COCONUT RESEARCH BOARD

COCONUT RESEARCH INSTITUTE OF SRI LANKA

REPORT FOR 1997

COCONUT RESEARCH INSTITUTE - REPORT FOR 1997

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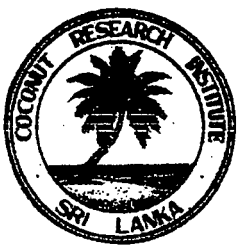

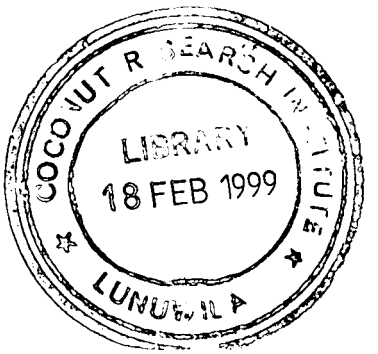

REPORT OF THE

COCONUT RESEARCH INSTITUTE

FOR 1997

Editors

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

C Jayasekera, Ph D

Printed at Coconut Research Institute, Lunuwila, Sri Lanka

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CONTENTS

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REPORT OF THE DIRECTOR

M de S Liyanage, Ph D

1. GENERAL

The national coconut production showed an upward trend in 1997 with an estimated annual production of 2648 million nuts, representing a marginal increase of 4 percent over the previous year. The total foreign exchange earnings from export of coconut products amounted to Rs.8360 million, showing no appreciable difference in comparison to the export value in the preceding year. During the year, there was an appreciable increase in the quantity and distribution of rainfall throughout the country, which according the statistics, was the highest rainfall received for the past 35 years. It is therefore anticipated that coconut production in 1998 would be relatively higher than the current year.

The three seed gardens maintained by the Coconut Research Institute (CRI) produced 0.96 million seed nuts during the year, which was mainly influenced by the poor rainfall received and its distribution in the previous year and during the first quarter of the current year. Of the total quantity of seednuts produced, 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 satisfactory progress and 95 percent of the work was completed successfully by the end of the year, spending nearly Rs.2 million for soil surveys and completion of soil suitability maps for the coconut triangle and Southern Province. In addition, several development programmes and further training of senior scientists, launched by the CRI during the year was supported by Cess Funds amounting to a total of Rs.4 million.

During the year, notable achievements in the past ten years and progress of on-going research programmes and identification of new areas needing immediate attention were critically evaluated and appraised by a panel of external reviewers appointed by the Coconut Research Board (CRB). The Research Committee met once during the year to review the progress of implementing the research programme and to study the recommendations made by external reviewers. Several high priority projects in processing research were initiated during the year, which had hitherto been neglected.

During the year, nine in-house research seminars were held on several themes with a focus on coconut agronomy, biotechnology, coconut nutrition and pest and disease management. In addition one research and extension dialogue was organised with active participation of extension officers of the CCB.

In this regard, the CRI continued to provide technical assistance and advisory services to the estate and smallholder sector, particularly with regard to the different fertilizer recommendations (DFR) and management of coconut pests and diseases, and farm improvement.

It is noteworthy that during the year there was an unprecedented demand for DFR package, the number of coconut holdings provided with this service being more than double that of last year, the majority being smallholdings with less than 8 ha. The persuasive extension programme (PEP) proved to be an effective extension tool for motivating the coconut growers, particularly absentee landlords, to achieve increasing productivity by using the CRI technology. These servics have enabled the Institute to maintain a regular and closer interaction with the coconut planting community. The Institute has stressed the need for improving farm management skills, and the quality of management as one of the means for increasing farm productivity and incomes. In this regard, a joint programme was launched for the first time with the Faculty of Agriculture (Wayamba Campus) and North Western Provincial Council, to provide practical training in coconut estate management to unemployed Diploma holders from the North Western Province, with the objective of developing their coconut farm management skills in coconut and allied fields.

The CRI estates were maintained in good order, although an overall reduction of 15 percent in coconut production was recorded for the year, mainly due to the low intensity and poor distribution of rainfall experienced in the previous year.

In keeping with the Government policy, the Institute organized the formation of several productivity circles, with active participation of the staff. In order to facilitate improvement of productivity and skills of the staff, local training was provided to a large number of officers.

A public auction was held at Lunuwila during the latter part of the year and earned Rs.1.30 Million from the disposal of condemned articles.

Following a decision of the Government to revise the salaries of public servants with effect from 01st January 1997, all grades of CRI staff benefitted from a substantial increase in their salary, receiving as much as 80 - 90% increase over the existing salary.

2. RESEARCH & DEVELOPMENT

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

2.1 Agronomy Division

During the year, much emphasis was given to research on rehabilitation of low-yielding plantations, management and utilization of nitrogen fixing trees alternative methods of soil moisture conservation and weed management aimed at improving the productivity of coconut lands. The on-farm adaptive research programme was implemented successfully and found to be an effective tool in transfering technologies on coconut-based farming systems.

It has been demonstrated that low yielding plantations on shallow soils in Kalpitiya peninsular could be rehabilitated by light harrowing to a depth of 30cm to cause heavy pruning of thick root mat, resulting in an increased nut yield of 22% after two years. Studies on *gliricidia* and *accacia* were intensified to test their adaptability and biomass production in different agro-ecological regions. Moisture conservation practices such as husk burial and mulching on land suitability classes designated as S_1, S_2 and S_5 did not have any discernible effect on the nut yield. In regard to management of the noxious weed Pupula (*Vernonia zeylanica*), cover cropping and slashing were found to be more effective than using expensive chemicals such as glyphosate. However, glyphosate at 1.4kg a.i. per ha. gave effective control of weeds in coconut nurseries.

In intercropping trials in the Dry and Dry Intermediate Zones, both bud-graffed and air-layered cashew performed better than seedlings as indicated by the early flowering habit. Studies conducted over the past five years on the estimation of biological nitrogen fixation (BNF) capacity of tree legumes grown under coconut showed that gliricidia out-performed leucaena in terms of total dry matter, nitrogen yield and amount of nitrogen fixed, as evident from a higher proportion (65%) of total N being derived from atmospheric nitrogen fixation. Furthermore, tree pruning at 4 monthly intervals exerted a positive effect on BNF, producing 160Kg N/ha/year.

In on-farm trials, it was evident that profitability of crop models depends heavily on the prevailing market price and consequently those models with pepper, pineapple, rambutan, banana and ginger gave higher profits. It has been demonstrated that Sloping Agriculture Land Technology (SALT) model established with a combination of rambutan, banana, papaw between gliricidia hedgerows reduced soil erosion, as much as 73% on sloping land in the Wet Zone (WL_2). With regard to economic studies on coconut-based intercropping system, (CBIS) it has been shown that measures for alleviating household resource constraints such as labour and cash had a positive effect in production CBI systems over monocropping.

2.2 Genetics and Plant Breeding Division

Approximately 6000 Tall x Tall and 500 San Ramon nuts were produced during the year, from the controlled pollination programme carried out at the Isolated Seed Garden, at Ambakelle and Bandirippuwa Estate, respectively for the purpose of raising planting material for the fourth seed garden at Margaret estate, Pallama.

The progeny evaluation with Tall x Tall, Tall x Dwarf Green and Tall x San Ramon using different levels of the aadult palm fertilizer mixture revealed that the hybrid, Tall x Dwarf green out-yielded Tall x Tall and Tall x San Ramon at all sites. There was no significant difference in nut yield between the recommended (Adult Palm Mixture of 3kg/palm) and one and a half times the recommended dosage. On the other hand, an increase of 10 nuts was observed between half and one and a half times the recommended dosage at Bandirippuwa. Furthermore, all three cultivars respond to fertilizer levels in a similar manner.

In the cultivar evaluation trial, Dwarf Green x Tall yielded 17kg of copra/palm/yr on deep latosolic soils in Thammenna compared to 9.6kg at Bandirippuwa, 15 years after planting, thus emphasing the importance of site specificity in soil characteristics in hybrid planting.

During the year, germplasm collection and conservation programme made steady progress and 16 accessions comprising 1109 seedlings were planted at Lenawa model garden of the CCB. A new trial was set up at Loling Estate Payagala, to evaluate the potential of hybrid crosses for toddy tapping and to compare their performance against the ordinary tall variety, traditionally used for toddy tapping.

Evaluation of progenies arising from crossing putative drought tolerant

germplasm with Ambakelle Tall (Ambakelle Tall x Moorock; Ambakelle Tall x St Annes; Ambakelle Tall x Debarayaya; Ambakelle Tall x Kasagala and Ambakelle special as a control) at four sites in representative agro-climatic zones showed similar growth patterns as in the previous year, with Ambakelle special and Ambakelle Tall x Debarayaya out performing others. This trial was extended to another site at Kivulakelle estate, Madurankuliya representing sandy clay loam soil in the Dry Zone.

2.3 Soils and Plant Nutrition Division

The Division conducted nineteen field experiments with particular emphasis on nutrition of the palm, improving soil quality, integrated plant nutrition systems and irrigation systems. In addition, four glasshouse and laboratory investigations on soil physics and soil biology were carried out to complement the results of on-going field experiments.

The response of young palm to different sources of phosphorus (ie. Eppawela Rock Phosphate, imported rock phosphate, triple superphosphate) in terms of leaf nutrient levels and growth was found to be similar even after five years since the application of fertilizer.

Having recognized the importance of micronutrients in coconut palm nutrition, two experiments were set up during the year to determine the effect of two micronutrients (Copper and Zinc) suspected to be deficient in some coconut soils, on the growth and yield of palms.

In regard to the use of poultry manure, it has been shown that surface application of seasoned (stored for 1-3 months) poultry manure from layers rather than from broilers was beneficial to the palm. Further it caused 10% less permanent damage to active coconut roots, than using fresh form in trenches. Application of common salt (NaCl) at the rate of 2kg/palm/year enhanced the rate of nutrient release from organic manures (ie. available N, and P and exchangeable Mg). The rate of decomposition of different organic manure sources (cow dung, poultry manure, goat dung, green manure) caused by microbial degradation followed a similar trend and optimum nutrient release occurred three months after application.

Studies on soil biological properties of different coconut soils indicated that microbial population density and their activity were low in moisture limiting lateritic soils than in sandy soils, thus emphasing the importance of moisture conservation in coconut lands.

Field investigations on water retention capacity with respect to drip irrigation system revealed that placement of four drippers 1 metre away from the boll of the palm with 8 days irrigation interval could completely wet the soil in the effective root zone of 15 year old coconut plantation in the Andigama Soil series.

Preparation of soil suitability maps in the coconut triangle and Southern Province have been completed, which can be useful in the rational use of inputs for coconut cultivation in the future.

2.4 Crop Protection Division

The integrated management programme for pests and disease control progressed satisfactorily. The epidemic of bole and root rot disease of coconut in the Southern Province was contained by the recommended control measures. The causative fungus of the sporophore producing bleeding palms was confirmed as *Ganoderma boninense*. In bleeding palms with no sporophores, another fungus known as *Hyphomyces* species was isolated from decaying roots, indicating the possibility of other fungi species associated with the bleeding condition. Studies were initiated to investigate the pathogenecity of the fungus *Hyphomyces* sp. and the infectivity of coconut seedlings by *Ganoderma* in soil. Vegetative compatibility studies and isozyme tests for the *Ganoderma* isolates from Sri Lanka were conducted at the Insternational Institute of Mycology, United Kingdom.

Incidence of a new disease showing frond-breaking and rapid death of palms was recorded from Makandura Seed Garden (NWP) and three other estates in the NWP. The division participated in the multi-disciplinary project initiated to further investigate the condition.

The trap lured with 'ferrugineol' (4-methyl-5-nonanol) as an efficient tool in controlling red palm weevil *(Rynchophorus ferrugineus)* population and thereby reducing palm damage was established. Hence, bucket trap containing ferrugineol and a source of food (toddy or sugar cane) for the Red Weevils was recommended, and found to be very effective.

The synthetic aggregation pheromone ethyl-4-methyloctanoate of black beetle, *Oryctes rhinoceros* gave promising results as an efficient lure. Traps positioned 2m above ground level were more effective than these buried in the ground.

Daily activity patterns of parasitoids of coconut caterpillar *(Opisina*

arenosella) was monitored. In laboratory studies it has been shown that *Bracon hebetor* has a specific pattern of daily oviposition and activity and reduced the pest population but rate of parasitism did not increase considerably. The low parasitism rates cast doubts upon the species status, purity and the efficiency of the laboratory-bred *Bracon hebetor*, and studies were undertaken to determine the reasons for it. Female sex pheromone was recognized as a possible biological tool in forecasting coconut caterpillar infestation. Field studies were also initiated to establish the optimum blend of the synthetic sex pheromone that would attract males of coconut caterpillar.

Methodologies were established for laboratory screening of plant extracts using antifeedency index with yellow spotted locust *(Aularchis miliaris)* as the test insect.

2.5 Plant Physiology Division

The research programme of the Division has been adjusted to give high priority to projects that have a direct bearing on the coconut industry.

In a study to develop a post-harvest storage technique for King Coconut (whole nut), it was found that flavour of nut water and cosmetic appearance of outer skin could be maintained for three weeks if nuts were wrapped with cling film and stored at 14°C, provided nuts are free from mechanical or insect damage. A series of techniques were tested to improve shelf-life of shaved nuts. Preliminary studies showed that browning of the cut surface could be reduced by applying anti-oxidants such as citric acid. Further, experiments are in progress to determine the optimum concentration and suitable fungicide to be applied on the cut surface.

In the selection of cultivars for high toddy yields, it was found that the Dwarf x Tall is high yielding than the commercial tapping cultivar, Ordinary Tall. This means toddy yields of Ordinary Tall and Dwarf x Tall were 689 and 1214 ml per palm day, respectively. Experiments are underway to develop a rapid biochemical technique to select high toddy yielding palms by studying the changes in trunk and leaf carbohydrates in relation to sap production. Two yield stimulants ethrel and paste applied to kithul spathe and an anti-oxidant (ascorbic + citric acid) are being tested to improve toddy yield. The possibility of using the same coconut palm for dual purposes of nut production and toddy production is being investigated.

Studies on the impact of canopy and root pruning on coconut yield indicated that 60% removal of leaflets from the lowermost mature fronds or 25% root pruning

in the manure circle area do not affect nut setting, yield or fruit components of palms.

It has been shown that physiological and biochemical parameters such as Leaf Scorch Decline palms were affected only in those palms showing moderate to severe symptoms. There was a significant reduction in total functional leaf area, leaf cell production and initiation of stomata in moderate and severe LSD palms compared to controls. None of the physiological, biochemical or anatomical characters of leaves were affected at mild stage of the syndrome. The leaf biochemical characters were affected only at the severe stage. In another study, some mild and moderate palms were tapped for a period of eight months in order to determine the impact of symptoms. Initially, there was a significant reduction in daily toddy volume of mild and moderate palms compared to controls and from the fifth inflorescence onwards, the daily toddy volume of LSD-affected palms increased. Further, pre-tapping and post-tapping LSD symptoms of the palm have been monitored.

The morphology, growth and regeneration of root system of four coconut varieties in different land suitability classes were studied to evaluate their performance under specific conditions.

2.6 Tissue Culture Division

The Divisional research programme gave much emphasis to the development of a reliable protocol for clonal propagation of coconut. Immature inflorescence, tender leaf, shoot meristem, Immature zygotic embryo, plumule and root tissues were used as explants for clonal propagation research.

In spite of the slow response of coconut tissues to *in vitro* culture conditions, encouraging results were obtained from immature embryo, immature inflorescence and shoot meristem cultures. The culture conditions were refined further to improve somatic embryo formation and subsequent plant regeneration in immature embryo-derived calli. A preliminary study on the development of charcoal-free protocol for callus induction in immature embryo explants was completed. The results indicated that activated charcoal in the callus induction medium could be replaced by antioxidants such as polyvinylpyrrolidone (PVP) and ascorbic acid.

Shoots were regenerated in immature inflorescence-derived calli through somatic embryogenesis. Direct shoot regeneration from floral meristems also occurred at a very low frequency and roots were induced successfully on these shoots.

Embryogenic calli were obtained from cultured-shoot meristems and several plantlets were regenerated from these calli through a process of somatic embryogenesis.

