the seed garden is expected to be harvested during 1997.

Fourty palms out of 100, initially selected from field 4, at ISG, were used to cross with pollen from the 4 germplasm accessions Kasagala, Debarayaya, Moorock and St. Anne's from January - March 1996, in order to raise planting material for the trial due to be established in Kivulakelle under the multilocational trials of project 12.3. An average production of 200 seednuts is expected from each of the above crosses.

W M U Fernando, A A L Perera, C K Bandaranayake & R Jayatilleke

Experiment 12.2.2 Progeny trial for testing putative drought tolerant palms by the performance of their progeny at ISG (1988)

Design: Fully randomized with minimum of 4 progenies each from 56 families

Location: Isolated Seed Garden, Ambakelle

Agroclimatic zone : Dry Intermediate Zone

The flowering percentage of palms increased to 97% of the 1988 planting (236 palms) and 70% of the 1989 planting (197 palms, replaced as vacancies in the original planting of 1988) was also recorded to be flowering accounting to 85% of the total population to attain flowering. A total of 9868 nuts were picked during the year from the 250 bearing and 126 partially bearing palms.

Growth measurements during the first 5 years after establishment and time taken for flowering were used to estimate the genetic parameters. Superior palms were identified on the basis of breeding values of the above characters and parent palm Nos. 1.05, 1.07, 1.09, 1.21, 1.28 and 1.34 of field Nos. 1 and 2 of ISG were selected for further propagation.

Results indicated that girth, number of total leaves produced per year and flowering time of the progeny are significantly correlated with yield of female parents and estimated to be 0.33, 0.42 and -0.64 respectively. Broad heritability values of girth, number of total leaves produced per year and flowering time was estimated to be 0.15, 0.06 and 0.29 respectively.

W M U Fernando, C K Bandaranayake & M H L Padmasiri

Experiment 11.2/12.3: Crossing of selected palms at ISG with promising germplasm accessions (1993)

The trial was initiated in 1993, in order to evaluate the performance of the progeny derived from crossing of Ambakelle elite palms with putative drought tolerant germplasm accessions. The main objective was to introgress the characters high yield and stability in production whilst producing a new base population for future breeding with a broader genetic base.

Design: Randomized block with five treatments (crosses) replicated in 5 blocks with twelve palms/plot

Treatments	Crosses	Ambakelle tall x Moorock tall
		Ambakelle tall x St Annes tall
		Ambakelle tall x Kasagala tall
		Ambakelle tall x Debarayaya tall
		Ambakelle special

Expt. No.	Location	Year of establishment	Soil type/ soil class	Agroecological region
11.3a	Girtland	1995	Gravel	Wet intermediate zone
11.2a	Melsiripura	1995	Reddish brown latosol	Wet intermediate zone
11.2b	Siringapatha	1995	Sandy Loam	Wet zone
12.3b	Bata Atta	1996	Reddish brown earth	Dry zone

Planting at the Bata-Atta site which could not be accomplished in 1995 was undertaken in October 1996, with the onset of Maha rains. Results of vegetative growth characters, after one year from establishment (Table 6), indicated that the control, Ambakelle special outperformed other crosses at all 3 sites. The cross, Tall x Debarayaya consistently performed well for both characters assessed, except for number of new leaves at Girtland.

Table 6. *Means of the characters, number of new leaves produced (A) and girth (B) of the 5 crosses planted at Siringapatha, Melsiripura and Girtland Estates (LSD = Least significant difference)*

Cross	Siringapatha		Melsiripura		Girtland	
	A	B (cm)	A	B (cm)	A	B (cm)
Tall x Moorock	7.34	26.70	6.54	23.18	6.75	27.87
Tall x St. Annes	7.46	27.27	6.55	22.82	6.74	28.10
Tall x Debarayaya	7.62	28.79	6.91	25.18	6.52	29.31
Tall x Kasagala	7.12	25.95	6.83	23.75	6.73	28.52
Ambakelle Special	7.86	30.73	7.38	26.34	7.28	31.73
LSD	0.47	2.31	0.39	3.82	0.29	1.76

W M U Fernando, C K Bandaranayake, M H L Padmasiri, W B S Fernando & S Mallawaarachchi

Experiment 12.4: Selfing of F2 palms at Bandirippuwa Estate and evaluation of F3 progenies at Ratmalagara (1994)

The experiment was designed with the objective of comparing the selfed and crossed progenies of F_2 generation palms of Dwarf x Tall hybrid coconut and, to study the segregation patterns of important quantitative characters in their subsequent generations. Thirty six F_3 progeny families arising from selfing and open pollination of 18 F_2 palms were planted in a fully randomized design at Ratmalagara Estate in November 1995.

Despite constant weed control measures undertaken within the trial area, the heavy growth of pasture in adjoining blocks caused severe rat infestation with in the trial and 120 seedlings died during the year. Pollination would be carried out during the first half of 1997 in order to raise material to replace the casualties.

W M U Fernando, C K Bandaranayake & G K Ekanayake

PROJECT: Evaluation of progenies of selected Ambakelle tall palms crossed to selected tall, dwarf green, dwarf yellow and San Ramon in different combinations and evaluation of the progeny in multilocational trials with different input systems.

Combination 1: Tall (Ambakelle special) seed palms using tall, dwarf green or San Ramon pollen from palms selected for high and stable yields.

Experiment 11.1.1.1: Trial at Bandirippuwa Estate, Lunuwila, (50-acre block for the evaluation of progeny (1986)

Experiment 11.1.1.2: Trial at Rathmalagara Estate, Madampe, (Field no. 2) for the evaluation of progeny (1986)

Experiment 12.5.1.1: Trial at NLDB Andigama Farm, Giriulla (Mudalihamy block) for the evaluation of progeny (1986)

Experiment 12.5.1.2: Trial at JEDB Mangala Eliya Estate, Puttalam for the evaluation of progeny (1987)

Combination 2.: Ambakelle special and selected *dwarf green* seed palms using *tall*, *dwarf green* and *San Ramon* pollen from palms selected for high and stable yield.

Experiment 12.5.2.3: Trial at NLDB Andigama Farm, Giriulla (Puras Block), for the evaluation of progeny (1987)

Experiment 11.1.2.3: Trial at JEDB Daisy Valley Estate, Mawathagama for the evaluation of progeny (1987)

Combination 3: Ambakelle special, selected dwarf green and dwarf yellow seed palms using tall, dwarf green, San Ramon and dwarf yellow pollen from palms selected for high and stable yield (1986)

Experiment 12.5.3.4: Observation Trial at SLSPC Sirikandura Estate, Dodanduwa, for the evaluation of progeny (1989)

Experiment 11.1.3.4: Observation trial at Ratmalagara Estate, Madampe for the evaluation of progeny (1989)

A series of trials was established to evaluate the progeny of selected Tall and dwarf palm crosses at ISG and of San Ramon, in different agroclimatic areas and under different management conditions, so that recommendations could be made of suitable crosses for specific agroclimatic zone and those with a broader adaptation for growing in a range of environmental conditions.

Design: Factorial design with 3 varieties and 3 fertilizer levels in a randomized block design with 3 replicates.

No. of palms/plot: 10 palm

Treatments	Crosses	Fertilizer levels
	Tall x Dwarf green (V1)	Recommended fertilizer (T1)
	Tall x Tall (V2)	Half of the recommended dosage (T2)
	Tall x San Ramon (V3)	One and a half times the recommended dosage (T3)

V_1T_1	V_1T_2	V_1T_3
V_2T_1	V_2T_2	V_2T_3
V_3T_1	V_3T_2	V_3T_3

Locations	Year of establishment	Soil type	Agroecological region
Bandirippuwa	1986	Loamy sand	Wet intermediate zone
Ratmalagara	1986	Lateritic	Wet intermediate zone
Mudalihamy Andigama	1986	Sandy loam	Dry intermediate zone
Mangala Eliya (with T(OP) as a control variety)	1987	Loamy sands	Dry zone
Daisy Valley (with DGxT and DGxSR as added treatments)	1987	Clay loam	Wet intermediate zone
Puras Andigama (with DGxSR added)	1987	Lateritic	Dry Intermediate zone

Two observation trials were established at Sirikandura (1989; TxDG, TxT, TxSR and TxDY) and at Ratmalagara (1989; DGxT, DYxT, DGxSR and DYxSR) to assess their performance under average estate management.

Data on the number of nuts/palm/year for 3 varieties at Ratmalagara and Bandirippuwa are presented in Tables 7 and 8. Following the application of differential fertilizer treatments to progenies at Bandirippuwa and Ratmalagara since June 1993, a significant difference in nut number was observed between all fertilizer level treatments, except between half the recommended dosage and the recommended dosage at Ratmalagara. An increase of 8 nuts/palm was observed between half and one and a half times the recommended dosage. No significant difference was observed in nut number among the 3 fertilizer levels at Bandirippuwa. At Ratmalagara although a significant difference was observed in nut number among the fertilizer levels, the interaction between variety and fertilizer level was non-significant (Table 9), indicating that response to fertilizer levels, did not vary according to the variety.

Comparison of cultivar performance over sites showed that all cultivars have attained 90% flowering by the 9th year after establishment except for Tall x Tall in the 2 blocks of Andigama, and T x SR of Andigama Puras block (Table 10.).

The performance of the two observation trials was not satisfactory due to the poor management at Sirikandura and elephant damage at Ratmamlagara. Despite the repeated requests made to the management of Sirikandura, thining of old plantation was not undertaken resulting in heavy shade to young palms. Eight bearing palms died at Ratmalagara due to the elephant damage followed by red weewil infestation.

W M U Fernando, J M D T Everard, C K Bandaranayake, W B S Fernando, M H L Padmasiri, S Mallawaarachchi & R Jayatillaka

Table 7. *The number of palms harvested and the number of nuts/palm in the three types of progeny TxDG, TxT, TxSR at Bandirippuwa*

Progeny	Number of palms harvested 1996	Number of nuts harvested 1996	Nuts/palm 1996
T x DG	84	3087	37
T x T	83	2828	34
T x SR	80	2120	27

(DG - dwarf green; T - tall; SR - San Ramon)

Table 8. *The number of palms harvested and the number of nuts per palm in the three types of progeny T x DG, T x T, T x SR at Ratmalagara (1986)*

Progeny	Number of palms harvested 96	Number of nuts harvested 96	Nuts/palm 96
T x DG	84	4148	49
T x T	77	1761	23
T x SR	85	2216	26

(DG - dwarf green; T - tall; SR - San Ramon)

Table 9. *Results of the analysis of variance test for nut number at the two sites Ratmalagara and Bandirippuwa*

Source	Ratmalagara df	Ms	F	Bandirippuwa df	Ms	F
Variety	2	17334.74	51.07***	2	13290.12	38.07***
Replicate	2	1032.87	3.04*	2	4335.03	12.42***
Fertilizer level	2	1540.31	4.54**	2	902.67	2.59
Var*fertilizer level	4	49.80	0.15	4	306.11	0.88
Error	235	339.42		239	349.01	

Table 10. *Cumulative number of palms and percent (*) in flower at the sites Andigama (M), Mangala Eliya, Daisy Valley and Andigama (P). [The year of establishment of each trial is given along with the names of Estates]*

	1986 Andigama (M)	1987 Mangala Eliya	1987 Daisy Valley	1987 Andigama (P)
T x DG	88 (100)*	72 (100)*	83 (95)*	80 (93)*
T x T	59 (73)*	77 (95)*	74 (94)*	34 (40)*
T x SR	74 (88)*	74 (98)*	71 (90)*	56 (66)*
DG x SR	-	- 84 (97)*	83 (97)*	
T (OP)	-	81 (95)*	-	-
DG x T	-	- 85 (98)*	-	

[DG, dwarf green; T, tall; SR, San Ramon; T (OP), Tall (open pollinated)]

Table 11. *Cumulative number of palms in flower and percent (*) in different progenies observed at Sirikandura and Ratmalagara Estates*

(1989) Progeny	Sirikandura	(1989) Progeny	Ratmalagara
T x DG	62 (86)*	DG x T	16 (94)*
T x T	35 (49)*	DY x T	08 (53)*
T x SR	40 (56)*	DY x SR	06 (54)*
T x DY	59 (82)*	DG x SR	14 (88)*

(DG - dwarf green; T - tall; SR - San Ramon; DY - dwarf yellow)

Experiment 12.6: Comparative evaluation of DG x Tall hybrid progeny of parents of the first and second generation palms at the ISG for yield and physiological drought tolerance at Andigama Farm, Giriulla - 1993

Design: Complete Randomized Block design with 8 blocks; 8 palms/plot; Each plot was surrounded by a guard row of Ambakelle special.
Year of Planting: December 1993
Location: Andigama Farm, Giriulla
Agroclimatic area/soil type: Wet Intermediate zone/Clay loam soil

Rat damage further aggravated during the early part of the year due to very slow response of the NLDB staff for controlling weeds and improving field sanitation. The total number of casualities went up to 40% in the mid year. However, with change of hands in the management of the estate the sanitation conditions improved by the end of 1995.

It has been impossible to fill all the vacancies with appropriate varieties since the number of casualities were so high. Therefore, all vacancies were filled with CRIC60 as a measure to maintain unifromity within plots.

J M D T Everard, C K Bandaranayake & R Jayatilleke

PROJECT: COLLECTION, CONSERVATION AND EVALUATION OF COCONUT GERMPLASM

Experiment 12.7.1: Collection of germplasm of the commercial *tall* variety (*Typica typica*)

A grant of US$ 13,800.00 from the ADB through COGENT has been approved for a three year project for acceleration of the coconut germplasm conservation and evaluation at the CRI. Although the project was due to commence from early 1995 the instalment for the first year (US $ 4600.00) was recieved on 24th October 1995. However, a great deal of work planned under this project has already been in progress because the germplasm conservation programme of the CRI is also geared along the same line of activities.

The details of the ADB funded projects are outlined below.

PROJECT 1: ACCELERATION OF THE COLLECTION OF GERMPLASM FOR DROUGHT TOLERANCE AND CONSERVATION OF THE COCONUT BIODIVERSITY AT RISK IN SRI LANKA

OBJECTIVES OF PROJECT 1:

1. Systematic collection and conservation of the existing coconut bio-diversity as random sampling from islandwide surveys and setting up of *ex-situ* gene banks

2. Collection and conservation of drought tolerant germplasm as biased sampling from drought-prone areas and setting up *ex-situ* gene banks

3. Evaluation and characterisation of collected material to identify possible accessions for future breeding programme

4. Introgression of genetically distinct material to exploit hybrid vigour for economic traits and to develop a base population for subsequent generation

PROJECT 2: Evaluation of existing coconut populations for physiological adaptation and setting up of *in-situ* germplasm repositories (ecobanks)

OBJECTIVES OF PROJECT 2:

1. Set up *in-situ* gene banks wherever possible for all material showing adaptation
2. Study the physiological adaptation of identified diverse populations

Eighty seedlings each from Chitrakala, Wilhelmina, Kivulakelle, Thammanna, Yatawatte, Marandawila, Mirishena, Andigama and Dehigahalanda along with 80 seedlings from Tall x Tall as a control and 40 from drought screened

embryo cultured seedlings from the Tissue Culture Division, CRI are ready for planting at the Lenawa model garden of the Coconut Cultivation Board under the *ex-situ* germplasm conservation programme.

J M D T Everard, C K Bandaranayake, G K Ekenayake & S Mallawarachchi

Experiment 12.7.1a: Germplasm from other countries

The request to import exotic germplasm was finally approved by the Department of Agriculture and the permit was obtained to import Tall forms Palu, Bali and Tenga and dwarf forms Nias Yellow and green from safe areas of Indonesia in the form of pollen and embryo. Formal arrangements would be made in 1997 for importation.

W M U Fernando & J M D T Everard

Experiment 12.7.1b: Collection of germplasm of different forms of coconut (a) San Ramon (b) Dwarf forms (c) Indigenous tall form and (d) Others (1996)

Two blocks of dwarf brown form comprising 45 seedlings at Bandirippuwa and 102 seedlings at Ratmalagara were established in May and June 1996, respectively.

Experiment 12.7.1c: Collection of drought tolerant germplasm

No new selections were made during the year.

Experiment 12.7.2: Conservation Blocks at Poththukulama Research Station (PRS) and Bandirippuwa (1988/89)

A steady increase in the number of palms flowered and in bearing was observed during the year and the current status of the two blocks appear in Tables 17 and 18.

Experiment 12.7.3: Evaluation of Dwarf green x Debarayaya tall (1995)

Fourty eight seedlings of DG x Debarayaya cross along with 48 CRIC 65 seedlings as the control, planted in Raddegoda estate, Delwita in June 1995 performed well during the year without any casualties.

A A L Perera, C K Bandaranayake, A Thavaratnerajah & G K Ekanayake

Table 17. *The status of the PRS conservation block, as at 31 Decemberr.*

Accession	% Flower	% Bearing	No. of palms	No. of vacancies	Total
1. Moorock	86.41	77.77	81	01	82
2. Palugaswewa	90.24	82.92	82	02	85
3. Pitiyakanda	90.12	87.65	81	04	85
4. Clovis	43.75	35.00	80	05	85
5. Namalwatta	81.33	73.33	75	10	85
6. St. Annes	71.95	68.29	82	03	85
7. Mageret	52.50	38.75	80	05	85
8. Kasagala	-	-	71	09	80
9. Debarayaya	1.26	-	79	02	81
10. Kundasale Dwarf	57.35	35.29	68	20	88
11. Akuressa	35.29	24.70	85	05	90
12. Ambakelle Special	27.58	22.98	87	04	91
13. Melsiripura	3.52	-	85	06	91
14. Mangala Eliya	-	-	80	06	86
15. Goyambokka	-	-	86	04	90
16. Cameroon Red Dwarf	73.61	58.33	72	14	86
17. Goluwapokuna	4.9	3.7	75	06	81
18. Keenakelle	-	-	74	16	90
19. Dwarf Brown	48.86	6.81	88	14	102
20. Maliboda	-	-	86	04	90
21. Horakelle	-	-	73	17	90
22. Walahapitiya	-	-	82	03	85
23. Wellawa	-	-	64	15	79
24. Embryo Culture Plants	5.55	-	18	01	19
25. Brazilian Green Dwarf	-	-	33	06	39

Table 18. *The status of germplasm conservation block at Bandirippuwa*

Accession	% Flower	% Bearing palms	No. of palms	No. of vacancies	Total
1. Wellawa	55.5	46.9	81	03	84
2. Pitiyakanda	37.5	30	80	06	86
3. Ambakelle tall	65.27	56.9	72	14	86
4. Moorock	34.78	17.39	23	61	84
5. Namalwatta	-	-	20	64	84
6. Debarayaya	8.57	1.42	70	10	80
7. Clovis	1.17	-	85	-	85
8. Palugaswewa	9.85	8.45	71	09	80
9. Ambakelle especial	15.58	10.38	77	01	78
10. Akuressa	-	-	79	07	86

A A L Perera, R R A Peries & K Ekanayake

PROJECT: Conservation and evaluation of coconut germplasm

Experiment B-8.1: New variety block or crop museum, at Block No. 5, Bandirippuwa Estate, Lunuwila (1983)

A total of five palms, three of the form Ran Thembili and one each from Pora pol and Gon thembili flowered during the year resulting in 103 bearing palms. Self pollinations carried out on the inflorescences of 'Dikiri pol' palms did not result any 'Dikiri' type nuts leading to ambiguity of the origin of these seedlings.

W M U Fernando, A A L Perera, M H L Padmasiri & K Ekanayake

Experiment B-8.2: Purification of local (indigenous) germplasm, Bandirippuwa Estate, (B/E) Lunuwila (1984)

The current status of the local germplasm conservation block at B/E is shown in Table 12. A self pollination programme was initiated for indigenous Tall forms in this block during the first quarter of 1996 in order to raise planting material for the Middeniya germplasm repository which was supposed to be acquired by the Coconut Research Institute. Five palms from each of the 6 forms, were hand pollinated with its own pollen and the results are presented in Table 13.

A A L Perera, C K Bandaranayake & S Mallawarachchi

Table 13. *The status of the local germplasm collection at Bandirippuwa as at 31 December*

Status of collection	Type (form) of coconut						
	Bodiri	Gon thembili	Pora pol	Ran thembili	Nawasi	Dikiri pol	Kamandala
Number established	80	69	57	38	36	03	06
Vacancies	31	16	21	07	01	02	00
Young palms	06	00	07	12	23	00	01
In flower	00	00	04	01	03	00	00
In bearing	42	52	20	12	09	01	05
Seedlings	01	01	05	06	00	00	00

(Note: Total number of standing palms = Young palms + Seedlings + In flower + In bearing)

Table 14. *Number of inflorescences, female flowers pollinated and buttons remaining after 3 months on the indigenous tall forms at Bandirippuwa Estate*

Form	No. of Inflorescences	No. of buttons pollinated	Buttons after 3 months	Setting %
Bodiri	30	284	60	21
Kamandala	48	459	87	19
Pora pol	48	713	93	13
Gon thembili	44	723	177	24
Nawasi	47	637	85	13
Ran thembili	40	752	238	32

Experiment B-8.3 Conservation of San Ramon, (1986)

One hundred and forty one palms were in bearing whilst 08 were young palms as at 31 December 1996 and 13 vacancies were reported.

Thirty San Ramon palms from this block selected on the basis of nut yield and desirable agronomic characters were used for a crossing programme in order to raise planting material (San Ramon) to obtain pollen for mass production of the cross Tall x San Ramon. In order to rejuvenate the San Ramon characters from the

Table 15. *Details of the pollination programme carried out in the San Ramon block during 1996 (The palm nos. indicated were used as the female parent)*

Palm No.	No. of inflorescences pollinated	No. of female flowers pollinated	Expected no. of nuts (estimated as 20% of the female flowers)
04	12	210	42
12	07	52	11
15	09	164	33
14	12	330	66
16	11	239	48
37	11	173	35
39	11	226	45
46	10	82	16
57	11	194	39
59	11	159	32
69	08	73	15
70	09	132	26
71	08	100	20
72	10	145	29
80	13	434	87
82	10	191	38
83	13	226	45
108	12	391	78
111	13	189	38
112	12	165	33
135	10	119	24
136	12	110	22
138	12	292	58
139	11	152	30
141	11	121	24
158	11	187	37
159	11	220	44
160	12	116	23
161	08	100	20
162	11	207	41

original introduction of San Ramon to Sri Lanka, pollen from selected elite palms from Uhumiya (24 palms) and Bandirippuwa were used to cross the above San Ramon palms (2nd generation progeny of original introduction) and a summary of pollination carried out during the year is given in Table 15.

C K Bandaranayake, W M U Fernando, S Mallawaarachchi & M H L Padmasiri

Experiment B-8.4: Establishment of "field gene bank" for dwarf palms at Bandirippuwa Estate, Lunuwila (1987)

The current status of the dwarf palm block Bandirippuwa is shown in Table 16. Fifty nine vacancies were filled with self pollinated dwarf green seedlings. Severe black beetle attack followed by red weevil infestation was reported and 06 dwarf red palms, 01 dwarf yellow and 04 dwarf green palms succumbed to death as a result.

Five dwarf yellow palms were self pollinated during the year and a total of 1653 buttons arising from 59 inflorescences were pollinated.

Table 16. *The status of the dwarf palm block at Bandirippuwa Estate*

Status	DR	DY	DG
Total number established	73	44	99
Vacancies	21	28*	14**
Young palms/Seedlings	-	-	61
Palms in flower	-	-	-
Palms in bearing	52	16	24

* 15 vacancies were filled with Tall x Tall seedlings by the estate.
** 07 planting points were reserved for the tank

C K Bandaranayake & R Jayatilleke

Experiment B-8.5: Evaluation of nine promising germplasm accessions at Nariyapotta division, Andigama farm, Giriulla (1994)

Out of the 245 vacancies occured during 1994, 167 seedholes were infilled with seedlings from the relevant accession and 77 seedholes with seedlings of a different origin. Maintaining the levels of sanitation was a severe problem in this

field due to heavy growth of pasture grass despite continuous chemical and mechanical weed control methods practised.

L Perera, C K Bandaranayake & G K Ekenayake

Experiment B-9: Characterization and evaluation of indigenous Thembili germplasm (1996)

King coconut suffers from the disadvantage of being seasonal in bearing, and improved planting material of this variety is not currently available.

The existing thembili populations were surveyed in Puttalam, Kurunegala, Gampaha and Colombo Districts. Most of them were grown in home gardens and very few were found in plantations. Selections were carried out in larger populations during the year according to the selection criteria, regular bearing habit, desirable nut characters, high sugar concentration in nut water, free from pests & diseases and agronomically sound morphological characters of palms.

Concentration of total sugars in nut water was found to vary from palm to palm, bunch to bunch and even within nuts in a single bunch. But, the difference in taste of nut water between nuts within a bunch, could be identified by the taste. As a result, taste of nut water (degree of sweetness) was later included as a selection criterion. Based on the above characters a sample of palms were selected from each population and the number of palms in each population are as follows.

Place	Number of palms selected
Marandawila Estate, Bingiriya	7
Walahapitiya Estate, Nattandiya	6
Walpita Farm, Walpita	12
Senanayaka Aramaya, Madampe	5

The selected palms have been prepared for self pollination.

C K Bandaranayake & W M U Fernando

Experiment B-10.1: Characterization of Coconut germplasm and identification of suitable genotypes for breeding, using biochemical markers (isozymes) (1994).

The study funded by the Council for Agricultural Research Policy (CARP) for the duration June 94 - 96 was successfully completed and the terminal report was submitted in September 1996.

Polymorphism was experienced only for two enzyme systems namely Esterase (EST) and peroxidase (PER) out of seven enzyme systems tested. The ideal tissue for enzyme extraction was identified as immature leaf tissues obtained from the last fully opened leaf. Eventhough with a limited number of isozymes the polymorphism revealed by EST and PER was sufficient to differentiate populations of Tall and dwarf and specific rare allels were found to be present in improved cultivars Tall x Tall and Moorock Tall which would be of value in identifying relationships with useful quantitative characters.

W M U Fernando & S Mallawaarachchi

PROJECT: PRODUCTION OF HIGH QUALITY SEEDS AND SEEDLINGS

Improvement of nursery techniques

Testing of suitable alternative material for coir dust for polybagged coconut seedlings, especially in areas outside the coconut triangle (1995)

The experiment conducted in the Research Nursery at Bandirippuwa revealed that the effects of saw dust, paddy husk, decomposed paddy straw and weed trash were comparable to coir dust in the potting media, considering the growth parameters of seedlings. But from a practical point of view, saw dust was found to be the best alternative. If there is no labour shortage, partially decomposed straw and weed thrash could be used with replacement following decomposition. Paddy husk was found to be the least important.

C K Bandaranayake, A A L Perera & R Jayatillaka

3. SEED GARDENS

3.1 The Isolated Seed Garden at Ambakelle

3.1.1 Rainfall

The amount and distribution of rainfall for 1996 are shown in Table 19 along with the values for the previous year and the 10 year average (1987-1996). The intensity of annual rainfall diminished to the levels typical of the dry zone area, with 1195 mm/year. Except during the periods Jan - Feb and August - October the monthly rainfall was far below compared to 1995.

Table 19. *The amount and distribution of rainfall for 1995 and 1996 and the 10 year average (1987-1996) for comparison at ISG*

Month	1995			1996			10 year average (1987-1996)		
	A	B	C	A	B	C	A	B	C
January	51.2	5	5	127.7	3	3	63.2	3	5
February	32.6	7	5	91.2	6	5	33.3	3	2
March	59.5	3	3	-	-	-	47.1	4	4
April	315.6	16	16	105.0	11	9	158.7	10	9
May	370.3	14	13	7.4	2	2	142.2	9	9
June	58.1	14	12	133.6	9	8	105.6	9	8
July	50.7	3	3	10.4	6	5	51.7	6	5
August	0.5	1	1	66.6	3	3	24.5	4	3
September	16.0	3	3	159.1	13	12	105.5	8	8
October	127.7	15	14	263.4	13	13	249.9	15	15
November	717.0	13	13	139.7	10	10	287.3	14	14
December	34.9	3	3	90.9	6	6	85.2	6	6
Total	1834.1	97	91	1195.0	82	76	1354.1	91	86

(A = rainfall amount in mm; B = number of rainy days; C = number of wet days (rainfall >1 mm)

3.1.2 Nut yields

Total crop figures for 1995 and 1996 are shown in Table 20 with the 10 year average (1987-1996). The nut yields of *Talls* and *Dwarfs* are shown separately in Table 21. As predicted in the Annual Report of 1995, the total yield at ISG decreased by 28% in 1996 comapred to 1995. The per palm yield decreased to 73 nuts in Tall and 49 nuts in Dwarf. Conversion of field No. 14 ISG to a pure tall field resulted in uprooting of several dwarf green palms and contributed to the reduction of the total crop. However the marked reduction in per palm yield in dwarf was due to the unfavourable climatic conditions prevailed in the seed garden which affected the dwarf palms considerably, comapred to tall. The crop disposal from the ISG is given in Table 22.