Culture conditions were developed for successful callogenesis and somatic embryogenesis in plumule and tender leaf explants.

Studies on cell suspension culture were initiated with the objective of mass producing embryogenic calli and somatic embryos. Preliminary investigations on coconut anther culture were undertaken.

Experiments on *in vitro* screening for drought-tolerant coconut germplasm were continued using polyethylene glycol (PEG) as the water stress simulant. Seventy seedlings (T x T) that survived stress conditions caused by different concentrations of PEG were planted to evaluate their performance under field conditions.

The embryo culture technique was used successfully to rescue embryos of *"dikiri"* coconuts.

2.7 Processing Research Programme

During the year, Processing Research programme mainly concentrated on the study of biosynthetic processes during kernel development, quantitative estimation of kernel constituents, copra production and improvement of copra kiln design. Furthermore, existing methods of making sap based products such as jaggery and treacle were refined to improve their quality.

It was found that kernel formation in Tall x Tall occurs between fifth and sixth months after maturity of developing nuts and formation of oil increased from 1% to 32% (on wet basis) at maturity. Lauric (C 21.0), Myristic (C 14.0), Palmitic (C 16.0), Oleic (C 18.1) and Linoleic (C 18.2) acids are the most prominent fatty acids formed in early stages. With increasing maturity, Palmitic, Oleic and Linoleic acid content decreased while Lauric acid content increased.

In studies of fatty acid formation in Tall x Tall, Dwarf Green x Tall and Dwarf Yellow x Tall, it was found that among coconut cultivars, Tall x Tall had the highest percentage of medium and short chain fatty acids (68.8%) followed by DG x T (61.3%) and DY x T (55%).

In terms of copra yield of different coconut varieties viz. Dwarf x Tall, Tall x Dwarf, Tall x Tall, Tall x San Ramon and Ordinary Tall, the highest yield of 205g per nut was recorded for Ordinary Tall.

Study on the oil extraction efficiency of using industrial scale *"baby"* expeller revealed that highest amount of extractable oil and total available oil per kilogram of copra were achieved in Tall x San Ramon cultivar.

It has been shown that pH of the coconut sap has a direct influence on the quality of the final product. For example, it has been demonstrated that high quality jaggery could be produced when the pH is adjusted to 5.5 or more, and treacle with rich colour and taste could be produced when pH is 4.5 or more.

2.8 Extension Services Division

During the year, training and extension programmes were implemented with the objective of transferring, more effectively, the technology developed by the CRI to coconut growers, plantation managers etc. Under the Persuasive Extension Programme eighty two estates received advisory service covering an extent of 5526 ac. Although it was expected to cover 100 coconut estates during the year 1997, the expected target could not be achieved due to staff shortages.

In order to improve the knowledge and skills of coconut growers and the management staff of coconut estates, seven "One Day Training" programmes were successfully conducted and certificates were awarded to participants who attended at least six programmes. Two programmes were conducted for the Diploma in Plantation Extension Course and the Coconut Processing Course sponsored by the Institute of Plantation Management. Attachment training and familiarization programmes were organized for students from technical institutes and universities. During the year 2926 students from 48 schools visited the Institute and participated in short programmes. One Research - Extension dialogue was held with active participation of the CRI Scientific Staff and Extension Staff of the Kuliyapitiya and Marawila regions of the Coconut Cultivation Board.

The Division also conducted job-oriented practical training programme for unemployed Agriculture Diploma holders, in collaboration with Agriculture Faculty, Wayamba Campus and the Wayamba Industrial Services Bureau funded by the Wayamba Provincial Council. It is interesting to note that out of the 25 trainees participated in the above programme, 18 have already secured employment in the private sector estates as trainee Assistant Superintendents.

To demonstrate and educate the technology developed, the Institute participated in seven exhibitions at schools in different coconut growing areas. The Division conducted one field demonstration in the use of pheromone trap for *red weevil* control in Diulapitiya and also participated in two seminars on Coconut Cultivation held at Madampe and Diulapitiya. The Division responded to 65 advisory inquiries raised by farmers in coconut cultivation.

2.9 Library Services Division

The library actively participated in information networks with a view to resource sharing. Facilities were made available for Electronic Mail communication for rapid information retrieval and exchange. Internet Service was introduced during the last quarter of the year providing global access to information.

Fund constraints resulted in the reduction of the number of journal titles (45) and annual reports (9) received during the year. Special attendance was drawn to the preservation of literature of historical value both to the Institute and the Coconut Industry. A number of computer databases providing information relevant to agricultural resources available within the country were installed during the last quarter of the year. Further, two new databases were created to accommodate references to contents of CRI publications and references.

2.10 Estates Management Division

Three seed gardens and four estates were administered by the Division under the supervision of the Acting Manager (Estates). Out of the total coconut extent of 574 ha, about 176 ha (30%) remained immature. All seven units had 58,886 bearing palms. The cumulative coconut yield recorded for all seven units was 3.05 million nuts. Coconut yield in Maduruoya and Makandura seed gardens increased by 8% and 17% respectively mainly as a result of higher proportion of young palms coming into bearing. During the year, marked increase in rainfall was noted as indicated by a 35% and 18% increase in the amount of rainfall and number of rainy days, respectively. As a result, we would expect a corresponding increase in nut production in 1998.

During the year, 961,963 Tall x Tall and 75,470 Dwarf x Tall seednuts were produced from the three seed gardens. Issue of seednuts from Makandura seed garden was temporarily suspended from the sixth pick due to the occurrence of diseased palms of unknown etiology.

General cultural practices in all properties were carried out following the CRI recommendations. In fertilizer application much emphasis was given to the use of organic manures. For example, half the coconut area in Walpita Estate was applied with goat manure (15kg/palm) supplemented with P, K and Mg. Biological weed management by controlled grazing with ruminants (cattle, buffalo and goats) was encouraged, particularly in Makandura, Bandirippuwa and Ratmalagara estates, which gave a 60% reduction in the cost of weeding.

Several measures were introduced to increase the efficiency of estate labour and reduce a work contracted to outsiders to the bare minimum.

During the year, food production programme was implemented in all CRI estates and earned a total income pf Rs/294,590/= mainly from vegetables, fruit crops and treacle.

2.11 Administration Division

During the year, 02 Executive and 06 non Executive positions were filled. At the end of 1997, there were 356 employees in the CRI permanent staff. Regular staff meetings were held to discuss the implementation of the work programme for the year 1997. Every attempt was made to maintain good employer-employee relationship and as usual the Division continued to assist in all welfare activities.

The budget allocation for the year was Rs.87.8 million made up of Rs.69.8 as recurrent and Rs.18 million as Capital Expenditure. The total revenue (excluding transport) for the year was 19.8 million. The Government grant was Rs.50.5 million.

The Board's contribution to the Medical Aid Scheme was Rs.2,010,577.99. The Board continued to extend financial assistance to the Seva Vanitha Unit, Co-operative Society, Recreation Club and Art Circle and Day Care Centre run by the Institute and for conduct of an English Class with the assistance of the Official Language Department, for the benefit of 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.1,299,815/-.

3. OUTSIDE FUNDED PROJECTS

3.1 The Council for Agricultural Research Policy (CARP)

The Council for Agricultural Research Policy (CARP) in Sri Lanka awarded a research grant on the project entitled "Determination of optimum conditions for drip irrigation and soil moisture conservation techniques in three drought susceptible soil series" and continued to support two on-going projects in the area of molecular biology and soil microbiology.

3.2 Cess Fund

The Cess Fund administered by the Ministry of Plantation Industries continued to support the on-going Persuasive Extension Programme (PEP) implementing a field programme to arrest further spread of the *Ganoderma* bole and root rot disease in Hambantota District, pilot project on the preparation of a coconut milk/cream for domestic market and survey on the impact of subsidy on the growers in five regions.

3.3 Coconut Genetics Resources Network (COGENT)

The Asian Development Bank (ADB) continued to support the on-going project entitled "Acceleration of collection and conservation of coconut biodiversity at risk", which was implemented successfully during the year.

3.4 The Overseas Development Administration (ODA)

In collaboration with the Institute of Agricultural Crop Research (IACR) in UK continued to support the on-going project entitled "Investigation on lethal coconut diseases of unknown etiology".

3.5 The International Atomic Energy Agency (IAEA)

IAEA in Austria extended financial support for a further period of one year, to study the "effect of tree management and age of *gliricidia* and *leucaena* grown under coconut on biological nitrogen fixation (BNF)", which was completed successfully during the year.

3.6 The Australian Tree Seed Centre

The Australian Tree Seed Centre continued to support the on-going "International Provenance trial on *Casuarina equisetifolia*".

4. ACKNOWLEDGEMENTS

The co-operation given by the Deputy Director (Research), Deputy Director (Admn. & Fin.) and staff of the Coconut Research Institute in successful implementation of the work programme is gratefully acknowledged.

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

The continued support given by the following organizations is also acknowledged.

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* Coconut Cultivation Board
* Coconut Development Authority
* Sri Lanka Council for Agricultural Research Policy
* Natural Resources Energy & Science Authority of Sri Lanka
* National Institute of Plantation Management
* GTZ/CARP Project
* Medical Faculty, University of Colombo
* Coconut Genetics Resources Network (COGENT)/Asian Development Bank
* Overseas Development Administration and Institute of Agricultural Crop Research, UK
* Asian and Pacific Coconut Community, Indonesia
* International Atomic Energy Agency, Austria
* Rothamsted Experimental Station, UK
* Natural Resources Institute, UK
* International Mycological Institute, UK
* Commonwealth Institute for Scientific and Industrial Research, Australia
* International Agricultural Centre, Netherland
* Central Plantation Crops Research Institute, India
* Australian Tree Seed Centre

REPORT OF THE AGRONOMY DIVISION

Head - H A J Gunathilake, Ph D

1. GENERAL

The research programme of the Division for the past 10 years was evaluated by a panel of external reviewers, to appraise the current recommendations and to identify new areas needing attention. During the year, much emphasis was given to research work on rehabilitation of low yielding plantations, planting of coconut in shallow lateritic soils, management of nitrogen fixing trees, improvement of soil moisture conservation practices and weed management. The adaptive research programme was monitored on schedule. In addition to the above several economic analyses were completed on selected topics.

2. RESEARCH PROJECTS

PROJECT 2: REHABILITATION OF LOW YIELDING PLANTATIONS

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

Results over the past five years show that none of the treatments were effective in rehabilitating low yielding coconut palms. Agronomic practices on the improvement of palms did not compensate for the cost of operation.

It is concluded that young (10-15 years old) coconut palms in shallow Andigama soil can not be rehabilitated by burying goat manure or green manure or soils brought from outside in pits located within the manure circle.

The experiment was terminated.

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 this year, disc harrowing and fertilizer application have been done according to treatments.

Table 1 shows that there was no significant variation in yield among treatments.

H A J Gunathilake & S D J N Subasinghe

Experiment 2.3.5: Study the effect of root pruning on palms showing drastic yield reduction due to heavy root mat formation, Palavi - 1996

Field operations were similar to the experiment 2.3.4. During this year, coconut yields were not significantly different among treatments (Table 1). However, yield improvement of palms due to fertilizer application plus disc harrowing was 22% higher than those treated with fertilizer application without harrowing.

H A J Gunathilake & S D J N Subasinghe

Table 1. *Effect of three different treatments on the yield of coconut at Madurankuliya and Palavi in 1997*

Treatment	Nuts/palm/year (1997)	
	Madurankuliya	Palavi
T_1 Control	63.6	21.0
*T_2 Disc Harrowing + Fertilizer	61.6	30.5
T_3 Disc Harrowing only	74.6	27.0
T_4 Fertilizer only	62.0	25.0
Significance (P=0.05)	n.s.	n.s.

* Depth of harrowing (20 cm)

Experiment 2.4.2: Performance of improved planting materials on Andigama Series and the effect of size of the planting hole on the growth of seedlings. Rathmalagara Estate, Madampe - 1997

The objective of this experiment was to determine the effect of size of the planting hole on seedling establishment and subsequent growth performance of Tall x Tall seedlings in shallow Andigama series.

Treatments were as follows:

T_1 - Establishment of seedling in 1.0 x 1.0 x 1.0 m pits (planting density of 156 palms/ha) with standard management practices.
T_2 - 1.3 m x 1.3 m x 1.3 m pits with standard practices.
T_3 - 1.3 m x 1.3 m x 1.3 m pits filled with soil brought from out side.
T_4 - 1.3 m trench filled with husk and same soil.
T_5 - 1.3 m trench filled with husk and same soil, but planting density is increased by 30% (8.5 m x 6.5 m - distance between plants is reduced to 6.5 m within the trench)

Preliminary soil survey was conducted before commencing the experiment to determine the variation of soil depth and extremely shallow (less than 15-30 cm) or deeper (more than 60 cm) soil pockets were avoided. The treatments were arranged in RCB Design with three replicates.

Trenches and seed-holes were excavated using a back-hoe machine. Selected TxT poly-baged seedlings were planted in trenches and in pits during September, 1997.

Experiment is in progress.

K B Dassanayake, A D Samarajeewa,
D N S Fernando (Agronomy Division),
L P Vidhanarachchi, L L W Somasiri (SPND),
C S Ranasinghe (PPD), H A Abeysoma & W R S Fernando

Experiment 2.4.3: Effects of competition of pasture for soil moisture on the growth of coconut on shallow soils. Rathmalagara Estate, Madampe - 1997

This experiment was initiated to investigate the pasture/weed competition for soil moisture and their effect on the performance of coconut, when established, on Andigama shallow soils.

Treatments were as follows:

T_1 - Complete removal of undergrowth (Control)
T_2 - Standard estate practices with controlled weeds (Slashing 4 times a year)
T_3 - Uncontrolled grass (*B. brizantha*) cover
T_4 - Ground cover with *Pueraria* (Live mulch)
T_5 - Ground cover with coir dust (Dead mulch)

The experiment was commenced in June, 1997. Treatments were arranged in a RCB design with three replicates. Land was blocked against the soil depth to minimise the soil depth variability. Yield records are being maintained. Soil water depletion and palm water status will be monitored with the on-set of dry season.

Experiment is in progress.

K B Dassanayake, A D Samarajeewa, D N S Fernando (Agronomy Division)
L P Vidhanarachchi, L L W Somasiri (SPND), C S Ranasinghe (PPD),
K C P Perera & K J S Perera (Agronomy Division)

Experiment 2.4.4: Effects of sub-soiling on the performance of coconut on shallow soils. Rathmalagara Estate, Madampe - 1997. Investigation of effects of loosening hard lateritic soil on root growth and subsequent performance of coconut

Treatments were as follows:

T_1 - Control with standard estate practices
T_2 - Trenches (1.0 m x 1.3 m) along tree rows on one side, 1.3 m away from the bole and filled with same soil
T_3 - Trenches (1.0 m x 1.3 m) along tree rows on one side, 1.3 m away from the bole and filled with husks/coir dust mixed with soil
T_4 - 1\3 circle trenches (1.0 m x 1.3 m) 1.3 m away from the bole filled with husks and soil
T_5 - Cultivation of Gliricidia in the inter-rows of coconuts (2.0 m x 2.0 m) (Double rows)
T_6 - Cultivation of Acacia in the inter-rows of coconuts (2.0 m x 2.0 m) (Double rows)

Treatments were arranged in a RCB design with three blocks. Blocks

were marked against the soil depth. The experiment was commenced in September, 1997. Trenches were excavated by back-hoe machine.

Experiment is in progress.

K B Dassanayake, A D Samarajeewa,
D N S Fernando (Agronomy Division),
L P Vidhanarachchi, L L W Somasiri (SPND),
C S Ranasinghe (PPD), H A Abeysoma & W R O Fernando

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

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

Application of treatments were repeated and nut yield recording was continued. It is important to note that coconut yields in cover-cropped plots were significantly higher than those plots with no-cover (Table 2). However the effect of different methods of cover management on the coconut yields was not consistent.

Analysis of soil samples from treatment plots indicated that Puero-cover improved soil chemical properties such as soil pH, soil organic matter, and Cation Exchange Capacity.

The experiment was terminated.

D N S Fernando, K B Dassanayake & W E J Tissera

Experiment 3.2.1: Demonstration on the use of cover-crops and Gliricidia in coconut lands. Rathmalagara Estate, Madampe - 1988

Experiment 3.2.2: Demonstration on the use of cover-crops and Gliricidia in coconut lands. Walpita Estate, Divulapitiya - 1988

Gliricidia produced sufficient quantities of foliage for manuring the palms in each plot. However, regrowth of pueraria ground cover was poor after the dry period due to incomplete life cycle. Coconut yields in different plots did not show significant differences (Table 3).

Table 2. *Effect of different cover management on coconut yield at Saddhatissa Estate, Divulapitiya*

Treatment	Nuts/palm/year	
	1996	**1997**
Cut & add	56 [a]	69 [a]
Slashing	54 [a]	58 [a]
Light Harrowing	50 [ab]	57 [a]
Control (no -cover)	41 [b]	44 [b]

Table 3. *Effect of cover crop and Gliricidia on yield of coconut at Rathmalagara and Walpita Estates*

Treatment	Nuts/palm/year (1997)	
	Rathmalagara	Walpita
Control (APM)	70.2	42.0
Puero Cover	76.8	46.1
Gliricidia	64.6	31.0
Cover + Gliricidia	75.6	45.2

Experiment 3.3: Improvement of water storage capacity of soil. Minuwangoda, Hettipola and Kumarakattuwa - 1995

According to the original proposal, a site in shallow Andigama soil at Bingiriya (3.3.4) was established during the year. None of the treatments complising husk burial or mulching or both had improved on nut yield of coconut up to the end of second year (Table 4). This suggests that different moisture conservation techniques are not effective in improving nut yield within a short period.

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

Table 4. *Nut yield (nuts/palm/year) in different treatments at three locations, (Minuwangoda, Hettipola and Kumarakattuwa)*

Treatments	Nuts/palm/year (1997)		
	Minuwangoda	Hettipola	Kumarakattuwa
T_1 - Control	50.6	55.3	50.6
T_2 - Mulch	50.3	62.6	57.6
T_3 - No burial	55.3	56.6	50.0
T_4 - Husk burial	58.3	48.3	48.3
T_5 - Husk mulch	59.7	41.3	41.3
T_6 - Burial + Mulch	60.3	55.6	51.7
T_7 - Jumbo pit	58.7	47.6	42.3
T_8 - Husk pits	61.3	48.0	41.7
T_9 - Husk pits (4'x4'2')	58.0	49.3	45.7
LSD (P=0.05)	11.7	16.7	12.7

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, Rathmalagara Estate, Madampe - 1992

This study comprises two experiments aimed at selecting the most suitable nitrogen fixing tree species to be grown under coconut, as a source of green manure and animal fodder.

In the first experiment, nitrogen fixing capacity of *Gliricidia sepium* was compared with *Leucaena leucocephala* over a period of one year, using the ^{15}N technique. Results from this study clearly demonstrated that Gliricidia was superior to Leucaena, in terms of total dry matter production, nitrogen yield and the amounts of N_2 fixation from the atmosphere. In both species percentage nitrogen derived from atmosphere did not differ markedly and ranged between 47-53% whereas, the amount of N_2 fixed was higher in Gliricidia (17 g N plant) than in Leucaena.

In the second experiment, the influence of tree pruning on biological nitrogen fixation capacity of the two species was investigated. This study confirmed that Gliricidia is a better N_2 fixer (150kg N ha^{-1}) than Leucaena under coconut and that tree pruning was a beneficial management practice in producing a higher

pruning biomass (leaves + branches) and enhancing biological nitrogen fixation. Among pruning treatments, four monthly pruning was found to be more effective than pruning at six monthly intervals, irrespective of the tree species. These findings suggest that Gliricidia could be used as a tree component in developing low-cost manuring systems for coconut plantations, on lateritic gravel soils.

This study was conducted with financial support from the International Atomic Energy Agency and the final report submitted by the Senior Author will be published shortly as Technical Document of the Agency.

The experiment was terminated.

M de S Liyanage & H A Abeysoma

Experiment 4.2.2: Substitution of inorganic Nitrogen requirement of coconut palms with two different sources of organic matter. Siringapatha Estate, Badalgama - 1992

Nut yield records were maintained during the year. None of the locations produced significant results during the year, except that organic fertilizer treatments had only marginal effect on the nut production in all sites

At both locations, there were no significant differences in nut yield between organic (organic manure) N and inorganic N (urea) applications. This reveals that both forms of N are equally effective for coconut.

Experiments are in progress.

D N S Fernando & W E J Tissera

Experiment 4.2.3: Substitution of inorganic Nitrogen requirement of coconut palms with two different sources of organic matter. Bandirippuwa Estate, Lunuwila - 1995

Several coconut palms died due to red weevil and black beetle damage. Although dead and weak seedlings were replaced with new seedlings they also did not establish well. This has caused a large variation in seedling sizes therefore it was decided to abandon the trial.

D N S Fernando & 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 loamy soil in the Intermediate dry zone (IL3). Poththukulama Research Station (PRS), Pallama - 1995**

Coconut yield was decreased from 1996 to 1997 which could be due mainly to the drought (Table 5). It is too early to comment on the effect of legume trees on the coconut, but in general, yield reduction was greater in control plots than in intercropped plots.

The estimated biomass yield of tree legumes per ha (Table 6) indicated that acacia performed better than gliricidia under coconut at PRS But in terms of total foliage biomass in both species were found to be comparable.

The experiment is in progress.

D N S Fernando, K B Dassanayake, & M J I Costa

Table 5. *Yields of coconut under different tree legume densities at Poththukulama Research Station, Pallama*

Treatment	Nut Yield/Palm 1996	1997	% change over the time	% charge over the control
T_1 - Mulch with coconut fronds	101.2	55.4	-45.9	-
T_2 - Gliricidia - density 1 (16 trees/square)	106.4	66.1	-40.4	19
T_3 - Gliricidia - density 2 (32 trees/square)	116.4	80.2	-36.2	45
T_4 - Gliricidia - density 2 (loppings buried)	111.7	86.1	-25.1	55
T_5 - Acacia - density 1 (16 trees/square)	113.0	85.9	-27.1	55
T_6 - Acacia - density 2 (32 trees/square)	104.2	76.2	-28.0	38

Table 6. *Biomass yields(mt/ha) of tree legumes planted under coconut at Poththukulama Research Station, Pallama*

Treatment	Foliage biomass (kg)	Wood biomass (kg)	Total biomass	Foliage fraction
T_1 - Mulch with coconut fronds	-	-	-	-
T_2 - Gliricidia - density 1 (16 trees/square)	2.0	1.4	3.4	0.60
T_3 - Gliricidia - density 2 (32 trees/square)	2.1	1.2	3.4	0.64
T_4 - Gliricidia - density 2 (loppings buried)	2.2	1.4	3.6	0.60
T_5 - Acacia - density 1 (16 trees/square)	2.9	1.7	4.6	0.64
T_6 - Acacia - density 2 (32 trees/square)	4.6	2.1	6.7	0.63

Experiment 4.3.2: **Study the effect of high density planting of Gliricidia and Acacia under coconut for substitution of inorganic nitrogen to coconut palms on clay loamy soil in the Intermediate dry zone (IL3). Bernath Estate, Horombawa - 1995**

Both nut yields of coconut (Table 7) and biomass yield of tree legumes at Horombawa followed a similar trend as those of PRS.

The experiment is in progress.

D N S Fernando, K B Dassanayake, M Bastian & K J S Perera

Table 7. *Coconut yields at Horombawa Estate as affected by different planting densities of legume*

Treatment	Nuts/palm 1997	% change over the control
T_1 - Mulch with coconut fronds (control)	51.3	-
T_2 - Gliricidia - density 1 (16 trees/square)	60.5	17.9
T_3 - Gliricidia - density 2 (32 trees/square)	58.3	13.6
T_4 - Gliricidia - density 2 (loppings buried)	61.8	20.4
T_5 - Acacia - density 1 (16 trees/square)	60.6	18.0
T_6 - Acacia - density 2 (32 trees/square)	61.4	19.6

Experiment 4.3.3: **Study the effect of Gliricidia and Acacia planted at high densities under coconut for substitution of inorganic nitrogen of coconut palms on sandy loam soil in the Intermediate Wet Zone, (IW3). Nilpanagoda - 1996**

The experiment was commenced in June, 1996 on a private estate, and the yield recording is in progress. The initial growth of NFTs was poor compared to the other sites and therefore, trees were not pruned during the year.

The experiment is in progress.

D N S Fernando, K B Dassanayake & H A Abeysoma

PROJECT 5: DEVELOPMENT OF LOW COST WEED MANAGEMENT SYSTEMS FOR COCONUT LANDS

Experiment 5.1.1: Identification of most economical management method of most common weed species in coconut plantations and to assess the effect of weed species on yield of coconut. Isolated Seed Garden, Ambakele - 1996

Treatments were applied during the year. Weed biomass and yield of coconut were recorded. So far, there is no significant difference in nut yield due to treatments.

Establishment of *Puraria* cover was not satisfactory due to inadequate rainfall.

Experiment is in progress.

D N S Fernando, A Samarajeewa, M J I Costa & I A N Hemasiri

Experiment 5.1.2: Identification of most economical management method of most common weed species in young coconut plantations and to assess the effect of weeds on growth performance of young coconut palms. Isolated Seed Garden, Ambakele - 1996

Experiment 5.1.3: Identification of most economical management methods of most common weed species in young coconut plantations and to asses the effect of weeds on growth performance of young coconut palms. Rathmalagara Estate, Madampe - 1996

Treatments were applied twice during the year at Rathmalagara, whereas treatments were applied only once at Ambakele due to poor re-growth of weeds.

Growth parameters of both coconut and weed biomass were taken. However, there is no significant difference in growth due to treatments. It was observed that plots treated with Glyphosate (2.85 kgs. a.i./ha) were heavily invaded by easily manageable dycoteledonous weeds replacing monocotyledonous grasses.

Establishment of *Puraria* cover at Ambakele was not satisfactory.

Experiment is in progress.

D N S Fernando, A Samarajeewa, M J I Costa & I A N Hemasiri

Experiment 5.2.1: Identification of most economical and effective control methods(s) for Illuk (*Impereta cylindrica*) in adult coconut plantations. Mangalaelilya Estate, Mundal - 1996

Application of treatments was not completed in 1996 as scheduled due to prolonged drought. Therefore, treatments were imposed during the year as designed. Weed biomass was measured before application of treatments and recording of coconut yield was continued.

Experiment is in progress.

D N S Fernando, A Samarajeewa, M J I Costa & I A N Hemasiri

Experiment 5.3.1: Identification of most economical methods for Pupula (*Vernonia zelanica*) in coconut plantations, Nimalka Estate, Wallipannagahamulla - 1996

Treatments were applied once during the year. It was observed that control of Pupula was difficult even with Glyphosate at the concentration of 4.2 kgs a.i./ha). However, Glyphosate at the rate of 4.2 kgs a.i./ha and 2.85 kgs a.i./ha were more effective than Paraquat and 2.4 .D. Therefore repeated application of Glyphosate would be required to control this weed as there is no other alternative measures except establishment of grasses such as *Bracharia brizantha*.

A Samarajeewa, D N S Fernando, M J I Costa & I A N Hemasiri

Experiment 5.4.1: Effectiveness of different concentrations of Glyphosate to control weeds in coconut nurseries and its impact on coconut seedlings, (Wilpotha Coconut Nursery) - 1996

At present, weed control in coconut nurseries is done at considerable expenses. Shortage of labour aggravates the problem. Use of Glyphosate has been practiced in several coconut nurseries and it has been reported that Glyphosate could

be used to control weeds successfully. However, concentration of the chemical, time of application are not known. Hence this experiment was designed to provide more information on the use of glyphosate in coconut nurseries for weed control.

Treatments were as follows.

T_1 - Application of Glyphosate (2.8 kgs a.i/ha)
T_2 - Application of Glyphosate (2.1 kgs a.i/ha)
T_3 - Application of Glyphosate (1.4 kgs a.i/ha)
T_4 - Control (Manually weeded)

These applications were done without any precaution to avoid contact of herbicide with coconut leaves. Hence, Glyphosate even at the concentration of 1.4 kgs a.i/ha caused significant damage to the foliage when it contact with coconut leaves.

A subsequent applications following necessary precautions (single nozzle sprayer with a guard) and eleminating contact of herbicide with coconut leaves showed that glyphosate at a concentration of 1.4 kg a.i/ha caused minimal damage to coconut seedlings while providing effective control of weeds. Furthermore, it has been found that application of glyphosate could be practiced safely up to four months old seedlings.

The experiment was terminated.

A Samarajeewa, M J I Costa & I A N Heamasiri

PROJECT 18: IMPROVEMENT OF SMALL HOLDER COCONUT FARMING SYSTEMS WITH ANNUAL/PERENNIAL CROPS IN THE WET ZONE AIMING AT MAXIMIZING FARM INCOME AND SUSTAINABLE PRODUCTION

Experiment 18.1: On farm cropping models in the wet and wet intermediate zone of coconut - 1997

Recording of the agronomic and economic data from eighteen existing models is being continued. Nut yield records continuously showed the improvement of nut yield with different intensive cropping/farming under on-farm level (Table 8).

The farm model at Gaspe (WL_3) consisting of pasture, fodder and milking cattle had a remarkable improvement in nut yield compared to monoculture coconut.

Pepper, pineapple, banana and cashew yielded well and these crops received reasonable farm gate price during the year. The rate of return to a Rupee invested was highest with coconut+pineapple crop mixture followed by coconut+milking cattle (Table 9). The least rate of return was realised for coconut mango+lime mixture in the Intermediate Dry Zone.

In general, the following recommendation were made after evaluating all crop/farm models.

a. Pineapple could be intercropped with both stands of coconut; mature and seedlings. Ginger established in the interspace of pineapple rows is beneficial and increased farm income as well as it controlled weeds.

b. When cashew intercropped in shallow coconut soils, yield of coconut was improved. Hence, cashew is an ideal intercrops for marginal coconut lands where soil depth is shallow (eg. Andigama soil series).

c. Ginger, cassava and yams are suitable seasonal crops that could be combined with perennial intercrops (eg. Pepper & Coffee) at the initial years.

d. Yams and ginger could be intercropped with coconut even under the age of 5-10 years in the WZ.

e. Pineapple, ginger and papaya are ideal intercrops where coconut underplanting is practiced.

f. Carrying capacity of goat (breed; Sri Lankan Boer) with improved pasture *(B.miliiformis and Green panic)* and gliricidia/Ipil tree fodder is 15 per hectare in the IMZ.

g. Mixture of fodder and pasture increased the feed availability of cattle. In this systems, Guinea-B fodder grass should be established in the center of the coconut square in two rows to avoid competition with coconut. Rest of the area should be planted with pasture.