Table 20. *Total nut yields at ISG from the six picks of the year.*

Pick	1995	1996	Ten year average (1987-1996)
01	220 114	97 291	120584.8
02	246 453	191 738	161328.2
03	329 918	271 282	198467.3
04	295 516	266 173	175910.2
05	258 482	149 215	152496.7
06	183 886	116 905	131008.8
Total	1 534 369	1 092 604	939796.0
Number of bearing palms	15 957	15 843	
Average number of nuts per palm	96	69	

3.1.3 Emasculation of *dwarf* palms for the production of CRIC 65 hybrid nuts

Details of the emasculation programme are shown in Table 23. A total of 2772 *dwarf* palms comprising 1511 *dwarf green* and 1261 *dwarf yellow* palms were emasculated during the year.

Table 21. *Nut yields from the tall and dwarf palms at ISG during the year.*

A: Tall Crop

Pick	1995	1996	Five year average (1992- 1996)
01	191 213	96 759	116900.2
02	215 600	173 142	171588.2
03	281 122	246 942	234435.0
04	247 643	231 863	212575.6
05	213 213	133 761	164389.0
06	161 559	104 154	135066.0
Total	1 310 350	976 621	1034954.0
Number of palms in bearing	13 331	13 456	
Number of nuts/palm	98	73	

* Of this total, 527 palms were adversely affected by drought.

B: Dwarf (D x T) Crop

Dwarf Pick	1995	1996	Five year average (1992- 1996)
01	28 901	10 532	21646.8
02	30 853	18 596	27732.0
03	48 796	24 340	35181.4
04	47 873	34 310	37693.4
05	45 269	15 454	29375.2
06	22 327	12 751	23448.0
Total	224 019	115 983	
Number of palms in bearing	2 626	2 387	
Number of nuts/palm	85	49	

Table 22. *Crop Disposal at ISG 1996*

Method of disposal	T x T	DG x T	DY x T	Total	%
Delivered as seed nuts	643 265	31 076	50 847	725 188	66.37
For research purposes					
GPB	100			)	
PPD		300		)	
TCD	5 782			)	
Soil			75	) 7 757	0.71
Agro D.		250		)	
B/E	750		500	)	
Nut allowance to staff	10 234			10 234	0.94
Copra	37 665	6 794	12 523	56 982	5.21
Sold on contract	148 848	1 258	2 087	152 193	13.93
Rejections	57 352	1 886	4 221	63 459	5.81
To be disposed	72 625	2 547	1 619	76 791	7.03
Total crop	**976 721**	**44 111**	**71 872**	**1 092 604**	**100.0**

Table 23. *Emasculation of dwarf palms for the production of CRIC 65 seed nuts*

Field number	Number of palms emasculated		Number of inflorescences emasculated		Number of button nuts at emasculation	
	DG	DY	DG	DY	DG	DY
05	153	-	2082	-	33042	-
09	543	-	6462	-	71246	-
10A	108	932	1190	13056	22384	171292
10B	335	329	4526	5196	65423	72741
14	372	-	3785	-	40533	-

3.1.4 Thinning of palms

A systematic thinning programme was initiated during end 1996 in all fields of the Isolated Seed Garden and palms which were weak and suffering from leaf scorch decline were specially marked for removal. An average of about 2-3% of weak palms were reported in each field and arrangements would be made for removal in early 1997.

W M U Fernando, C K Bandaranayake,
M H L Padmasiri & R Jayatilleke

4. SEED PRODUCTION

In collaboration with the Coconut Cultivation Board, reselection of plus palms was carried out at Udalawela Estate, Dispansary, Randeniya, Lenawa, Nagansola and Midland Estates.

W M U Fernando, A A L Perera, R Jayatilleke, M H L Padmasiri & G K Ekenayake

4. POLLEN AND POLLINATION

4.1 Pollen collection and issue

Pollen of the *typica* variety was collected from 20 selected palms from ISG, Field No. 1, 2 and 4 and from 35 selected palms from BE. Ampoules amounting to 792 and 144 respectively were sealed from above. Pollen of *dwarf green* was collected from 07 selected palms from ISG and 145 ampoules were sealed. San Ramon pollen was collected from 05 selected palms from Uhumiya and 07 selected palms from BE and this resulted in 220 and 26 ampoules respectively following sealing (Table 24). A total of 397 ampoules of *typica* pollen and 129 ampoules of *dwarf green* pollen were issued to Palugaswea at Rs. 10/= per ampoule.

W B S Fernando

5. RESEARCH NURSERY

5.1 Bandirippuwa Research Nursery

The number of seed nuts laid in the nursery during the year, seedling issues and seed nuts availability as at 31 December are given in Tables 25, 26 and 27.

6. TRAINING AND EXTENSION

Dr W M U Fernando functioned as the resource person in the training programme organized by the CDTC of the Coconut Cultivation Board for Extension Officers Of the Dept of Agriculture on 08 January and for Agriculture teachers on 02 February and 13 March respectively. Mr L Perera functioned as the resource person in the training programme for Agriculture teachers on 27 May.

Dr W M U Fernando, Mr J M D T Everard, Mr A A L Perera, Mrs C Bandaranayake and the technical and field staff of the Genetics & Plant Breeding Division participated as resource persons in the one day programme on Coconut planting organized by the CRI on 19 April.

Dr W M U Fernando functioned as the resource person in the training programme organized by the CDTC of the Coconut Cultivation Board for Extension Officers Of the Dept of Agriculture/Export Agriculture/Animal Production and Health on 27 June and 15 August. Agriculture teachers on 27 May.

Mrs C Bandaranayake functioned as the resource person in the training programme Replanting of coconut organized by CRI for Mawathagama Area Estate Officers on 01 August.

Dr R R A Peries, Dr W M U Fernando and Mr J M D T Everard functioned as resource persons in the coconut component of the Diploma in Plantation Managent course for Estate Superintendents.

Two trainees from the Tecnical College Kuliyapitiya underwent training in the Genetics & Plant Breeding Division for a duration of 3 months.

7. ACKNOWLEDGEMENTS

The cooperation and assistance of the staff of the Genetics & Plant Breeding Division in conducting the long term field experiments, tedious data collection and documentation is gratefully acknowledged.

Table 24. *Pollen collection and issue during the year*

	No. of ampoules								
	Tall					DG	Variety palms		SR
	ISG	(K)	(D)	(M)	(S)	(ISG)	(BE)	(BE)	(U)
Carried over from 1995									
Pollen from individual palms	-	-	-	-	-	-	15	-	-
Mixed pollen	-	53	93	33	76	-	-	-	-
Sealed in 1996									
Pollen from individual palms	792	-	-	-	-	145	144	220	206
Used for pollination programmes									
Pollen from individual palms									
1. At BE	-	-	-	-	-	-	117	59	85
2. At ISG	350								
Issued to estates	395	-	-	-	-	129	-	-	-
Other uses (Viability tests, demonstrations, breakages etc.)									
Pollen from individual palms	20	05	10	05	08	10	07	10	15
No viability /Low viability									
Pollen from individual palms	15	48	83	28	68	-	-	-	-
Balance as at 31 December 1996									
Pollen from individual palms	10	-	-	-	-	06	35	151	106
Mixed pollen	-	-	-	-	-	-	-	-	

(K, Kasagala; D, Debrayaya; M, Moorock; S, St. Annes)

Table 25. *Seed nuts laid in the Bandirippuwa nursery during the year 1996*

Variety	Source	Number of seed nuts			
		Polybags	Pre Nursery	Beds	Total
Ordinary Talls					
Wilhelmina	Wilhelmina Estate	-	100	-	100
Thammenna	Thammenna Estate	-	100	-	100
Kivulakelle	Kivulakelle Estate	-	100	-	100
Andigama	Andigama Estate	-	130	-	130
Mirishena	Mr. W.D Buddadasa, Mahagama	-	208	-	208
Yatawatta	Yatawatta Estate	-	100	-	100
Sithrakala	Lanka Estate Agency Ltd.	-	100	-	100
Dehigahalande	Dehigahalande Estate	-	100	-	100
Marandawila	Marandawila Estate	-	100	-	100
Namalwatta	Mr. W.W. Pathirana, Kirama	-	204	-	204
Debarayaya	Debarayaya Estate	-	132	-	132
Goyambokke	Goyambokke Estate	-	111	-	111
Dickwella	Dickwella Estate	-	102	-	102
Haragama	Haragama Farm	-	-	100	100
PRS	Poththukulalama Research Station	-	-	160	160
Walahapitiya	Walahapitiya Estate	-	-	160	160
Walpita	Walpita Estate	-	-	160	160

Table 25. *Contd.*

Variety	Source	Number of seed nuts			
		Polybags	Pre Nursery	Beds	Total
Improved talls					
Ambakelle TT	Ambakelle Seed Garden	-	100	-	100
Hand Pollinated Nuts					
DY x Debarayaya	Ambakelle Seed Garden	-	70	-	70
DG x Debarayaya	Ambakelle Seed Garden	-	54	-	54
Dwarf green	Bandirippuwa Estate	-	296	-	296
Dwarf red	Bandirippuwa Estate	-	68	-	68
Ran Thembili	Bandirippuwa Estate	-	-	09	09
Rath ran thembili	Bandirippuwa Estate	-	15	-	15
Total		**-**	**2190**	**604**	**2779**

Table 26. *Seedling issues from the Bandirippuwa Research Nursery during the year*

Variety/ Accession	G & PBD		Other Divisions		Other purposes		Commercial issues		Total	
	A	B	A	B	A	B	A	B	A	B
Ambakelle special		40						02		42
DG x Dabarayaya		03		15			03	08	03	26
Tall x Tall		336		43			03	127	03	506
Dwarf Red							01	21	01	21
Dwarf Green		77						01		78
Dwarf Yellow								10		10
Dwarf Brown		164						06		170
San Ramon							10		10	
Kamandala		02				01				03
Nawasi thembili		05								05
Ran thembili		05								05
Nawasi						01				01
Akuressa		137								137
Dehigahalande								55		55
Walahapitiya		23								23
Margaret		37								37
Clovis		16								16
Debarayaya		40								40
Maliboda		16								16
St. Annes		44								44
Moorock		46								46
Tall x Kasagala		91								91
Tall x Debarayaya		73								73
Tall x St. Annes		81								81
Tall x Moorock		83								83
F3 Generation		34								34
Total		**1353**		**58**		**02**	**17**	**230**	**17**	**1643**

(A and B are seedlings from conventional seed beds and polybags respectively).

Table 27. *Availability of planting material at Bandirippuwa Research Nursery as at 31 December*

Variety	Seedlings over 5 months in age		
	In seed beds	In polybags	Total
Ambakelle TT	-	594	594
Pollinated			
Dwarf Brown	-	110	110
Dwarf Green	-	153	153
Brazilian Green	-	98	98
Dwarf Red	-	94	94
Akuressa	-	85	85
Kamandala	-	14	14
Nawasi	-	69	69
Dwarf Yellow	-	27	27
F3 generation	-	27	27
DY x Debarayaya	-	49	49
DG x Debarayaya	-	45	45
T x Moorock	-	30	30
T x Debarayaya	-	80	80
T x St. Annes	-	74	74
T x Kasagala	-	28	28
CRD x T	-	124	124
D x Debarayaya	64	76	140
Other			
DY (Weralugama)	-	02	02
Spicata	-	11	11
Wilhelmina	-	78	78
Thammenna	-	70	70
Kivulakelle	-	80	80
Andigama	-	115	115
Seedlings over 05 months			
Mirishena	-	117	117
Yatawatta	-	70	70
Sitrakala	-	86	86
Dehigahalanda	-	50	50
Marandawila	-	84	84
Namalwatta	-	158	158
Debarayaya	-	117	117
Goyambokka	-	90	90
Dickwella	-	70	70
Ran Thembili	09	-	09
Total	**73**	**2975**	**3048**

A A L Perera, R Jayatillaka & W B S Fernando

REPORT OF THE SOILS AND PLANT NUTRITION DIVISION

HEAD - L L W Somasiri, Ph D

1. GENERAL

The research programme of the Division comprised of nineteen field experiments, two projects funded by the CARP, one project funded by the coconut CESS and miscellaneous laboratory and field studies carried out by the university/ technical college students. The main research programme was aimed at studying various aspects of coconut nutrition such as the fertilizer application techniques, fertilizer recommendations for king coconut and tapping palms, efficiency of different organic sources as manures, chemical, physical and microbiological characteristics of coconut growing soils, improvement of water storage capacity of soils and supplementary irrigation of coconut.

Two projects funded by the CARP were completed this year and terminal reports were submitted. The other projects funded by the CARP is in progress. The land suitability mapping project carried out with CESS assistance is nearing completion.

2. RESEARCH PROJECTS

PROJECT 5: DEVELOPMENT OF AN IMPROVED PACKAGE OF SOIL MOISTURE CONSERVATION PRACTICES FOR SOIL CLASSES 3, 4 AND 5 TO INCREASE YIELD BY 25%

Experiment 5.0.2: Use of polythene for soil moisture conservation under rainfed condition. (1996-2000)

For this experiment Sudu series and Andigama series (moderately deep phase) were selected from Kajulanda Estate and Ratmalagara Estate, Madampe respectively. Both sites are located in the agro-ecological region IL_1. Demarcation of experimental plots was completed taking into account the variation in soil conditions and the yield of palms. Monitoring of soil moisture status in treatment plots and recording yield data are in progress.

L P Vidhana Arachchi, S K Gunaratna & K R E M Fernando

Research No. 6.2: Development of a method to use common salt as a partial substitute for muriate of potash fertilizer for adult coconut palms

Experiment 6.2.1: **Effect of sodium and chloride on yield of coconut (1995-2000)**

Experimental sites: Wayagolla Estate, Attanagalla
Ganewatte Estate, Ganewatta

Leaf and soil sampling prior to treatment application were done at both sites. Treatment application was accomplished in January at Attanagalla and in June at Ganewatta respectively. The yield records in terms of number of nuts and husked nut weight were maintained at bimonthly intervals.

Analysis of leaf samples collected prior to treatment application indicated that K, Cl and S levels in the 14th frond were within the sufficiency range. The available K, Cl and S in the soils collected prior to treatment application were also determined. The effect of application of potassium fertilizers with and without Cl and also application of Cl fertilizers with and without Na on coconut nutrition after treatment application will be studied by leaf analysis.

L L W Somasiri, K L Ranasinghe, D S Wijetunge & N M D Chandrasoma

Research No. 7.2: **Development of suitable fertilizer mixture for palms in tapping, continuously or seasonally**

Experiment 7.2.1: **Formation of a suitable fertilizer recommendation for toddy tapping palms (1996-2000)**

Two sites were selected for this experiment; one at Ethgala and the other at Toppuwa. Both sites are situated in the agro-ecological region of WL_3. Soils in the site at Ethgala are imperfectly drained deep colluvial sandy loam (Pallama series) and those in Thoppuwa are imperfectly drained deep alluvial sandy loam (Metikotuwa series).

Three treatments were applied to three plots comprised of 20 palms each. The treatments were as follows:

Treatment	Urea (kg)	Saphos phosphate (kg)	Muriate of potash (kg)	Dolomite (kg)	Goat dung (kg)
T_1	3.5	1.0	2.5	-	-
T_2	1.5	1.0	2.5	2.0	-
T_3	1.3	1.0	2.5	-	15

Treatment application to Ethgala site was completed in July and yield records (in terms of the volume of toddy) were maintained every Thursday of the week. Six months after treatment application (in December) the toddy yield per palm per day was as follows.

Treatment	Toddy yield(l)/palm/day
T_1	1.92
T_2	2.00
T_3	2.14

There was no significant difference between the toddy yield of each treatment.

The treatment application to Toppuwa site was accomplished in November. Therefore, the treatment effect could not be evaluated with available data by December. Prior to treatment application the average toddy yield in the site was 2.02 l/palm/day.

M N Fernandopulle & K K I C K Kannangara

Research No. 7.3: Development of a suitable fertilizer mixture for king coconut palms

Experiment 7.3.1: Formation of suitable fertilizer recommendations for king coconut (1996-2000)

Uniform plantations of king coconut suitable for the experiment were scarce. Two sites were selected for the experiment; one at Marandawila situated in the agro-ecological region of IL_3 and the other at Walpita situated in the agro-ecological region WL_3. The soils at Marandawila site are imperfectly drained deep sandy loam (Welipellessa series) while those at Walpita site are well drained moderately deep gravelly sandy clay loam (Boralu series). The site at Walpita had not been manured for a long time while the site at Marandawila had been manured regularly with APM. The age of both plantations were about 20 years.

King coconuts were sampled for those sites and analyzed for N, P, K and Mg to determine the removal of nutrients. The analysis showed that removal of K was much greater than N, P and Mg. The treatment level of nutrients has to be determined based on the annual removal those nutrients.

M N Fernandopulle & K K I C K Kannangara

PROJECT 8: Improvement of poultry manure by supplementation with inorganic fertilizers

Experiment 8.0.1: Evaluation of the effects of seasoning of poultry manure on the availability of nutrients to the coconut palm (1996-2000)

This experiment is being conducted in two locations, namely, Pottukulama and Badalgama.

Pottukulama Experimental Site

The site is located in the agro-ecological region of IL_3 on moderately deep sandy loam soil (Ambakelle series). The treatment layout was done according to randomized block design and selection of palms was based on girth parameters measured in the previous year. Premanurial leaf and soil samples were collected after blocking out. The first manure application (fresh poultry manure and poultry manure stored for 1 month and 3 months respectively) was done in May 1996.

The yield parameters such as no. of nuts per bunch, female flowers and copra were recorded in bimonthly intervals. Root samples of treatment palms were collected 6 months after manure application to determine whether any root damage has occured due to poultry manure application.

Badalgama Experimental Site

The site is located in the agro-ecological region of WL_3 on moderately deep gravelly soils (Boralu series). Preliminary data such as soil physical and chemical properties, girth of palms etc. were collected. Selection of plot palms was based on girth of the palms, which was completed in June 1996. Premanurial soil and leaf sampling was carried out prior to the first manure application which was done in August 1996. Yield parameters such as no. female flowers, no. of nuts per bunch and copra content were recorded at bimonthly intervals.

N A Tennakoon

PROJECT 9: Development of improved fertilizer application techniques for coconut to improve efficiency of uptake and to minimize cost

Experiment 9.0.1: Evaluation of different fertilizer application techniques on the yield of coconut (1995-2000)

This experiment was commenced at two locations; Thammanna estate,

Puttalam and Wayagolla estate, Attanagalla. The yield parameters such as female flowers, nuts and copra were recorded bimonthly in both sites. Leaf sampling and 2nd treatment application which had been due in November 1996 at both sites were postponed to January 1997 owing to financial restrictions.

The chemical analysis of leaf samples collected from each palm prior to first treatment application was completed. The sample size per plot for leaf sampling was established by studying the variation of leaf nutrients levels within each plot using these data.

N A Tennakoon

PROJECT 10: DEVELOPMENT OF DRIP IRRIGATION SYSTEM FOR SOIL CLASSES 3 AND 4 TO ACHIEVE 40%-50% INCREASE IN YIELD

Experiment 10.0.1: Design a suitable drip irrigation system for coconut plantations. (1995-2000)

This study was carried out on Andigama soil series at Ratmalagara estate situated in the agro-ecological region of IL_1. Data from a detailed soil survey and the initial yield records were used in laying out of experimental plots. A sub-terranian tubing system was established to provide water at different irrigation intervals.

The lateral and vertical wetting pattern of soil was determined prior to deciding the optimum flow rate of dischargeable water through the drip system.

The soil water absorption regime of the coconut palm was studied by neutron probe technique. The data showed that soil water stored at the 20-100 cm depth range was highly extractable by coconut palm. Roots localized at a distance from 50 to 100 cm away from the bole of coconut palm were found to be more responsible for absorbing soil water and the highest extraction was observed 100 cm away from the palm. The study on the wetting pattern of soil showed that irrigating coconut through drippers at the rate of 30 l/h wetted a large volume of soils in the effective root zone of coconut. It was evident from the results that placement of four drippers 100 cm away from the bole of the palm with equal distance between drippers and irrigating at the flow rate of 30 l/h was sufficient for maximum wetting of the effective root zone of coconut. The experiment is in progress.

L P Vidhana Arachchi, M N Fernandopulle & D T Mathes

PROJECT 26: STUDIES ON SOIL PHYSICAL PROPERTIES OF COCONUT GROWING SOILS

Experiment 26.0.1: Determination of the threshold level for soil oxygen concentration in the vicinity of coconut root system (1996-2000)

The objective of the study was to find out the threshold level for soil oxygen concentration below which coconut roots are permanently damaged particularly where soil drainage is poor. The oxygen concentration in the soils was measured by inserting the probe of an oxygen meter to a vertical cross section of soil (obtained by cutting a pit) at 10 cm depth intervals from the surface. The oxygen meter was calibrated to potassium hydrogen sulphide solution as zero oxygen concentration and to atmospheric air as 21% oxygen concentration. Preliminary findings obtained for Sudu series soils at Bandirippuwa Estate, Lunuwila (located in the agro-ecological region of IL_1) showed that high moisture level (> 12 %, on dry basis) tends to reduce soil aeration and O_2 content of soils. Results also revealed that oxygen concentration 16-19% exist upto a depth of 150 cm in soil profile of well drained and moderately well drained soils were favourable for root growth of coconut. The oxygen content of poorly drained soil (Sudu series) beyond depth of 60 cm was significantly ($P < 0.001$) lower than that of well and moderately well drained soils at the same depth.

Detailed study of the poorly drained Sudu series soil showed that oxygen concentratiion of 15% could be the threshold level below which the growth of coconut roots is significantly ($P < 0.001$) restricted. Moreover, 5% oxygen level existing beyond 80 cm depth of Sudu series was found to be severely detrimental for functioning of the respiratory system and the growth of coconut roots.

Use of lithium as non-radio active tracer to find out the effective root zone of coconut, grown in Sudu series soils and the effect of oxygen level on the absorption process of coconut roots are in progress.

L P Vidhana Arachchi, L L W Somasiri, S K Gunaratna & N A Tennakoon

PROJECT 28: STUDIES ON BIOLOGICAL PROPERTIES OF COCONUT GROWING SOILS

Experiment 28.0.1: Study of the microbiological and other related properties of different coconut soils and the assessment of their changes amended with organic manure (CARP Funded Project) (1995-1998)

Eight different soil series i.e. Kalpitiya, Kurunegala, Melsiripura, Maho, Weliketiya, Ambakelle, Wariyapola and Pallama were sampled from the major coconut growing area (coconut triangle). From each soil series, soil samples were collected from three locations. Microbiological parameters, of these soils such as number of total bacterial colonies, number of total fungal colonies, CO_2 evolution, N mineralization rate, biomass C and biomass N were determined. Chemical and physical parameters of some of the soils were also determined. The soil analysis is in progress.

Six soil series i.e. Andigama, Kuliyapitiya, Boralu, Pallama, Weliketiya and Ambakelle were selected for the second part of the experiment. Three locations were selected from each soil series. Three soil series i.e. Andigama, Kuliyapitiya and Boralu were considered as moisture limiting soils and the rest were considered as nutrient limiting soils.

Cattle manure (35 kg) and muriate of potash 1200 g were applied to four coconut palms in each location and another four coconut palms were kept unmanured (control). This part was established in June 1996. The soil samples were collected in every two months interval up to the 6th sampling. Three such soil samplings were completed by the end of year.

N A Tennakoon, K S K S Fernando, D Priyantha & P Liyanage

PROJECT 30: STUDIES ON DECOMPOSITION PATTERN OF DIFFERENT ORGANIC MANURES

Experiment 30.0.1: Evaluation of effect of common salt for organic manure decomposition (1995-1998)

Soil samples, collected at three monthly intervals were analyzed for monitoring changes in soil pH, available N (NH_4-N and NO_3-N), available P, exchangeable cations and organic C.

According to the available results, the availability of N, exchangeable K and Mg of soils treated with different sources of organic manures (cattle manure, goat manure and poultry manure) and sodium chloride was greater than those treated only with organic manures. Sodium chloride, applied at the rate of 2 kg per coconut palm (4.2 g/5 kg of soil in a pot) showed the highest nutrient availability in the three soil series viz. Sudu series, Boralu series and Madampe series respectively.

N A Tennakoon & Wasanthi Mala

PROJECT 30: STUDIES ON DECOMPOSITION PATTERN OF DIFFERENT ORGANIC MANURES

Experiment 30.0.2: Estimation of the decomposition rate of different sources of organic manures and nutrient availability to the coconut palm (1995-1999)

The experiment was conducted at two locations, viz. Horombawa and Mangala Eliya.

Horombawa Site

The site is situated in the agro-ecological region of IL_1. It comprised of Kuliyapitiya series soils and the land belongs to the suitability class S_4. The number of fronds, girth measurements were recorded as girth parameters and the number of bunches, number of female flowers and number of nuts were recorded as yield parameters prior to the plot arrangement. The treatment layout was done according to the Randomized Block Design and palms in each plot were selected on the basis of yield and growth parameters in order to minimize variation within plots.

Premanurial leaf and soil samples were collected in February 1996. The first treatment application (comprised of different sources of organic manures) was completed in May 1996. The number of nuts, number of female flowers and copra weight were recorded bimonthly as yield parameters.

Mangala Eliya Site

This site is situated in the agro-ecological region of DL_3. It is comprised of Borupan series soils and the land falls into suitability class S_2. The treatment layout was done according to the Randomized Block Design and girth parameters of palms obtained in February 1996 were used for selection of palms for plots. Pre manurial soil and leaf samples were collected in March 1996. The first organic manure application was made in May 1996. The number of nuts, number of female flowers and copra weight were recorded bimonthly as yield parameters.

For the assessment of decomposition rates of different sources of organic manure, soil samples were collected in every three months interval from both experimental sites. Accordingly two soil samplings were done at each site by the end of the year. The study on the decomposition rate was carried out by a MSc student from University of Kelaniya.

N A Tennakoon, R Fernandopulle,

Research No. 30.1: Studies on the role of micro-nutrients in the productivity of the coconut palm

Experiment 30.1.1: Determination of critical nutrient levels of Zn, Cu, B, Mn and Fe in coconut palm (1996-2000)

Previous studies on micronutrient status of coconut palms in the coconut triangle indicated that only Cu and Zn were bordering the respective critical levels and other micronutrients (Fe, Mn and B) were above the respective critical levels. (CRI Annual Report, 1995). Therefore it was decided to carry out field experiments to investigate the effect of Cu and Zn treatments on coconut yield. Accordingly two field experiments on Zn and Cu treatments were commenced, one at Pottukulama Research Station and the other at Ratmalagara Research Station.

Treatment scheme of the field experiments were as follows.

Treatment	Fertilizer			
	APM(kg)	Dolomite(kg)	$ZnSO_4$(kg)	$CuSO_4$(kg)
T_1 (control)	3	1	-	-
T_2	3	1	50	-
T_3	3	1	100	-
T_4	3	1	-	100
T_5	3	1	-	200

The treatments were laid according to the randomized block design. Preliminary yield data were collected prior to treatment application. The treatment application will be done next year.

L L W Somasiri, K K I C K Kannangara & A H Norman Hewage

Research No. 6.0: Substitution of low cost phosphate (ERP) in place of saphos phosphate fertilizer for young coconut palms in different agroclimatic zones

Experiment 6.0.1: Effect of phosphorus nutrition on the performance of coconut seedlings (TxT), Ratmalagara Estate, Madampe (1991)

Treatment application to the experiment was accomplished for the fifth year as follows:

Treatment	Triple super phosphate (g)	Saphos phosphate (g)	Eppawela rock phosphate (g)
1 (control)	-	-	-
2	109	182	167 = 50g of P_2O_5
3	218	364	333 = 100g of P_2O_5
4	436	728	667 = 200g of P_2O_5

Basal treatment - 343 g urea, 343 g of muriate of potash and 200 g of kieserite.

One half of the above dosage was applied in January and the other half was applied in July. Plant height and the No. of fronds were measured quarterly. The statistical analysis of data showed that there was no significant difference in growth of young palms treated with different sources of phosphate. But growth of young palms of control treatment was significantly ($P < 0.05$) less than phosphate treated palms. The results show that ERP is also a promising source for young coconut.