Table 8. *Coconut yield in different crop/farm models*

Locations	Agro Ecological Zone	Crop/Farm Models	Nut yield/ Palm (1992-96)		Nut Yield/Palm/ Year 1997	
			With Inter-cropping	Without Inter-cropping	Intercrops With Intercropping	Without Inter-cropping
Divulapitiya	WL3	Coconut(m.p)+ Papper+Coffee	61	46	45	40
Walpita-A	WL3	Coconut(m.p)+ Crop+Banana	75	56*	53	46
Walpita-B	WL3	Coconut(m.p)+ Crop+Pineapple	78	50	45	38
Udulla	WL3	Coconut(r.p)+ Ginger+Pepper+ Coffee+Yam	34	30*	47	46
Kadanegedara	WL3	Coconut(m.p)+ Pineapple+Ginger+ Cashew	53	40	46	42
Kahatawila-I	IL1	Coconut(m.p)+ Pepper+Coffee	52	31	56	54
Kahatawila-II	IL1	Coconut(u.p)+ Pinepple+Ginger	48	40*	56	53
Rathmalagara	IL1	Coconut(m.p)+ NFT's+Pasture+Goat	61	59	-	-

Table 8. *Contd.*

Locations	Agro Ecological Zone	Crop/Farm Models	Nut yield/ Palm (1992-96)		Nut Yield/Palm/ Year 1997	
			With Inter-cropping	Without Inter-cropping	Intercrops With Intercropping	Without Inter-cropping
Deegalla	IL1	Coconut(m.p)+ Cashew+Lime+ NFT's	39	34	35	33
Divulwewa	IL1	Coconut(m.p)+ Lime+Mango	52	43	-	-
Madurupitiya	WL3	Coconut(m.p)+ Pepper+Pasture+ Cattle	57	52	59	57
Katuneriya	IL3	Coconut(m.p)+ Pepper+Pasture	66	61	-	-
Gaspe	WL3	Coconut(m.p)+ Pasture+Fodder+ Cattle	59	45	60	40

- m. p = Mature Plantation
- r. p = Re-plantation
- u.p = Under Plantation

* Less than five years

Table 9. *Performance of Intercrops in on-farm crop/livestock models in the Wet & Wet Intermediate Zone*

Locations	Agro-Ecol. Zone	Models	Agronomic Yield/ha	Cumulative Expenditure Rs./ha	Cumulative Income Rs./ha	Rate of return (Rp. invested)
Divulapitiya	WL_3	Crop	Papper-380 kg/ha Coffee-150 kg/ha	32,670	103,362	3.16
Walpita-A	WL_3	Crop	Pepper-155 kg/ha Banana-845 kg/ha	73,251	468,728	6.40
Kahatawila-I	IL_1	Crop	Pepper-234 kg/ha Coffee- 35 kg/ha	15,754	62,973	4.00
Kahatawila-II	IL_1	Crop	Pinepple-21160 frout/ha	27,848	315,812	11.34
Kadanegedara	WL_1	Crop	Cassawa-1275 kg/ha	27,638	60,000	2.17
Deegalla	IL_1	Crop	Cashew-390 kg/ha M.P.T.S-25380 kg/ha	11,565	36,248	3.13
Balagollagama	IL_1	Crop	Mango-1250 kg/ha Lime-1730 kg/ha	26,627	41,805	1.57
Madurupitiya	WL_3	Farm	Pepper-274 kg/ha Coffee- 15 kg/ha Milk - 2440l	31,853	180,692	5.67
Gaspe	WL_1	Farm	Milk - 5448l	26,059	186,322	7.15

h. SALT system (Coconut+Gliricida+Rumbutan+Pineapple+Papaw) in the contours is agronomically and economically viable on sloping lands (12%-15% slope) in the WZ.

The experiment is in progress.

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

Experiment 18.2: Intercropping coconut with selected medicinal plants. Walpita Research Station, Walpita.

During the year a field experiment was carried out to investigate the effect of planting density on growth and yield of two selected medicinal plants; Komarika (*Aloe vera*) and Hinguru-piali (*Kaempheria galanga*) under coconut. The treatment combinations consist of six planting densities (248866, 123333, 74000, 44000, 36667 & 27333 plants/ha of coconut for Komarika and 133333, 66667, 31733, 20000, 19733 & 16133 plants/ha of coconut for Hinguru-piali respectively).

It was concluded that the optimum planting densities for two species under coconut were 74,000 plants/ha for Komarika (Table 10a) and 31,733 plants/ha for Higuru-piali (Table 10b).

Table 10a. *Effect of planting densities on growth of Komarika*

Density (Plant/*coconut hectare)	No. of leaves/plant	Leaf length (cm)	No. of bushes/plant	Root length (cm)
27333	31^{a}	38.0^{a}	5^{a}	11.8^{a}
36667	30^{a}	36.0^{ab}	6^{a}	10.9^{a}
44000	25^{ab}	35.0^{ab}	4^{a}	10.3^{a}
74000	21^{b}	34.0^{cb}	3^{a}	10.8^{a}
123333	11^{c}	26.7^{cb}	2^{a}	12.7^{a}
248666	9^{c}	21.2^{d}	2^{a}	10.2^{a}
CV%		10.85		12.55

* Coconut hectare = 6,666.7 m^2

Values within a column, sharing a common letter do not differ significantly at P = 0.05

Table 10b. *Effect of planting densities on growth of Higuru-piyali*

Plant density (Plant/*coconut hectare)	No. of leaves/plant	Leaf area/plant (cm^2)	No. of bushes/plant	Root length (cm)
16133	32	3278.6^{a}	17^{a}	12.52^{d}
19733	33	3612.3^{a}	16^{a}	11.31^{c}
20000	32	3544.4^{a}	14^{a}	11.80^{d}
31733	32	2928.3^{b}	11^{a}	10.67^{ab}
66667	19	1022.1^{c}	7^{a}	4.94^{a}
133333	13	542.1^{d}	4^{a}	2.43^{a}
CV%		7.07		3.52

* Coconut hectare = 6,666.7 m2

Values within a column, sharing a common letter do not differ significantly at P = 0.05

H A J Gunathilake, B R K Medha & M A Dayawansa

PROJECT 21: DEVELOPMENT OF SMALL HOLDER COCONUT FARMING SYSTEM WITH LIVESTOCK (CATTLE AND SMALL LUMINOUS) INTEGRATIVE IN THE INTERMEDIATE AND DRY ZONE)

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

This experiment was continued for nine months. Results indicated that *B.mutica* could be used as a pasture goats if it is supplemented with straw or if given after overnight drying. (Table 11)

Further, it was found that 700-1000 g of fresh dung could be collected from an adult animal per day. On this basis, one hectare of coconut can be manured (supplemented with P, K & Mg) by rearing 10-12 goats per hectare.

The experiment was terminated.

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

PROJECT 22: ECONOMIC STUDIES TO ENHANCE THE PRODUCTIVITY OF COCONUT LANDS

Experiment 22.1: Economic analysis of coconut-based cropping/farming systems

Five different coconut-based intercropping (CBI) systems, namely coconut+pineapple+banana, coconut+banana, coconut+pineapple, coconut+betel and coconut+betel+banana were analaysed employing a range of economic indicators such as Total Gross Margin (TGM), Net Present Value (NPV), Benefit-cost Ratio (BCR), returns to labour and returns to variable costs. These economic indicators were also separately calculated for monocrop coconuts to assess the economics of CBI systems as compared with monocrops, and the results are presented in Tables 12 to 16.

The results obtained for different economic indicators with respect to coconut monoculture and CBI systems provide strong evidence that intercropping systems are economically viable as compared to monocrop coconuts. However, some of the indicators, namely BCR and returns to variable costs, are reasonably attractive for monocrop coconuts, though they are less than for some intercropping systems.

The profitability of an agricultural enterprise, although not the sole criterion is a key determinant for its adoption by small farmers. This study has concluded that CBI systems generate higher incomes per unit of land compared to monocrops. Hence, it can be argued that the low rate of adoption of CBI is not attributed to the low profitability. The problem stems from the fact that CBI systems require more farm resources, viz. labour and cash for external inputs, and efficient management of inputs to generate these high returns, i.e. they all give a high income per unit of land, but many CBI systems give poor returns per unit of labour and cash, compared with monocrops. These resources are limiting among different farmer groups, in varying degrees, which affect the initial adoption decision, and the further expansion of existing CBI.

M T N Fernando, S R Samarajeewa & S D J N Subasinghe

Table 11. *Effect of different feeding mixtures of B.mutica on weight gain of goats*

Treatments	Initial body weight animal	Total body weight gain (kg)/animal			Total dung production (kg)/animal		
		1-3 months	4-6 months	7-9 months	1-3 months	4-6 months	7-9 months
Free grazing on Br.mutica	23.0	3.0	4.50	1	25.00	69.90	62.5
Br.mutica+Gliricidia	21.0	1.20	6.90	3.5	47.60	97.30	-
Br.mutica+Straw	22.8	3.45	7.50	3	39.30	91.70	-
Br.mutica+Grasses	19.7	4.90	4.40	-	19.0	47.0	-
Br.mutica(dried overnight) + Gliricidia	17.0	7.00	5.50	3.5	18.10	57.50	60.0

Table 12. *Annual Total Gross Margin (TGM) of different cropping systems*

Cropping system	Year 1	Year 2	Year 3	Year 4	Year 5
			TGM (Rp/ha)		
Monocrop	15000	15000	15000	15000	15000
Coconut+pineapple+banana	-37700	232370	248040	189250	99780
Coconut+banana	25815	79140	71475	54675	41825
Coconut+pineapple	-76720	166615	189880	138915	72495
Coconut+betel	71305	211660	274280	180785	122575
Coconut+betel+banana	54480	177985	201630	138080	96255

Source: Farmer survey, 1995

Table 13. *Net Present Value (NPV) of different cropping systems over five years (Rs/ha)*

Cropping system	NPV (Rs)		
	15%[a]	20%[b]	25%[c]
Monocrop	20364	18168	16337
Coconut+pineapple+banana	454250	392735	341190
Coconut+banana	183580	163968	147585
Coconut+pineapple	285690	240085	201875
Coconut+betel	567703	503215	449395
Coconut+betel+banana	443725	394220	352848

Notes : a, b and c are discount rates.
Source : Farmer survey, 1995.

Table 14. *Benefit cost ratio (BCR) of different cropping systems*

Cropping system	BCR
Monocrop	2.87
Coconut+pineapple+banana	3.24
Coconut+banana	3.07
Coconut+pineapple	2.74
Coconut+betel	1.88
Coconut+betel+banana	2.12

Source: Farmer survey, 1995.

Table 15. *Returns to family labour in different cropping systems*

Cropping system	Year 1	Year 2	Year 3	Year 4	Year 5
			Rs/man day		
Monocrop	656	656	656	656	656
Coconut+pineapple+banana	(-)ve	1870	1955	1773	941
Coconut+banana	339	1528	1588	1088	650
Coconut+pineapple	(-)ve	1586	1649	1834	1171
Coconut+betel	177	378	461	320	254
Coconut+betel+banana	198	519	586	404	309
Wage rate of an agricultural labourer	104	104	104	104	104

Source: Farmer survey, 1995

Table 16. *Returns to variable cost in different cropping systems*

Cropping system	Year 1	Year 2	Year 3	Year 4	Year 5
	Returns to variable cost (Rs/rupee invested)				
Monocrop	2.87	2.87	2.87	2.87	2.87
Coconut+pineapple+banana	0.67	6.13	6.80	5.54	3.50
Coconut+banana	1.50	5.59	5.47	4.20	3.21
Coconut+pineapple	0.23	5.42	6.21	5.45	3.46
Coconut+betel	1.35	2.19	2.54	1.89	1.61
Coconut+betel+banana	1.37	2.76	3.01	2.21	1.83

Source: Farmer survey, 1995

Table 17. *Effects of in-situ grown Pueraria on soil (0.30 cm depth) conditions at Saddhatissa Estate, Divulapitiya*

Treatment	OM	Soil %	N% p^H (1:5)	P (ppm)	K (ppm)	WHC %
Control (no cover)	1.43	4.47	0.06	9.96	1.39	36.68
Pueraria (with N fertilizer)	2.19	6.80	0.11	26.99	6.06	44.66
LSD (5%)		0.23	0.02	5.38	0.83	

6. MISCELLANEOUS STUDIES

Experiment M-1: The effects of in-situ grown *Pueraria phasioloides* on coconut root distribution and yield of coconut and soil nutrient status in the Low Country Wet Zone of Sri Lanka

The study was conducted the selected plots from an existing experiment to determine the Effects of three methods of management practices on the performance of *Pueraria phasioloides* and their effects on coconut production (Expt. No 3.1.1.) at Saddatissa Estate, Divulapitiya. Selected treatments were (a) plots with *Pueraria* where coconut palms were fertilized with the recommended NPK mixture (b) plots with *Pueraria* where coconut palms were fertilized with PK only (c) plots without Pueraria (control) where coconut palms were fertilized with NPK mixture.

The results indicated that irrespective of nitrogen treatment cover crops have increased the total root length of coconut and also the length of primary and secondary roots.

Further, the fertility of soils in plots with pueraria cover has improved compared with those plots without pueraria, as indicated by higher organic matter contents, higher availability of plant nutrients such as N, P, K and Mg and Cataion Exchange Capacity.

Analysis of past three years nut yields data indicated that cover cropping with *Pueraria* has increased the nut yield of palms. Furthermore, there were no significant difference in coconut yield of palms treated with and without N fertilizer indicating that pueraria cover was able to provide the total nitrogen requirement of the palm.

K N N Herath & D N S Fernando

Experiment M-2: The effects of moisture stress on the growth, transpiration and chlorophyl content of leguminous cover crop species at early growth stage.

The above study was conducted using four creeping legumes i.e.*pueraria, calopogonium, centrosema* and siratro under glass house conditions. There were three moisture levels (a) no stress (soil water at FC), (b) mild stress (0.3-0.8 bars) and severe stress (above 0.8 bar). Water stress significantly reduced the growth of

legumes measured in terms of leaf area, shoot length, mean inter-nodal length and shoot dry matter.

Siratro maintained the highest transpiration and the lowest diffusive resistance while *Centrosema* showed the highest diffusive resistance. Data indicated that covers in general are sensitive to moisture stress however, *Centrosema* showed the highest tolerance to moisture stress. This experiment indicate that moisture stress during the initial stage of covers is very important factor determining the cover establishment.

M T E Athulapriya, K B Dassanayake & C S Ranasinghe (PPD)

4. TRAINING AND EXTENSION ACTIVITIES

The following lectures/demonstration were conducted.

Dr. D N S Fernando on management of pasture and cattle under coconut, cover cropping and green manuring in coconut lands; Dr. H A J Gunathilake on soil moisture conservation, intercropping, farming systems; Dr. K B Dassanayake on rehabilitation of low yielding plantations, use of tree legumes in coconut lands; Dr. M T N Fernando and Mrs. S Samarajeewa on economics of coconut based farming systems and Mr. A Samarajeewa on weed management in coconut lands, delivered lectures and also conducted field demonstrations to officers from Coconut Cultivation Board, University Students from Peradeniya, Colombo, Kelaniya, Ruhuna and Rajarata campases and Sgtudents from Technical Colleges of Kuliyapitiya, Kundasale and Palwehera.

Dr. D N S Fernando, Dr. H A J Gunathilake, Dr. K B Dassanayake, DR. M T N Fernando, Mrs. S Samarajeewa and Mr. A Samarajeewa, Mr. M H F G I Appuhamy of the division visited number of coconut estates on Persuasive Extension Activities.

The following papers were presented at the Silver Jubilee Celebrations of the Coconut Cultivation Board held at the Coconut Development Training Center, 01-05 April, 1997.

* Recent advances in coconut agronomy by Dr. D N S Fernando
* Agronomy of coconut based farming systems by Dr. H A J Gunathilake
* Economics of coconut based farming systems by Mrs. S Samarajeewa

5. ACKNOWLEDGMENTS

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 Dr. 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. L L W Somasiri, 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

A grant amounting to US $ 30 000 for the project on Identification, multiplication and strain improvement of king coconut and development of technology to improve its shelf life was approved for the Coconut Research Institute by the International fund for Agriculture Development (IFAD). The project on "RAPD-based" characterization of conserved coconut biodiversity on the detection of markers linked to drought tolerance was approved by the Asian Development Bank (ADB) and a sum of US $ 13 000 was granted for a duration of 3 years. The experiments of these projects will be conducted by the Genetics and Plant Breeding Division in collaboration with the Plant Physiology and Tissue Culture Divisions.

The accelerated germplasm collection and conservation programme funded by the COGENT was completed successfully in September 1997. A total of 20 accessions were collected from drought prone areas based on biased sampling. Another 7 respresentative germplasm accessions, especially from non-traditional coconut growing areas were also collected under this programme based on random sampling. Out of these 27, sixteen accessions comprising 1110 seedlings were planted at the Lenawa model garden Melsiripura during the year.

Progeny of 4 Dwarf x Tall hybrid crosses along with Ambakelle Special and other Tall cultivars comprising 660 seedlings were planted at Loling Estate Payagala, in order to compare their potential for sap production.

The fifth site in the series of multilocational trials to test the performance of the progeny of Ambakelle Tall crossed with germplasm accessions was planted at Kivulakelle estate Madurankuliya in December 1997.

2. RESEARCH PROJECTS

PROJECT 12.1: EVALUATION OF EXISTING CULTIVARS

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

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

Treatments:

The five cultivars used as treatments were:

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
12.1a.1	Bandirippuwa	1983	Loamy sand	Wet intermediate zone
12.1a.2	Thammenna	1983	Latasol	Dry zone
12.1a.3	Palugaswewa	1985	Sandy clay loam	Dry intermediate zone
12.1a.4	Suriyapura	1986	Lateritic gravel/ clayey	Wet zone

The number of nuts/palm/yr (A) and estimated copra/palm/yr (B) were evaluated during 1993-97 period at Bandirippuwa and Thammenna Estates. The results of fruit component analysis are given in Tables 1 - 4.

At the 14th year from establishment, the hybrids (DG x T; DY x T) planted at Thammenna have produced a mean yield of 13 kg/palm/yr copra during the 5 year period 1993-97 compared to a yield of 12 kg/palm/yr at Bandirippuwa. Despite the wide fluctuations in yield of hybrid cultivars at Bandirippuwa, a mean increase of 3 kg/palm/yr copra is recorded compared to the tall cultivars indicating the early yielding advantage of hybrids. Out of the tall cultivars, Moorock tall consistently produced yields similar to Tall x Tall at Bandirippuwa but was inferior to the other tall cultivars at Thammenna elucidating its suitability within the Intermediate Zone.

The palms at the two sites, Palugaswewa and Suriyapura have now attained stability in nut production and show similar cropping patterns to Bandirippuwa and Thammenna, with hybrids out-performing tall cultivars. (Tables 5 and 6).

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

Table 1. *Nuts/palm/yr (A) and estimated copra/palm/yr (kg) (B) of the five cultivars at Bandirippuwa (1993-97) and mean of 5 years*

Cultivar	1993		1994		1995		1996		1997		MEAN	
	A	B	A	B	A	B	A	B	A	B	A	B
DG x T	06	1.3	101	21.7	70	16.2	67	13.0	46	9.6	58	12.4
DY x T	07	1.3	83	19.8	61	15.0	65	13.2	45	10.7	52	12.0
T x T	08	1.7	51	12.1	47	11.5	48	10.8	32	7.9	37	8.8
MT	09	2.0	39	10.8	45	11.5	42	10.3	32	8.1	33	8.5
PPT	09	1.7	50	12.6	50	11.8	44	9.6	34	8.1	37	8.8

Table 2. *Fruit component analyses of cultivars at Bandirippuwa. (mean of six picks in 1997)*

FRUIT COMPONENT	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)	1225	25.3	1294	27.0	1432	28.0	1555	20.9	1411	20.4
Husked nut weight (g)	654	25.8	708	26.4	769	27.0	792	23.7	741	24.6
Split nut weight (g)	470	26.4	509	21.8	574	22.1	600	19.7	558	20.1
Kernel weight per nut (g)	322	21.4	337	27.9	364	23.3	385	20.3	360	21.3
Estimated copra weight (g/nut)	209	na	227	na	246	na	253	na	237	na
Estimated copra weight (kg/palm)	9.6	na	10.2	na	7.9	na	8.1	na	8.1	na

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

Table 3. *Nuts /palm/yr (A) and estimated copra/palm/yr (Kg) (B) of the five cultivars) at Thammenna (1993-97) and mean of 5 years*

Cultivar	1993		1994		1995		1996		1997		MEAN	
	A	B	A	B	A	B	A	B	A	B	A	B
DG x T	54	10.7	60	13.6	80	17.3	73	13.5	81	17.2	70	14.8
DY x T	42	7.8	39	8.4	63	13.7	65	13.6	71	13.8	56	11.5
T x T	30	6.0	28	7.1	46	10.5	51	11.7	46	10.8	40	9.2
MT	24	5.0	24	5.6	35	7.9	36	8.2	36	8.2	31	7.0
PPT	31	6.3	31	7.6	47	10.9	49	11.2	49	11.2	41	9.4

Table 4. *Fruit component analyses of cultivars at Thammenna. (mean of six picks in 1997)*

FRUIT COMPONENT	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)	1069	26.4	1015	23.9	1240	21.7	1278	23.7	1210	21.0
Dehusked weight (g)	662	29.0	606	25.0	734	28.8	716	25.5	717	25.6
Split nut weight (g)	491	24.6	451	22.0	599	21.2	541	22.2	541	21.4
Kernel weight per nut (g)	323	26.0	293	24.0	360	25.3	367	25.6	355	25.0
Estimated copra weight (g/nut)	212	na	194	na	235	na	229	na	229	na
Estimated copra weight (kg/palm)	17.2	na	13.8	na	10.8	na	8.2	na	11.2	na

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

Table 5. *Number of palms harvested (A) and number of nuts/palm (B)* of cultivars at Suriyapura and Palugaswewa Estates*

Cultivar	Suriyapura		Palugaswewa	
	A	B*	A	B*
DG x T	63	42	54	25
DY x T	61	36	69	22
T x T	63	20	66	16
MT	59	21	65	10
PPT	53	19	66	17

(* nuts/palm for 5 picks of 1997; yield data could be obtained only for 5 picks)

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

PROJECT 12.2: 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, Ambakelle (1993)

The progeny obtained by crossing palms selected for sustained high nut weights during adverse climatic conditions in 1991, were planted in field No. 14, ISG in 1993 (151 progeny families). These seedlings recorded a mean leaf production rate of 6 leaves/seedling/year at 42 months from planting. Another 95 progeny families arising from above crosses which were established in 1995 are being evaluated at the Maduru Oya Seed Garden.

C K Bandaranayake

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

The systematic crossing programme initiated in March 1996 on 100 elite palms from fields 1, 2 and 4 ISG, were selected on the basis of long-term yield data and on progeny testing was continued until September 1997. A total of 19 168

female flowers from 1065 inflorescences were pollinated during January to September with pollen from 20 palms selected out of the 100 palms. An amount of 6993 button nuts have set after 3 months from pollinations and approximately 5000 nuts are expected to be harvested during 1998. A total of 5287 Tall x Tall seednuts were harvested during the year resulting from pollinations carried out in 1996, on the above palms and were laid in the Bandirippuwa Research Nursery.

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

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/soil type: Dry intermediate zone

This experiment was initiated with the objective of evaluating the performance of the present progeny for long term yield stability and drought tolerance. The parent palms were selected from fields 1 and 2 of the ISG based on their yield potential and stability in nut production during adverse climatic conditions.

The trial consisting of 58 progeny families (each with a minimum of 4 individuals) has attained full bearing (96% bearing) and 13877 nuts were harvested during the year from 399 palms, recording 35 nuts/palm/year.

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

PROJECT 11.2/12.3: CROSSING OF SELECTED PALMS AT ISG WITH PROMISING GERMPLASM ACCESSIONS (1993)

Progeny arising from the four crosses Ambakelle Tall x Moorock Tall, Ambakelle Tall x St. Annes, Ambakelle Tall x Debarayaya and Ambakelle Tall x Kasagala were evaluated in multilocational sites with Ambakelle Special as the control cultivar, in order to test the recombination and segregation of yield stability (ISG female parent) and drought tolerance (germplasm accessions; male parent) of parents in the resulting progenies and their subsequent performance.

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
12.3a	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
12.3c	Kivulakelle	1997	Red yellow latasol	Dry zone

The fifth site in the series was planted in December 1997 at Kivulakelle with seedlings resulting from a fresh round of artificial pollinations of the same crosses.

Results of the analysis of vegetative growth characters, recorded after 2 years from establishment at the sites Girtland, Melsiripura and Siringapatha (Table 6) indicated that Ambakelle Special out-performed all other crosses for all growth characters assessed at all sites. (site and variety interaction was not significant). The cross Ambakelle Tall x Debarayaya scored second best cross for the characters assessed with the absence of significant differences at Melsiripura with Ambakelle Special.

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

PROJECT 12.4: SELFING OF F2 PALMS AT BANDIRIPPUWA ESTATE AND EVALUATION OF F3 PROGENIES AT RATMALAGARA (1994)

The experiment was planned with the objective of comparing the selfed and crossed progenies of F2 generation palms of Dwarf x Tall hybrid coconut and to study the segregation patterns of important quantitative characters in their subsequent generations. Thirty six F3 progeny families arising from selfing and open pollination of 18 F2 palms were planted in a fully randomized design at the Ratmalagara Estate in November 1995.

Table 6. *Means of the characters, number of new leaves produced (A), girth (B;cm) and height (C;cm) of the 5 crosses at Siringapatha, Melsiripura and Girtland Estates (LSD = Least significant difference at 0.05 level)*

Cross	Siringapatha			Melsiripura			Girtland		
	A	B	C	A	B	C	A	B	C
Tall x Moorock	6.55	36.13	283.66	6.51	37.01	289.23	7.43	46.91	357.15
Tall x St. Annes	6.45	35.53	268.76	7.33	42.36	331.33	7.36	46.81	366.48
Tall x Debarayaya	7.083	42.90	337.46	7.91	47.83	369.40	7.45	47.20	347.85
Tall x Kasagala	6.25	32.90	258.23	6.93	42.66	322.41	7.23	46.95	346.83
Ambakelle Special	8.35	49.28	356.76	8.36	48.55	374.33	8.48	55.00	394.9
LSD	0.566	5.54	23.65	0.498	4.55	24.56	0.482	3.862	N.S

A total of 122 seedlings survived at the end of January 1997, out of the 294 seedlings originally planted, due to severe rat infestation caused in 1996. The growth characters, total leaves and new leaves produced, split leaves and girth of seedlings were recorded twice during the year and analysis of the results revealed that no significant difference was present between the selfed and open pollinated progenies. Selfed and open pollinated progenies recorded a leaf production of 6.5 leaves and 6.7 leaves per seedling/year respectively and a girth of 28.2 cm and 28.7 cm respectively at 18 months from planting.

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

PROJECT 11.1/12.5: 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 and 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 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 were established to evaluate the progeny of the crosses of selected Tall and Dwarf palms 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 different agroclimatic zones and/or the most adapted types for growing under 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

Location	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	Wet 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	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 conditions.

Different fertilizer levels were practised only at Ratmalagara and Bandirippuwa and rest of the sites were used purely for testing progenies under different agro-climatic conditions and soil types.

In the progeny trials at Bandirippuwa and Ratmalagara with different fertilizer levels, highly significant differences were observed in nut yield between the hybrids and tall cultivars, with hybrids producing a mean of 48 nuts/palm and Tall cultivars producing 28 nuts/palm. Data on the number of nuts/palm/yr for 3 varieties at Ratmalagara and Bandirippuwa are presented in Table 7.

Considering the two sites Ratmalagara and Bandirippuwa no significant site differences were present for nut yield during 1997 for the 3 types of progenies. A significant difference in nut yield was observed between half the recommended dosage and one and half times the recommended dosage at Bandirippuwa for the first time since 1993 (Table 7), when the fertilizer treatments were first initiated. In contrast, no significant difference in nut yield was observed between the 3 fertilizer levels at Ratmalagara during 1997.

Fruit component studies carried out in the 3 crosses show that T x SR out-yields in copra production, recording 307 g copra/nut whilst T x DG produced only 219g/nut and T x T 252 g/nut. (Table 8).

Table 7. *Nut yield (nuts/palm/yr) of 3 types of progenies and fertilizer levels of the progeny trials at Bandirippuwa and Ratmalagara during the years 96 and 97. (The figures with the same letter are not significantly different at 0.05 level)*

Treatment	Bandirippuwa		Ratmalagara	
	1996	1997	1996	1997
Variety				
T x DG	37 a	47 a	49 a	50 a
T x T	34 a	30 b	23 b	30 b
T x SR	27 b	26 b	26 b	29 b
Fertilizer level	34)	35 a	33 a	37)
T1 recommended	29) ns	25 b	29 b	33) ns
T2 half the recommended	35)	36 a	37 a	38)
T3 One and half the recommended				

Table 8. *Mean weights of Fruit components, shell and kernel thickness of the 3 crosses evaluated at the progeny trial Bandirippuwa in 1997*

Cross	Fruit wt. (g)	Husked nut wt. (g)	Kernel wt. (g)	Kernel thickness (mm)	Shell thickness (mm)
T x DG	1181	686	336	12.25	3.79
T x T	1379	787	382	13.13	4.29
T x SR	1714	959	457	13.71	4.59

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

Comparison of cultivar performance in different sites reveals that despite the contrasting climatic differences at Mangala Eliya Estate, Puttalam and Daisy Valley Estate, Mawathagama, nut yields at the two sites were almost comparable (Table 9). However, recording of accurate yield data has been hampered due to theft problems at Daisy valley and procupine damage to nuts at Mangala Eliya along the border rows. The condition of the two progeny trials at Andigama estate has now improved and systematic yield recording would be initiated from 1998 in the Mudalihamy block. Except for Tall x Tall, other 3 cultivars T x SR, T x DG and DG x SR at the Puras block have exceeded 85% flowering. Palms in flower in the two

observation blocks at Sirikandura Estate and Ratmalagara are given in Table 10.

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 9. *Nut yields of the progeny trials at Mangala Eliya and Daisy Valley Estates*

Cross	Nuts/palm/yr	
	Mangala Eliya	Daisy Valley
T x DG	40	36
T x T	30	27
T x SR	31	24
T (OP)	31	-
DG x SR	-	36
DG x T	-	33

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

Table 10. *Cumulative number of palms in flower and percent (*) in different progenies at Sirikandura and Ratmalagara Estates*

Cross	(1989) Sirikandura	Cross	(1989) Ratmalagara
T x DG	64 (88)	DG x T	17 (94)
T x T	51 (70)	DY x T	12 (66)
T x SR	54 (75)	DY x SR	12 (66)
T x DY	60 (83)	DG x SR	16 (88)

[DG, dwarf green; T, tall; SR, San Ramon; DY, dwarf yellow]

PROJECT 12.6: COMPARATIVE EVALUATION OF DG X TALL HYBRID PROGENY OF PARENTS OF FIRST AND SECOND GENERATION PALMS AT ISG FOR YIELD & 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 region/soil type: Wet Intermediate zone/Clay loam soil

The sanitation conditions of the trial improved following the change of ownership of the management and, with careful monitoring of cultural practices adopted, a significant improvement was observed in the performance of seedlings. Five palms came into flowering during the 4th year after planting.

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

PROJECT 12.7: COLLECTION CONSERVATION AND EVALUATION OF COCONUT GERMPLASM

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

As indicated in Annual Report 1996 (CRI 1996) the ADB/COGENT funded projects on Acceleration of the collection of germplasm for drought tolerance and conservation of the coconut biodiversity at risk in Sri Lanka and Evaluation of existing coconut populations for physiological adaptation and setting up of *in-situ* germplasm repositories were successfully completed in August 1997. The terminal reports were presented at the Annual Project review meeting of the COGENT/ADB held in Bogor Indonesia in September 1997.

Under the acceralated programme, 7 representative germplasm accessions especially from the non-traditional coconut growing regions were collected under random sampling from the Central, North Central, Southern and North Western Provinces. A total of 20 accessions from drought prone areas which tolerated severe drought conditions were collected under biased sampling and also 3 accessions from introduced populations. Palm selection, nut collection fruit component analysis and nursery laying were accomplished. Sixteen accessions out of these were planted at the Lenawa Model Garden Melsiripura of the Coconut Cultivation Board. Data on the fruit component analysis of the collected accessions are given in Tables 11 and 12.

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

Table 11. *Fruit component analysis of nine coconut accessions collected during 1995/96*

Accession	Fresh nut wt. (g)	Husked nut wt. (g)	Husk wt. (g)	Shell wt. (g)	Kernel wt. (g)	Copra wt. (g/nut)
Marandawila	1383	645	729	197	337	207
Kivulakelle	1671	797	834	221	405	255
Thammenna	1931	816	1115	229	393	261
Yatawatta	1930	781	1148	233	378	250
Wilhelmina	1979	769	1210	223	369	246
Mirishena*	1570	747	823	206	348	239
Chitragala	1726	820	905	223	410	263
Andigama	1590	759	831	218	379	243
Dehigahalande	1680	791	889	227	396	253

*Note: All accessions are tall (typica) forms, except Mirishena, which is a semi-tall type.