M N Fernandopulle

Research No. 7.0: Development of suitable fertilizer mixture for young palms

Experiment 7.0.1: Effect of N, K, Mg on the performance of coconut seedlings (1991)

The treatment application to the experiment was accomplished for the fifth year as follows.

Treatment	Urea(g)	Muriate of potash (g)	Kieserite (g)
1	129	129	156
2	257	257	313
3	514	514	625

Basal application - 153 g of triple super phosphate

One half of the above dosage was applied in January and the other half was applied in July. Plant height and the number of fronds were measured every quarter of the year. The statistical analysis of the data are in progress.

M N Fernandopulle

Research No. 7.1: Improvement of different fertilizer mixtures (DFR) based on nutrient status of leaf and soil of the estates

Experiment 7.1.1: Efficiency of DFR based on leaf and soil nutrient status and productivity of coconut (1992-2000)

The experiment was commenced in 1992. From 1992 to 1995, there were four treatment plots as follows.

T_0 - Control (no fertilizer)
T_1 - 3 kg of ACM + 0.8 g urea
T_2 - 5 kg of ACM + 1.0 kg urea
T_3 - Fertilizer rates to be determined by leaf analysis (DFR)

This experiment did not show treatment differences as the variation of soil conditions between plots were high. Therefore the experiment was redesigned and carried out with following treatment.

T_1 - Control (no fertilizer)
T_2 - 3 kg of APM + 1 g dolomite
T_3 - 800 g of urea, 600 g Eppawela rock phosphate, 1600 g muriate of potash and 2 kg dolomite (DFR)
T_4 - 4.5 kg of APM + 2 kg dolomite

Each plot consists of 16 palms. Yield records were maintained regularly.

N A Tennakoon & L L W Somasiri

Research No. 25.1: Input balance of coconut lands under different soil types and agroclimatic conditions

Experiment 25.1.1: Evaluation of input balance in coconut plantations under different agroclimatic conditions (modified 1994)

Under the project well water samples from estates of the Coconut Research Institute were collected bimonthly from March to December bimonthly. Chemical analysis of these samples are given in the Table 1.

Table 1. *The chemical analysis of well water samples of different estates*

Estate	Range of ion concentrations (ppm)						pH range
	K^+	Mg^{2+}	Ca^{2+}	Na^+	NH_4^+	NO_3^-	
Bandirippuwa Estate	2-5	2-3	3-7	6-10	2-5	1-2	6.0-6.9
Ratmalagara Estate	2-5	1-3	3-8	6-10	2-5	1-2	6.1-6.8
Makandura Estate	3-8	1-2	2-6	6-7	4-7	1-2	6.2-6.9
Walpita Estate	2-4	2-3	3-7	5-6	2-5	1-2	5.9-6.5

The ionic concentrations of most of the wells in different estates were almost similar. Variation was observed in NH_4^+-N, NO_3^--N and K^+ concentrations of which values were higher in September to December than those in the rest of the period. The periodical variation of those value, indicates that there could be a possibility for occurrence of ground water pollution in coconut lands due to washing away and leaching down of fertilizer nutrients.

M N Fernandopulle, U S S Perera and E M A T Banda

Research No. 27.0: Studies on chemical and mineralogical properties in coconut growing soils

Experiment 27.0.1: Evaluation of nutrient status of coconut growing soil (nutrient mapping) (1994-2000)

For the above study, composite leaf samples (from 14th frond of three palms per each location) were collected at the rate of one composite sample per every 80 ha of each soil series. Thus, 180 samples from Kuliyapitiya series and 350 samples from Kurunegala series were separately collected. Soils were sampled from the manure circle of each palm from which leaf was sampled. Soils were sampled from two depths; 0-25 cm and 25-50 cm. At the same time soil samples from unmanured area (about 3 m away from the palms) were also collected.

There were three objectives for this sampling. Firstly to establish the representative sample size (i.e. number of samples) of soils and coconut leaf per each soil series separately. Secondly to determine the soil nutrient status and nutrient status of coconut palms on each series. Thirdly to determine the critical soil threshold nutrient levels in respect of the coconut palm in each soil series.

Chemical analysis of about 500 soil samples for exchangeable bases, total N and DTPA extractable Zn, Cu, Fe and Mn was completed. Chemical analysis of about 200 leaf samples for total N, P, K, Ca, Mg, Fe, Mn, Cu, Zn and B was also completed. The chemical analysis of other samples are in progress.

L L W Somasiri, U S S Perera, E M A T Banda & K L Ranasinghe

3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES

3.1 Land Suitability Mapping Project (CESS funds) (1992)

Preparation of detailed soil maps and land suitability maps on 1:63,360 scale was completed. The maps were drawn on lithographic papers which can be used for reproducing blue prints, photocopies or offset prints. Those soils maps show the distribution of different land forms in the southern coconut growing areas and the soil series occur within each land forms. The land suitability maps show the distribution of areas of different potential categories for coconut production. Those categories are highly suitable (S_1), suitable to highly suitable (S_2). suitable (S_3), moderately suitable (S_4) and marginally suitable (S_5). Two unsuitable land types are also shown in the maps, viz., currently unsuitable which can be developed by a major investment (N_1) and permanently unsuitable (N_2).

Compilation of composite soil maps on 1:250,000 scale showing the distribution of soil associations in the coconut growing region of the country was also completed. Copies of those maps can be reproduced by offset printing. Preparation of composite land suitability maps on 1:100,000 scale covering the southern coconut growing region is in progress.

L L W Somasiri, K L Ranasinghe & D S Wijethunge

3.2 Studies on water balance of coconut under different soil landscapes, agro-climates and management practices (CARP Project no. 12/104/89) (1992-1996)

The above project was terminated and the terminal report was submitted to the CARP in 1996.

Results of the water balance studies with Borupan soil series (Yellow latosol) at Thammanna Estate, Puttalam in the agro ecological region of DL_3 showed that with the onset of the rain-free period, water uptake by roots of the coconut palms was initially confined to the top 0-50 cm layer of soil but two weeks later, roots extracted water mainly from soils below 1 m depth. The soil water depletion (mm of water) at 1 m away from palm and at 2 m depth of soil profile was 91 mm and 122 mm for two rain-free periods of 34 and 78 days respectively. Hence the evapotranspiration rate of coconut was 1.7-2.7 mm/d when the average pan evaporation for the two periods was 4-5 mm/d. Results showed that the crop factor for coconut is approximately 0.7 under the conditions of the study.

In addition, results indicated that water extraction zone by coconut roots in deep loamy soils (Borupan series and Welipelessa series) extended upto 150 cm depth.

Results also showed that in all soil series subjected to study, downward and upward water movement were higher than lateral movement. Furthermore, the highest upward and downward capillary water movement was observed in soil profiles of Andigama and Borupan series respectively. Moreover, water storage capacity of soil profiles was higher in deep loamy soils (Welipellessa, Madampe and Borupan soil series) compared to moderately deep gravelly sandy clay loam soils (Andigama series).

In situ leaf transpiration measurements made between 8.00 am and 2.00 pm of the day showed that a 15 years old coconut palm comprised of 37 fronds with total leaf area of 118.7 m^2 transpired about 110 litres of water during the day from the canopy under non-limiting conditions of soil water.

Leaf water potential of coconut palms ranged from -8 to -12 bars during the dry and wet periods as well. It was apparent that rate of transpiration was in the range of 2-4 ml cm^{-2} s^{-1}, Concomitantly stomatal diffusive resistance also increased significantly during the dry period at ISG and Thammanna Estates. From those observations it became clear that under dry conditions, palms maintained leaf water potential within the range of -8 to -10 bars either by stomatal regulation of canopy transpiration or uptake of available water from deeper layers of soil or by both means. To test this hypothesis further, it is necessary to collect canopy water relation measurements during one or two dry periods along with neutron probe data on soil moisture depletion pattern.

Moreover, soil physical limitation in respect of water retention and appropriate cultural practices to over come the consequent constraints were also discussed in the report. However, this study was terminated prematurely due to unavoidable circumstances. Therefore, all objectives of the project were not fulfilled.

S Jayasekera, C Jayasekera, S Dimantha (Land Use Division), K R R A Peries & L P Vidhana Arachchi

3.3 Characterization of physical properties of coconut soil and studies on the development of coconut roots (CARP Project No. 12/175/149) (1993-96)

Studies on the characterization of soil physical properties of major soil series in coconut growing areas, were completed and the terminal report was submitted to the CARP in 1996. The soil series used for the above study were Madampe, Andigama, Rathupasa, Sudu, Ambakele, Welipellessa, Borupan. Weliketiya, Kalpitiya, Wilpattu, Mavillu, Gambura, Melsiripura, Maho, Kurunegala, Wariyapola, Kuliyapitiya, Boralu, Pallama and Katunayake. Results revealed that bulk density and available water mainly affected the coconut production. Using

multiple regression and cluster analysis, above soil series were classified into three classes according to their soil physical properties.

Results showed that physical properties were significantly correlated (R^2 = 81.37; $P<0.01$) with coconut yield. The predicted equation for the correlation was found to be most reliable to evaluate the soil characters on coconut performance. Results also showed that available water, bulk density, ratio of macro to micro porosity and fine particles (silt and clay) are found as key factors affecting coconut yield significantly ($P<0.01$). Soil physical limitations and favourable factors on coconut production were also identified as indicated the above.

Results also revealed that B horizon in the soil profile is more important than A and AB horizons for coconut production. Hence management practices should be directed towards improving and maintaining the B horizon.

The effect of soil compaction on root distribution and water absorption of coconut grown in Andigama and Madampe soil series was also studied. The penetrometer resistance higher than 200 N/cm^2 was found to be limiting for coconut root growth and proliferation.

Coconut root distribution in Andigama and Madampe series showed that in adult coconut palms about 15%-20% of the total root mass was localized in the top soil layer (0-20 cm), 75%-80% of roots in the depth range of 20 cm to 80 cm. and about 5% were beyond 100 cm depth respectively. Neutron probe studies showed that water extraction regime by coconut roots was confined to a distance ranging from 0.5 to 2 m away from bole of the palm in both soil series. It was also shown that water stored in the depth range from 20 to 100 cm and 20 to 150 cm in Andigama and Madampe series respectively was highly extractable. Study of soil strength of Andigama and Madampe series revealed that soil strength was negatively correlated ($r=0.8298$; $p<0.01$) with coconut root growth. Soil strength higher than 200 N/cm^2 hindered the root water absorption process in addition to retardation of growth and proliferation of coconut roots.

Detailed studies on the morphological adaptations of absorption cells and respiratory organs of coconut roots in response to soil physical properties were also completed. Morphological characters of absorption cells and respiratory organs of coconut roots under physical and moisture stress in soil were studied using scanning electron microscope technique (SEM).

The experimental results showed that the high soil compaction reduced the growth of coconut roots due to low availability of water and low aeration capacity. Moreover, soil water stress made more suberization and dehydration rates.

Scanning electron microscopic photographs showed that physical and water stress of soil reduced the cell volume per unit area of the absorption zone and the number of openings of respiratory organs of coconut roots. It results in retardation of water and nutrient absorption and air exchange processes of coconut roots.

Scanning electron microscopic photographs also showed that gravel particles reduced the contact surface of coconut roots with soil in the root-soil interface. Reduced root respiration, water absorption and root absorption area resulted in retardation of growth and development of coconut seedlings. These findings on adaptations of morphological characters of coconut roots are of important for further research on fertilizer application and nutrient management practices with a view to optimizing coconut production.

The information generated from this project can be extensively used for the assessment of land suitability for coconut cultivation and making sites-specific recommendations for cultural practices. Results of land suitability evaluation using soil physical parameters can assist in identifying high potential areas for coconut cultivation.

L P Vidhana Arachchi, S K Gunaratna & K R E M Fernando

4. LABORATORY/ MISCELLANEOUS STUDIES

4.1 Long-term effects of organic manuring in a coconut plantation

Long-term effects of different combinations of inorganic fertilizer and organic manure (goat dung) application on nutrient status of coconut and physical and chemical conditions of the soil were studied after 10 years of initial treatment. The study was carried out at a site situated in Heenmaliyagara Estate, Bingiriya (located in agro ecological region IL_3) where an organic manure treatment experiment was carried out from 1985 to 1990. Five years after continuous application of different organic manure and inorganic fertilizer combinations, the experiment was terminated and handed over to the owners for general management.

In 1996, ten years after initial fertilizer application, soils and coconut palm subjected to different organic manure treatments were sampled for the assessment of residual effect of goat dung on coconut nutrition. The following treatment combinations were tested. (i) T1 - control, (ii) T2 - recommended inorganic fertilizer, (iii) T3-T6 - 6, 12, 18 and 24 kg of goat dung with PK supplements and (iv) T7 to T10 - 6, 12, 18 and 24 kg goat dung without P and K supplements respectively. Residual effects of organic manure application were evaluated by physical and chemical changes in the soil and nutrient level in the 14th leaf of palms in 10 different treatments.

Available P and available water was significantly ($P \leq 0.001$) higher in soils treated with goat dung + NPK supplements than others. Nitrate N, total N, exchangeable K and Mg, CEC and organic carbon were significantly ($P \leq 0.001$) higher in soils treated with only goat dung than others. The highest values for above parameters were obtained for soils treated with 18 kg goat dung + NPK supplements. Values correspond to all the above parameters were greater in soils treated with goat dung than with inorganic fertilizer only and the control treatment. Soil NH_4-N did not show significant difference between treatments.

Leaf K and Mg were significantly ($P \leq 0.001$) higher in goat dung treated palms than others. Although there were no significant differences in leaf N and P concentrations, higher N and P concentrations were observed in only goat dung (24 kg) treated palms. The results showed that the residual effects of organic manure would cause improvemement in soil quality and nutrient states of palms in the palm.

U D D Damayanthi & N A Tennakoon

4.2 Net N mineralisation in coconut/NFT plantation

A field incubation study was carried out to estimate net N mineralisation rates in a mixed cropping system of coconut/NFT plantation and coconut monocropping. Four types of NFT i.e. Acacia, Calliandra, Gliricidia and Ipil Ipil grown under coconut for six years and a coconut monocrop in Ratmalagara Estate, Madampe were selected for this study.

Forty PVC tubes (50 mm diameter and 30 cm long) were installed in the soil to a depth of 15 cm, 1 m and 2 m away from both NFT and coconut palm and kept for field incubation period of 2 weeks. Another set of 40 tubes were also inserted similarly for a 4 week field incubation period. Fresh soil samples (same depth) were also taken very near to the inserted tubes on the day on which tubes were inserted for the estimation of initial N concentrations in the soil. Mineralised N in the soil were extracted by 2 M KCl and the net N mineralisation rates were calculated.

Net N mineralisation was significantly higher ($P \leq 0.001$) after field incubation period of four weeks than two weeks. Also the net N mineralisation was significantly higher ($P \leq 0.001$) 1 m away from NFT than 2 m away from NFT. The highest net N mineralisation (4.9-15.5 $kgha^{-1}$) was observed in the Gliricidia site compared to the other NFT sites. The highest net N mineralisation of other NFTs in the decreasing order was Ipil Ipil > Calliandra > Acacia. The lowest net N mineralisation (1.2-2.2 $kgha^{-1}$) was recorded in plots of coconut mono- cropping either 2 weeks or 4 weeks after incubation period. This study clearly indicates that growing NFTs with coconut enhances N availability in coconut lands.

N A Tennakoon & M de S Liyanage

4.3 Changes in microbiological and chemical parameters in different types of coconut soils after amended with cattle manure

The short-term effects of cattle manure application in coconut plantation on six different soil series, two months after application of manure. The soil samples were collected from the on-going experiments at different location i.e. Katupotha (Kuliyapitiya series), Weerakodiyana (Andigama series), Pottukulama (Ambakelle series), Marawila (Weliketiya series) and Divulapitiya (Pallama and Boralu series). The palms were treated with 35 kg of cattle manure and 1.2 kg of muriate of potash per palm^{-1} year^{-1}. The changes of microbiological and chemical parameters of soils of manured and unmanured coconut palms were determined.

The parameters such as moisture content, available nitrogen (NH_4N and NO_3N), total nitrogen, number of total fungal colonies, CO_2 evolution were high in Boralu soil after cattle manure application. The highest values of pH, exchangeable bases (K and Mg), total C, C/N ratio were obtained for Andigama soil series after cattle manure application. The soils of Weliketiya series (after cattle manure application) showed high values for number of available P and N mineralisation rates compared to other soils while the Kuliyapitiya soil series (after cattle manure application) showed the maximum values of total bacterial colonies.

B S V J Perera & N A Tennakoon

4.4 Effect of nitrogen fixing tree (NFT) species on soil physical properties of Andigama series

The root distribution pattern of NFT species, *Calliandra calothyrsus, Leucaena leucocephala, Acacia auriculiformis* and *Gliricidia sepium,* their interaction with coconut roots and effect on soil physical improvement of Andigama series were studied. Competitive effect of NFT species with coconut for soil water was also evaluated.

Study of the improvement of soil physical aspects in relation to root growth of nitrogen fixing tree (NFT) species showed that bulk density was significantly ($P<0.001$) reduced by NFT species followed by enhanced aeration in AB and B horizon of the soil profile. NFT species except *Leucaena,* significantly ($P>0.001$) increased total and readily available water fraction in AB and B horizons over control plots. Results of root distribution of NFT species showed that root growth and proliferation of *Calliandra* in A horizon was predominantly higher than that of *Leucaena, Acacia* and *Gliricidia* species. In contrast, *Gliricidia* roots penetrated into B horizon more than the roots of other species.

The root growth of coconut palms in the *Acacia* and *Calliandra* plots were

optimum in the A horizon of the soil profile. The total coconut root mass in AB and B horizons was higher in *Gliricidia* and *Acacia* plots than in plots with other species. These increased values compared to the control were 91% and 0.3% in AB horizon and 21% & 23% in B horizon for these species respectively. In contrast, total root mass of coconut in *Calliandra* grown plots was reduced by 5%, and 45% in AB and B horizons respectively. Results indicated that soil physical conditions of Andigama series could be improved by *Acacia* and *Gliricidia* which would bring about enhanced coconut root growth and proliferation. Results also suggested that root penetration of NFT into hard soils is a "natural" process which may effectively ameliorate gravelly soils.

Comparison of the effect of Gliricidia cuttings and seedlings on improving soil physical properties in Andigama series showed that both Gliricidia cuttings and seedlings improved soil physical properties and readily available water fraction throughout the soil profile upto 1.25m depth but Gliricidia seedlings reduced readily available water fraction in the A horizon.

Study of the competitive effect of NFT species with coconut for soil moisture using neutron scattering methods revealed that roots of NFT species and coconut effectively extracted soil moisture upto 1 m distance from coconut palm. Gliricidia and Acacia extracted significantly higher quantity of soil water ($P < 0.001$) than Calliandra and Leucaena respectively. As expected, moisture extraction by NFT species positively correlated with their root growth and distribution. However, results clearly showed that NFT species did not significantly reduce the water regime in the effective root zone of coconut due to planting pattern of NFT in the experimental plot. The results of the experiment suggested that the above NFT species did not compete with coconut for soil moisture.

L P Vidhana Arachchi, M de S Liyanage,
K R E M Fernando, H A Abesoma & S K Gunaratna

4.5 Calibration of methods for soil phosphorus determination by field experiment data

Five soil series, viz., Madampe series, Pallama series, Boralu series, Sudu series and Lunuwila series which are widespread coconut growing soils were used for the calibration study. *Pueraria phaseoloides* were grown on each soil in beds of dimension 1.5x1.5 m which were treated without (P_0) and with added P fertilizers (P_1; 595 kg of TSP/ha) in triplicate in the randomized block design. Basal treatment of $(NH_4)_2SO_4$ (95 kg/ha), muriate of potash (119 kg/ha) and kieserite (59 kg/ha) were applied to each plot. Plants were grown on both top soil and B horizon of each soil series separately.

The correlation between the relative dry matter yields of *Pueraria* obtained 3 months after planting and soil P determined by different methods was tested. The laboratory methods tested were 2.5% acetic acid extraction Olsen's bicarbonate extraction, anion exchange resin extraction and mixed anion and cation exchange resin extraction. The results showed that the acetic acid extraction accounted for 62.8% of the variation of relative dry matter yield of *Pueraria* whereas other methods accounted for less than 46% of the variation. It showed that 2.5% acetic acid method was more reliable for phosphorus determination in soils of coconut growing areas. The threshold level for 2.5% acetic acid-P was found to be 7.8 mg/kg.

D M D I Wijebandara & L L W Somasiri

4.6 Comparison of different production grades of Eppawela Rock Phosphate with imported rock phosphate

Due to low solubility of commercially available Eppawela rock phosphate (ERP) compared to imported rock phosphate (IRP), attempts are being made to upgrade the ERP either by mechanical separation of more soluble chloro fluoro apatite fraction (UERP) or selectively mined primary apatites (SERP) by manual picking up. The objective of the present study was to compare the efficiency of CERP and UERP with IRP in respect of enhancing P availability in soils.

A green house incubation study was carried out by mixing 1-1.3 g of each rock phosphate based on citric acid soluble P fraction with 250 g soils (3 different soils). Another set of rock phosphates was incubated with the same amounts of soil but adding 4 g cow dung also. Available P in each soil was determined after 7 months by the following methods. (1) 0.5 M $NaHCO_3$ at pH 8.5, (2) 2.5% acetic acid and (3) water (H_2O) extraction).

$NaHCO_3$-P fraction in CERP as well as IRP treatments increased by 78% and that in SERP treatment by 31% over the control. In the UERP treatment, $NaHCO_3$-P fraction did not significantly increase. Acetic acid extractable P fraction in CERP treatment increased by 928%, 728%, 743% and 424% in CERP, UERP, IRP and SERP treatments over the control respectively. The H_2O-P fraction significantly increased only in UERP (320%) and IRP (400%) treatments.

Although cowdung alone increased $NaHCO_3$-P fraction by 320%, HAc-P fraction by 63% and H_2O-P fraction by 830%., it did not significantly increase the available P fractions of soil + cowdung + rock phsophate treatments with respect to above three methods. The results suggest that both CERP and UERP are

comparable to IRP in respect of enhancing available P in soil, but SERP is inferior to both CERP and UERP in the above respect.

J S Kuranage, M N Fernandopulle, N A Tennakoon & L L W Somasiri

4.7 Evaluation of the suitability and calibration of methods for the determination of available potassium of coconut growing soils.

A study was carried out to evaluate the suitability and to calibrate ammonium acetate method and 2.5% acetic acid method for determination of available K in soils in respect of nutrient status of coconut palms.

To evaluate the suitability of methods, a greenhouse pot experiment was carried out with 10 different soil series including both A and B horizons of the soil profiles.

Each soil in pots received-K (without KCl) and +K (1kg/KCl/pot) differential treatments in duplicate. Basal doses of N, P and Mg were also applied to each pot. *Panicum maximum* was grown on each pot and grass shoots were harvested monthly for 6 months. Available K of each soil prior to treatment application was determined by the ammonium acetate and 2.5% acetic acid methods respectively.

The ammonium acetate extractable-K accounted for 31.9% of the variation in total dry matter (shoots) weight, but acetic acid extractable K accounted only for 19.9%. Nevertheless, ammonium acetate extractable-K accounted for 61.1% of the variation in relative K uptake while acetic acid K accounted for only 44.4%. The results showed that K values determined by both methods were more related to plant K uptake than growth parameters but the ammonium acetate method was superior.

For field calibration, data on leaf K concentration in 14th frond of coconut and available K of soil at 1 m distance from the palm were obtained from an experiment which received different K and Mg fertilizer levels for 6 consecutive years.

The leaf K concentration of coconut showed curvilinear relationships with both ammonium acetate-K and acetic acid-K. The curves showed a plateau at leaf K sufficiency range. The threshold values derived for ammonium acetate-K and acetic acid-K of soils for coconut palm by the above relationships were 180 and 185 mg/kg respectively.

L L W Somasiri & D D K S Liyanage

4.8 Effect on simultaneous application of potassium and magnesium fertilizers on growth characteristics of grass

Simultaneous potassium and magnesium fertilizer application often results in antagonistic effects in coconut palms. To study the nature of K x Mg interaction in plants grown on two contrasting coconut growing soils, viz., Boralu series and Sudu series, a pot experiment was carried out using *Panicum maximum* as the indicator plant. Pot soils were treated with four levels of potassium fertilizer (K_1 = no KCl; K_2 = 0.3 g KCl/pot; K_3 = 0.1 g KCl/pot and K_4 = 0.9 g KCl/pot) and four levels of magnesium fertilizers (Mg_0 = no kieserite; Mg_1 = 0.2 g kieserite/pot; Mg_2 = 0.4 g kieserite/pot and Mg_3 = 0.6 g kieserite/pot) arranged in 4 x 4 factorial design with 3 replicates for each soil. A basal treatment of 0.112 g of ammonium sulphate and 0.7 g of triple super phosphate was given to each pot. Vegetative parts of each pot were harvested at 30 days interval for 3 months.

The total dry matter yield of grass was significantly ($P<0.001$) greater in Boralu series than Sudu series. Different K treatments showed a significant dry matter increase upto K_2 level in Boralu series and upto K_1 level in Sudu series. Interaction between soil type and K levels, soil type and Mg levels on dry matter production was significant at 5% or greater probability levels. A significant ($P<0.05$) interaction between potassium and magnesium levels on dry matter production was observed for both soils. A highly significant interaction ($P<0.001$) between soil type and K treatment levels on leaf K concentration was also observed. Further it was shown that a highly significant decreasing effect was imposed on leaf Mg concentration by K treatment levels.

The overall results indicated that for maximum dry matter production of *Panicum maximum*, the required K and Mg treatment levels were different for the two soils. The treatment combination of K_2Mg_2 gave the maximum yield for Boralu series whereas K_1Mg_0 gave the maximum yield of Sudu series. The results show that the combined effect of K and Mg treatment levels on growth depends on the soil type.

W D A L Jayasekara & L L W Somasiri

5. TRAINING AND EXTENSION ACTIVITIES

A workshop on Soil and Plant Analysis was held at Coconut Research Institute from March 1-2, 1996, jointly organised by Coconut Research Institute, University of Kelaniya and University of Calgery, Canada. Dr L L W Somasiri, Dr N A Tennakoon and Mr L P Vidhana Arahchci participated as resource personnel in this workshop.

Dr M N Fernandopulle, Dr L L W Somasiri, Dr N A Tennakoon, Mr L P Vidhanaarachchi and Miss K K I C K Kannangara functioned as resource personnel in following training programmes.

* Familiarization programme for NIPM trainees held at CRI from 22 January to 16 February 1996.

* One day training programme for coconut growers on fertilizer use held at CRI on 21 June 1996.

* Diploma in Plantation Management Course held at CRI from 16-23 September.

* Familiarization programme for Farm Development Officers held in CRI from 04 November to 23 December 1996.

* Training programmes organized by the Coconut Development Training Centre for extension officers.

For Differential Fertilizer Recommendation, 214 individual lands were inspected covering 20,000 ha. The demand of growers for DFR has increased compared to the situation in the last year.

The following nos. of leaf, soil, fertilizer and coir dust samples were analyzed in the analytical laboratory.

Leaf samples analyzed	(a)	Research	-	1300
	(b)	DFR	-	1500
Soil samples analyzed		DFR	-	1500
		Chemical	-	2500
		Microbiological	-	250
Physical			-	150
Fertilizer samples analyzed			-	4
Coir dust samples analyzed			-	6
Organic manure samples analyzed			-	10

6. ACKNOWLEDGEMENTS

The assistance and co-operation of the staff of the Soils and Plant Nutrition Division for the progress of the research and extension activities is gratefully acknowledged. Thanks are due to the Head and Staff of the Biometry Division for assistance in designing experiments, data recording and statistical analysis of data. Thanks are also due to Head of the Agronomy Division for granting permission to use the NFT trial at Ratmalagara for soil physical and microbiological studies.

REPORT OF THE CROP PROTECTION DIVISION

Head - C N K Rajapakse, M Sc

1. GENERAL

The most remarkable achievement during the year was the isolation and confirmation of the causative fungus (*Ganoderma boninense*) of the root and bole rot disease of coconut, which has reached epidemic levels in the Hambantota District.

A collaborative programme for Ganoderma disease was initiated with the International Mycological Institute (IMI), UK. As a result, Sri Lanka has been included as a member country of International Ganoderma Working Group. Another collaborative venture has been commenced on the use of pheromones for biological control of coconut pests, with the assistance of Natural Resources Institute (NRI), UK. The Division also contributed to the multi-disciplinary project on Leaf Scorch Decline of coconut. Valuable assistance was provided to growers on the identification and control of pests and diseases of coconut.

2. RESEARCH PROJECTS

PROJECT 12.0: MONITORING AND CONTROL OF ADULT RED WEEVIL POPULATION IN SRI LANKA BY USING AN ATTRACTANT BAITED TRAP - 1995

Experiment 12.0.1: Studies on the aggregation pheromone of the red palm weevil (*Rhynchophorus ferrugineus*) from Sri Lanka - 1996

Adults and pupae of *R. ferrugineus* were collected from infested coconut palms in Sri Lanka and hand carried to UK where they were maintained on sugar cane in an insectary at 27°C, 65% RH on a 12 h : 12 h light/dark cycle. Volatiles released by weevils were collected on Porapak Q filters and adsorbed volatiles were removed from the filters with dichloromethane. Collected volatiles were analyzed by Gas chromatography (GC) with flame ionization detector, GC link electroantennograpy (EAG) and GC link mass spectrometry (GC-MS). Analysis of volatiles collected from adult male *R. ferrugineus* by GC-MS showed a peak at the same retention time (KI 1518) as that of (4*S**, 5*S**)-4-methyl-5-nonanol (ferrugineol) with a mass spectrum identical to that of the synthetic material. A component with the same retention time (KI 1330) and mass spectrum as 4-methyl-5-nonanone (ferrugineon) could be detected by GC-MS. The ketone in the natural pheromone

blend was estimated to be present at no more than 1% of the alcohol. Male and female weevils gave similar EAG response to ferrugineol and significantly weaker response to ferrugineon ($P \leq 0.05$) (Fig 1). A major component which elicited a significant EAG response was identified as 3-hydroxy-2-butanone (acetoin) by mass spectrometry. This compound is presumably derived from the sugarcane. Rates of pheromone production by the males seemed to be similar during light and dark periods at 12-16 ng/weevil/hr (S.E. ± 2.6).

C N K Rajapakse & David R Hall (NRI, UK)

Experiment 12.0.2: Influence of pheromone based mass trapping system for red palm weevil - 1996

Plastic bucket traps (5 l) filled with soap water up to 1/3 of its volume and baited with 200 µl of 4-methyl-5-nonanol (ferrugineol) were installed in several coconut estates with a history of high red weevil infestation. Trap density was maintained at 4 traps per hectare. Ferrugineol filled glass capillary tubes were fixed on the rim of the bucket and a metal hood was fitted just above the capillary to protect the pheromone from rain water. Traps were hung on coconut stems at 1.5 m height. Adult weevils caught in the traps were counted weekly and damaged palms were surveyed at monthly intervals until the pheromone was over. Clear reduction of the red weevil population and gradual decline of damaged palms were evident since the installation of traps thus showing the efficiency of the pheromone baited trap as a tool for controlling adult red palm weevil populations (Table 1.).

Table 1. *Mean number of weevils caught in pheromone baited traps and the number of palms damaged by red weevil in different estates*

Estate	Mean trap catch	Number of damaged palms/ha			
		0	1 (months)	2	3
Sicilia	26.0/3 months	3	0	0	0
Dummalasooriya	71.8/3 months	10	4	1	0
Thummodara	24.4/3 months	10	3	2	0
Bulathsinghala	11.8/2 months	8	1	0	0
Puliyankulama	26.25/4 months	20	4	1	0

C N K Rajapakse, D C L Happuarachchi, K F G Perera & W W N Fernando

Experiment 12.0.3: Evaluation of different pheromone release devices to be used in the trap for red weevil - 1996

In the open bucket trap currently in use, a glass capillary is used as the pheromone release device. Release rate of this capillary tube is very low and inconsistent with the time. Therefore, different slow release devices were evaluated in the laboratory and in the field. Pheromone dispensers were constructed at NRI from heat-sealed, polyethylene layflat tubing or polyethylene vials, as detailed in Table 2. Release rates were compared with those from the commercially available sachet dispensers and the glass capillary tubes. At least two samples of each dispenser were maintained in a wind tunnel (8 kph) in a room held at constant temperature (27°C) and weighed at intervals to determine mean release rates. There was little release from the vials for 3-4 days after loading, presumably as the material permeated through the wall, while from the thinner walled sachets commenced essentially immediately. Thereafter, release rates from the vials and sachets remained constant until the quantity was exhausted. The release rates are shown in Table 2. Field evaluation of these devices were commenced in the Isolated Seed Garden, Ambakelle, and in an estate at Dummalasooriya. Results so far revealed that the amount released from the polythene sachets is fairly high and the quantity in the sachets exhausted early under field conditions. The two types of vials seem to release constant amount of pheromone over the time.

Table 2. *Release rates of synthetic ferrugineol from various release devices in a laboratory windtunnel*

Type	Dimensions (mm)	Loading (mg)	Rate (mg/day) 2°C	Rate (mg/day) 27°C
sachet	50x20x0.12	400	5.35	0.22
sachet	50x30x0.12	200	7.20	0.30
sachet	50x60x0.12	400	13.76	0.57
C. sachet	30x30x0.21	720	7.20	0.30
thick vial	20x16x1.5	200	0.82	0.034
thin vial	20x15x1.0	200	0.65	0.027
capillary		200	0.04μg	0.002μg

C N K Rajapakse, David R Hall, S Chittamuru (NRI, UK) & K F G Perera

PROJECT 12.1: IMPROVEMENT OF BACULOVIRUS ORYCTES RELEASE TECHNIQUES TO MANAGE BLACK BEETLE POPULATION -1995

Experiment 12.1.1: Incorporation of baculovirus oryctes into natural breeding sites of black beetle, *(Oryctes rhinoceros)* - 1995

This experiment was carried out in a 05 acre block of coconut plantation at Horakelle estate, Kudawewa. The experimental site consisted of 06 year old uniform stand of coconut with heavy black beetle damage, caused by the presence of partially decayed coconut stumps. Black beetle larvae infected with baculovirus oryctes were introduced to randomly selected stumps at monthly intervals. Assessment of fresh bud damage was done before commencing the release of virus and at monthly intervals thereafter.

Since the release of virus infected larvae, decline of bud damage in palms was evident. However, the rate of dissemination of the viral disease among the larval population in these stumps was rather slow.

C N K Rajapakse, K A S Chandrasiri & Roshan de Silva

Experiment 12.1.2: Viability of baculovirus oryctes in a suspension - 1996

A laboratory trial was conducted to determine the viability of the virus in suspension. A baculovirus oryctes suspension was prepared by macerating infected larvae with distilled water and keeping it at room temperature ($27^0c \pm 1$). A batch of 16 healthy black beetle larvae was infected separately with the suspension at 15 min, 01 h, 02 h, 04h, 08 h, and 24 h after preparation. Infected larvae were kept in a sterilized breeding medium until they produce symptoms. Another batch of healthy larvae was maintained as a check. Infectivity of the virus suspension was estimated in terms of larval mortality. Results revealed that the viability of the virus in suspension for effective infection of healthy larvae lasts only for 4 hrs. (Table 3).

Table 3. *Percentage black beetle larvae infected using a suspension of baculovirus oryctes kept for varying length of time after preparation*

Age of the virus suspension	% larval mortality (± SE)
15 min	68.75 ± 0.5
01 h	75.00 ± 0.51
02 h	56.25 ± 0.68
04 h	68.75 ± 0.5
06 h	16.66 ± 0.36
08 h	33.33 ± 0.36
24 h	16.66 ± 0.36

C N K Rajapakse, K G D Melani Chandima (Aquinas College) & R de Silva

Experiment 12.1.3: The duration of excreting infective virus material by infected larvae - 1996

Hundred healthy black beetle larvae were fed with baculovirus oryctes and confined in 04 containers filled with sterilized cow dung medium and were reared at laboratory conditions (27°C ± 1, 70% RH). The infected larvae were then removed from the medium of each container at day 5, 7, 9, and 12 and ten healthy larvae were introduced separately into each medium which contained faecal pellets of viral contaminated larvae. These healthy larvae were observed daily for disease symptoms until their death. Results showed that infected larvae can excrete virus containing faecal matter at least up to 12 days which can cause 50 % larval mortality in a healthy larval population.

Table 4. *Percentage larval mortality obtained by rearing healthy larvae in cowdung contaminated with fecal pellets of viral infected larvae*

Time after infection (Days)	No. of larvae died by viral infection	% mortality (± SE)
5	9	90 ± 0.44
7	8	80 ± 0.89
9	7	70 ± 0.89
12	5	50 ± 1
control	0	0

K G D Melani Chandima, C N K Rajapakse & R de Silva

PROJECT 12.2: DEVELOPMENT OF AN EFFICIENT PARASITOID RELEASE PROGRAMME AND INTEGRATION OF BIOLOGICAL AND CHEMICAL CONTROL IN OUTBREAKS OF COCONUT CATERPILLAR - 1994

Experiment 12.2.1: Studies on activity patterns of larval and pupal parasitoid species of coconut caterpillar - 1994

Experiment 12.2.1.1: Effect of a sugar diet on the fecundity and longevity of *Goniozus nephantidis* females - 1996

Eighty newly emerged females were individually confined into vials and assigned to two groups of 40 each. Females of one group were provided with honey

while the other group was given only distilled water. Females were offered with hosts from their third day and continued until their death.

Females provided with honey deposited significantly more batches of eggs, had a higher fecundity and lived longer than those provided with water (Table 5). Therefore, during dry weather when nectar is scarce, fecundity and longevity of the field population of *G. nephantidis* females could be enhanced by supplying a sugar diet.

Table 5. *Mean (± S.E.) number of egg batches deposited, fecundity and longevity of G. nephantidis females provided with and without a sugar diet*

Parameter	Mean		Probability
	With sugar diet	No sugar diet	
No. egg batches	5.1±0.34	3.1±0.32	<0.001
Fecundity	36.0±2.53	19.3±2.13	<0.001
Longevity	15.6±0.71	10.5±0.71	<0.001

L C P Fernando & H Jayawardene (Aquinas College)

PROJECT 12.3: DEVELOPMENT OF AN ATTRACTANT BAITED TRAP FOR BLACK BEETLE CONTROL IN COCONUT LANDS - 1996

Experiment 12.3.1: Evaluation of the efficacy of ethyl 4-methyloctanoate as a lure for black beetle - 1996

The aggregation pheromone of the black beetle ethyl 4-methyloctanoate was synthesized at the NRI, UK and tested in 10 acre block of coconut at the Agricultural Research Station, Makandura. Two trap designs (pit fall and vain traps) were baited with 100 μl of ethyl 4-methyloctanoate. Each trap design was replicated 5 times. Empty plastic buckets (5 l) filled with water were used as check. Adult beetles caught in the traps were separate into sexes visually and counted weekly.

Results showed the high efficacy of ethyl 4-methyloctanoate as a lure which attracted a total of 96 adults in a 45 day period. Female beetles were significantly more attractive to the pheromone than male beetles (Chi square test, $P \leq 0.05$). No significant difference was observed in trap catches between the two types of traps (Table 6).

Table 6. *Number of adult black beetles caught in plastic pit fall traps and vain barrier traps baited with ethyl 4-methyloctanoate for 45 days*

	Pit fall trap	vain trap	control
Female beetles	30	28	0
male beetles	21 *	17 *	1

* $P \leq 0.05$

C N K Rajapakse, David R Hall, L C P Fernando & K F G Perera

PROJECT 12.4: ASSESSMENT OF YIELD LOSSES OF COCONUT CATERPILLAR AND COCONUT SCALE INSECT AND DEVELOPMENT OF CONTROL MEASURES - 1994

Experiment 12.4.1: Effect of coconut scale infestations on the yield of coconut - 1995

Yield records of scale insect affected palms at Randeniya farm Wariyapola were continued. The experiment was repeated in another site at Andigama farm (NLDB) Giriulla.

L C P Fernando, K F G Perera & W W N Fernando

Experiment 12.4.2: Estimation of yield losses in coconut caterpillar infested palms - 1996

Caterpillar infested palms in Mangalawelli estate, Mangalaeliya and Silverine estate, Kottantivu were grouped according to the severity of infestation. The groups comprised of each of 15 -20 palms in 4 severity levels of infestation; 20%, 20-40%, 40-60% and < 60%,. Records on immature nuts, mature nuts and weight of nuts are being collected.

C N K Rajapakse, R de Silva & D M Jayakody

Experiment 12.4.3: Attraction of males to virgin females of *Opisina arenosella* - 1996

There is evidence that virgin females of *O. arenosella* emit a sex pheromone

to attract conspecific males. To confirm this behaviour in the field, an experiment was carried out in three estates in Ja-ela, Thalawila and Madurankuliya. One to three day old virgin females were individually confined to cages covered with muslin cloth and fixed between two thick, square (8"x8") plastic sheets of 4" apart. Inner surfaces of the sheets were applied with insect glue to trap the insects attracted to females. The traps (sandwich traps) were hung in the canopy of the infested trees for two consecutive nights. Unbaited traps were used as controls.

In all three sites, female baited traps caught a higher number of male moths than female moths indicating the attractiveness of males towards virgin females (Table 7).

Table 7. *Mean number (± S.E.) of moths caught in baited and unbaited traps at Ja-ela (n=16), Thalawila (n=20) and Madurankuliya (n=20)*

Site	No. caught			
	Baited		Unbaited	
	Male	Female	Male	Female
Ja-ela	4.75±0.79	0.25±0.16	0.25±0.16	0.12±0.12
Thalawila	4.1±0.69	0.20±0.13	0	0.2±0.2
Madurankuliya	8.0±0.89	0.20±0.13	1.00±0.33	1.5±0.63

L C P Fernando & K A S Chandrasiri

PROJECT 36: IDENTIFICATION OF INDIGENOUS PLANT SPECIES AGAINST TERMITES IN COCONUT - 1994

Experiment 36.0.1: Evaluation of indigenous plant species on termites in coconut - 1995

Laboratory experiments revealed that rhizome extract of tumeric (*Curcuma domestica*) and corm extract of *Allocacia* sp. (Habarala) have insecticidal effect on termites. Also there is a common belief among farmers that the termite damage in coconut seedlings can be prevented by growing *Allocacia* around coconut seedlings. Therefore, this experiment was carried out to test whether there is any allelopathic effect of these plants on termites in the field. A coconut nursery at Kandetiya which reportedly has high termite incidence was selected as the experimental site. Rhizomes of turmeric and corms of allocacia were laid 30 cm away and around seed beds consisting of 30 seednuts in Completely Radomized Design and both treatments and control were replicated 6 times. Termite attack, collar rot incidence, and other causes were assessed separately from the crow beak stage up to the point

of transplanting. Results showed that there is no significant difference in termite damage between the nursery beds planted with tumeric and allocacia and control beds ($p \leq 0.05$). High termite damage was observed in all plots regardless of the treatments. However, a slight reduction was observed in termite attack in nursery beds planted with allocacia (Table 8).

Table 8. *Number of seedlings damaged by termites, collar rot disease and other causes in nursery beds planted with Tumeric and Allocacia and in control beds*

Treatment	termite damage	collar rot	other causes
Allocacia	69 (38%)	05	18
Tumeric	72 (40%)	05	17
Control	78 (43%)	11	7

(Not significant at 5% P level)

C N K Rajapakse, H T R Wijesekara,
D C L Hapuarachchi & W W N Fernando

PROJECT 37: SCREENING OF PESTICIDES AGAINST PESTS OF COCONUT AND STUDIES ON PESTICIDE RESIDUES 1994

Experiment 37.0.1: Translocation, persistence and distribution pattern of a systemic insecticide in the crown - 1996

Rate of translocation, distribution pattern in the crown and persistence of Monocrotophos 60% were determined using bioassay tests.

Four palms of about 15' in height were treated with 8 ml of Monocrotophos by trunk injection. At each observation few leaflets from 8th, 12th, 16th, 20th, 24th and 28th frond of each palm were removed and fed each sample to 25 *O. arenosella* larvae for 3 days. Sample from each frond was replicated thrice. Sampling was done at 1, 2, 3, 4, 6, 12, 24, 42, 48 and 72 hours after treatment initially and 1, 3, 5 and 7, weeks later. Thereafter, sampling was continued at monthly intervals until mortality of larvae was not observed.

Results indicated that the insecticide reached the crown within one hour of treatment and persist in the leaves up to 4 months. A higher concentration of the

insecticide was distributed in the younger leaves than in mature leaves. The results are being analyzed.

L C P Fernando & K A S Chandrasiri

3. MISCELLANEOUS

GANODERMA ROOT AND BOLE ROT DISEASE OF COCONUT IN HAMBANTOTA DISTRICT

An outbreak of stem bleeding in coconut was reported in the southern part of the country. Observations in the field and the laboratory revealed that the disease symptoms were similar to those caused by the fungus *Ganoderma sp.* and it was confirmed as *Ganoderma boninense* by the International Mycological Research Institute.

A comprehensive survey was conducted by a multi-disciplinary team with the assistance of the Coconut Development Officers in the diseased area, to ascertain the disease incidence. It revealed that nearly 4000 palms (10% of the total area surveyed) have been affected of which 400 palms were in advanced stage. The disease continued to spread in Ambalantota, Netolpitiya, Tissamaharamaya and Beliatta areas. These areas were demarcated and mapped. Survey further indicated that palms in proximity to water sources such as rivers, canals and paddy fields had high disease incidence. Thus it was evident that there was a predisposing factor associated with the disease. Water samples from the irrigation canals were analyzed by the Soils and Plant Nutrition Division and it was revealed that the salinity was high.

Since, the disease was endemic to the above mentioned areas, those areas were declared as areas under quarantine and transport of seednuts, seedlings, and coconut logs from that area were prohibited. A temporary laboratory was set up at Angunakolapelessa Agricultural Research Station to facilitate experimenting in the diseased areas. Mr. C K Jayasinghe, Head, Plant Pathology Division Sri Lanka Rubber Research Institute was appointed as a consultant for further work on the disease and Sri Lanka was included in the International Ganoderma working Group. A control programme was proposed and the implementation of the programme was handed over to the Coconut Cultivation Board. The proposed control programme included uprooting of palms at the advanced stage and treatment of palms at the early stage of the disease by 1% Copper Fungicides. The diseased palms have been marked separately by the officers of the Division during their survey. Many field days, seminars were conducted in the affected areas for Coconut growers and

Government Officials. Cess Assistance has been sought to cover the expenses for laboratory and disease management work. An insect which is suspected to be responsible for germination of sporospores of Ganoderma was identified as *Byrsex cornutus* F (Coleoptera: Tenebrionidae).

C N K Rajapakse, H T R Wijesekara, L C P Fernando, P S Manoher & K F G Perera

4. CROP PROTECTION SERVICES

During the year, total of 167 reported pest incidence were investigated and appropriate control measures were recommended. Reported incidence of pest and diseases are in Table 9.

Table 9. *Reports of pests and diseases in 1996*

Pests & Diseases	Province								Total
	NWP	WP	EP	SP	NP	CP	NCP	SAP	
Coconut caterpillar	15	3	2	4	-	-	-	-	24
Red weevil	16	19	-	1	-	1	2	1	40
Black beetle	15	13	1	1	1	1	-	-	32
Scale insect	7	1	-	-	-	-	-	-	09
Termite	3	-	-	-	-	-	-	-	03
Mammalian Pests	9	2	-	1	1	1	-	-	14
Fungal diseases	25	9	-	9	-	2	-	-	45
Total	**90**	**47**	**3**	**16**	**2**	**5**	**3**	**1**	**167**

WP - Western Province
NCP - North Central Province
EP - Eastern Province
CP - Central Province
SP - Southern Province
NWP - North Western Province
SAP - Sabaragamuwa Province

4.1 Biological control

Parasitoids were mass reared in the insectary at Bandirippuwa estate and

released to many coconut caterpillar infested lands. The number of parasitoids released in different provinces are given in Table 10.

4.2 Chemical Control

Outbreaks of coconut caterpillar and red weevil pests were controlled by trunk injection with 60% monocrotophos. Total of 15487 palms were treated which included 13 Estates and 37 Small holdings.

Table 10. *Number of parasitoids released in different Provinces for the control of Opisina arenosella*

Parasitoid Species	WP	NP	SP	EP
Goniozus nephantidis	15500	41550	5000	2500
Bracon herbator	120450	527750	51250	48000
Eriborus trochanteratus	18000	51925	3250	4500
Tichospilus pupivora	91400	71000	-	-
Total	**245350**	**692225**	**59500**	**55000**

WP - Western Province
NCP - North Central Province
EP - Eastern Province
CP - Central Province
SP - Southern Province
NWP - North Western Province
SAP - Sabaragamuwa Province

5. TRAINING AND EXTENSION ACTIVITIES

One day training on pest and diseases of coconut was provided to the final year students of Sri Jayawadanepura University on 27 January 1996

One week training programme on pest control in coconut with special reference to coconut caterpillar was conducted for Coconut Development Officers (CDO) who represented each District from 12 - 17 February 1996.

One day training on pest control was provided to the executive staff of the Haychem Limited, Colombo on 15 February, 1996.

A practical training on biological control of coconut caterpillar was conducted for CDOO in Amparai/Baticaloa Districts from 2 - 4 October 1996.

Research Staff participated in two Research Extension Dialogues held in Marawila and Ratnapura on 29 February and 30 May 1996 respectively.

Research Staff participated as Resource Personnel in many work shops and training programmes on pest and diseases which included

* Two day field work shop in Tissamaharamaya and Ambalantota organized by the CCB and SLBC (Ruhunu sevaya).

* Entomological working group meeting organized by the Dept. of Agriculture.

* Training programmes organized by the National Institute of Plantation Management.

* Training programmes for students of Universities and Technical Colleges.

* Training programmes for Agricultural teachers, Agricultural Extension Officers and CDOO.

6. ACKNOWLEDGEMENTS

Assistance given by the Head and the Staff of the Biometry Division for analyzing data is greatly acknowledged. Assistance of the Staff of the Crop Protection Division for their co-operation in conducting the experiments and preparing this report is acknowledged.

REPORT OF THE BIOMETRY DIVISION

Head - D T Mathes, FIS

1. GENERAL

Computerization: The staff is shifting gradually from DOS environment to windows environment.

2. BIOMETRICAL ASSISTANCE

Assistance to the research staff was provided by way of statistical consultation, selection of lands, layout of experimental designs, design of field surveys and analysis and interpretation of data.

Special assistance was provided to Mr M T N Fernando (Agronomy Division) and Mr L P Vidanarachchi (Soils & Plant Nutrition Division) in respect of their post-graduate projects. Number of undergraduate and post graduate students, from the Universities of Colombo, Peradeniya, Matara and Sri Jayawardenapura were provided with similar assistance.

3. RESEARCH PROJECTS

PROJECT 20: APPLICATION OF BIOMETRY IN COCONUT RESEARCH

Experiment 20.03:

(a) Calibration trial at Walpita Estate (Wet Zone) - (1984)

The bimonthly recording of vegetative and yield parameters was carried out during the year. Variation in yield parameters and general status of yield pattern in the area between six picks of 1995 and 1996 are given in Tables 1 and 2. The total number of bunches for the year showed a decrease of 6.0% over 1995. The number of nuts per palm, showed an increase of 38% for the 4th pick. However, on the whole, there was 9.1% decrease in number of nuts per hectare over the previous year. The recorded yield was 12710 nuts/ha compared to 13985 nuts/ ha in 1995. The copra yield per hectare was 2548.5 Kg/ha which again represented a 10.4% decrease over 1995.

Table 1. *Average yield components of palms at Walpita Estate in 1996*

Pick Number	Number of bunches/palm		Number of nuts/palm		Number of nuts/ha		Number of nuts/bunch	
1	1.9	(2.1)	6.8	(12.3)	1074	(1948)	3.6	(5.9)
2	2.4	(2.6)	10.6	(15.0)	1669	(2369)	4.4	(5.7)
3	2.0	(2.2)	18.3	(19.3)	2890	(3050)	9.2	(8.8)
4	2.3	(2.1)	23.2	(16.8)	3668	(2664)	10.2	(8.1)
5	1.7	(2.2)	11.6	(14.3)	1827	(2262)	6.9	(6.4)
6	2.2	(2.1)	10.0	(10.7)	1582	(1692)	4.6.	(5.2)
Total	12.5	(13.3)	80.5	(88.4)	12710	(13985)		

(Figures in paranthesis are those recorded in 1995)

Table 2. *Average weight of husked nut and Copra yield of palms at Walpita Estate in 1996*

Pick	Weight of husked nut(g)		Copra (Kg/ha)	
	1996	1995	1996	1995
1	682	652	234.4	406.4
2	747	661	399.0	501.1
3	667	626	616.8	611.0
4	592	652	694.9	555.8
5	523	607	305.8	439.4
6	588	611	297.7	330.8
Total/Ave.	625	636	2548.5	2844.5

(Copra Yield = husked nut weight x 0.32)

(b) Two monthly vs. monthly harvesting

Since the beginning of 1990, palms in the calibration trial were divided into two groups of 50 palms each and harvesting was carried out at two monthly intervals for one group and monthly intervals for the other group. The number of nuts and number of bunches per 50 palms recorded for the two groups since 1990, are shown in Tables 3 and 4. The results indicated an increased yield for monthly harvesting for all years. The year 1994 being a good crop year, has shown a marked difference in the number of nuts and bunches for monthly harvesting as against two monthly harvesting. In spite of the poor crop in 1996 monthly harvesting, recorded 18.4% increase in nut yield as against bimonthly harvesting. The increase in number of bunches was 13.4%. Harvesting at 30 day intervals showed 16% fallen nuts against 35% for harvesting at 60 day intervals.

Table 3. *Number of nuts per 50 palms*

Frequency of harvesting	Year						
	1990	1991	1992	1993	1994	1995	1996
Monthly	4976	5354	5023	2499	6167	4881	4366
Two monthly	4348	4910	4654	1947	4661	3981	3687
Difference							
No	628	444	369	552	1506	900	679
%	14.4	9.0	7.9	28.4	32.3	22.6	18.4

Table 4. *Number of bunches per 50 palms*

Frequency of harvesting	Year 1990	1991	1992	1993	1994	1995	1996
Monthly	711	630	691	579	673	715	658
Two Monthly	653	598	643	410	600	613	580
Difference							
No	58	32	48	169	73	102	78
%	8.9	5.4	7.5	41.2	12.2	16.6	13.4

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PROJECT 13: DEVELOPMENT OF NEW HARVESTING FREQUENCY TO INCREASE COCONUT PRODUCTION

Experiment 13.0.1: Selection of lands and other prelimineries were completed during the year to commence the experiment in January, 1997

Objective: To compare and estimate the impact of different frequencies of harvesting at two yield levels as against harvesting at 60 day intervals on the yield of coconut

Treatments: Frequencies of harvesting

(a) 30 day intervals
(b) 60 day intervals
(c) 120 day intervals
(d) no harvesting, but collecting fallen nuts

yield levels

(a) low yielding (3750-5000)nuts per ha.
(b) high yielding (10,000-12,500) nuts/ha

D T Mathes

PROJECT 20.1: APPLICATION OF CLIMATOLOGY IN COCONUT RESEARCH

Rainfall changes scenarios in coconut growing areas in Sri Lanka

Rainfall data for 30 years (1962-1991) from twelve locations within the coconut triangle and three locations in the "mini" coconut triangle in the Southern Province were analyzed to highlight the significant importance of rainfall in agricultural planning. The selected locations and their geographical details are given in Table 5. While statistics on annual rainfall are shown in Table 6.