Table 12. *Fruit component analysis of nine coconut accessions collected during 1996/97*

Accession	Fresh nut wt. (g)	Husked nut wt. (g)	Husk wt. (g)	Shell wt. (g)	Kernel wt. (g)	Copra wt. (g/nut)
Haragama	1542	644	898	202	316	206
Dickwella	1857	824	1033	268	459	264
Kahatagasdigiliya	1355	551	804	176	268	176
Millawana	1596	753	844	200	366	241
Aluthwatta	1362	610	751	200	286	195
Wellawaya East	1477	773	705	227	369	247
Wellawaya West	1478	718	760	210	348	228
Madagama	1398	695	702	186	330	222
Temple Raddegoda	1254	577	677	179	277	185

(Note: All accessions are tall (typica) forms)

Experiment 12.7.1a: Germplasm from other countries

Repeated requests made to the Indonesian Authorities seeking approval to release germplasm have not been met with success to date. Attempts would be made through the Coconut Genetic Resources Network (COGENT) in order to obtain the requested germplasm through the International gene bank to be established in Indonesia.

W M U Fernando & J M D T Everard

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

Flowering percentages amounting to 75 and above have been achieved in 5 Tall accessions whilst 6 Tall accessions have attained 50% and above at the Pothukulama conservation block after 9 years from planting (Table 13). Performance of cultivars at the Bandirippuwa block (Table 14) was not up to the standard of Pothukulama as soil conditions at Bandirippuwa are rather poor. With the addition of organic manure and with husk burying carried out during 1997 an improvement is expected in flowering and nut setting at Bandirippuwa.

C K Bandaranayake & G K Ekanayake

Table 13. *The status of the PRS conservation block, as at 31 December*

Accession	% Flower	% Bearing	No. of palms	No. of vacancies	Total
1. Moorock	94	85	81	01	82
2. Palugaswewa	91	78	82	03	85
3. Pitiyakande	90	80	80	05	85
4. Clovis	66	46	76	09	85
5. Namalwatta	79	75	77	08	85
6. St. Annes	84	68	82	03	85
7. Margaret	66	59	79	06	85
8. Kasagala	23	4	71	09	80
9. Debarayaya	42	19	77	04	81
10. Kundasale Dwarf	30	30	66	22	88
11. Akuressa	67	46	83	07	90
12. Ambakelle Special	59	42	86	05	91
13. Melsiripura	53	8	85	06	91
14. Mangala Eliya	48	9	81	05	86
15. Goyambokka	35	6	83	07	90
16. Cameeron Red Dwarf	97	97	68	18	86
17. Goluwapokuna	52	21	75	06	81
18. Keenakelle	5	-	73	17	90
19. Dwarf Brown	64	54	87	03	102
20. Maliboda	20	6	85	05	90
21. Horakelle	18	-	72	18	90
22. Walahapitiya	11	4	83	02	85
23. Wellawa	-	-	62	17	79
24. Embryo Culture plants	33	33	18	01	19
25. Brazilian Green Dwarf	27	-	30	09	3

Table 14. *The status of germplasm conservation block at Bandirippuwa*

Accession	% Flower	% Bearing	No. of palms	No. of vacancies	Total
1. Wellawa	64	39	80	04	84
2. Pitiyakande	49	30	80	06	86
3. Ambakelle tall	79	56	70	16	86
4. Moorock	26	26	38	46	84
5. Namalwatta	7	3	28	56	84
6. Debarayaya	15	3	61	19	80
7. Clovis	9	2	84	01	85
8. Palugaswewa	20	14	69	11	80
9. Ambakelle Special	23	6	77	01	78
10. Akuressa	5	3	34	52	86

Experiment 12.7.3: Evaluation of Dwarf green x Debarayaya tall

Forty eight seedlings of DG x Debarayaya planted with 48 CRIC 65 seedlings as the comparison at Raddegoda estate Delwita in 1995 recorded an average of 8 new leaves/seedling/year after 24 months from planting.

C K Bandaranayake, A Thavaratnerajah & G K Ekanayake

PROJECT B-8: CONSERVATION AND EVALUATION OF COCONUT GERMPLASM

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

No new flowering were recorded during the year in this block leaving the number of bearing palms as 103 consisting of 12 varieties/forms of 7 palms each and Dwarf red, Rathran thembili, Pora pol, Dwarf yellow x Tall which have only 05, 05, 03 and 06 bearing palms respectively. Only two young palms of Navasi thembili are available.

W M U Fernando & M H L Padmasiri

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

The current status of the local germplasm conservation block is shown in Table 15. As a result of the self pollination programme initiated in 1996, 159 Bodiri, 144 Gon thembili, 245 Ran Thembili, 47 Kamandala, 73 Pora pol and 72 Navasi seednuts have been harvested during 1997 and laid in the research nursery at Bandirippuwa. The existing vacancies of the local germplasm block B/E would be supplied during maha 1998 with this material.

C K Bandaranayake, W M U Fernando & S Mallawaarachchi

Table 15. *The status of the local germplasm collection at Bandirippuwa as at 31 December*

Status of collection	Bodiri	Gon thembili	Pora pol	Ran thembili	Navasi	Kaman-dala	Dikiri
Bearing	40	52	28	13	16	06	01
Young palms	04	-	06	16	19	-	-
Seedling	01	01	03	01	-	-	-
Vacancies	35	16	22	06	01	-	02
Total	**80**	**69**	**57**	**38**	**36**	**06**	**03**

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

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

One hundred and forty four palms were in bearing whilst 04 were young palms as at 31 December 1997 and 14 vacancies were reported.

As indicated in CRI Annual Report 1996, a systematic crossing programme was carried out on 30 San Ramon palms from this block with pollen from San Ramon palms at Bandirippuwa (San Ramon palms 04 and 16/field 7c; palms 65 and 66/old variety block). A total of 980 San Ramon seednuts were harvested as a result of pollinations carried out in 1996 and were laid in the Bandirippuwa research nursery. A summary of pollinations carried out during 1997 are given in Table 16. Out of the 30 San Ramon palms used as female parents, palms Nos. 04, 14, 15 and 16 recorded high nut setting consistently during the whole period.

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

Table 16. *Details of the pollination programme carried out in the San Ramon block during 1997. (The palm no.s indicated were used as the female parent*

Palm no.	No. of inflorescences	No. of buttons pollinated	No. of buttons remained after 3 months	No. of buttons remainded after 6 months
37	11	239	42	11
39	10	383	77	24
46	11	247	32	15
57	10	236	62	45
59	10	212	63	37
69	10	137	20	05
71	09	148	23	05
72	11	274	45	06
73	10	251	57	23
80	11	376	62	34
82	11	251	34	10
83	11	217	55	01
108	10	535	28	15
111	11	217	52	07
112	12	205	37	09
135	09	108	26	11
136	10	155	32	12
138	10	305	32	06
139	10	217	54	20
141	10	187	38	03
158	12	242	64	16
159	10	265	19	04
160	11	110	32	06
161	08	105	53	15
162	10	162	37	12
04	11	201	79	56
12	06	99	-	-
14	13	358	103	61
15	10	199	89	78
16	13	312	146	70

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

The current status of the dwarf palm blocks at Bandirippuwa and Ratmalagara is shown in Table 17. The vacancies filled during 1996 in Dwarf green at BE could not be retained due to the severe black beetle infestation. Nine Dwarf red palms (bearing) and 2 Dwarf yellow palms (bearing) died due to red weevil infestation. Sanitation has been intensified and routine checking are now being undertaken to control the pest infestation.

The casualties occurred at Ratmalagara were due to severe water logging during the heavy rains in September/October 1997. Seventy seven Brazilian green dwarf seedlings were planted in September 1997 at Bandirippuwa adjacent to the existing Dwarf palm block.

Table 17. *The status of the dwarf palm blocks at Bandirippuwa and Ratmalagara estates (DR Dwarf red ; DY Dwarf yellow; DG Dwarf green ; DB Dwarf brown ; BGD Brazilian green dwarf)*

Status	Bandirippuwa				Ratmalagara	
	DR	DY	DG	DB	BGD	DB
Total number established	73	44	99	45	77	117
Vacancies	30	30*	60**	04	02	27
Young palms/seedlings	-	-	14	41	75	90
Palms in flower	-	-	05	-	-	-
Palms in bearing	43	14	16	-	-	-

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

C K Bandaranayake, G K Ekenayake & R Jayatilleke

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

The experiment was initiated to carry out a systematic evaluation of 9 selected germplasm accessions which were diverse in their origins and to characterize between and within population variability. The original planting consists of 9 accessions. An accession represent 75 progenies at the rate of 5 progenies each, obtained from 15 parent palms. But a large number of casualties occurred during

96/97. Several vacancies were filled during 1997 according to the availability of relevant seedlings and the rest were filled with Ambakelle tall.

C K Bandaranayake & G K Ekenayake

Experiment B-8.6: Evaluation of hybrid crosses utilizing local and exotic germplasm to test their potential for sap production

Progeny of three hybrid crosses Dwarf green x Debarayaya (117 seedlings); Cameroon Red Dwarf x Ambakelle Tall (120 seedlings) and Dwarf x tall (165 seedlings) were planted with Ambakelle special as a control at Halkandawila Payagala in May 1997 in order to evaluate the progenies for sap production potential. As an extension to the trial, 25 Navasi, 14 Kamandala, 25 Andigama Tall, 39 St. Annes tall and 33 Tall x Debarayaya along with 77 Tall x Tall (guard rows) seedlings were planted.

PROJECT B-9: CHARACTERIZATION AND EVALUATION OF INDIGENOUS THEMBILI GERMPLASM (1996)

The self pollination programme initiated in March 1997 for selected populations of Marandawila, Walpita, Madampe and Walahapitiya was continued during the year. Regular bearing thembili palms with high sugar concentration and with desirable nut characters were selected from each population for the self pollination programme in order to raise planting material with improved characters. A summary of the pollinations carried out during the year and differences in nut setting are given in Table 18.

C K Bandaranayake & W M U Fernando

Table 18. *The number of female flowers per infloresence and nut setting percentage of selected Thembili palms in different populations.*

Estate	Palm No.	No. of female Flowers/inflorescence	Setting % (after 3 months)
Walpita	1	20	46
	2	22	45
	3	18	53
	4	16	40
	5	22	43
	6	19	26
	7	19	28
	8	22	57
	9	22	40
	10	26	45
	11	30	42
	12	19	35
Marandawila	1	20	50
	2	25	53
	3	18	69
	5	18	45
	6	19	54
	7	20	50
	8	18	49
Walahapitiya	2	27	51
	3	29	22
	4	38	48
	5	40	40
	6	44	42
	7	23	57
Madampe	1	30	41
	4	28	42
	5	21	39

PROJECT B-10: CHARACTERIZATION OF COCONUT GERMPLASM USING MOLECULAR MARKERS FOR ENHANCEMENT OF THE COCONUT BREEDING AND CONSERVATION STRATEGIES (1996)

Selection of a set of appropriate primers for characterization of coconut germplasm:

The first assay was planned to evaluate the extent of genetic variation in the coconut germplasm conserved at CRISL using RAPD markers.

The study was initiated with the funds granted by the Council for Agriculture Research Policy (CARP 12/344/253 Rs 1.11 million) and was conducted as a collaborative project with the Department of Biochemistry and Molecular Biology, Faculty of Medicine University of Colombo.

The main objective of the project was to select the most promising primers (using primers from three OPERON kits) that gives highly reproducible amplified fragments exhibiting polymorphism across coconut accessions to be used for measuring genetic relationships and for efficient conservation of germplasm without being duplicated. Following the work carried out on this aspect, 30 primers have been found extremely good in amplifying coconut DNA with highly reproducible polymorphisms both within and between parental accessions that are being regularly used in the breeding programme.

J M D T Everard

3. SEED GARDENS

3.1 The Isolated Seed Garden at Ambakelle

3.1.1 Rainfall

The amount and distribution of rainfall for 1997 is shown in Table 19 along with the values for the previous year and the 10 year average (1988-1997). The total rainfall during the year increased to 1767 mm compared to 1996 but with a significant decrease in the rainfall during the first 3 months of the year.

Table 19. *The amount and distribution of rainfall for 1996 and 1997 and the 10 year average (1988-1997) for comparison at ISG*

Month	1996			1997			10 year average (1988-1997)		
	A	B	C	A	B	C	A	B	C
January	127.7	3	3	-	-	-	62.6	3	3
February	91.2	6	5	3.6	1	1	33.6	3	3
March	-	-	-	2.5	2	1	45.2	4	4
April	105.0	11	9	101.7	6	6	154.7	9	9
May	7.4	2	2	179.3	12	10	150.1	10	9
June	133.6	9	8	70.3	8	7	107.6	9	8
July	10.4	6	5	97.1	11	10	60.9	6	6
August	66.6	3	3	7.0	3	2	20.4	3	3
September	150.1	13	12	256.3	19	18	104.0	9	8
October	263.4	13	13	387.4	19	18	241.9	15	15
November	139.4	10	10	448.6	19	18	317.8	15	15
December	90.9	6	6	213.2	8	8	101.6	7	6
Total	**1195.0**	**82**	**76**	**1767.0**	**108**	**99**	**1400.6**	**93**	**88**

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 1996 and 1997 are shown in Table 20 with 10 year average (1988-1997). The nut yields of Tall and Dwarf are shown separately in Table 21. The annual rainfall of 1195 mm in 1996 typical to a dry zone regime has resulted in a 10% drop in the yield in 1997 at ISG. However a further reduction in yield could be expected in the first half of 1998 compared to the first 3 picks of 1997. However an increase in the nuts/palm/year yield was recorded for dwarf crop when compared with the yield in 1996.

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

Pick	1996	1997	Ten year average (1983-1997)
01	97 291	160 925	124538.7
02	191 738	193 749	164549.7
03	271 282	195 749	201333.2
04	266 173	150 292	180765.5
05	149 215	174 436	159086.5
06	116 905	105 393	131482.6
Total	1 092 604	980 544	961756.2
Number of bearing palms	15 843	15 494	
Average number of nuts per palm	69	63	

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

A. Tall Crop

Pick	1996	1997	Ten year average (1983-1997)
01	86 759	142 933	125211.4
02	173 142	174 827	162698.8
03	246 942	177 799	230563.2
04	231 863	136 001	202802.8
05	133 761	151 677	170719.0
06	104 154	91 113	129337.0
Total	976 621	874 350	1021332.2
Number of bearing palms	13 456	13 439	
Average number of nuts per palm	73	65	

B: Dwarf (D x T) Crop

Pick	1996	1997	Ten year average (1983-1997)
01	10 532	17 992	20723.6
02	18 596	18 922	24479.2
03	24 340	17 950	31275.0
04	34 310	14 291	28611.6
05	15 454	22 759	25491.2
06	12 751	14 290	18134.8
Total	115 983	106 194	148715.4
Number of bearing palms	2 387	2 055	
Average number of nuts per palm	49	52	

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

Details of the emasculation programme are shown in Table 22. A total of 2184 dwarf palms comprising 1026 dwarf green and 1158 dwarf yellow palms were emasculated upto December 1997.

Table 22. *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
	142	-	1723	-	21713	-
05	493	-	5553	-	76596	-
09	93	841	752	12550	15352	201655
10A	298	317	3537	4800	60444	79848
10B						

3.1.4 Thinning of palms

The survey carried out by the staff of Genetics and Plant Breeding Division identified a total of 450 tall palms (3% of tall palms) to be uprooted in January 1997 but several constraints were experienced by the Estate management Division in executing the programme resulting in only 200 palms being removed. A further set of 65 dwarf palms from fields 9, 10A and 10B were identified and uprooted during the year.

C K Bandaranayake, M H L Padmasiri & R Jayatilleke

4. SEED PRODUCTION

In collaboration with the Coconut Cultivation Board, selection of new estates and reselection of plus palms was carried out in Luxman Estate Welipannagahamulla (862 palms), St. Anthony's Estate Battulu Oya (891 palms), Devagiriya Estate Melsiripura (1078 palms), St. Annes Estate Mampuri (4039 palms), Jasintha Estate (336 palms), Yakgasmulla Estate Weeraketiya (219 palms), Daisy Valley Estate Mawathagama (581 palms) and Keenakelle Estate (481 palms).