Table 5. *Station index of the 15 locations*

Location	Agro Ecological Zone	Latitude (N)	Longitude (E)	Elevation (m)
'Within coconut triangle'				
Ambakelle	IL_1	7°35'	79°47'	n/a
Bandirippuwa	IL_1	7°20'	79°53'	30.5
Horakelle	IL_1	7°27'	79°51'	15.2
Kurunegala	IL_1	7°28'	80°22'	116.1
Palugaswewa	IL_1	7°39'	79°52'	12.2
Ratmalagara	IL_1	7°33'	79°54'	27.4
Nikaweratiya	IL_3	7°44'	80°06'	30.5
Polonthalawa	IL_3	7°42'	80°00'	26.2
Mediyawa	IL_3	7°53'	80°17'	93.0
Ridibendiwela	IL_3	7°44'	80°14'	56.0
E-saltern	DL_3	8°03'	79°49'	3.1
Puttlama	DL_3	8°02'	79°49'	3.1
'Within mini-coconut triangle'				
Kekenadura	WL_4	5°59'	80°36'	48.8
Hambantota	DL_5	6°07'	81°08'	18.1
Kirama	$I(L_1-L_3)$	6°12'	80°39'	122.0

Table 6. *Basic statistics of annual rainfall at selected coconut growing areas (based on data 1962-1991)*

Location	maximum	long-term average	minimum	CV	75% prob. value	rainy days
Ambakelle	2389 (84)	1403	850 (89)	26	1153	102
Bandirippuwa	2564 (63)	1880	1191 (86)	16	1672	134
Horakelle	2443 (63)	1551	938 (83)	21	1393	106
Kurunegala	2932 (72)	2087	1403 (89)	18	2122	165
Palugaswewa	2396 (77)	1385	721 (74)	28	1146	89
Ratmalagara	2394 (84)	1542	1035 (83)	19	1371	113
Nikaweratiya	1864 (62)	1333	786 (86)	18	1161	79
Polonthalawa	2264 (84)	1338	679 (86)	26	1152	79
Mediyawa	1854 (62)	1188	45 (82)	34	861	77
Ridibendiela	2063 (62)	1322	411 (85)	24	1118	78
E-saltern	2595 (84)	1195	566 (74)	32	967	89
Puttlama	2179 (84)	1136	351 (89)	30	898	97
Kekenadura	2958 (63)	1601	66 (89)	30	1392	112
Hambantota	1509 (63)	1045	661 (89)	21	867	109
Kirama	3090 (63)	2202	1015 (91)	21	1900	125

(The year of which maximum & minimum rainfall occured is given in the paranthesis)

As shown in Table 6, the maximum and minimum rainfall amounts were different in many locations. The highest rainfall in many locations was reported in 1963 or 1984, with exceptions at Hambantota. High coefficient of variation (30%) was shown at low rainfall locations (eg. Puttalam, Mediyawa, E-Saltern) while low coefficient of variation was shown at high rainfall stations (eg. Kirama, Kurunegala, and Bandirippuwa). Thus, suggesting that the wet areas are characterized by lower variability, and dry areas by the higher variability. The variation of annual rainfall is generally low in IL_1.

Temporal variability of the annual rainfall for the locations indicated that there was no cyclic or seasonal pattern of the annual rainfall. The total annual rainfall in all stations had a considerable inter-annual variation and rainfall during recent past had been consistently below the long-term average of the respective locations. As a clear decline in rainfall was noticed during 1975/1976 onwards in many locations, the average rainfall from 1962-1976 and 1977-1991 were computed. It was noted that except at Puttalam and E-Saltern rainfall during 1977-

1991 decreased from 30% (at Kekandure) to 3% (at Ambakelle) with respect to the annual rainfall during 1962-1976 (see Table 3).

Table 7. *Decline of rainfall during the period from 1962-1976 to 1977-1991*

Location	Mean (1962-1976)	Mean (1977-1991)	% drop during 77-91 wrt 62-76
Ambakelle	1424	1382	2.9
Bandirippuwa	1976	1784	9.7
Horakelle	1758	1344	23.6
Kurunegala	2164	2010	7.1
Palugaswewa	1461	1309	10.4
Ratmalagara	1567	1518	3.1
Nikaweratiya	1434	1232	14.1
Polonthalawa	1457	1220	16.3
Mediyawa	1371	1006	26.6
Ridibendiwela	1406	1238	11.9
E-saltern	1123	1272	-13.2
Puttlam	1089	1183	-8.6
Kekandura	1893	1309	30.8
Kirama	2411	1993	17.3
Hambantota	1109	980	11.7

The months were grouped into four periods and the variability in the amount of rainfall during March and April (first intermonsoon), May and June (south-west monsoon), October and November (second intermonsoon), and December (north-east monsoon) were studied for 10 year periods 1962-1971, 1972-1981, and 1982-1991. The other five months can be considered as dry months with few exceptions in September at some locations.

It was noted that in general the rainfall dropped during four periods in all three scenarios except at Puttalam and E-Saltern (DL_3) during first intermonsoon and south west monsoon rains. At these two locations, mean rainfall during first intermonsoon and south-west monsoon increased over different periods. The rates of decrease in the first intermonsoon and south-west monsoon rains were lower than the rate of decrease in the second intermonsoon and north-east monsoon rains. The rate of decrease in the second intermonsoon and north east monsoon rains from the period 72/81 to 82/91 was almost double the corresponding rate from the period 62/71 to 72/81. At all the locations in IL_1, rainfall during south-west monsoon was higher than during first intermonsoon. It indicates that considerable amount of rainfall could be expected from March to June in IL_1 region.

Both "Yala" and "Maha" rains and the first inter-monsoon rains did not show a significant decline over the years. However rainfall in north-east monsoon (December) showed significant declining trend between the years as well as over the 10 year period.

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PROJECT: Survey on 'The Assessment of the Impact of the Subsidy on Coconut Industry and Subsidy Recipients'

The above survey was conducted in eight Regional Managers Divisional of the Coconut Cultivation Board (CCB) namely; Gampaha, Kurunegala, Kuliyapitiya, Marawila, Kalutara, Galle, Matara, and Hambantota using CESS funds. Six Agricultural graduates were temporary recruited as enumerators for this survey. The survey was conducted from 15 July, to 30 September and from 06 November to 30 November.

The study focussed on three subsidy schemes namely under/re planting, new planting, and home gardening. The sample unit of this survey is one subsidy recipient who had obtained at least one instalment for under/re-planting, new planting or home gardening scheme during 1983-1992 and the sample size of 1125 of the survey was decided at the desired degree of precision at 2% level. The rate of response from the subsidy recipients was about 80%.

A part of data on new planting and under/re-planting were analyzed. The results indicated, about 60% of the subsidy recipients had education level at least GCE (O/L) level. About 40% of the subsidy recipients do not reside in the subsidy land irrespective of the regions and this rate is significantly influenced by the holding size.

The distribution of subsidy material was found to be highly variable among the subsidy recipients. The dropout ratio of the subsidy recipients was very high irrespective of the holding size, region and the period. The full benefit of the subsidy scheme was achieved only by 9% of the farmers irrespective of the scheme and holding size. The corresponding rates with respect to new planting and under/re planting programmes were 12 and 8% respectively. The dropout rates between instalments of the under/re-planting and the new planting subsidy programmes are shown below.

Dropout rates between instalments in the under/re planting subsidy program

Instalment received	Instalment not received		
	2nd	3rd	4th
1st	19%	85%	98%
2nd		81%	98%
3rd			92%

Dropout rates between instalments in the new planting subsidy program

Instalment received	Instalment not received		
	2nd	3rd	4th
1st	16%	76%	95%
2nd		72%	94%
3rd			85%

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5. ASSISTANCE IN USE OF COMPUTERS AND COMPUTING

(a) A basic training on the use of, Statistical Analysis System (SAS) and Word Processing packages were provided, to the staff in the Research/ Establishment divisions.

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(b) Computerization of experimental data continued throughout the year.

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(c) Assistance was provided quite often to all divisions on the use/application of data base packages and statistical packages.

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(d) Assistance in computerizing and processing of information of the Medical Aid Scheme.

T S G Peiris

(e) Analyses were done for Information for Research Management (INFORM) at the Institute and was submittted to the CARP.

T S G Peiris

(f) Assistance was provided for the installation of computers and maintenance of hardware and software.

H P De Zoysa

6. YIELD RECORDING

The recording of yield components of (30) experiments in all, conducted by the Research Divisions was continued in the following estates.

1. Bandirippuwa
2. Pothukulama
3. Ratmalagara
4. Saddhatissa Estate
5. Wayagolla Estate, Attanagalle
6. Walpita Estate
7. Thambapanni Estate, Puttlam
8. Siringapatha Estate
9. Ganewatta Estate, Ganewatta
10. Badalgama Estate
11. Mangalaweli Estate, Mangala Eliya
12. Ambakelle
13. Banath Estate, Horombawa
14. Kadjulanda Estate, Madampe

All readings were computerized for each harvest and computer prints of the raw data and summary data were send to the officer in charge of each experiment.

7. EXTENSION ACTIVITIES

* Lectures were provided to trainees attending courses conducted by the Coconut Research Institute and National Institute of Plantation Management.

* Trainees from the National Apprentice Board were accommodated from time to time.

* Visitors and students from Universities were briefed on the work of the Division.

8. AGRI-METEOROLOGY

The four Agri-meteorological stations at Bandirippuwa Estate, Ratmalagara Estate, Isolated Seed Garden and Maduru Oya Seed Garden at Bogaswewa were maintained. At Bandirippuwa, daily recordings were taken throughout the year on rainfall, air temperature (at 8.30 and 15.30 hrs), evaporation, relative humidity (morning and afternoon), sunshine hours and soil temperature at six different depths.

Computerization of the meteorological data at Bandirippuwa Estate, Ratmalagara Estate, Isolated Seed Garden and Maduru Oya seed garden and providing, information on monthly basis to Department of Meteorology and other Institutions continued.

Protus Fernando, J D J S Kularatne & D T Mathes

8.1 Bandirippuwa Estate

(a) Rainfall: (Table 8). All months recorded rainfall, except the month of March. Fairly heavy rainfall was recorded for April (355.5 mm) as against 1741.5 mm, the total rainfall for the year. It contributed to about 20% of the total rainfall. On the whole the year recorded the lowest rainfall since 1992, with 60% of the rainfall being for the 2nd half of the year.

(b) Temperature: (Table 9). The monthly maximum temperature ranged from 29.6 (September) to 32.7°C (March). The monthly minimum temperature ranged from 21.5 (January) to 25.3°C (May).

(c) Sunshine: (Table 9). Longer sunshine hours were observed during the early part of the year with a maximum of 9.1 hrs per day in March. The average for the year was 6.7 h.

(d) Evaporation: The lowest and highest evaporation was recorded in November and March respectively. The range being 3.1 to 5.1 mm.

(e) Relative Humidity: The average relative humidity in the morning fluctuated around 82 during the year. In the afternoon it varied from around 57 in February to around 81 in June.

(f) Soil Temperature: (Table 10). The average temperatures recorded at depths 5, 10, 20, 30, 60 and 120 cm during the morning were 27.7, 28.1, 28.4, 29.1 29.9, 29.8°C while those for the afternoon were 32.4, 31.0, 29.8, 29.4, 29.8, 29.8°C respectively.

(g) **Wind velocity:** The wind velocity varied from 3.3 km/hr in November to 6.00 km/hr in January with the mean of 4.8 km/hr.

8.2 Ratmalagara Estate

All months recorded rainfall, with March showing the lowest of 0.7 mm. An all time low rainfall was shown for the year. The total being 1199.3. (Table 11)

8.3 Isolated Seed Garden

Except for March, all months received rainfall. The total rainfall for the year was 1195 mm as against 1834.1 recorded in 1995. The rainfall recorded was the lowest since 1991. (Table 12)

Table 8. *Rainfall (mm) for the last 10 years and in 1996 (Bandirippuwa Estate)*

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	86-95 Ave	1996
Jan	61.7	31.2	0.0	25.4	201.8	37.7	5.3	3.8	122.4	45.3	53.5	94.1
Feb	35.0	0.0	111.4	0.0	16.8	12.2	0.0	20.6	195.7	51.6	44.3	68.8
Mar	62.0	118.3	87.4	65.7	84.3	97.5	0.0	63.5	71.4	100.8	75.1	0.0
Apr	60.2	237.6	283.0	234.9	74.8	90.3	54.5	191.4	132.9	276.6	163.6	355.5
May	284.7	187.2	109.9	52.3	227.7	481.5	413.5	255.2	262.9	399.1	267.4	76.8
Jun	44.7	61.6	255.8	153.4	29.0	269.4	260.2	49.2	70.4	207.2	140.1	84.3
Jul	33.5	6.4	151.8	99.0	156.3	105.8	78.0	73.6	60.6	35.2	80.0	58.4
Aug	77.2	156.5	105.2	20.4	0.3	22.6	57.3	56.7	37.5	35.4	56.9	223.5
Sep	94.7	410.7	303.4	222.1	11.9	59.3	362.6	200.9	279.6	41.1	198.6	234.4
Oct	224.3	579.3	88.8	395.9	395.1	309.2	443.7	324.7	378.3	194.5	333.4	192.1
Nov	149.4	194.7	370.7	379.4	623.3	161.4	317.9	301.6	284.2	558.3	334.1	216.5
Dec	63.5	79.9	19.1	50.3	90.2	29.1	60.7	237.6	9.1	18.8	65.8	137.1
TOTAL	1190.9	2063.4	1886.5	1698.8	1911.5	1676.0	2053.7	1778.8	1905.0	1963.9	1812.8	1741.5

Table 9. *Summary of meteorological observation in 1996 (Bandirippuwa Estate)*

	Temperature(°C)		Evaporation (mm)	Relative Humidity(%)		Sunshine (hrs)	Wind Velocity
	max	min	per day	a.m.	p.m.		(km/h)
Jan	31.4	21.5	4.5	81	58	7.4	6.0
Feb	32.3	21.7	4.7	80	57	7.5	5.7
Mar	32.7	22.7	5.1	77	63	9.1	4.3
Apr	31.6	24.1	4.0	82	73	6.6	3.6
May	31.4	25.3	4.2	83	75	8.9	4.9
Jun	30.2	24.3	3.4	85	81	5.3	5.1
Jul	29.9	24.2	3.4	83	77	5.8	5.8
Aug	30.0	24.3	3.6	81	77	6.7	5.9
Sep	29.6	24.3	3.4	81	79	4.7	5.2
Oct	30.1	23.4	3.4	82	77	5.5	3.7
Nov	30.5	22.9	3.1	84	74	6.8	3.3
Dec	30.0	22.0	3.2	86	70	6.2	4.1
Ave	30.8	23.4	31.1	82.0	72.0	6.7	4.8

Table 10. *Soil temperature (°C) at different depths (Bandirippuwa Estate)*

	Morning						Afternoon					
	5 cm	10 cm	20 cm	30 cm	60 cm	120 cm	5 cm	10 cm	20 cm	30 cm	60 cm	120 cm
Jan	25.8	26.6	27.1	28.0	29.0	29.0	31.4	29.5	28.6	28.5	28.9	29.0
Feb	26.8	27.5	28.1	28.9	29.6	29.3	34.4	31.1	29.8	29.3	29.5	29.3
Mar	29.1	29.8	30.5	31.2	31.5	30.7	38.3	34.1	32.3	31.6	31.4	30.7
Apr	29.1	29.1	29.5	30.0	30.8	30.7	33.1	31.8	30.7	30.4	30.7	30.7
May	29.5	29.5	29.9	30.4	31.1	30.9	33.1	31.9	30.9	30.8	31.1	30.9
Jun	28.2	28.3	28.6	29.3	30.1	30.3	31.9	30.8	29.6	29.3	30.1	30.2
Jul	27.9	28.1	28.4	29.1	30.1	30.2	32.8	31.6	29.9	29.6	30.0	30.1
Aug	28.1	28.4	28.8	29.4	30.1	30.9	33.0	31.9	30.2	29.7	30.0	30.1
Sep	27.6	27.8	28.0	28.5	29.6	29.7	30.3	30.1	29.0	28.8	29.5	29.6
Oct	27.8	28.0	28.2	28.7	29.5	29.5	31.2	31.0	29.6	29.2	29.4	29.4
Nov	27.2	27.5	27.8	28.4	29.3	29.4	30.8	30.3	29.2	28.7	29.3	29.3
Dec	25.7	26.1	26.4	27.0	28.2	28.4	28.5	28.2	27.4	27.2	28.0	28.3
Ave	27.7	28.1	28.4	29.1	29.9	29.8	32.4	31.0	29.8	29.4	29.8	29.8

Table 11. *Rainfall (mm) for the last 10 years and in 1996 (Ratmalagara Estate)*

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	86-95 Ave	1996
Jan	64.8	13.6	0.0	77.7	185.5	36.2	0.0	17.5	101.5	16.6	51.3	41.1
Feb	54.3	0.0	101.3	0.0	8.3	12.2	0.0	22.9	63.4	55.7	31.8	104.8
Mar	74.7	72.0	53.3	117.4	96.2	88.8	0.0	85.1	21.0	85.6	69.4	0.7
Apr	143.4	120.4	231.4	204.2	37.7	104.4	236.9	278.9	218.2	287.3	186.3	133.2
May	246.1	141.5	68.0	54.2	114.6	375.7	275.2	216.4	281.8	257.9	203.1	54.5
Jun	50.9	65.1	221.9	126.5	12.6	264.2	191.2	23.5	64.5	121.0	114.1	93.1
Jul	22.6	16.9	57.9	124.2	92.7	38.1	71.5	25.8	55.9	19.9	52.6	31.8
Aug	85.9	139.5	158.1	10.0	0.0	16.1	11.5	22.7	22.1	17.3	48.3	91.0
Sep	26.4	190.0	259.7	161.4	17.4	43.0	192.8	198.3	132.7	13.5	123.5	238.2
Oct	153.0	502.8	58.0	238.9	389.2	211.3	326.9	281.4	545.8	148.1	285.5	204.9
Nov	228.4	195.9	230.1	298.7	434.6	175.8	505.5	393.5	204.4	584.3	325.1	164.5
Dec	95.9	53.2	88.8	24.4	76.7	82.2	56.4	197.6	6.4	22.5	70.4	41.5
TOTAL	1246.4	1510.9	1528.5	1437.6	1465.5	1448.0	1867.9	1763.6	1717.7	1629.7	1561.4	1199.3

Table 12. *Rainfall (mm) for the last 10 years and in 1996 (Isolated Seed Estate)*

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	86-95 Ave	1996
Jan	59.1	5.9	3.3	58.4	221.6	44.0	0.0	9.4	110.5	51.2	56.3	127.7
Feb	65.8	0.0	135.0	0.0	0.0	0.0	0.0	2.0	71.6	32.6	30.7	91.2
Mar	55.3	21.7	77.4	29.5	34.0	116.0	0.0	53.5	79.6	59.5	52.6	0.0
Apr	104.9	141.1	233.3	81.7	38.8	147.9	217.8	164.0	141.4	348.2	161.9	105.0
May	121.9	100.2	71.7	16.0	145.6	182.5	207.3	136.3	184.3	337.7	150.3	7.4
Jun	74.5	49.8	129.7	112.2	8.4	236.5	239.5	2.4	85.5	81.1	102.0	133.6
Jul	4.2	4.5	91.4	72.1	67.7	29.2	116.9	35.0	39.4	27.7	48.8	10.4
Aug	47.4	48.1	60.1	1.7	0.0	17.1	28.4	17.5	4.9	13.8	23.9	66.6
Sep	37.4	270.8	272.2	34.0	9.5	25.8	62.3	89.3	115.9	2.7	92.0	159.1
Oct	199.9	467.6	61.3	221.9	288.6	221.6	342.3	239.6	274.6	178.2	249.6	263.4
Nov	236.1	143.2	319.5	214.7	306.7	208.1	406.0	242.8	165.5	666.5	290.9	139.7
Dec	7.6	49.5	64.8	8.0	59.2	151.5	75.9	304.5	12.8	34.9	76.9	90.9
TOTAL	1014.1	1302.4	1519.7	850.2	1180.1	1380.2	1696.4	1296.3	1286.0	1834.1	1335.9	1195.0

REPORT OF THE TISSUE CULTURE DIVISION

Head - L K Weerakoon, Ph D

1. GENERAL

The Division continued its experiments giving greater attention to research on clonal propagation of coconut. Results obtained from immature embryo and immature inflorescence cultures were most encouraging. Studies on the development of charcoal-free culture media for coconut tissue culture were commenced.

2. RESEARCH PROJECTS

PROJECT 18: STUDIES ON THE VEGETATIVE PROPAGATION OF COCONUT

Experiment 18.1: *In-vitro* culture of embryos of local forms and varieties of coconut

Experiment 18.1.1: Propagation of *"dikiri" coconut* using embryo culture technique (1992)

Propagation of *"dikiri" coconut* using the embryo culture technique was continued. The conditions for establishment of *in vitro*-raised seedlings were improved and as a result, the production of *dikiri* seedlings was increased. A total of 186 *in-vitro* grown *"dikiri"* seedlings were produced during the year (Table 1). Five of the *in-vitro* raised seedlings were planted in the field in October. Eighty seedlings will be subjected to hardening and subsequently planted in the field. Further experiments are in progress to shorten the *in-vitro* growth period and to improve the soil establishment of seedlings further.

Table 1. *Production of dikiri seedlings in 1996*

Month	Number of *dikiri* embryos cultured	Number of embryos germinated	Number of seedlings obtained
January	80	65	42
March	104	85	41
May	58	45	34
July	88	70	55
September	25	14	14
Total	355	279	186

L K Weerakoon, C K A Gamage & E S Santha

Experiment 18.1.2: Application of embryo culture technology to select drought tolerant coconut germplasm (1986)

The experiments on *in-vitro* screening of drought tolerant coconut germplasm were continued using polyethylene glycol (PEG) as the water stress simulant. Seedlings developed from zygotic embryos of Ambakelle Special, Dwarf x Tall, and *San Ramon* were used as experimental material. Forty three seedlings (developed from zygotic embryos of Ambakelle special palms) that survived the stress conditions caused by different concentrations of PEG (2%-7%) were hardened. These seedlings will be planted in the field early next year in order to evaluate their performance under field conditions. The growth of the palms (that survived the stress conditions caused by different concentrations of NaCl) planted at the Pothukulama Research Station was found to be satisfactory.

L K Weerakoon, V R M Vidhanaarachchi & E S Santha

Experiment 18.1.3: Studies on the improvement of coconut embryo culture technology (1994)

In order to cut down the cost of production of *in-vitro* raised seedlings, the feasibility of using tap water (instead of deionized water) in the growth medium and elimination of plant hormones (BAP and 2, 4-D) in the growth medium were studied. Preliminary results indicate that the use of tap water in the growth medium and elimination of BAP and 2, 4- D from the growth medium do not have a negative effect on the growth of plants. However, these experiments have to be repeated in order to come to a conclusion.

L K Weerakoon, V R M Vidhanaarachchi & E S Santha

Experiment 18.1.5: Studies on *in-vitro* preservation of mature zygotic embryos of coconut *(1996)*

Development of suitable *in-vitro* culture conditions for preservarion of mature coconut embryos will be beneficial for safe movement of coconut germplasm between countries as well as for conservation of coconut genetic resources.

Preliminary investigations on medium-term preservation of mature embryos were commenced. The experimental material consist of embryos excised from mature nuts of the variety T X T. The suitability of two culture media (with varying concentrations of sucrose and activated charcoal) for preservation of the embryos up to 12 months is being evaluated. Growth of the embryos during storage is being

monitored by recording changes in their length and width. Samples of the embryos will be recovered at 3 monthly intervals for viability assessments.

L K Weerakoon & V R M Vidhanaarachchi

Experiment 18.2: Studies on clonal propagation of coconut

Experiment 18.2.1: *In-vitro* culture of immature zygotic embryos of coconut (1986)

Culture conditions for callogenesis from immature embryo explants were optimized and calli were obtained on a regular basis. Therefore it was possible to set up a number of experiments for induction of somatic embryogenesis and subsequent plant regeneration from immature embryo-derived calli.

A number of published papers have described the stimulation of embryogenesis in plant tissue culture systems by certain stress inducing factors. Therefore the effects of three stress inducing factors, namely Polyethylene glycol (PEG), NaCl, and abscisic acid (ABA) on somatic embryogenesis were studied. Low levels of PEG (0.5-1.0%), NaCl (0.1-0.2 M), and ABA (4-10 μM) promoted somatic embryo formation and their maturation. A combined treatement of PEG (0.5%) and ABA (4 μM) also enhanced somatic embryo formation amd maturation.

Culture conditions for shoot regeneration were improved. Incorporation of zeatin (2-10 μM) into the regeneration medium promoted shoot regeneration. The combination of zeatin (2.5 μM) and BAP (2.5 μM) also enhanced shoot regeneration. Some of the shoots further developed into plantlets.

Histological studies of immature embryo-derived calli, somatic embryos, and regenerated shoots were initiated, in order to understand the cellular changes that take place during callogenesis, somatic embryogenesis and shoot regeneration.

Activated charcoal is used in coconut tissue culture media mainly for its potent adsorption of growth inhibitors secreted by the tissues, such as phenolic compounds. However, charcoal also adsorbs certain growth regulators in the medium, making the culture medium composition undefined. This introduces a further source of variability in culturing. Therefore elimination of activated charcoal from the culture media would allow determination of the effective levels of growth regulators to obtain consistent plant regeneration. Preliminary investigations on development of chrcoal-free media for immature embryo culture were commenced. The feasibility of replacing charcoal in the culture media with four different

antioxidants, namely ascorbic acid, citric acid, cysteine hydrochloride, and polyvinylpyrrolidone (PVP) are being tested.

L K Weerakoon & C K A Gamage

Experiment 18.2.2: Culture of leaf explants (1983)

Attempts were made to enhance direct somatic embryogenesis from tender leaf explants. The effect of two stress inducing factors, Polyethylene glycol (PEG) and NaCl on direct somatic embryogenesis were studied. Low levels of NaCl (0.1M-0.2M) and PEG (0.5-1.0%) promoted somatic embryo formation. The effect of stress conditions induced by abscisic acid on embryogenesis is being studied.

The possibility of avoiding a continuous supply of 2, 4-D in embryo induction media was tested. The effect of high 2, 4-D pulse treatements (100, 200, 300 μM of 2, 4-D for 48, 72, 96 hrs) on direct somatic embrogenesis from leaf explants was studied. After the pulse treatements, the leaf explants were cultured in a media containing low levels of cytokinin (4-8 μM) but without any 2, 4-D. Intense tissue browning and inhibition of growth were observed in the explants subjected to above pulse treatements. These results indicate that a continuous supply of 2, 4-D (at a lower level) is necessary to induce the production of somatic embryos from leaf explants.

The effects of several preculture treatements on somatic embryo formation were studied. Somatic embryo formation was enhanced when leaf tissues were precultured in a liquid medium containing 0.25% activated charcoal and 16 μM of zeatin, for 3 days.

All the attempts to induce shoot regeneration in leaf-derived somatic embryos failed. Upon germination, most of the somatic embryos produced roots whereas a few produced non-embryogenic calli. This could be due to an incomplete expression of embryogenesis leading to the formation of embryos lacking shoot poles. Further experiments are underway to identify the factors that are critical for the production of complete somatic embryos from tender leaf explants. Histological studies of leaf-derived somatic embryos were also initiated to elucidate the cytological changes that take place during somatic embryogenesis.

The feasibility of developing a charcoal-free culture medium for somatic embryo germination is being tested.

L K Weerakoon & E S Santha

Experiment 18.2.3: Culture of root explants (1991)

Attempts were made to induce callogenesis and somatic embryogenesis in root explants using several culture media with different combinations and concentrations of growth regulators. Nodular structures that resemble somatic embryos obtained from tender leaf explants were produced in one of the culture medium tested. Several experiments are underway to induce further development of these nodules.

V R M Vidhanaarachchi & L K Weerakoon

Experiment 18.2.4: Culture of floral meristem explants (1995)

Culture of flower meristem explants (obtained from 10-25 cm long immature inflorescences) gave encouraging results. Several of the published culture media were tested for their ability to induce callogenesis and subsequent somatic embryogenesis in floral explants. In most of the culture media tested, the explants were observed to follow the normal developmental pattern of flowers. However, in the medium formulated by Verdeil J., Huet C., Grosdemange F., and J. Buffard - Morel (1994) [Plant regeneration from cultured immature inflorescences of coconut (*Coco nucifera* L.): evidence for somatic embryogenesis], some of the flower meristems gave rise to shoot-like structures, indicating partial reversion of flower meristems into vegetative tissues. Various modifications to the above medium were done and the modified media are being tested to achieve complete plant regeneration from cultured-floral explants.

The culture conditions developed to induce callogenesis and somatic embryogenesis from immature embryo explants were tested on flower meristem cultures. The callus induction medium (containing 0.25% activated charcoal and 24 μM 2, 4-D) developed for immature embryos was shown to be suitable for callogenesis in floral explants as well. When cultured into the above medium, about 30% of the cultured-explants produced compact, embryogenic calli. Some of the callus cultures produced globular somatic embryos when transferred to reduced levels of 2, 4-D. However, preculturing of floral explants in a hormone-free medium (containing 0.25% activated charcoal) was found to be essential for callus production. Incubation of flower cultures at 30°C (instead of 27°C) enhanced callus production. Further experiments to optimize the culture conditions for callus and somatic embryo production are in progress.

The flower meristem explants were subjected to high 2, 4-D pulse treatements (100, 200 300 μM 2, 4-D for 48, 72, 96 hrs) and the effects of these treatements on callogenesis are being studied.

The effects of cold and heat pretreatements of floral explants on callogenesis are also being studied.