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

5. POLLEN AND POLLINATION

5.1 Pollen collection and issue

Pollen of the *typica* variety was collected from 20 selected palms from ISG, and 644 ampoules were sealed. Pollen of dwarf green was collected from 08 selected palms from ISG and 240 ampoules were sealed. San Ramon pollen was collected from 07 selected palms from BE and 98 ampoules were sealed. A total of 550 ampoules of typica pollen and 210 ampoules of dwarf green pollen were issued to Palugaswewa at Rs. 15/- per ampoule.

W B S Fernando

6. RESEARCH NURSERY

6.1 Bandirippuwa Research Nursery

The number of seednuts laid in the nursery during the year, seedling issues and seedling availability as at 31 December are given in Tables 24, 25 and 26.

C K Bandaranayake, R Jayatillaka & W B S Fernando

7. ACKNOWLEDGEMENTS

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

Table 23. *Pollen collection and Issue during the year*

	Tall (ISG)	DG (ISG)	Variety palms	SR (BE)	Uhumiya	F2 (BE)
Carried over from 1996						
Pollen from individual palms	10	6	35	151	106	-
Mixed pollen	-	-	-	-	-	-
Sealed in 1997						
Pollen from individual palms	644	240	-	98	-	96
Used for pollination programmes						
Pollen from individual palms						
1. At BE	-	-	-	128	-	83
2. At ISG	80	-	-	-	-	-
Issued to estates	550	210	-	-	-	-
Other uses (Viability tests, demonstrations, breakages etc.)						
Pollen from individual palms	10	10	05	15	20	05
No viability/Low viability						
Pollen from individual palms	-	-	25	66	86	-
Balance as at 31 December						
Pollen from individual palms	14	26	-	40	-	08
Mixed pollen	-	-	-	-	-	-

Table 24. *Seed nuts laid in Bandirippuwa nursery during the year 1997*

Variety	Source	Seednuts laid in Beds	Pre Nursery	Poly Bags	Total
Hand pollinated nuts					
T x Kasagala	Ambakelle Seed Garden	-	221	-	221
T x Debarayaya	- do -	-	206	-	206
T x Moorock	- do -	-	148	-	148
T x St. Annes	- do -	-	186	-	186
Dwarf yellow	Bandirippuwa Estate	-	307	-	307
Gon thembili	- do -	-	144	-	144
Bodiri	- do -	-	159	-	159
San Ramon	- do -	-	949	-	949
Pora pol	- do -	-	73	-	73
Ran thembili	- do -	-	245	-	245
Kamandala	- do -	-	47	-	47
Ambakelle Tall	Ambakelle Seed Garden	-	5054	-	5054
Navasi	Bandirippuwa Estate	-	72	-	72
Germplasm Collection					
Mahakubukwewa	Mr. S A Ariyaratne	-	105	-	105
Millawana	Millawana Estate	-	100	-	100
Aluthwatta	Mr. R M Heenbanda	-	100	-	100
Raddegoda	Delvita Estate	-	100	-	100
Wakwella	Dr. M P de Silva, Armitage Hill	-	56	-	56
Dadalla	Mrs. L Wickramasinghe, Hapugala Mrs. L L Mendis Mr. Lional de Silva	-	100	-	100
Wellawaya G.	Mr. Gunasekara, Wellawaya	-	109	-	109
Wellawaya B.	Mr. Bandara	-	100	-	100
Mahagama	Sri Sudharmaramaya	-	100	-	100
Galenbindunuwewa	Mr. D Dharmaratna, Ashwayabandiwewa Mr. K B Jayasinghe, " Mrs. Anula Sugathadasa, " Mr. H A Wimalaratne, " Mr. K Gunapala, Ulpathagama Mr. M Jinadasa, "	-	100	-	100
Haragama	Haragama Farm	-	44	-	44
Mr. B. Wijesinghe	Mr. Wijesinghe, Beliatta	-	50	-	50
Mr. B. Gunasekara	Gunasekara Estate, Beliatta	-	50	-	50
Other Collections					
Ambakelle Tall	Ambakelle Seed Garden	225	444	-	669
Dwarf x Tall	- do -	225	261	-	486
Total		450	9630	-	10080

Table 25. *Seedling issues from Bandirippuwa Research Nursery during the year*

Variety/ Accession	G & PB		Other Divisions		Other purposes		Commercial issues		Total	
	A	B	A	B	A	B	A	B	A	B
DG x Debarayaya	35	83	15	-	-	-	05	55	55	88
Tall x Tall	200	114	13	50	-	-	201	170	414	334
Dwarf x Tall	95	-	-	-	-	-	13	188	108	188
Dwarf Red	-	03	-	-	-	-	-	31	-	34
Dwarf Green	-	82	-	-	-	-	-	02	-	84
Dwarf Yellow	-	02	-	-	-	-	-	04	-	06
Dwarf Brown	-	70	-	15	-	-	-	-	-	85
Kamandala	-	14	-	-	-	-	-	-	-	14
Navasi	-	25	-	34	-	-	-	-	-	59
BGD	-	77	-	10	-	-	-	-	-	87
Thammenna	-	70	-	-	-	-	-	-	-	70
Dehigahalande	-	50	-	-	-	-	-	-	-	50
Chithragala	-	80	-	-	-	-	-	-	-	80
Wilhelmina	-	78	-	-	-	-	-	-	-	78
Marandawila	-	80	-	-	-	-	-	-	-	80
Kivulakelle	-	80	-	-	-	-	-	-	-	80
Mirishena	-	60	-	-	-	-	-	-	-	60
Yatawatta	-	70	-	-	-	-	-	-	-	70
Andigama	-	105	-	-	-	-	-	-	-	105
CRD x T	-	120	-	-	-	-	-	-	-	120
T x St. Annes	-	113	-	-	-	-	-	-	-	113
T x Debarayaya	-	111	-	-	-	-	-	-	-	111
T x Kasagala	-	83	-	-	-	-	-	-	-	83
T x Moorock	-	96	-	-	-	-	-	-	-	96
Namalwatta	-	75	-	-	-	-	-	-	-	75
Debarayaya	-	75	-	-	-	-	-	-	-	75
Goyambokke	-	75	-	-	-	-	-	-	-	75
Dickwella	-	50	-	-	-	-	-	-	-	50
Haragama	-	65	-	-	-	-	-	-	-	65
Total	**330**	**2006**	**28**	**109**	**-**	**-**	**219**	**400**	**577**	**2515**

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

Table 26. *Availability of planting material at Bandirippuwa Research Nursery as at 31 December*

Variety	Seedlings over 5 months in age		Total
	In seed beds	In polybags	
Pollinated			
Dwarf Brown	-	22	22
F3 seedlings	-	27	27
T x Kasagala	-	150	150
T x Debarayaya	-	166	166
T x Moorock	-	55	55
T x St. Annes	-	125	125
Dwarf Green	-	105	105
Dwarf Red	-	55	55
Rath Ran Thembili	-	13	13
Dwarf Yellow	-	51	51
Gon thembili	-	09	09
Bodiri	-	26	26
San Ramon	-	145	145
Pora pol	-	07	07
Ran thembili	-	06	06
Kamandala	-	02	02
Ambakelle Tall	-	1534	1534
Germplasm Seedlings			
Kivulakelle			
Andigama	-	14	14
Mirishena	-	08	08
Sithrakala	-	57	57
Marandawila	-	06	06
Namalwatta	-	04	04
Debarayaya	-	83	83
Goyambokka	-	42	42
Mahakubukwewa	-	15	15
Millawana	-	88	88
Aluthwatta	-	82	82
Raddegoda	-	77	77
Madagama	-	100	100
Wellawaya G	-	82	82
Wellawaya B	-	77	77
Total	-	82	82
	-	**3315**	**3315**

REPORT OF THE SOILS AND PLANT NUTRITION DIVISION

Acting Head - N A Tennakoon, Ph D

1. GENERAL

The Division conducted nineteen field experiments in the area of coconut nutrition, field management and improvement of soil quality, out of which two projects were funded by the Council for Agricultural Research Policy (CARP) and the Coconut Cess Fund respectively. Four miscellaneous short-term green house and laboratory studies on soil physics, soil biology and field management were also carried out to obtain complementary data for the ongoing field experiments. A review of research carried out by the Division during the period of 1992 to 1997 was critically evaluated by a panel of external reviewers who made new suggestions to improve the ongoing research.

Four new experiments were approved by the Research Committee during this year. One of those experiments would be funded by the CARP. There was wider acceptance of the Differential Fertilizer Recommendation (DFR) programme by the coconut growers during the year, and as a result growers demand increased by 51% compared to last year.

2. RESEARCH PROJECTS

PROJECT 5: DEVELOPMENT OF 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 conditions (1995-2000)

For this experiment, Sudu soil series and Andigama soil series (moderately deep) were selected at Kajulanda Estate and Ratmalagara Estate at Madampe. Both sites are located in the agro ecological region IL_1. Identification of experimental plots was done on the basis of variation in soil conditions and yield potential of palms.

The experiment consists of five treatments as follows.

T_1 - 1/3 circle pit filled with soil
T_2 - Only husk (recommended practice)
T_3 - Only polythene (sealing the sides of pits)
T_4 - Polythene and husk
T_5 - Control (only soil)

Soil moisture measurements during the first year indicated that the disturbance of soil for husk burial resulted in decrease of moisture retention in the soil. However, husk burial treatments and the control retained more moisture than the polythene (Table 1). Monitoring of soil moisture status and nutrient retention in different treatment plots and recording of the yield data are in progress.

L P Vidhana Arachchi, M R D Perera & K R E M Fernando

PROJECT 6: SUBSTITUTION OF LOW-COST PHOSPHATE (ERP) IN PLACE OF SAPHOS PHOSPHATE (SOP) FERTILIZER FOR YOUNG COCONUT PALMS IN DIFFERENT AGROCLIMATIC ZONES

Experiment 6.0.1: Effect of phosphorus nutrition on the performance of coconut seedlings (1991)

Treatment application for the 6th year of the experiment was completed in December 1997. The treatments consist of three phosphate sources, tripple super phosphate, saphos phosphate and muriate of potash applied in terms of P_2O_5 equivalens pf 150 g, 300 g and 600 g respectovely. The age of palms is 6 years.

The number of fronds per palm was counted and representative leaf samples were taken from each plot prior to fertilizer application. The results are shown in the Table 2.

Table 1. *Soil moisture status (volumetric moisture percentage) of different treatments during dry period (1997)*

Week	1/3 circle pit filled with soil	Only husk	Only polythene	Polythene + husk	Control	LSD	CV	Significance
1	14.873	20.102	17.458	16.199	17.226	2.69	19.1	$p < 0.01$
2	14.803	18.771	17.423	15.731	17.261	2.65	19.21	$p < 0.01$
3	19.287	23.473	21.235	19.931	20.513	3.42	19.96	NS
4	21.469	25.548	23.898	22.05	22.261	3.26	17.23	$p < 0.01$
5	21.461	24.612	23.53	21.722	21.63	2.83	15.27	NS
6	21.08	25.196	22.716	21.270	22.885	3.384	18.23	NS
7	18.578	22.453	20.674	19.613	20.313	3.51	21.03	NS
8	15.557	26.230	18.224	16.710	18.842	3.09	21.03	$p < 0.01$
9	14.194	17.749	15.986	15.067	15.866	2.59	20.04	$p < 0.01$
10	11.977	15.957	15.037	13.330	14.648	2.12	18.21	$p < 0.001$
11	10.151	14.627	14.067	12.168	13.847	2.54	22.15	$p < 0.001$
12	9.659	13.868	12.162	10.717	12.069	2.55	26.56	$p < 0.01$
13	8.429	11.757	11.098	9.349	11.070	2.29	27.02	$p < 0.01$
15	7.712	10.354	11.170	9.279	15.647	3.09	34.86	$p < 0.0001$
16	6.09	8.487	8.563	7.696	8.747	2.05	32.04	$p < 0.01$
17	5.772	7.237	7.402	6.240	7.727	1.79	31.79	NS
18	5.778	6.797	7.253	6.218	7.225	1.39	25.05	NS

Table 2. *The cumulative number of fronds and % P (within parenthesis) for the period 1992-1997 as affected by phosphate treatment*

Phosphate level (g) as (P_2O_5)	Phosphate source		
	TSP	SP	ERP
0	44 (0.110)	44 (0.110)	44 (0.110)
150	49 (0.125)	47 (0.120)	52 (0.121)
300	47 (0.114)	49 (0.129)	49 (0.116)
600	45 (0.143)	48 (0.124)	47 (0.117)

The number of fronds of palms in the control plots were significantly lower than the palms received P_2O_5 irrespective of the source. But there was no significant difference in number of fronds either between sources or between phosphate treatment levels. The phosphorus level (% of dry matter content) of the 6th frond found to be significantly lower in the control plot than phosphate treated plots ($p < 0.05$). There was no significant difference of leaf phosphate level between phosphate treatment levels of both saphos phosphate and Eppawela rock phosphate. But leaf phosphate level of the highest in tripple super phosphate treatment equivalent to 600 g P_2O_5 which was significantly higher than other two treatment level ($p < 0.01$). Nevertheless, there was no significant difference in leaf phosphorus level between phosphate sources except for the highest phosphate treatment level.

L L W Somasiri, C P A Kurundukumbura & W Gunasena

PROJECT 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)

Treatment application of this experiment was completed in May 1997 in both sites i.e. Wayagolla Estate at Attanagalla and Ganewatta Estate at Wariyapola. Representative leaf samples from each plot were taken prior to treatment application in both sites. Analysis of leaf showed that K level of palms treated with NaCl and Na_2SO_4 had not dropped significantly one year after initial treatment application in 1996. Even the K level of palms those do not receive K, Na and Cl (control palms)

had not dropped significantly. Also there was no significant difference in yield between treatments or between control and the treatments in the 2nd year of the experiment.

L L W Somasiri, U S S Perera, N M D Chandrasoma & K L Ranasisnghe

PROJECT 7: DEVELOPMENT OF SUITABLE FERTILIZER MIXTURE FOR YOUNG PALM

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

The experiment was established in 1991 with coconut seedlings of TxT on Andigama series soil at Ratmalagara Estate, Madampe. Three levels of N (150g, 300 g, 600 g) as urea, K_2O, (200 g, 400 g, 800 g) as muriate of potash and MgO (38 g, 76 g, 152 g) as kieserite were combined factorially in 3^3 design with 3 replicates. A basal application of 500 g, TSP/palm/year was given. Only few palms reached bearing stage. There were no significant differences between treatments in respect of the cumulative number of fronds up to 1997.

L L W Somasiri, C P A Kurundukumbura & W Gunasena

PROJECT 7.1: IMPROVEMENT OF DIFFERENT FERTILIZER MIXTURES (DFR) BASED ON NUTRIENT STATUS OF LEAF AND SOIL

Experiment 7.1.1: Efficiency of DFR based on leaf nutrient status and productivity of coconut (1995)

The experiment was started in 1995 at Poththukulama Research Station. Fertilizer applications were made annually, that is three times todate. For the Differential Fertilizer Recommendation (DFR), the 14th leaf of palms were sampled in April 1997 and the samples were analyzed for major nutrients. The treatments and the nut yield in the year 1997 are given in Table 3. The treatment - 3 (T_3) was decided on leaf analysis results as done for differential fertilizer recommendation (DFR). The nut yield of DFR applied palms (T_3) were higher by 600 nuts per ha per year than the APM (T_2) applied palms. It showed that palms treated with DFR gave a better yield than those treated with general fertilizer mixture. Also the yield of the control was lower than that of other treatments.

Table 3. *The treatments and the nut yield in 1997*

Treatments	Urea (g)	ERP (g)	MOP (g)	Kieserite (g)	Dolomite (g)	Nuts/ha/y
T_1 - control	-	-	-	-	-	14250
T_2 - 3kg APM	800	600	1600	-	1000	16200
T_3 - DFR	800	600	1600	-	2000	16800
T_4 - 4.5kg APM	1200	900	2400	-	1500	16500

ERP - Eppawela rock phosphate, MOP - Muriate of potash

N A Tennakoon, L L W Somasiri,
D M D I Wijebandara & W Gunasena

PROJECT 7.2: DEVELOPMENT OF SUITABLE FERTILIZER MIXTURE FOR PALMS IN TAPPING, CONTINUOUSLY OR SEASONALLY

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

The three treatments, NPK, NPK + dolomite and NPK + goat dung were continued to be applied this year in the experiment at Ethgala and Toppuwa. Toddy samples were measured once a week for a period of one year. The application of organic manure appears to have marginally increased the toddy yield compared to the other two treatments. The average highest toddy yield per palm per day was recorded 20 weeks after manuring from the site at Toppuwa and 36 weeks after manuring from the site at Ethgala (Table 4).