V R M Vidhanaarachchi & L K Weerakoon

3. TRAINING AND EXTENSION ACTIVITIES

Mrs. Chandrani Nawaratne, a M. Sc. candidate from the faculty of Science, University of Colombo commenced her thesis research at the Tissue Culture Division in December. Her research project is on the "Development of a charcoal-free protocol for immature embryo culture of coconut".

4. ACKNOWLEDGMENTS

The assistance and co-operation of the staff of the Tissue Culture Division in conducting the experiments and compiling this report are gratefully acknowledged. Thanks are due to the Head and the staff of the Biometry division for the assistance given in designing experiments.

REPORT OF THE PLANT PHYSIOLOGY DIVISION

Officer-in-Charge - C S Ranasinghe, Ph D

1. GENERAL

The research programme of the division, comprising three main areas namely development of post-harvest storage technique for king coconut, physiological and biochemical studies of different varieties/cultivars of coconut, studies on growth and morphological differences in the root system of young and adult palms under four major soil classes, made satisfactory progress. A series of new experiments was commenced to improve the income from coconut groves used for toddy tapping. Another set of experiments was commenced to gain basic knowledge on physiological and biochemical nature of Leaf Scorch Decline (LSD) palms. The staff actively participated in the LSD survey.

2. RESEARCH PROJECTS

PROJECT 16: PHYSIOLOGY OF THE COCONUT PALM

Experiment 16.4: Studies on heritability of drought tolerant characters into open pollinated seedlings from selected drought tolerant palms. [Glass house study] - 1987

This experiment was temporarily suspended.

C Jayasekara, A Nainanayake & R D N Premasiri

Experiment 16.7: Studies on physiology and biochemistry of different varieties and forms of coconut - 1989

Collection of data was continued at three-monthly intervals. Data on transpiration rates revealed that these 13 cultivars could be categorized into two groups. Whilst DG x T, DY x T, T x T, DG and DY showed a high rate of transpiration (range 19.786 - 21.657 ug cm^{-2} s^{-1}) all the other cultivars showed comparatively low rates (range 13.809 - 16.217 ug cm^{-2} s^{-1}). Accordingly, DGxT, DYxT, TxT, DG and DY showed significantly lower stomatal resistance compared to other cultivars. Results did not show significant difference in leaf water potential among cultivars with DY giving the highest value (-10.8 bars) and San Ramon the lowest value (-11.96 bars).

It was observed that all three colour forms of dwarf variety have higher stomatal density than other cultivars. Within the variety, DY recorded the highest stomatal density (153 stomata/mm^2), and it was significantly higher than DG and DR. The lowest stomatal density was shown by Kamandala (127 stomata/mm^2). According to the epicuticular wax content the 13 cultivars could be categorized into two groups. Whilst the three dwarf cultivars, Thembili and Bodiri were included in the low wax group, the other cultivars were included in the high wax group, differences being statistically significant.

Differences in the rate of photosynthesis were also observed among the cultivars. Thembili and Bodiri showed significantly higher photosynthetic rates than the other cultivars except Typica rathi, San Ramon and Kamandala. There was no significant difference in total chlorophyll content of the last open most mature green leaf among the cultivars except DY and DR in which the chlorophyll contents were significantly low (0.6918 and 0.7577 mg/g fw in DY and DR respectively). Bodiri recorded the highest concentration of chlorophyll. Nitrate reductase enzyme activity of Thembili was significantly higher than the other cultivars and it was 1.4664 nmol/g/hr.

Leaf production rate of DY and DG was higher than the other cultivars but number of functional leaves at a given time was almost similar in all seedlings.

R Wimalasekara, C Jayasekara, C S Ranasinghe, N P A D Nainanayake, L R S Silva & P S A De Saram

Experiment 16.9: Studies on vegetative growth and physiology of Ambakelle special seedlings grown under field conditions 1988

Comparison of the yield between two cultivars, Ambakelle Special and TxT seedlings, was continued. During the first year of harvest, mean annual yield of Ambakelle Special seedlings was significantly higher than that of TxT seedlings (Table 1).

Table 1. *Average number of nuts per palm from Ambakelle Special and TxT seedlings during the year 1996*

Cultivar	No of nuts/palm/year
Ambakelle Special	23
T x T	15

C Jayasekara, C S Ranasinghe & R D N Premasiri

Experiment 16.10: Studies on the effect of canopy and root modification on yield of coconut - 1990

The canopy size and root volume were monitored according to the designated treatments. Total female flower production, nut setting and final yield were recorded at bimonthly intervals. The data collected over seven years revealed that neither canopy modification (pruning of 50% of the frond from the distal portion in 20%, 40%, 60% of the total canopy) nor root modification (pruning 1/8, 1/6, 1/4) has affected the above characters. Data on fruit component analysis also showed that there wasn't any consistent effect of either root modification or canopy modification on fresh nut weight, husked nut weight, split nut weight, kernal fresh and dry weight.

N P A D Nainanayake, C Jayasekara & L R S Silva

Experiment 16.13: Studies on water-use efficiency of different ecotypes of coconut in relation to the stable carbon isotope discrimination ratio - 1992

This experiment was not continued due to adverse weather conditions and lack of personnel.

C Jayasekara, N P A D Nainanayake & R Wimalasekara

Experiment 16.15: Sap exudation in different cultivars of coconut - 1996

The quality and quantity of sap were determined from four locally available coconut cultivars, TxT, DxT, Nawasi and Bodiri. Six palms per cultivar were selected except Nawasi and Bodiri from which only two palms per cultivar were selected due to lack of suitable palms. Physical parameters (*viz.* volume, pH and specific gravity) and biochemical parameters (*viz.* soluble sugars) of the sap were measured.

Among these cultivars tested, Nawasi was apparently the best sap yielder (Table 2). Furthermore, both Nawasi and DxT produced significantly higher volume of sap per inflorescence than the commercially used cultivar TxT.

Table 2. *Variation in sap (toddy) volume collected per inflorescence in different cultivars of coconut*

Variety	Sap volume per inflorescence(l)
TxT	15.61
Bodiri	18.68
DxT	33.68
Nawasi	69.36

No differences were observed in the pH, sucrose and total sugar contents of the sap among cultivars. However, the highest glucose and fructose contents were observed in DxT (Table 3). To confirm the above results, a new experiment was started with more replicates.

Table 3. Variation in pH and sugar contents in the sap of four cultivars of coconut

Variety	pH	Sucrose (mg/ml)	Glucose (mg/ml)	Fructose (mg/ml)	Total sugars(mg/ml)
TxT	5.95	124.33	13.88	11.86	150.07
Bodiri	5.5	121.79	12.71	13.32	147.82
DxT	5.7	119.69	18.87	16.49	156.05
Nawasi	5.9	119.61	10.67	11.13	141.41

N P A D Nainanayake, C S Ranasinghe, R Wimalasekara, C Jayasekara, W P K K Fernando, P S A de Saram & A Dharmasena

Experiment 16.16: Changes in the carbohydrate content of trunk and subtending leaf in relation to sap production in coconut 1996

The main objective of this experiment was to develop a rapid biochemical technique to select high yielding palms for toddy tapping. Twenty TxT palms were selected at Bandirippuwa Estate. Studies were commenced to elucidate the relationship between carbohydrate content and sap production. Starch and total soluble sugar content in the trunk and subtending leaf were measured at monthly intervals. After a period of six months the same palms will be used for toddy tapping while monitoring changes in the above biochemical parameters.

C S Ranasinghe, R Wimalasekara, L R S Silva & W P K K Fernando

Experiment 16.17: Sequential toddy and nut production in coconut - 1996

To maximise income from the coconut palm, sequential harvesting of toddy and nut, could be explored. Therefore, the main aims of this study are; (a) to investigate the possibility of producing nuts and toddy from the same palm and (b) to determine the yield and economics of sequential nut and sap production. Sixty four TxT palms were selected at Bandirippuwa Estate and seperated into four groups.

T1 - Sap production only
T2 - Nut production only
T3 - Sequential sap and nut production from the same spathe
T4 - Three month tapping and three month nut production intervals

Volume of toddy, number of nuts, nut components and leaf nutrients will be recorded and a comparison of cost and benefit analysis will also be carried out.

C S Ranasinghe, W P K K Fernando, L R S Silva & P S A De Saram

Experiment 16.18: Yield stimulation and sustainability of coconut sap using yield stimulants - 1996

The main objective of this study was to examine the response of yield stimulants on coconut sap flow. Ethrel and 'Kitul palm mixture' could be suggested as stimulants for coconut sap and a suitable concentration of application has to be identified. Ascorbic acid and citric acid could be used to prevent polyphenol oxidation at the cut surface. Therefore, thirty six TxT palms were selected at Bandirippuwa Estate for the following treatments.

T1 - Control
T2 - Ethrel
T3 - Ascorbic acid + Citric acid
T4 - Mixture (paste) used for 'Kitul'palm

C S Ranasinghe, R Wimalasekara & A Jayatilleke

PROJECT 22. ROOT SYSTEM OF THE COCONUT PALM

Experiment 22.1. Anatomy and morphology of roots in different varieties of coconut and under different growth conditions - 1995

As reported in the previous year (1995), studies on root morphology and

growth performance of four different cultivars; TxT, Ambakelle Special, DxT, and San Ramon at 1-3 year age group, under different soil types, were continued. Frequency of root sampling was reduced from six months to annually due to budgetary constraints and staff shortages.

N P A D Nainanayake, C Jayasekara & R D N Premasiri

Experiment 22.2: Studies on root carbohydrate reserves and root respiration in young coconut seedlings in relation to root growth and soil type - 1995

Seedlings of TxT, Ambakelle Special, DxT and San Ramon were grown in the field under four major land suitability classes, S1, S2, S3 and S4 to study differences in root carbohydrate reserves and root respiration rates.

N P A D Nainanayake, C Jayasekara, R D N Premasiri

Experiment 22.3: Root carbohydrate reserves, root respiration and root growth in different varieties of coconut (bearing palms) and soil types - 1995

Studies on morphology and growth performance of the root system of TxT cultivar (adult palms) under four different soil types were continued. Frequency of root sampling was reduced from six months to annually due to budgetary constraints and staff shortage.

N P A D Nainanayake, C Jayasekara & R D N Premasiri

PROJECT 23. BIOCHEMISTRY OF COCONUT

Experiment 23.1: Biochemical changes associated with harvested young king coconut - 1995

Seven months old king coconuts were collected from two different areas, Marawila and Walpita, and appropriate storage methods were tested to improve the keeping quality. Waxing the perianth region, wrapping with cling film and cold storage (12-14°C) treatment was tested in detail. Sugar content in the liquid endosperm revealed that waxing the perianth region was not necessary to improve the keeping quality of tender king coconuts provided the whole nut, including the perianth region, is covered with cling film and stored at 12-14°C. Apparently, there wasn't any difference/reduction in sugar content of liquid endosperm after five weeks of storage (Table 4).

Table 4. *Variation in sugar contents of liquid endosperm of king coconut with storage period upto 6 weeks*

Sugar type	Weeks						
	0	1	2	3	4	5	6
Sucrose (mg/ml)	2.29	1.35	2.04	2.16	4.46	1.52	3.16
Glucose (mg/ml)	26.57	25.20	23.98	23.24	23.22	21.57	19.90
Fructose (mg/ml)	24.73	23.52	22.58	22.57	15.20	19.50	14.72
Total sugars (mg/ml)	57.68	56.00	54.15	51.72	53.14	52.73	47.72

Since there was a high variation in sugar content of nut water within a bunch and among the bunches harvested from different palms, study is being continued with more replicates. The best maturity stage of harvesting for cold storage has to be elucidated.

R Wimalasekara, C S Ranasinghe, C Jayasekara & W P K K Fernando

PROJECT 25. ESTABLISHMENT AND FURTHER GROWTH OF AMPUTATED POLY-BAGGED SEEDLINGS

Experiment 25.4. Field performance of amputated poly-bagged seedling - 1989

Field trial was maintained satisfactorily to identify differences, if any, in flowering pattern of amputated and bare rooted seedlings. Both types of seedlings received young palm mixture (YPM) as split applications.

R Wimalasekara, C Jayasekara, P S A De Saram & R D N Premasiri

3. TRAINING AND EXTENSION ACTIVITIES

Mr. Anil Dharmasena continued working as a graduate trainee in the division.

Plant Physiology Divison actively participated in training programmes for Plantation Management Diploma courses conducted by the National Institute of Plantation Management (NIPM). Growers, undergraduates, Agriculture Diploma students and school children were briefed on research activities and findings of the division.

4. ACKNOWLEDGEMENTS

The assistance provided by the staff of the Plant Physiology Division in conducting experiments and in compiling this report is gratefully acknowledged.

Thanks are also due to Head/Genetics & Plant Breeding Division for allowing to use experimental palms for toddy tapping studies and to Head and staff of Biometry Division for statistical analysis of data.

MULTIDISCIPLINARY PROJECTS

PROJECT 17 - PREMATURE DECLINE OF PALMS

(Project Co-ordinator - L C P Fernando, Ph D)

Divisions participated: Genetics and Plant Breeding Division
Plant Physiology Division
Tissue Culture Division
Survey Group (Agronomy Division, Crop Protection Division, Genetics and Plant Breeding Division, Plant Physiology Division, Soil and Plant Nutrition Division)

General Remarks

The multi-disciplinary research programme continued satisfactorily with studies on physiology and anatomy of Leaf Scorch Decline (LSD) affected palms and the effect of LSD on germination of nuts. The survey group undertook an extensive survey in Gampaha District to assess the incidence of LSD and Premature Decline (PMD) in relation to soil types and different agronomic practices.

A collaborative project funded by the Overseas Development Administration (ODA) was initiated between the Coconut Research Institute and scientists from the Natural Resources Institute, United Kingdom to determine the probable cause(s) of LSD and Premature Decline (PMD) in Sri Lanka. Although several tissue samples were tested by Dr K Weerakoon (CRI), Mr P Jones and Dr A Tymon (IACR, Rothamsted) to detect the presence of phytoplasma or viroids, the results are yet inconclusive. Mr P Oldham, a Socio-Economist from the Natural Resources Institute visited CRI to assess the impact of the two conditions on the coconut industry.

Experiment 17.1: Studies on leaf area development, leaf cell production and cell expansion rates in LSD-affected palms - 1996

Main objective of this investigation was to study the causes for the reduction in leaf area (canopy) development, cell production and cell expansion rates in LSD-affected palms. Six palms from each category (healthy, mild, moderate and severe) were selected at Bandirippuwa Estate (BE) and data collection was carried out at three monthly intervals.

C S Ranasinghe, A Nainanayake,
R D N Premasiri & P S A De Saram

Experiment 17.2: Studies on stomatal physiology and cell water relations in LSD-affected palms - 1996

An understanding of the stomatal behavior (% stomatal opening, stomatal conductance and stomatal density) and water relations (leaf water potential, solute potential and turgor pressure) of LSD-affected palms is of fundamental importance in order to examine the consequences of scorching and reduced growth rates. Six palms from each category (healthy, mild, moderate and severe) were selected at BE and data collection was carried out at three monthly intervals.

C S Ranasinghe, R D N Premasiri & P S A De Saram

Experiment 17.3: Determination of net assimilation rates, enzyme activities, photosynthetic pigments, proteins and phenolic compounds in LSD-affected palms - 1996

Main aim of this study was to investigate the relationship among leaf scorching, net assimilation rate, internal biochemical characters and accumulation of secondary metabolites. This will in turn, assist to determine control measures for LSD-affected palms. Six palms from each category (healthy, mild, moderate and severe) were selected at BE and data collection was carried out at three monthly intervals.

C S Ranasinghe, R Wimalasekara, R D N Premasiri, P S A De Saram & A Dharmasena

Experiment 17.4: Studies on inflorescence sap of LSD-affected palms: biochemical nature of the sap and effect of tapping on expression of 'disorder' symptoms - 1996

This study was commenced with a view to understand the impact of toddy tapping (creating an artificial sink) on expression of symptoms in LSD affected palms and to elucidate the biochemical condition of the sap. During the current year six palms from each category (healthy, mild and moderate) were selected at BE and sap studies were commenced. Severely affected palms were not selected as they hardly produce any inflorescence. Before tapping the palms for toddy, visual characters of each palm (number of nuts, number of inflorescence and female flowers, number of fronds and severity of symptoms) were recorded. Volume of

sap collected and biochemical parameters (soluble sugars, solute potential and polyphenol content) of the sap were measured. Studies on anatomy of vascular bundles in the inflorescence stalks were also commenced.

C S Ranasinghe, R Wimalasekara, W P K K Fernando, L R S Silva, P S A de Saram & A Dharmasena

Experiment 17.5: Studies on growth regulators of LSD-affected palms - 1996

The main objective of this study was to investigate possible relationship between hormonal imbalance and Leaf Scorch Decline in coconut. Six palms from each category (healthy, mild, moderate and severe) were selected at BE. Analysis of hormones (growth regulators) was not commenced during this year due to lack of required facilities.

C S Ranasinghe, L R S Silva & W P K K Fernando

Experiment 17.6: Germination of nuts from LSD-affected palms (1996)

The experiment was conducted at the Bandirippuwa Research Nursery commencing from October 1996 with the objective of studying the pattern of germination of nuts obtained from LSD-effected palms. Nuts were obtained from 3 sites; Walahapitiya, Walpita and Pothukulama and within each site the nuts from representative samples of palms at incipient, moderate & severe stages along with nuts from healthy palms were used.

Nuts were laid in a randomized block design with 3 replicates per treatment and 20 nuts per replicate. The number of days taken for germination was recorded. The number of days taken for germination and percentage germination at five months after laying of nuts, picked from palms of different stages of severity of symptoms in Tables 1 and 2 respectively.

When considering the 3 sites separately, only the seeds from Walahapitiya estate showed significant difference in time taken to germinate, indicating a decreasing duration of germination with increasing severity of LSD. But it is important to note that in all sites, the percentage of germination five months after laying decreased with the severity stage.

C K Bandaranayake & W M U Fernando

Table 1 : *Average number of days taken for germination of coconuts taken from LSD-affected palms at different stages of severity of symptoms at three sites.*

Stage	Walahapitiya Estate	Walpita Estate	Pothukulama Estate
Healthy	129.76±2.13	123.48±2.57	121.20±3.28
Incipient	122.24±2.73	118.81±2.55	116.37±3.59
Moderate	120.00±2.68	122.32±2.80	126.00±2.74
Severe	115.70±2.68	125.04±1.84	122.87±2.52

Table 2. *Germination percentage 5 months after laying of nuts taken from LSD-affected palms of different stages of severity of symptoms at three sites.*

Stage	Walahapitiya Estate	Walpita Estate	Pothukulama Estate
Healthy	95.0	80.0	77.5
Incipient	82.5	67.5	90.0
Moderate	65.0	70.0	67.5
Severe	60.0	55.0	70.0

Survey : Incidence of LSD and PMD in Gampaha District (1996)

A survey was initiated to estimate the incidence of LSD and PMD in coconut lands of Gampaha district. Of the total area of land cultivated under coconut in the district 1% (over 15 years of age) was chosen randomly from each of 15 Coconut Development Officer's (CDO) range and were categorized into four groups; >20 Ac, 10-20 Ac, 5-10 Ac and <5 Ac according to the extent of the land. Each group and each CDO range comprised of approximately equal acreage. In all the estates soil types were determined and the number of LSD-affected palms of each severity level (mild, moderate and severe) and the number of PMD-affected palms were recorded in each soil type separately. In addition, information on the type of plantation, agronomic practices, source of seedlings etc. were collected. The survey is being continued.

L C P Fernando, W M U Fernando, N P A D Nainanayake, H T R Wijesekara, C K Bandaranayake, G D George, R D N Premasiri, M H L Padmasiri, R Silva, D Priyantha, N G Premasiri, E Perera, A Jayatillake, N Hemasiri & D M Sarathchandra

ODA Project: Investigation of lethal diseases of unknown etiology (1996)

The main objective of the project was to determine whether a phytoplasma or a viroid is associated with Leaf Scorch Decline-affected palms. As the first step, a study was undertaken using molecular diagnostic techniques. Heart tissues, mature and immature leaves and immature inflorescence were collected from LSD-affected palms at different stages of symptoms (mild, moderate, severe) and healthy palms. Total genomic DNA from the above tissues was extracted based on published procedures. A polymerase Chain Reaction (PCR) assay using MLO specific primers was employed for the detection of phytoplasmas in the samples. The PCR assays were performed using genomic DNA isolated from healthy and diseased tissue as templates. No amplified products were detected in healthy or diseased tissues, thus any association of the phytoplamsa with LSD was not established. However, more samples have to be analysed to arrive at a conclusion.

DNA hybridization techniques (with viroid-specific probes) were also used to elucidated any association of viroid with LSD. The results obtained so far were inconclusive.

L K Weerakoon, L C P Fernando, A Tymon & P Jones

REPORT OF THE EXTENSION SERVICES DIVISION

Head - P A H Nimal Appuhamy, M Sc.

1. GENERAL

The Division implemented various programmes and involved in different activities in respect of technology transfer more particularly to the coconut estate sector. As a result, the number of coconut growers who directly interact with the Institute has increased tremendously.

2. OTHER ACTIVITIES

Mr P A H Nimal Appuhamy, Head, Extension Services Division served as a member of the Extension Committee of the Coconut Cultivation Board.

Mr P A H Nimal Appuhamy continued to attend to the duties of the Head, Library Services Division in this year too.

3. EXTENSION PROGRAMMES AND ACTIVITIES

3.1 Persuasive Extension Programme

The Persuasive Extension Programme(PEP) introduced to assist coconut estate owners to increase the productivity of their lands was strengthened during the year to cover more acreage. Three agriculture graduates were recruited as Farm Development Officers to monitor the implementation of this programme. One double-cab and three motorcycles were purchased to facilitate the implementation and monitoring the programme. During the year under review, seventy coconut estates were inspected and the estate development plans were prepared in consultation with owners covering the extent of 1280 ha. The Division received the fullest co-operation from agronomists, soil scientists, economists and other research staff of the Institute. During the implementation of this programme it was noticed that the unavailability of educated and experienced personnel to manage private sector estates, is one of the major reason for inefficient management of the coconut estate sector. In order to solve this problem, preliminary discussions were held for a joint programme with Rajarata University and North Western Provincial Council to train unemployed agriculture diploma holders for estate management. This programme is scheduled to be commenced during the early 1997.

3.2 Coconut Pickers Training

Owing to the acute shortage of coconut pickers in the sector, the Division

organized a coconut pickers training programme, on the advice of the Chairman, Coconut Research Board with the objective of attracting job less youth to the profitable venture. It was decided to implement the programme as a pilot project in the Pannala Divisional Secretariat area. This covered 22 Grama Niladari Divisions and forty five young men were trained with the assistance of 27 trainers. The training was for a period of 2 months commencing in May, 1996. While the training of coconut pickers were continuing arrangements were made with the Agricultural Insurance Board to extend the retirements financial benefits and an insurance scheme not only to those engaged in the trade but also to their families.

In order to recognize their contribution to the coconut industry and to give them a sense of social status in future, arrangements were made to distribute certificate of training and insurance policies to the trainees. Hon Ratnasiri Wickramanayake, Minister of Public Administration,Home Affairs, Plantation Industries and Parliamentary Affairs gave away these certificate in a function held on 26 October at the Coconut Research Institute.

3.3 TODDY TAPPING TRAINING

The preliminary survey on toddy tapping conducted last year revealed a shortage of skilled toddy tappers. All arrangements were made to re-establish the Toddy Tapping Training Centre. A syllabus was prepared and the programme was expected to be commenced in October. Due to an unavoidable reason it was postponed to be started in the early part of 1997.

4. PRINTING SECTION

Each year the Institute spends a callosal sum of money for printing. In order save time and money the division started a separate printing section with the acquisition of printing equipment including a digital printer. Printing equipment taken over from the Library Services Division were repaired and put to efficient use with the setting up of the printing section. The printing machine operator who was transferred to Administration Division for clerical work was reverted for printing work under this Division. During the year, the most of CRI publications including, Annual Reports, Cocos, Coconut Bulletin and advisory circulars were printed at the newly set up printing section.

5. PUBLICATIONS

During the year the following publications were issued by the Institute.

Annual Reports for 1993 and 1994

Cocos Volume 10

Coconut Bulletin Volume 10 (reprinting)

Pol Pawath Volume 16

Handbook on Coconut Cultivation (English)(reprinting)

Booklet on Toddy Tapping

6. ADVISORY ACTIVITIES

Numerous requests were received from Estate owners for inspections. Advisory reports based on inspections were posted on time. Areas needing specific advice were referred to the relevant research division.

Specific advisory material was prepared in relation to preparation of coconut paste. Many students, boarding houses, Police mess and Army camp etc. were appraised of the advantages of the coconut paste and all were supplied with the data. The leaflet is being distributed to all CRI visitors especially to groups of school children, and teachers who visit the Institute, in order to motivate Sri Lankan to use the coconut paste and also to transfer the idea to others.

Preliminary investigations were initiated in the manufacture of a bamboo type telescopic light aluminium picking pole.

7. TRAINING PROGRAMMES AND STUDY TOURS

7.1 One Day Training Programme

The popular one training programme aimed to improve the knowledge and skills of coconut land owners and managing staff of coconut estate was successfully completed during this year too.

7.1.1 Programme No. 1 was held at the Head Office, Bandirippuwa Estate on the subject of coconut replanting with the technical guidance of the Genetics and Plant Breeding Division on 19 April, 1997. For this programme 67 trainees participated.

7.1.2 Programme No. 2 was held at the Ratmalagara Estate,Madampe, with the participation of 83.trainees on the subject of Soil Moisture Conservation in coconut lands on 24 May with the technical guidance of the Agronomy Division.

7.1.3 Programme No. 3 was held at Bandirippuwa Estate on 21 June on the subject of fertilizer and plant nutrients with the participation of 73 trainees with the technical assistance of the Soils and Plant Nutrition Division.

7.1.4 Programme No. 4 was held at Walpita Estate Kotadeniyawa on 19 July with the participation.75 trainees on the subject of Intercropping under coconut with the technical guidance of the Agronomy Division.

7.1.5 Programme No. 5 on the subject of coconut pests and diseases was held at the Head Office, Bandirippuwa Estate on 20 September with the technical guidance of the Crop Protection Division. For this progroamme 80 trainees participated.

7.1.6 Programme No. 6 was held on 11 October on the subject of Rehabilitation of low yielding coconut plantations with technical assistance from Agronomy and Soils and Plant Nutrition Division at Ratmalagara Estate. 65 trainees participated in this programme.

7.1.7 Programme No. 7 was held at Bandirippuwa Estate on the subject of Estate Management and cost control on 09 November with the participation of 78 trainees.

7.2 Other Training Programmes

7.2.1 Diploma course in plantation management organised by the National Institute of Plantation Management (Coconut Module) form 16 to 21 September

7.2.2 Two students from the National Apprentice and Industrial Training Authority (NAITA) commenced four months attachment training in December 1995 in research divisions.

7.2.3 One month attachment training for one trainee from Wijaya Estate Agency, Negombo, on estate management on 01 March.

7.2.4 Two trainees from Aquinas Collage , Colombo, for 06 months from 22 April.

7.2.5 One trainee from the School of Agriculture, Anuradapura for six months training from 20 March.

7.2.6 Two trainees from the Technical College, Kuliyapitiya, for six months training from 01 March .

7.2.7 One trainee from the School of Agriculture, Pelwehera for six months attachment training from 22 April.

7.2.8 Three trainees from NAITA for four months training from 01 June.

7.2.9 Full day training programme for the field staff of Pitiyakanda Estate, Mawathagame on 01 August .

7.2.10 Four trainees from NAITA, commenced four months attachment training programme on 01 December.

7.3 Study Tours

The following study and familiarization tours were organized for

7.3.1 A group of 60 Plantation Management students from the Rajarata University on 06 January .

7.3.2 Seven member delegation from the Coastal Development Authority, Pakistan from 20 to 22 January .

7.3.3 Fifty members of the Gami Seva Sevana, Galaha on 26 January.

7.3.4 A group of coconut breeders from India, Pakistan, and Bangladesh from 17 to 28 June.

7.3.5 A group of Botany Special undergraduates from the Kelaniya University on 13 September.

7.3.6 15 agriculture diploma students from the Polytechnic Collage, Gampaha on 11 March .

7.3.7 Seven Plantation Management students from the Wayaba Campus, Kuliyapitiya on 03 July .

7.3.8 35 second year agriculture students from the Technical Collage, Kuliyapitiya on 20 March.

7.3.9 A group of agriculture students from the District Agriculture Training Center, Homagama, on 22 February .

7.3.10 Eighty biology undergraduates from the Jayawardenapura University , Nugegoda on 21 January.

7.3.11 A group of officers from the Coconut Cultivation Board, Colombo on 09 February.

7.3.12 A group of local journalists and media personnel on 09 February.

7.3.13 A group of coconut pickers from Pannala on 03 April.

7.3.14 Fifty five students from the Agriculture School, Matale on 11 October.

7.3.15 A group of Grama Niladaries in the Pannala Divisional Secretarial Division on 11 May .

7.3.16 Twenty staff members of the Mahaweli Economic Agency on 27 December.

In addition, 1750 school children visited the Institute from 32 schools during the year. They were appraised of the activities and the new technology developed by CRI with the help of audio visual materials.

8. SEMINARS/LECTURES/FIELD DAYS/EXHIBITIONS

The Division co-ordinated two research extension dialogues between the research staff of CRI and the extension personnel of the Coconut Cultivation Board. One programme was held at the District Agricultural Training Center, Matale on 02 April and the other one was held at the Coconut Cultivation Board Regional Office at Ratnapura. The extension field staff of CCB in the Ratnapura and Kalutara regions attended this dialogue.

8.1 The division co-ordinated the seminar organized for copra manufactures on New Technology in Copra Manufacture on 13 December.

8.2 The division participated in the following field days.

8.2.1 Field day organized by the Coconut Cultivation Board for coconut growers on toddy tapping at Beruwala on 24 February .

8.2.2 Field held at Beruwala Co-operative Society organized by the CCB on 26 March.

8.2.3 Field day organized for coconut pickers at CRI on 03 April.

8.3 The division participated in the following exhibitions

8.3.1 Mini Coconut Day at Sandalankawa on 27 January .

8.3.2 Mahaweli Exhibition on 25 April.

8.3.3 Coconut Exhibition at Labuduwa from 18 to 20 October.

9. PHOTOGRAPHY

Transparencies, photographs and slides requirements for research divisions were supplied by the division. On the request of CCB, colour slides and enlarged photographs were supplied to Regional offices to be used in their extension programmes.

10. MUSEUM

The exhibits in the CRI museum were updated and made attractive to visitors, especially to school children.

11. AUDITORIUM

The facilities of the CRI auditorium have been improved in order to conduct seminars, workshops, meetings and training programmes more effectively. This facility was also extended to out side organizations at a nominal charge.

REPORT OF THE LIBRARY AND COCONUT INFORMATION CENTRE

Librarian - P A S F PERERA, B Sc

1. GENERAL

Mr. Henry Nimal (Head, Extension Division) functioned as the Acting Librarian during the period of overseas study leave of the Librarian.

2. ACQUISITIONS

Sixty eight (68) new books were accessed to the library during the year, the stock recording five thousand and twenty one (5021) books as at 31 December, 1996. Out of the new accessions, six (6) were donations from Dr. R Mahindapala (former Director) and Mr. P Jeganathan, former Head, Soils and Plant Nutrition Division. Sixty six (66) periodical titles and nineteen (19) annual reports (both local and foreign) were received during the year. Of these 27 titles were on subscription while the rest were on exchange and complimentary basis. In addition reference services were made available to outsiders (students, scientists and industrialists etc.) on requests. The number of journals received on exchange showed a gradual decline over the last few years. Computerising of journal holdings in the library was commenced during the latter part of the year.

The database on coconut recorded six thousand six hundred and fifty (6650) references with the addition of one hundred and eleven (111) new entries. The complete documents to these references mainly journal articles were added to the literature collection on coconut.

Fifty two (52) items from the literature collection on coconut were microfiched. In addition the journal Cocos (Vol. 1-10) , Coconut Bulletin (Vol. 1-9) and Pol Pawath (Vol. 7-16) were also microfiched for preservation purposes.

3. SERVICES

Reference, lending and inter-library loan services (ILL) were provided regularly to the staff. Sixty eight (68) new books received during the year were processed and made available to the users.

A satisfactory ILL service was rendered by the library during the period under review. The total number of requests received from the outside libraries for ILL was thirty five (35) out of which thirty (30) were supplied satisfactorily. Out of forty nine (49) requests for ILL made by the library from outside resources on behalf of the staff, forty (40) were received.

In addition reference services were made available to outsiders (students, scientists and industrialists etc.) on request.

One issue of the Current Awareness Bulletin (including 100 references on coconut) was issued in December.

4. EXTERNAL SERVICES

The library continued to be an active member of the Agricultural Information Network (AGRINET) with a view to sharing of resources. It provided eight hundred and fifty eight (858) content pages from thirty five (35) journal titles to member libraries under the Selective Dissemination of Information Services (SDCP) and received ninety nine (99) contents pages from forty four (44) journal titles from other member libraries. Through AGRINET, the library became eligible to receive articles from foreign sources under the Agricultural Libraries Network (AGLINET). Accordingly 3 articles not available from local sources were received from a Canadian library for the staff.

The Assistant Librarian participated in three 3 AGRINET meetings during the year held at the Council for Agricultural Research Policy (CARP) for the promotion of AGRINET services.

5. WORKSHOPS AND TRAINING

Acting Librarian, Mr. Henry Nimal participated at a workshop organised by the SAARC Documentation Centre held at the Indian National Scientific Documentation Centre (INSDOC), New Delhi from 15-23 October, 1996.

Acting Librarian, Mr. Henry Nimal and Library Assistant Mrs. P D U C Dharmapala participated at the Seminar on "New Information Technologies" on 26 July held at Natural Resources, Energy and Science Authority (NARESA). The Librarian, Mrs. P A S F Perera reported for duty on 08 November, 1996 after completing one year overseas study programme (22 September, 1995 - 07 November, 1996).

6. PRINTING AND BINDING

In-house binding of journal volumes and repairing of books were commenced during the latter part of the year.

REPORT OF THE ESTATES MANAGEMENT DIVISION

Actg. Manger (Estates) - H A J Gunathilake, Ph D

1. GENERAL

The following seven units were administrated by the division.

1. Bandirippuwa Estate, Lunuwila.
2. Rathmalagara Estate, Panirendawa.
3. Poththukulama Research Station, Pallama.
4. Walpita Estate, Walpita.
5. Isolated Seed Garden, Ambakelle.
6. Makandura Seed Garden , Gonawila.
7. Maduru Oya Seed Garden, Bogaswewa.

The two main functions of the division, production of seed nuts and providing field facilities for research activities, were continued satisfactorily by managing three seed gardens and four estates.

Out of the total planted extent of 573.6 ha, about 195.7 ha were immature. Furthermore, all seven units had 60057 bearing palms in production. (Table 1 A & B).

A marked decrease of rainfall was experienced in all estates, except in Maduru Oya affecting considerably the production of coconut. (Table 2) The decrease of rainfall varied from 10% to 35%.

Cumulative coconut yield of the all units was 3,37,2579 and it shows 15.7 percentage reduction compared to the yield records in 1995. This could be explained as due to reduction (Table 2) of rainfall during the year. However, coconut yield in Maduru Oya and Poththukulama Estate were increased by 11% and 6% with the increase of immature to mature phase (approximately 10%) of coconut.(Table 1 A and Table 3).

During the year , 1.150,293 seed nuts were produced in three seed gardens. The Coconut Cultivation Board (CCB) was the major buyer, purchasing 98.6% of the production.(Table 6)

General agronomic practices in all properties were carried out in accordance with the CRI recommendations. Due to a severe drought experienced during January - April, much emphasis was placed on soil moisture conservation practices such as mulching and husk burial. Adult palms in all seven units were manured in

accordance with the Differential Fertilizer Recommendations based on foliar and soil analysis. Young palms and seedlings were manured with Young Palm Mixture (YPM) in two split doses.

During the year a special food production scheme was launched aiming to provide fruits, vegetables and other food items to the staff of CRI at subsidized prices.

In weed management use of rota-slasher was dominant. However, cover-cropping also played a considerable role particularly in Ambakelle, Bandirippuwa, Walpita and Maduru Oya units.

Crops in four estates were disposed through auction to the Coconut Development Authority, mainly as husked nuts. The buyer's rejections of coconut were cured into copra.

2. PERFORMANCE OF INDIVIDUAL UNITS

2.1 Bandirippuwa Estate, Lunuwila

Superintendent	: Mr A N Ekneligoda
District	: Puttalam
Electorate	: Wennappuwa
Agro-ecological zone	: Wet intermediate

Of the total population of 15650 palms, 10644 palms (68%) were in production (Table 1 B)

Rainfall: Rain fall during the year was 1742 mm with 128 wet days. It was a decrease of 10% and 5% respectively, compared to the same in 1995. (Table 2)

Nut yield: Total yield was 538, 095, a decrease of 10% compared to the yield of 1995, which is parallels the decrease in rainfall.(Table 3)

Field operations:

Manuring: Adult palms were manured in accordance to DFR. However, coconut palms in 12 ha were not fertilized due to dry weather and lack of funds at the end of the year. Palms in Field 6 were manured with compost fertilizer supplemented with P,K and Mg.

Ground conditions were maintained using rota-slashers, manual weeding and grazing by cattle. Patches of Mana and Guinea grasses were controlled by applying Glyphosate. Cover crops in 60% of the area was also a key method in suppressing weeds.

Soil and moisture conservation: Mulching the manure circle was predominant.

Removal of palms: 71 senile and dud palms were removed.

Livestock: Herd strength by the end of the year was as follows.

(a) Cows	- 39
(b) Heifers	- 49
(c) Bull calves	- 21
(d) Bulls (studs)	- 02
Total	- 111

Milk Production and Sales:

(a) Milk collection Centre (12383 l)	-	132 160.00
(b) Sold to staff at subsidized rates (14494.25 l)	-	68 289.18
(c) CRI canteen (48 l)	-	226.22
(d) For milkers (355.5 l)	-	1 578.94
Total (27280.8 l)	**- Rs.**	**202 254.34**

Other production activities:

1. Number of palms tapped for sweet toddy	- 40
2. Amount of sweet toddy produced	- 8243 l
3. Amount of treacle produced	- 1828 bottles
4. Amount of juggery produced	- 22.5 Kg

Cost and returns:

Cost of production (COP) for 1000 nuts was Rs.2243/- (excluding staff salaries and transport) and Net Sales Average (NSA)was Rs 7718/- per 1000 nuts. (Table 4).

2.2 Rathmalagara Estate, Panirendawa.

(Superintendent : Mr M R L A Perera)

District : Puttalam
Electorate : Chilaw
Agro-ecological Zone : Dry Intermediate Zone

Of the total coconut extent of 98.3 ha, about 50% was in production. (Table 1 A) However, individual census show that out of 15701 palms, 10957 palms are in bearing stage,(Table 1 B) This was mainly due to high variation of number of bearing palms particularly in fields 5 & 6 (age 15 years), because of poor soil conditions.

Rainfall: The total rainfall for 1996 was 1199.3 mm (95 wet days), a 26% decrease than from that of 1995. (Table 2)

Nut yields: The total nut yield for the year was 432,287 which was 13.2% decrease compared to the previous year (Table 3). This was mainly due to low rainfall experienced in 1995.

Field Operations :

Manuring :

During the year, 10957 bearing palms were manured in accordance to the Differential Fertilizer Recommendations of 1995. Among the immature population, of 3439 young palms and 397 seedling were fertilized with recommended levels of the YPM in two split doses.

Weed Control: Weed growth was kept under control with the use of rota-slashers and manual weeding, while illuk and mana patches were sprayed with glyphosate.

Soil and moisture conservation: Husks were burried in field number 7 and 9 (733 pits) with the dimension of 2.5m x 1.3m x 0.6m.

All young and adults palms were mulched six times with coconut husks, fronds and weed trash.

General: Wild elephants damaged 46 young palms and the perimeter fence. The officers of Wild Life Department helped to chase out wild elephants. A new main gate was installed in field number o4 to make easy access to the office.

Cost and returns: COP for 1000 nuts was Rs 2313/(excluding staff salaries and transport) and NSA Average was Rs 7190/=(Table 4).

2.3 Poththukulama Research Station, Pallama

Officer-in-Charge	: Mr Newton Gamage
District	: Puttalam
Electorate	: Anamaduwa
Agro ecological zone	: Dry Intermediate

Out of the total planted area of 73.2 ha,of coconut about 56.1 ha was in bearing (Table 1 A).

Rainfall: The total rainfall was 1200 mm distributed in 57 wet days which was a decrease of 435 mm compared to the previous year. However,the distribution remained as same as in 1995 (Table 2).

Nut yields: The total production was 707,668 nuts, an increase of 4% compared with the production of 1995 (Table 3).

Field operations:

Manuring: A total of 8694 palms were manured in accordance with the DFR while 3115 young palms and seedlings were manured with recommended dose of YPM in two split applications.

Weeding: Use of rota-slashers was dominant in weed control. Mana and Guinea grasses were controlled with manual weeding.

Soil and Moisture conservation: Husks were buried in the 11 B field (414 pits). Size of a pit was 2.5m x 1.3m x 0.6m. All adult and young palms were mulched with coconut husks and fronds.

General: Monthly picking was commenced from the second pick onwards. Accasia, Jak,lime and mango were planted to commemorate the Tree Planting Day. Vegetables cultivated under the special food production programme, produced an income of Rs. 6915/-.

2.4 Walpita Estate, Walpita

Officer-in-Charge	: Mr Upali Rathnayake
District	: Gampaha
Electorate	: Divulapitiya
Agro-ecological Zone	: Intermediate wet

The whole plantation was mature and in production (Table 1 A)

Rainfall: The total rainfall was 1624 mm which was 35% lower than the previous year. It was distributed over 101 days, however no significant rainfall was received during March (Table 2).

Nut yield: Crop in 1996 declined by 19% compared to production of 1995, parallel to the decline in rainfall. (Table 2 & 3)

Field operations:

Manuring: A total of 2234 bearing palms were manured in according with the DFR of 1995; 101 young palms were treated with 2.2 kg of YPM in two split doses.

Weeding: Ground conditions were maintained satisfactorily with regular weeding by hand slashing and using rota-slashers.

Soil-moisture conservation: All palms were continuously mulched during the year.

Intercropping: Perennial intercrops such as pepper, coffee, cocoa, cinnamon, and arecanut, were maintained under the guidance of the Agronomy Division. Banana produced an income of Rs 12942 from 220 plants. Seasonal crops such as cassava and leafy vegetables were also grown under the Food Production Programme.

General: Monthly picking was introduced.

Cost and returns: COP of 1000 nuts was Rs 3196/ and the NSA was Rs.6941/= (Table 4)

2.5 Isolated Seed Garden, Amabakelle, Rajakadaluwa

Acting Superintendent	: Mr D M Pathirage
District	: Puttlam
Electorate	: Anamaduwa
Agro-ecological Zone	: Dry intermediate

Out of the total extent for 457.2 ha, 140.4 ha, were maintained with coconut. Of the total coconut area 34.9 ha was in immature phase. Jungle barrier was remained as 309.8 ha (Table 1 A).

Rainfall: Total rainfall experienced during the year was 1194 mm, a decrease of 30% compared to the rainfall in 1995 (Table 2) This reduction in rainfall affected several field operation such as manuring.

Nut yield: The total nut yield for the year was 1,092,604 which was from 16059 bearing palms (Table 3). This was a decrease of 30% compared to the previous year. Seed nut production of TxT and DxT was 976,621 and 115,983 nuts respectively (Table 5).

Disposal of crops: About 65.6% of the total production was disposed as seed nuts and the rest was mainly sold at the CDA auction.

Field operations:

Manuring: A total of 16583 palms were manured in accordance with the DFR done of 1995, whereas 6493 young palms and seedlings were treated with the YPM in two split doses.

Weeding: Rota-slasher was used in fields where no cover crops exists. Manual weeding and light harrowing was practised in areas having cover crops.

Soil and moisture conservation:

A total of 551 husk pits (2.5 x 1.3 x 0.6m) were completed in fields 11 B and regular mulching was done with fallen fronds and weed trash. A total of 3669 m drains were desilted.

Watering: All young palms were watered during the dry spell experienced July to September (40 l of water in every 10 days)

Pests and Diseases: Red weevil traps were introduced where emasculation was done.

2.6 Makandura Seed Garden, Makandura.

Superintendent	: Mr P B Silvan
District	: Kurunegala
Electorate	: Katugampola
Agro-ecological Zone	: Wet intermediate

Of the total population of 8710 palms, 7676 (90%) were in production.

Rainfall:

The total rainfall experienced during the year was 1641 mm a decrease of 30% compared to the previous year. However, there was no considerable variation between the two years in regards to number of wet days (Table 2).

Nut yield: The total nut production was 333,241 nuts, a decrease of 20% compared to the previous year. The reason was lower rains during the year.(Table 3).

Disposal of crops: Of the total crop, 254,699 seednuts were supplied to the CCB. (Table 4).

Field operations:

Manuring : A total of 8350 adult palms were manured in accordance with DFR and 420 young palms and seedlings were treated with 2.4 kg of YPM per palm in two split applications during the year.

Weeding: Three rounds of weeding were practiced with rota-slashers during the year.

Soil & moisture conservation: A mulch was continuosely maintained in the manure circle for all palms. A demonstration site (1.0 ha) was also established with several methods of husk burial and mulching.

General: Sixteen male calves were introduced for controlled grazing. A 10,000 gallons tank and a pipe system were installed for irrigation of coconut palms with the financial assistance received from Central Agricultural Research Project.

2.7 Maduru Oya Seed Garden, Bogaswewa

Superintendent	: Mr R B Attanayake
District	: Polonnaruwa
Electorate	: Polonnaruwa
Agro ecological Zone	: Dry

Of the total extent of 67.17 ha of coconut, 20.63 ha (30%) was in production (Table 1 A).

Rainfall: The total rainfall was 1433 mm, a slight increase of 10% compared to the

figures in 1995. (Table 2)

Disposal of crops: Of the total nut production of 138,529 nuts, 100,960 seednuts (70%) were selected and supplied to the CCB (Table 4) The rest was partly cured and partly supplied to the estate workers gratis.

Field operations:

Manuring:

4154 bearing palms were manured in accordance with the DFR and the young palms were treated with YPM in two split applications during the year.

Weeding: This was done by both rota-slashing and manual weeding. Patches of illuk was sprayed with Glyphosate. Over 50% of area was under cover cropping and this was very successful for suppressing illuk.

New plants and infilling: 675, TxT seedlings were used for infilling. 300 TxT seedlings were established as a new plantation in field number 01.

General: Boundaries were kept free of weeds particularly in dry spells (June - September)to prevent fire breaks into the seed garden. Damage by red weevil was considerably serious in fields, 5 and 6, hence integrated control measures were followed as guided by the Crop Protection Division.

Table 1. *General performance of the estates, seed gardens etc.*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
A. Coconut extent (ha)								
Mature	75.3	49.8	56.1	16.8	105.5	53.8	20.6	377.9
Immature	48.6	48.5	17.1	(0)	34.9	(0)	46.6	195.7
TOTAL	123.9	98.3	73.2	16.8	140.4	53.8	67.2	573.6
Nursery	1.6	-	-	-	1.0	-	-	2.6
Jungle	-	3.2	-	-	309.8	-	13.8	326.8
Vacant Land	0.3	6.9	6.05	0.5	2.0	2.0	-	18.2
Reservoir	0.3	-	-	-	21.0	0.4	-	21.7
Roads & buildings	22.0	2.0	2.5	0.5	3.0	2.0	4.0	36.0
TOTAL	148.1	110.4	81.8	17.8	457.2	58.2	85.0	958.5
B. Census of palms								
Bearing palms	11027	10957	8694	2234	16059	7676	3410	60057
Young palms	2918	3439	2975	101	6091	386	6326	22236
Seedlings	1596	397	140	-	402	295	-	2830
Dud Palms	109	15	101	54	159	353	42	833
Vacancies	3606	893	1662	151	4078	1152	2086	13628
Total	19256	15701	13572	2540	26789	9862	11864	99584

Table 2. *Rainfall (mm) with number of wet days in parenthesis*

Month	Bandirippuwua Estate		Rathmalagara Estate		Poththukulama Estate	
	1995	1996	1995	1996	1995	1996
Jan	49.3(07)	94.1(09)	16.6(04)	41.1(05)	91.0(04)	54.5(02)
Feb	51.6(08)	68.8(07)	55.7(03)	104.8(08)	16.8(02)	72.7(05)
March	100.8(05)	-	85.6(04)	07.1(01)	12.5(01)	-
April	276.6(19)	355.5(16)	287.03(14)	132.2(09)	323.8(13)	142.2(08)
May	399.1(21)	76.8(11)	257.9(11)	54.5(04)	449.5(08)	-
June	207.2(18)	84.3(14)	121.1(13)	93.1(08)	88.4(08)	118.8(07)
July	35.2(05)	58.4(14)	19.9(02)	21.8(07)	-	13.9(02)
Aug	35.4(09)	223.5(06)	17.3(04)	91.0(04)	6.3(01)	88.8(02)
Sept	41.1(08)	234.4(17)	13.5(03)	238.2(13)	-	19.02(08)
Oct	194.5(21)	192.1(14)	148.2(16)	204.9(17)	116.08(10)	257.10(10)
Nov	538.3(15)	216.5(11)	584.3(09)	164.5(11)	494.05(10)	199.9(10)
Dec	118.8(02)	137.1(09)	22.5(03)	41.5(08)	36.2(03)	62.1(03)
TOTAL	1943.9(135)	1741.5(128)	1629.7(86)	1199.3(95)	1635.8(60)	1200.8(57)

Table 2. *Contd.*

Month	Walpita Estate		ISG, Ambakelle	
	1995	1996	1995	1996
Jan	95.5(05)	65.0(04)	51.2(05)	127.7(03)
Feb	10.2(02)	79.8(06)	32.6(07)	91.2(06)
Mar	92.4(04)	-	59.5(03)	-
Apr	397.0(18)	349.8(13)	348.2(17)	105.0(11)
May	449.6(19)	64.6(08)	337.7(13)	7.4(02)
Jun	330.9(20)	112.5(09)	81.1(15)	133.6(09)
July	97.5(03)	100.9(10)	27.7(02)	10.4(06)
Aug	119.0(07)	111.7(06)	13.8(02)	66.0(03)
Sept	79.0(08)	252.4(20)	2.7(02)	159.1(13)
Oct	288.1(16)	194.4(12)	178.2(16)	263.4(13)
Nov	536.4(12)	203.0(12)	666.5(12)	139.7(10)
Dec	-	89.7(06)	34.9(03)	90.9(06)
Total	2495.6(114)	1623.8(104)	1834.1(97)	1194.4 (82)

Table 2. *Contd.*

	Makandura Seed Garden		Maduru Oya Seed Garden	
	1995	1996	1995	1996
Jan	134.0(06)	64.1(07)	247.0(11)	211.7(12)
Feb	117.0(03)	72.4(06)	125.4(07)	123.2(07)
Mar	43.3(03)	2.2(01)	4.8(01)	2.3(01)
Apr	461.5(16)	330.6(12)	162.7(14)	122.7(10)
May	391.9(19)	103.6(06)	48.7(09)	3.9(01)
June	238.6(17)	88.5(10)	6.9(01)	71.8(08)
July	98.6(04)	79.8(11)	7.2(02)	-
Aug	94.6(07)	170.2(06)	69.4(04)	122.8(08)
Sept	55.8(07)	313.8(02)	248.3(07)	9.3(02)
Oct	233.9(17)	175.3(16)	82.2(08)	149.5(05)
Nov	585.7(13)	206.2(09)	174.2(12)	334.7(13)
Dec	18.7(08)	34.6(06)	176.0(18)	240.6(13)
Total	2473.9(120)	1641.3(111)	1346.8(94)	1432.5(80)

Table 3. *Crop data (nuts)*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
Pick 1	78395	48897	65607	16598	97291	31518	11431	349737
Pick 2	182801	80961	53807	30415	191738	67625	9920	717267
Pick 3	111089	103592	229406	32196	271282	64134	24490	836189
Pick 4	109309	99095	106950	27023	266173	93289	31815	733654
Pick 5	27523	61741	70208	16414	149215	53956	31277	410334
Pick 6	28980	38001	81690	6687	183886	22719	29596	325400
Total-1996	538095	432287	70768	130155	1092604	333241	138529	3372579
Total-1995	600478	498372	665877	161068	1534369	416997	124559	4001720
Difference(+ - %)	-62383	-66085	+41791	-30913	-441765	-83756	+13970	-629141
Average (91-95)	472507	359740	679302	*905972	236460	47724	2701705	
Nuts/palm -1995	60	47	88	71	97	54	41	458
Nuts/palm -1996	51	49	81	58	73	43	41	396
Yield/ha -1995	7975	9584	11867	9942	15590	10692	7784	73434
Yield/ha -1996	7146	8218	12359	7656	-	6195	6715	48289

* Average yield from 1992 - 1995

Table 4. *Crop disposal (nuts)*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
Sold	426164	381290	539579	-	150028	45297	10904	
Converted to Copra	19472	20188	18547	-	59147	9984	2264	
Research	3969	-	1735	-	7582	-	-	
Seed Nuts	3497	-	4295	-	732945	254699	115460	
Staff issues	40152	10206	120292	-	10234	5906	2852	
Rejections	8297	20603	-	-	63459	9881	2649	
Awaiting sale	33669	-	120292	-	76791	7474	4000	
Others	2875	-	-	-	-	-	-	
Total	538095	432287	707668	130155	1100186	333241	138129	3379761
COP (Rs/1000 nuts)	2243/=	2312/=	1700/-	3196.16	-	-	-	
NSA (Rs/1000 nuts)	7718/-	7190/-	7676.67	6941.00	-	-	-	

Table 5. *Total number of nuts harvested from TxT and DxT at ISG Ambakelle 1995 and 1996*

Pick	T x T 1995	1996	D x T 1995	1996
01	191213	86759	28901	10532
02	215600	173142	30853	18596
03	281122	246942	48796	24300
04	247643	231863	47873	34310
05	213213	133761	45269	15454
06	161559	104154	22327	12751
Total	1310350	976621	224019	115946
Nuts/palm	98	71	85	49

Table 6. *Total seed nuts production of three seed gardens in 1995 and 1996 (nuts)*

Seed garden	1995	1996	Increase/ decrease %
ISG, Ambakelle	1001772	779734	-22.2
MSG, Gonawila	343236	254699	-25.8
MOSG, Bogaswewa	104941	115860	+10.4
TOTAL	1,449,949	1,150,293	-20.6

REPORT OF THE AGRICULTURAL RESEARCH PROJECT

Project Co-ordinator - D T Mathes, FIS

PROJECT OBJECTIVES

The principal objectives of the project were , to raise farmers income by increasing Agricultural production through the introduction of improved varieties, improved farming systems, animal husbandry practices, with a focus on addressing farmers specific problems.

In order to achieve these objectives, financial assistance was identified to cover the following project activities;

* Civil works
* Procurement of goods
* Manpower development
* Incremental operations, such as appointment of incremental staff.
* Contract research

The project terminated its activities on 31 December.

1. ACTIVITIES

1.1 Manpower Development Programme

1.1.1 Long-term Training

Mr I R Wickramananda, Crop Protection Officer, returned to the Island in December, after successfully completing the M Phil. programme at the University of Aberdeen, UK.

Ms. W N I S C Fernando, Botanist, returned to the Island in November, having completed the postgraduate training programme, leading to M Sc degree at the University of Notingham, U.K.

Mr. M T N Fernando, Agric. Economist, left the country in August, after completing the local component of field research, to continue with his Ph D Programme in U.K.

Ms. P A S F Perera, Acting Librarian, returned to the Island in November, having completed postgraduate training in Information and Library Studies, leading to M.Sc. degree at the University of Aberdeen, U.K.

Long-term Training (Local)

Mr. T S G Peiris, Senior Biometrician and Mr L P Vidana Arachchi, Assistant Soil Scientist continued their postgraduate studies at the University of Colombo and Sri Jayawardenapura, respectively.

Short-term training

Following short-term training was offered to the staff during the year.

Dr (Ms) W M U Fernando, Senior Geneticist and Plant Breeder, received one month training on 'Germplasm Conservation' at the Max-Plank Institute for Plant Breeding K'oln in Germany.

Ms C N K Rajapakse, Head, Crop Protection division, received one month training on "Physiology of the coconut palm as affected by pests", at Natural Resource Institute, Kent, UK.

Dr D N S Fernando, Head, Agronomy division underwent one month training in Animal Husbandry, in USA.

1.2 Civil Works

Construction of a fertilizer store and water supply and distribution installation system at Maduru oya and overhead tank and water distribution system at Makandura were completed.

1.3 Field Days, Workshops and Seminars

Several field days, training programmes, and research-extension dialogues were held during the year.

1.4 Diagnostic Team (Research & Extension linkage)

Periodic Diagnostic surveys to assess the efficiency of dissemination of research findings and to identify growers problems were recommended under the project. As a result the CRI carried out its second Diagnostic Survey in 1993 covering the small holder sector, to find out, (a) the acceptability of the CRI recommendations, (b) constraints if any, for such acceptances, (c) feed-back from the growers on areas requiring special attention.

In view of the interesting results surfaced from this survey, it was decided to extend a survey to cover the Estate sector in 1995, which, however, had to be

abandoned due to lack of funds.

1.5 Management Information System/Programme Budgeting System (INFORM)

The MIS/PBS system has been installed, and the information is being used to allocate funds for prioritized research programmes. Also this information has been used to re-allocate funds based on priorities.

2. CONTRACT RESEARCH PROGRAMME (CARP AWARDS)

2.1 A Study on the evaluation of Genetic variation (12/344/253)

The award granted in October continued satisfactorily.

2.2 Collection of Coconut Germplasm for physiological adaptation and their characterisation using quantitative traits and biochemical markers (isozymes) (12/195/179)

The award granted in September, 1994 was terminated on completion.

2.3 Economic analysis of coconut based cropping/farming system (12/201/174)

The award granted in January, 1995 continued satisfactorily.

2.4 Study of the microbiological and other related properties of different coconut soils (12/247/214)

The work commenced in March, 1995 was terminated on completion.

REPORT OF THE ADMINISTRATION DIVISION

Deputy Director (Adm & Fin) - H S Herath - SLAS

1. GENERAL

The Division continued to assist the research divisions in routine administrative and financial matters and related affairs including maintenance work.

2. CADRE

The staff position of the Coconut Research Institute at the end of December, 1996 is given in Table 1.

TABLE 1. *Staff position as at 31.12.1996*

Grade	Ungraded	sp cl.	cl 1	cl 11	cl 111	cl 1V	Total
Executive	02	-	08	11	22	13	56
Technical	-	28	09	22	-	-	59
Intermediate	-	01	02	03	-	-	06
Clerical & Allied	-	19	07	17	-	-	43
Operative	-	18	08	29	-	-	55
Minor	-	43	08	46	-	-	97
Driver	-	13	04	15	-	-	32
Watcher	16	-	-	-	-	-	16
Grand Total	**18**	**122**	**46**	**143**	**22**	**13**	**364**

3. WELFARE

Welfare facilities extended towards the employees of the Board were continued. Financial assistance given to the employees is given below:

3.1 Financial Aid

Provident Fund Loans: The loans granted from the Provident Fund to 32 employees amounted to Rs.2,912,735/-.

Distress Loans: Distress loans paid to 63 employees amounted to Rs.2,289,858/-.

Transport Loans: Transport loans paid to 35 employees amounted to Rs. 744,500/-.

Loans to Relieve Indebtedness: Loans to relieve indebtedness to 05 employees amounted to Rs. 37,500/-.

Refrigerator Loans: Refrigerator loans paid to 08 employees amounted to Rs.84,000/-.

Educational Loans: Educational loans paid to 02 employees amounted to Rs.20,000/-.

Medical Aid: A sum of Rs.1,546,976/- was reimbursed by the Medical Aid Scheme to its members during the year 1996 and an amount of Rs. 251,850/- was debited to members savings accounts.

3.2 Other facilities to employees

Financial assistance was also granted to the Multi-Purpose Co-operative Society, the Recreation Club, the Art Circle, the Day Care Centre, the Death Donation Society and the Seva Vanitha Unit during the year 1996.

An Eye clinic was organized under the Medical Aid Scheme at Bandirippuwa Estate on 18th August, 1996 for the benefit of the staff of the Institute and their families.

STAFF MATTERS

1. APPOINTMENTS

Thirty one appointments were made during the year 1996 and the details are shown in Table 2.

TABLE 2. Appointments made during the year 1996

Name	Designation	Division	Date
Mr A A Karunasekara	Clerk/Typist	Establishment	16.01.96
Mrs S A Dayawathie	Lab/Field Attendant	Soils & Plant Nutrition	01.02.96
Mr H K A N Appuhamy	Tractor Driver	Bandirippuwa Estate	01.02.96
Mr K P S Dissanayaka	Tractor Driver	Isolated Seed Garden	01.02.96
Mr W K Senadheera	Technical Assistant	Soils & Plant Nutrition	07.02.96
Mr K S A J Fernando	Lab/Field Assistant	Biometry	09.02.96
Mr N G Premasiri	Lab/Field Assistant	Crop Protection	09.02.96
Mr H M N B Herath	Technical Assistant	Genetics & Plant Breeding	09.02.96
Mr D M Sarathchandra	Lab/Field Assistant	Agronomy	12.02.96
Mr N P Indrawansa	Lab/Field Assistant	Soils & Plant Nutrition	12.02.96
Mr Bandula Perera	Lab/Field Assistant	Biometry	12.02.96
Mrs P G P Hewavitharanage	Research Assistant (BICM)	Plant Physiology	01.03.96
Mr Pemsiri Silva	Technical Officer (A/V)	Extension Services	15.03.96
Mr R M Gunasekara	Asst. Librarian	Library	01.04.96
Mr S S Rajapaksha	Technical Assistant	Biometry	01.04.96
Mr K A S C N Fernando	Office Attendant	Extension Services	01.04.96
Mrs I B Dayawathie	Office Attendant	Establishment	01.04.96
Mr T H Hector Perera	Office Attendant	Establishment	01.04.96
Mr J A D B D Appuhamy	Office Attendant	Agronomy	01.04.96
Mr J K Jensus Perera	Office Attendant	Establishment	01.04.96
Mr E C F'do Pulle	Office Attendant	Accounts	01.04.96
Mr W R O Fernando	Lab/Field Assistant	Agronomy	15.04.96
Mr K D D Appuhamy	Lab/Field Assistant	Agronomy	15.04.96
Mr P W A Fernando	Lab/Field Assistant	Agronomy	10.06.96
Mr R K S Wimalasiri	Office Attendant	Accounts	17.06.96
Mr W J P Fernando	Office Attendant	Establishment	17.06.96
Miss A P Illangakoon	Library Assistant	Library	01.08.96
Mr K G D Priyantha	Technical Assistant	Genetics & Plant Breeding	19.08.96
Mr M A P Rohitha	Driver	Establishment	17.09.96
Mrs S Z Suhair	Secretary to the Chairman	Establishment	20.09.96
Mr J M M Marrikkar	Research Assistant (CPRD)	Plant Physiology	30.09.96

2. RESIGNATIONS, RETIREMENTS & VACATION OF POSTS

The details are given in Table 3.

TABLE 3. Resignations, retirements & vacation of posts

Name	Designation	Division	Date
Resignations			
Mr S M W Banda	Estates Superintendent	Isolated Seed Garden	01.01.96
Mr D A N S Diyagoda	Technical Assistant	Biometry	01.02.96
Mr G D Gunasekara	Linesman	Engineering	01.05.96
Mr W J Tissera	Office Attendent	Establishment	01.06.96
Mr L Vanculanberg	Lab & Field Attendant	Soils & Plant Nutrition	15.06.96
Mrs T M H Fernando	Secretary to the Chairman	Establishment	01.08.96
Miss J L J L Pinto	Technical Assistant	Soils & Plant Nutrition	28.10.96
Mrs H J M D Jayasundara	Clerk/Typist	Extension Services	30.10.96
Mr S K Gunarathna	Technical Assistant	Soils & Plant Nutrition	01.11.96
Mr Vijith S Jayamanna	Research Assistant	Agronomy	04.11.96
Retirements			
Mr Albert Fernando	Lab/Field Assistant	Soils & Plant Nutrition	12.02.96
Mr D Amarasinghe	Lab/Field Assistant	Agronomy	01.04.96
Mr S M Gunarathhamy	Watcher	Isolated Seed Garden	01.04.96
Mr W E A Fernando	Lab/Field Assistant	Crop Protection	22.05.96
Mr S A C Appuhamy	Driver	Establishment	17.09.96
Vacation of posts			
Mr W A D Fernando	EH/PHO/PF	Engineering	27.05.96
Dr R R A Peiris	Head	Genetics & Plant Breeding	10.11.96
Mr P H V Fernando	Vehicle Attendant	Establishment	16.12.96

3. PROMOTIONS

3.1 Promotions in Executive Grades

Five Promotions were made during the year, 1996 of which details are shown in Table 4.

TABLE 04. *Promotions in executive grades during the year 1996*

Name	Designation	Division	Date
Executive Grade - Class II to I			
Dr R R A Peiris	Head	GPBD[1]	17.11.93
Dr (Mrs) M N Fernandopulle	Head	SPND[2]	16.03.94
Dr D N S Fernando	Head	Agronomy	15.04.94
Dr H A J Gunathilaka	Senior RA[3]	Agronomy	20.09.94
Executive Grade - Class III to II			
Dr (Mrs) L K Weerakoon	Head	Tissue Culture	11.09.95

1 Genetics & Plant Breeding Division
2 Soils & Plant Nutrition Division
3 Senior Research Assistant

3.2 Promotions in Non - Executive Grades

Following internal promotions in Non-Executive Grades were implemented during the year, 1996 as shown in Table 5. The effective date of these promotions was 01 January, 1995.

TABLE 05. *Promotions in non - executive grades during the year 1996*

Name	Designation	Division
Technical Grade - from Class I to Special Class		
Mrs S D H Bandara	Technical Officer	Soils & Plant Nutrition
Technical Grade - from Class II to I		
Mr J D J S Kularathne	Technical Assistant	Biometry
Intermediate Grade - from Class II to I		
Mrs P D U C Dharmapala	Library Assistant	Library

Table 05. *Contd.*

Name	Designation	Division
Drivers' Grade - from Class I to Special Class		
Mr R K Gunawardane	Tractor Driver	Estates Management
Mr H M Kirihamy	Driver	Estates Management
Drivers' Grade - from Class II to I		
Mr T M C Peiris	Tractor Driver	Estates Management
Mr A C S Ibrahim	Driver	Estates Management
Minor Grade - from Class I to Special Class		
Mr I J A Fernando	Vehicle Attendant	Estates Management
Mr M A L K Udayananda	Lab/Field Attendant	Crop Potection
Mr M A P Rohitha	Vehicle Attendant	Establishment
Minor Grade - from Class II to I		
Mr J A D N Stanley	Pollination Labourer	Estates Management
Mr S Marasinghe	Lab/Field Attendant	Estates Management
Mrs W M Gnanawathie	Lab/Field Attendant	Soils & Plant Nutrition

4. TRANSFERS

Mr Newton Gamage, Field Officer, from Walpita Estate to Poththukulama Research Station on 01 January.

Mr Ranjan Marasinghe, Technical Officer, from Rathmalagara Estate to the Agronomy Division on 01 January.

Mr R Wijethunge, Lab & Field Assistant, from Estate Management Division to Bandirippuwa Estate on 01 January.

Mr Jackson David, Supervisor, from Bandirippuwa Estate to the Estate Management Division on 01 January.

Mr Gamini Gunasinghe, Lab & Field Assistant, from Rathmalagara Estate to the Estate Management Division on 01 February.

Mr W E J Tissera, Lab & Field Assistant, from Agronomy Division to Rathmalagara Estate on 01 January.

Mr H M Manelhamy, Lab/Field Attendant, from Isolated Seed Garden to Rathmalagara Estate on 01 January.

Mr T M Rodrigo ,Pollination Labourer, from Isolated Seed Garden to Poththukulama Research Station on 01 January.

Mr B C Mendis, Pollination Labourer, from Isolated Seed Garden to Poththukulama Research Station on 01 January.

Mr G Gunarath Banda, Pollination Labourer, from Isolated Seed Garden to Poththukulama Research Station on 01 January.

Mr D Kumarapeli, Office Attendant, from Establishment Unit to Estate Management Division on 01 January.

Mr M M Thilakasiri, Watcher, from Maduruoya Seed Garden to Bandirippuwa Estate on 01 January.

Mr W Vipulasena, Watcher, from Makandura Seed Garden to Poththukulama Research Station on 01 January.

Mr P A C Chandrasekara, Watcher, from Isolated Seed Garden to Makandura Seed Garden on 01 January.

Mr D M Tilakaratne, Watcher, from Isolated Seed Garden to Bandirippuwa Estate on 01 January.

Mr H M Weerasinghe, Watcher, from Rathmalagara Estate to Bandirippuwa Estate on 01 January.

Mr W M U Rathnayake, Field Officer from Poththukulama Research Station to Walpita Estate on 01 January.

Mr U A Francis Calister, Watcher from Makandura Seed Garden to Walpita Estate on 01 January.

Mr H M Tikiri Banda, Driver, from Establishment Unit to Rathmalagara Estate on 04 January.

Mr D Kumarapeli, Office Attendant, from Estate Management Division to the Library on 19 January.

Mr M Sarath Abeytissa, Office Attendant, from the Library to the Estate Management Division on 25 January.

Mr M M Nimal Jayatissa , Lab & Field Attendant, from Soils & Plant Nutritions Division to Plant Physiology Division on 01 February.

Mr K D D Appuhamy , Lab & Field Assistant from Soils & Plant Nutrition Division to Agronomy Division on 17 April.

Mr D M Sarathchandra, Lab & Field Assistant, from Agronomy Division to Genetics and Plant Breeding Division on 17 April.

Mr M H Dhanasena, Lab & Field Assistant, from Genetics and Plant Breeding Division to Soils and Plant Nutrition Division on 24 April.

Mr L K Nimalarathne, Tractor Driver, from Maduruoya Seed Garden to Bandirippuwa Estate on 20 May.

Mr D M Pathirage, Technical Assistant (Estates) , from the Estate Management Division to Isolated Seed Garden on 06 June.

Mr R Wijethunge, Lab & Field Assistant , from Bandirippuwa Estate to Crop Protection Division on 11 June.

Mr L K Nimalarathne, Tractor Driver, from Bandirippuwa Estate to Poththukulama Research Station on 14 June.

Mr W A Hemawardane, Lab & Field Attendant from the Accounts Unit to Agronomy Division on 17 June.

Mr A G Bimal Silva, Supervisor, from Poththukulama Research Station to Bandirippuwa Estate on 05 August.

Mr H M Tikiri Banda, Driver , from Rathmalagara Estate to Poththukulama Research Station on 21 August.

Mr H M N B Herath, Technical Assistant, from Genetics and Plant Breeding Division to Isolated Seed Garden on 01 October.

Mr H T R Wijesekara, Research Assistant, from Crop Protection Division to Angunakolapelessa sub station on 01 October.

Mr S Prabath Manohar, Technical Assistant, from Crop Protection Division to Angunakolapelessa sub station on 01 October.

Mr A C S Ibrahim, Driver, from Establishment Unit to Angunakolapelessa sub station on 01 October.

Mr L M S R Jayathilake, Technical Assistant, from Isolated Seed Garden to Genetics and Plant Breeding Division on 04 October.

5. NO PAY LEAVE GRANTED FOR EMPLOYMENT ABROAD

Table 06.

Name	Designation	Country	Period
Mr Y H Wijesena	Clerk/Typist	Kuwait	from 28.06.96 to 27.06.98

6. FULL PAY LEAVE FOR STUDY IN SRI LANKA

TABLE 07.

Name	Period	Purpose
Miss P H A P Siriwardena Technical Assistant (Crop Protection Division)	from 20.03.95 to 19.03.98	B Sc (Agriculture) Degree
Mr. N P A D Nainanayake Research Assistant (Plant Physiology Division)	from 01.10.96 to 30.09.98	M Phil Degree

7. TRAINING IN SRI LANKA

Table 8.

Name	Designation	Period	Training Course/Institute
Mr. H S Herath	Deputy Director (Adm. & Finance)	3 days from 12.02.96	Discipline and disciplinary proceedings at NIBM
Mr P Daluwatta	Administrative Officer	02.04.96	Industrial disputes at Federation of Chambers of Commerce and Industries
Mr A S Nanayakkara	Accounting Assistant	16 days from 23.04.96	Computer Training at IDM Computer Studies Ltd., Negombo
Mr S K Gunarathne	Technical Assistant	10 days from 06.05.96	Designing of power supplies at Atomic Energy Authority
Clerical Staff (40)	Clerks/Typists	from 15.06.96 to 16.06.96	Clerical duties (conducted by the Public Service Training Institute)
Mr M R U Attanayaka	Audit/Clerk	from 01.07.96 to 05.07.96	Accounts and Auditing at NIBM
Mrs R D I Somasiri	Audit/Clerk	from 01.07.96 to 05.07.96	Accounts and Auditing at NIBM
Mr Danie Richard	Accounts Clerk	from 01.07.96 to 05.07.96	Accounts and Auditing at NIBM
Mrs A M N Ubeyasekara	Accounts Clerk	from 01.07.96 to 05.07.96	Accounts and Auditing at NIBM
Miss J L J L Pinto	Technical Assistant	from 01.07.96 05.07.96	Training Workshop for Laboratory Technicians at University of Peradeniya
Mr J M I Dupathi	Technical Assistant	from 01.07.96 05.07.96	Training Workshop for Laboratory Technicians at University of Peradeniya
Mr M R D Perera	Technical Assistant	from 01.07.96 05.07.96	Training Workshop for Laboratory Technicians at University of Peradeniya
Mr M B Upali	Store Keeper	from 22.07.96 to 22.09.96	Stores Management at Supply & Material Management Institute

Table 8. *Contd.*

Name	Designation	Period	Training Course/Institute
Mr T W Fernando	Asst. Inf. Officer	from 22.07.96 to 27.07.96	Diploma Course in Plantation Extensionat NIPM
Mr C Handalage	Chief Accountant	06.08.96	Seminar on Accounting matters at the Department of Public Enterprises
Mrs Anoma de Alwis	Accountant	from 26.08.96 to 29.08.96	Training workshop on design of a PC based Accounting System at NIBM
CRI Staff (50)	-	09 Months from 03.11.96	English Languate Training Course of the Official Language Department
Mr A S Nanayakkara	Acct. Assistant	from Sept. 1996 to Sept. 1998	Higher National Diploma Course in Accountancy at Technical College, Kuliyapitiya
Dr (Mrs) L C P Fernando	Research Officer	from 18.07.96 to 19.07.96	Workshop on food poisoning at University of Colombo
Mrs D M D I Wijebandara	Technical Assistant	from 18.07.96 to 19.07.96	Workshop on food poisoning at University of Colombo
Mr Ranjan Marasinghe	Technical Officer	from 03.07.96 to 15.07.96	Training on Artificial Inserrienation of cattle at the Department of Animal Production and Health, Peradeniya.
Mr W A P R Fernando	Field Assistant	from 03.07.96 to 15.07.96	Training on Artificial Inserrienation of cattle at the Department of Animal Production and Health, Peradeniya.

8. TRANSPORT UNIT

The administration of drivers and maintenance of the following fleet of vehicles was done by the Transport Unit during the year, 1996.

Cars	- 08
Buses	- 03
Lorries	- 02
Vans	- 06
Lite-Ace Vans	- 01
Elf	- 01
Double Cabs	- 03
Jeeps	- 07
Motor bicycle	- 34

9. FINANCE UNIT

The budget expenses during the year was Rs. 84 million made up of Rs. 66 million as recurrent and Rs. 18 million as capital expenditure. The total revenue (excluding transport) for the year was Rs. 77 million which is a 12 percent increase over the previous year.

Entire accounting functions of the Institute and accounting for several other outside funded projects were handled by this Unit. About 60 % of the accounting work connected with the Final accounts are computerized in addition to the Salaries and the General Ledger. Further, most of the reports used internally and externally are also prepared using computers. This exercise had cut down the volume of work manually done few years back increasing the productivity of the Unit.

The Stores which is under this Unit had played a fair role in serving the Research and Supporting Staff. Even with the financial difficulties experienced in this year the Stores managed to meet the demands of the Divisions/Units/Estates and to supply the requirements.

This year too the Officers in the unit have extended their invaluable cooperation which brought the Unit to a high standard and to build up the goodwill of the Unit and the Institute.

10. ENGINEERING UNIT

Maintenance work of buildings, electricity, vehicles and machinery were

carried out by the Engineering unit.

For the year, 1996 the Engineering Unit has attended to the following construction works.

(a) An aluminum fabricated glass house for Plant Physiology Division.

(b) A well dug at 50 acre block.

(c) Two numbers vehicle garages.

(d) LT power distribution line to Kirimatiyanamulla.

(e) A cubical for Soils and Plant Nutrition Division.

(f) Two numbers grade I quarters at Pottukulama Research Station.

(g) Two numbers grade I quarters at Maduruoya Seed Garden.

(h) Circuit Bungalow at Maduruoya Seed Garden.

(i) Rehabilitation of two numbers quarters at Bandirippuwa Estate.

(j) Completion of construction work to Circuit Bungalow at ISG, Ambakelle.

(k) Completion of construction work to Office, Store and Garage at Maduruoya Seed Garden.

(l) Extension to the existing building at Plant Physiology Division.

STAFF PUBLICATIONS AND COMMUNICATIONS AT SCIENTIFIC MEETINGS

(CRI members are shown in bold type)

THESES

Mr J M D T Everard - "Use of molecular markers for breeding of the coconut palm *Cocos nucifera*". MSc. thesis, University of New England, NSW Australia.

Dr K B Dassanayake - Differential Responses of Perennial Root Systems to Change in Soil Moisture PhD thesis, University of Aberdeen Scotland, U.K.

JOURNALS AND PRESENTATIONS AT SCIENTIFIC MEETINGS

Appuhamy, P A H Nimal and **Liyanage, M de S** (1996) Potential role of coconut as a multipurpose tree. Presented at the Seventh National Workshop on Multipurpose Trees, Peradeniya, 24-30 October.

Bandaranayake, C K and **Fernando W M U** (1996) Progeny evaluation as an effective method of selection in coconuts. Proc. Sri Lanka Assoc. Adv. Sci. (SLAAS) 52 (2):55.

Everard, J M D T, Katz, M and Gregg, K (1996) Inheritance of RAPD Markers in the Coconut palm, *Cocos nucifera,* 8th PGIA Congress Proceedings (Session V) University of Peradeniya.

Everard, J M D T and Gregg K (1996) Restriction fragment length polymorphism in the coconut palm - Proc. SLAAS, 52 (2): 129.

Everard, J M D T and Katz M (1996) Use of RAPDS for estimation of genetic distances between population of the coconut palm. *Cocos nucifera* Proc. Second Annual Forestry Symposium, Univ. Sri Jayawardenapura, Sri Lanka. 2:31.

Fernando M T N, Fernando D N S, Gunatillaka, H A J and **Samarajeewa S R** (1996) Economics of Intercropping under coconut in Sri Lanka. J.Nat, Inst, Plant Mgmt 2(1) 1-18.

Gunatilaka H A J and **Liyanage M de S** (1996) Multiple Cropping under coconut. In Agroforestry for Sustainable Development in Sri Lanka (eds P.A Huxley and D M S H K Ranasinghe), 77-94.

Kuranage, J S, **Fernandopulle M N; Tennakoon, N A** and **Somasiri, L L W** (1996). Composition of different production grades of Eppawala Rock Phosphate with Imported Rock Phosphate. Presented at the 52nd Annual session of the SLAAS, 25-29 November.

Liyanage M de S (1996) Coconut Research in Sri Lanka (Book Chapter). In: "Coconut for Prosperity" (ed. P K Thampan) P221-237. Published by the Peekay Tree Crops Development Foundation, India.

Liyanage, M de S and **Abeysoma H A** (1996) Management and utilization of *Calliandra Calothyrsus* in coconut plantations. In Proc. International Workshop on the Genus Calliandra (ed. D O Evans), 137-143.

Mathes D T and **J D J S Kularatne** (1996) Uncertainities in rainfall and its implication in coconut industry in Sri Lanka. Presented at the Regional Workshop in Asia and Pacific, Philippines 15-19 Janauary.

Pathirana, K K , Mangalika U L P, **Liyanage M de S** and Orskov, E R (1996) Effect of grazing and supplementation in a coconut plantation on cattle production, coconut yield and soil fertility. Outlook on Agriculture, 25(3) 187-192.

Rajapakse C N K and Gunawardena, N E (1996) Control of the red palm weevil, (Rhynchophorus ferrugineous) populations using pheromone baited trap presented at the 52nd Annual sessions of the SLAAS, 25-29 November.

Rajapakse C N K and Meola Roger (1996). Evaluation of insect growth regulators; juvenoids for outdoor control of cat fleas in soil. Presented at the 52nd Annual Sessions of the SLAAS, 25-29 November.

Ranasinghe C S (1996) The impact of elevated CO_2 on leaf cellular mechanisms. Presented at a seminar held at the Natural Resources Energy and Science Authority (NARESA), Sri Lanka, December, 07.

Ranasinghe C S and Taylor G (1996). Mechanism for increased leaf growth in elevated CO_2 changes in leaf anatomy and in molecular weight distribution of xyloglucan (Abstract), J Exptl. Botany, Suppl. 47,38.

Ranasinghe C S Taylor G and Flowers T J (1996) Elected CO_2 concentration and leaf growth: a biophysical and biochemical analysis of cell expansion (Abstract) presented at the 8th Annual congress of PGIA, Peradeniya.

Ranasinghe C S and Taylor G (1996) Mechanism for increased leaf growth in elevated CO_2 J. Exptl. Botany 47 (296), 349-358.

Somasiri L L W and Liyanage D D K S (1996) Evaluation of the suitability of calibration methods for the determination of available potassium for coconut growing soils. Presented at the 52nd Annual Session of the SLAAS, 25-29 November.

Somasiri L L W (1996) Use of Eppawala Appatite in coconut. Presented at the Seminar organised by Lanka Phosphate Ltd., held at Tangerine Beach Hotel, 20 November.

Somasiri L L W (1996) Soil degradation - experience with coconut. Presented at the seminar on soil degradation in Sri Lanka, 13 September.

Tennakoon N A Damayanthi, U D D and Thenabadu, M W (1996). Long term effects of organic manuring in a coconut plantation. Presented at the 52nd Annual Sessions of the SLAAS, 25-29 November.

Tennakoon, N A and Herath M (1996) Efficiency of two different fertilizer application methods for coconut. Presented at the 52nd Annual Sessions of the SLAAS, 25-29 November.

Tennakoon, N A (1996) Soil biology in lateritic coconut soils of Sri Lanka. Presented at the Annual Botanical Conference held in Chittagong University Bangladesh, 27-29 May.

Van Mele P, Dekens, E and **Gunatilaka H A J** (1996) Effect of coirdust mulching on weed incidence on pineapple intercropped under coconut in Sri Lanka. Presented at the 48th International Symposim on Crop Protection, Gent, Belgium 7, May.

Vidhana Arachchi L P and **Liyanage M de S** (1996) Role of *Gliricidia sepium* on physical improvement of soil. Presented at the Annual Sessions of the Institute of Biology, Sri Lanka, 20 September.

Vidhana Arachchi L P and **Liyanage M de S** (1996) Influence of nitrogen fixing trees species on the growth of coconut roots in gravelly soils. Presented at the Annual Sessions of the Soil Science Society of Sri Lanka, September, 13.

Vidhana Arachchi L P and **Liyanage M de S** (1996). Performance of *Gliricidia sepium* seedlings and cuttings on improvement of soil physical properties. Sri Lankan J of Agric. Sci., 33,1-19.

Vidhana Arachchi L P and Nor, Y M (1996) Estimation of N-uptake efficiency of oil palm seedlings *(Elaeis guineensis)* in palm oil sludge/urea amended soil. Presented at the Annual Sessions of the Institute of Biology, Sri Lanka 20, September.

Vidhana Arachchi L P, Mapa R B, Yapa P A J and Somapala, H (1996). Evaluation of land suitability for coconut production in relation to soil physical properties. Presented at the 52nd Annual Sessions of the SLAAS 25-29 November.

Vidhana Arachchi L P, Somapala H, Mapa R B and Yapa P A J (1996) Study of the effective root zone of coconut in relation to soil compaction. Presented at the 52nd Annual Sessions of the SLAAS 25-29 November.

Vidhana Arachchi L P, Yapa P A J, Mapa R B and Somapala H (1996) Effect of soil physical stress on the morphological characters of coconut roots. Presented at the 52nd Annual Sessions of the SLAAS, 25-29 November.

Wijebandara D M D I, and **Somasiri L L W** (1996) Calibration of methods for soil phosphorus determination by field experiment data. Presented at the 52nd Annual Sessions of the SLAAS, 25-29 November.

Wijebandara D M D I, and **Somasiri L L W** (1996) An anion exchange resin method for soil phosphorus estimation. J. Soil Science Soc. Sri Lanka, 9 70-86.