Significant difference in toddy yields between only inorganic fertilizer treatments and inorganic fertilizer + organic manure treatments were shown 17 weeks after manuring at Thoppuwa site and 20 weeks after manuring at Ethgala site.

Due to difficulties in data collection from these two sites a new site at Bandirippuwa was selected for this experiment. The treatments of the proposed new experiment are given in Table 6.

The new experiment comprised of 6 treatments based on the removal of nutrients from toddy as well as other parts of the coconut palm. Table 5 shows the percentage of major plant nutrients in toddy.

Table 4. *The average toddy yield of different treatments at Thoppuwa & Ethgala sites*

	Yield l/palm/day			
	Thoppuwa site	% increase	Ethgala	% increase
T_1 (N,P,K)	1.92	100	1.98	100
T_2 (N,P,K + Mg)	2.00	104	2.02	102
T_3 (N,P,K + OM)	2.14	113	2.12	107

Table 5. *Percentage of major plant nutrients in toddy*

N%	P%	K%	Ca%	Mg%	Na%
0.049	0.0125	0.224	0.00037	0.0039	0.0096

Table 6. *Treatments of the proposed new experiment on toddy tapping*

Treatment	Urea (g)	Imported rock phosphate (g)	Muriate of potash (g)	Dolomite (g)	Water (l/week)
T_1 Control	0	0	0	0	-
T_2 (1/2 of the nutrient removal)	500	450	1575	250	-
T_3 (equal to removal of nutrients from toddy & other parts of the palm)	1000	900	3150	500	-
T_4 (1 1/2 time of the nutrient removal)	1500	1350	4725	750	-
T_5 (APM)	800	600	1600	1000	-
T_6 Irrigation	-	-	-	-	150

The plots were demarcated in selected sites at Bandirippuwa Estate and leaf sampling was carried out prior to the different fertilizer application.

N A Tennakoon, G D George & M H Danasena

PROJECT 7.3: DEVELOPMENT OF A SUITABLE FERTILIZER MIXTURE FOR KING COCONUT PALMS

Experiment 7.3.1: Formulation of suitable fertilizer recommendation for king coconut (1995-2000)

The treatment application for the experiment in both sites at Marandawila and Walpita was completed in November. The 14th leaf of palms was sampled prior to fertilizer application and analyzed for major nutrient elements. The average annual nutrient removal of a king coconut plantation yielding 200 nuts per palm per year is given in Table 7.

Table 7. *Annual nutrient removal of king coconut palm*

Plant part	Nutrient element (g)			
	N	P	K	Mg
Nuts	299	50	1092	56
Flower parts and fronds	450	73	266	133
Total	749	123	1358	189

The quantity of fertilizer equivalent to the annual removal of plant nutrients by the king coconut palm was as follows.

Plant Nutrient	Fertilizer	Equivalent quantity (kg)
N	Urea	1.63
P	Saphos phosphate (SP)	1.02
K	Muriate of potash (MOP)	2.72
M	Dolomite	1.55

On basis of the ratio of N, P, K and Mg removal by the king coconut palm rational fertilizer combinations given in Table 8 were considered as treatments for the experiment.

Table 8. *Treatments of the experiment on fertilizer recommendation for king coconut palms*

Treatment	Rate of application g/palm/6 month			
	Urea (g)	SP (g)	MOP (g)	Dolomite (g)
T_1	-	-	-	-
T_2	400	250	650	400
T_3	600	375	1000	600
T_4	800	500	1350	800
T_5	400	300	800	500
T_6	600	450	1200	750

L L W Somasiri, S Sabaratnam, M H Danasena & N P E Indrawansa

PROJECT 8: IMPROVEMENT OF POULTRY MANURE BY SUPPLEMENTATION WITH ORGANIC 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 was conducted at two locations viz. Pottukulama and Badalgama. The 2nd manure application (fresh poultry manure; poultry manure stored for 1 month and 3 months) to experiments at Pottukulama and Badalgama was done in May and October respectively. The leaf samples were collected from both sites before the manuring and the samples were analyzed for major nutrients.

Coconut roots were sampled from Pottukulama site one year after manuring. Live roots and dead roots were separately counted and the results are given in Table 9. The results showed the following.

a. Broiler poultry manure was more damaging to primary and secondary roots than layer poultry manure.
b. Fresh poultry manure from both layer and broiler was more harmful to coconut roots than 1 month or 3 months old (seasoned in heap) poultry manure.
c. Surface application of poultry manure was less damaging to the roots than trench application.

N A Tennakoon, D M D I Wijebandara, W Gunasena & N P E Indrawansa

Table 9. *The percentage of dead roots of coconut palms due to poultry manure application*

Treatments	Dead roots (%)																Yield			
	Main roots 60 cm away from palm				Secondary roots 60 cm away from palm				Main roots 120 cm away from palm				Secondary roots 120 cm away from palm				Nuts/palm/y (90 May - 97 April)		Copra kg/palm/y (96 May-97 April)	
	0-30cm depth		30-60 cm depth		0-30 cm depth		30-60 cm depth		0-30 cm depth		30-60 cm depth		0-30 cm depth		30-60 cm depth					
	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T
Layer																				
Fresh	12	17	14	16	23	26	18	22	14	16	12	15	23	26	20	23	64	58	10	10
1 M	9	11	8	9	19	20	10	12	12	11	10	12	19	26	18	21	66	59	11	10
3M	4	7	5	7	8	12	7	8	4	5	4	6	10	14	8	10	76	67	12	12
Broiler																				
Fresh	19	21	15	18	29	31	17	19	19	20	18	19	29	30	27	28	62	57	10	9
1 M	11	12	9	10	21	22	12	16	13	14	11	13	22	24	22	24	63	62	11	10
3 M	7	8	6	7	14	16	6	9	7	7	7	8	15	17	13	15	69	66	12	11
Control	3	4	3	5	8	9	6	8	4	5	4	4	9	11	8	10	53	53	8	7
Significance	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	NS	NS	NS	NS

1 M - 1 month seasoning, 3 M - 3 month seasoning
S - Surface application, T - Trench application
** - $p < 0.01$, NS - Not significant

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 viz, Thammanna estate, Puttalam and Wayagolla estate, Attanagalla. The treatments of this experiment are as follows. The 14th leaf of palms was sampled in April, 1997 from both sites before the treatment application and the 2nd treatment application was done in May, 1997. The chemical analysis of leaf was also completed. The yield data i.e. number of female flowers, number of nuts and copra content in both sites did not show significant differences between treatments so far.

N A Tennakoon, N H R M de Silva & B C E Perera

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

Experiment 10.0.1: Preliminary requirements to design a suitable drip irrigation system for coconut plantations in gravelly soil (1995-2000)

This study was carried out in 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 of the site were used for demarcating the experimental plots. A sub-surface reticulation system was established to provide water at different irrigation intervals.

For irrigating the effective root zone of coconut, it was necessary to determine a number of parameters viz. optimum wetting pattern of soils with respect to flow rates of drippers, number of drippers per palm, the quantity of irrigation water, irrigation frequency and suitable position for placement of drippers in the effective root zone. Root distribution studies with respect to water absorption showed that 75-80% of coconut roots were concentrated at the depth range of 20 to 100 cm while about 5% roots were concentrated beyond 100 cm depth. About 15%-20% roots occurred in top soil layer (0-20 cm). Moisture stored in the depth range

of 20-120 cm from the surface was highly extractable by the coconut palm. Roots concentrated at a distance from 50 to 100 cm away from the bole of the coconut palm were more responsible for water absorption. The moisture extraction was the highest at 100 cm away from the palm. Irrigation of coconut through drippers at the rate of 30 lh^{-1} for 2.5 h wetted a large volume of soils in the effective root zone. The evapotranspiration rate of 15 year old coconut in Andigama soil series was 2.52 $\pm$ 1.12 mm/day after the establishment of the experiment and irrigation frequency required for those coconut was found to be 8 days. The overall results showed that placement of four drippers (flow rate of 30 lh^{-1} for 2.5 h) at 100 cm distance away from the bole of the palm with irrigation frequency of 8 days fully wetted the soils in the effective root zone of coconut grown on Andigama soil series. In the long term, drip irrigation system designed using the above information was found to be economically viable. It increased the coconut yield by 60% within the first sixteen months period after installation in gravelly soils.

L P Vidhana Arachchi, D T Mathes, M R D Perera & K R E M Fernando

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

The objective of the study was to find out the threshold level for soil oxygen concentration below which coconut roots were permanently damaged particularly where soil drainage was poor. The oxygen concentration in the soils was measured by inserting the probe of an oxygen meter to soil at 10 cm depth intervals of a vertical cross section from the surface. Preliminary findings obtained from Sudu soil series at Bandirippuwa Estate, Lunuwila (IL_1) showed that high moisture content (> 12 %, on dry basis) tends to reduce aeration and O_2 concentration of soils. It was also found that oxygen concentration of 16-19% existing upto a depth of 150 cm in the soil profile of well drained and moderately well drained soils were favourable for root growth of coconut. The oxygen content (< 15%) beyond depth of 60 cm of poorly drained soils (Sudu series) 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 soils showed that oxygen concentration of 15% could be the threshold level below which the growth of coconut roots was significantly ($P<0.001$) retarded. Moreover, 5% oxygen level existing beyond

80 cm depth of poorly drained soils was found to be severely detrimental to 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 on Sudu series and the effect of oxygen level on the absorption process of coconut roots will be continued.

L P Vidhana Arachchi, L L W Somasiri, S K Gunaratna & M R D Perera

PROJECT 27: STUDIES ON CHEMICAL AND MINERALOGICAL PROPERTIES OF COCONUT GROWING SOILS

Experiment 27.0.1: Evaluation of nutrient status of coconut growing soils (Nutrient Mapping-1992)

Composite leaf samples (from 14th leaf of three palms per each location) were collected at the rate of one composite sample for every 80 ha of each soil series. Thus 180 samples from Kuliyapitiya soil series and 350 samples from Kurunegala soil 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 2 m away from the palms) were also collected.

The soils were analyzed for exchangeable Ca, Mg, Na, K and DTPA extractable Cu, Fe, Mn and Zn. Chemical analysis of about 200 leaf samples for total N, P, K, Ca, Mg, B, Cu, Fe, Mn and Zn was also completed.

Statistical analysis of soil data showed that available Cu, Ca and Mn of Kuliyapitiya soil series were significantly ($p \leq 0.05$) higher than Kurunegala soil series. But available Fe and Na of Kurunegala soil series were greater than those of Kuliyapitiya soil series.

There was no significant difference of available K, Mg and Zn between the two soil series.

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

PROJECT 30: STUDIES ON DECOMPOSITION PATTERN OF DIFFERENT ORGANIC MANURES

Experiment 30.0.1: Evaluation of effect of common salt on organic manure decomposition (1995-1997)

The chemical analysis of the soil samples taken during the 2nd year of the experiment was completed except the last sampling in November 1997.

At the end of the 18 months, it was found that common salt enhances the decomposition rate of organic manure. Application of common salt (NaCl) at the rate of 2 kg per palm showed higher rate of decomposition and nutrient release than application at the rate of 1 kg per palm.

Each of the organic sources used in the experiment showed that the release of NH_4-N, NO_3-N, exchangeable Mg and available P in the treatment of 2 kg common salt/palm was greater than that of 1 kg treatment and the control. The decreasing order of the release of nutrients was 2 kg common salt > 1 kg common salt > control.

N A Tennakoon & Wasanthi Mala

Experiment 30.0.2: Estimation of the decomposition rate of different sources of organic manure and nutrient availability to the coconut palm (1995-2000)

This experiment was established at Mangala eliya and Horombawa in 1995. The treatments are as follows.

T_1 - Control
T_2 - Cattle manure (35 kg/palm/y)
T_3 - Goat manure (15 kg/palm/y)
T_4 - Poultry (layer) manure (30 kg/palm/y)
T_5 - Poultry (broiler) manure (30 kg/palm/y)
T_6 - Gliricidia (30 kg/palm/y)

The 14th leaf of plot palms was sampled from both sites, Horombawa and Mangala eliya in April just before the 3rd manure application. The leaf samples were analyzed for major nutrients. There was no significant difference in the leaf nutrient between the treatments so far. Soil was sampled at every 3 months interval

after the 2nd year. Manure applied and microbiological and chemical analysis were completed. The results revealed that the available nutrients such as NH_4-N, No_3-N, available P, exchangeable K and Mg and microbial activity increased upto first 2 sampling and then declined in the case of both Borupana series (at Mangala Eliya) and Kuliyapitiya series(at Horombawa) soils.

The yield records i.e. number of nuts, number of female flowers and copra weight were maintained throughout the year at monthly intervals. There was no significant difference in the yield between treatments so far.

N A Tennakoon, S D Hemamala & R Fernandopulle

Experiment 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 (1995-2000)

The soil and leaf samples were collected from both sites viz., Poththukulama and Rathmalagara in August. The treatments of the scheme is given in Table 10. The first micro-nutrient treatment application along with N, P, K, Mg fertilizers was completed in December. The soils and leaf samples taken from the site were analyzed for major and micro nutrients.

Table 10. *The micro-nutrient treatments and the basal dosage*

Treatment	APM(kg)	Dolomite (kg)	$ZnSO_4$ (g)	$CuSO_4$ (g)
T_1	3	1	-	-
T_2	3	1	50	50
T_3	3	1	100	100
T_4	3	1	50	100
T_5	3	1	100	200
T_6	3	1	200	400

L L W Somasiri, A H Norman, B C E Perera & W Gunasena

3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES

3.1 Land Suitability Mapping Project (CESS Fund)

Compilation of composite soil maps on 1:100,000 scale in the Southern coconut growing areas was completed. Copies of those maps are to be reproduced by offset printing. Calculation of the acreage of each soil series in the coconut triangle was also completed. Preparation of soil maps and Land Suitability maps for coconut on 1:63,360 scale to cover the coconut growing area of the Southern region was completed.

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

3.2 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)

Twelve sites were selected for determination of microbiological, chemical and physical parameters of the soil during this year. Four different soil series viz., Pallama, Gambura, Boralu and Kuliyapitiya were located in each site. The soils sampled from the sites were analyzed for microbiological and chemical parameters.

Identification of bacterial and fungal colonies of above soil series as well as soil samples was completed.

Among the selected soil series during the period of 1995-1997, significantly ($p \leq 0.05$) high values for microbiological and chemical parameters were obtained from soil series such as Rathupasa, Madampe, Ambakelle and Kalpitiya etc. Moderate values were obtained for Kurunegala, Katunayaka, Wariyapola, Melsiripura and Boralu series soils the low values were obtained for Sudu, Maho, Wilattawa and Andigama series soils.

Soil sampling of the 2nd part of the experiment, i.e. every 2 months after the organic manure (cattle manure) application, up to one year period was completed. Six soil series were used for this experiment viz., Andigama series, Ambakelle series, Kuliyapitiya series as nutrient limiting soils due to low cation exchange capacity and Boralu, Pallama and Weliketiya as moisture limiting soils.

Microbiological and chemical analyses of those soils were completed. Identification of microorganisms is in progress. The available results showed that,

in all six soil series upto 3rd sampling microbiological and chemical parameters increased in the cattle manure applied soils (i.e., 6 months after the cattle manure application) and thereafter decreased. However the exchangeable K concentration did not show the above pattern probably due to insignificant influence of microbial degradation on releasing of K to the soil.

N A Tennakoon, K S K S Fernando & H L A Pathmini

3.3 Determination of optimum conditions for drip irrigation and soil moisture conservation techniques in drought susceptible coconut lands (CARP Funded Project No. 12/370/268) (1997-1999)

Selection of site for the experiments was completed. Installation of aluminium access tubes for monitoring soil moisture status in Andigama soil series, Kuliyapitiya soil series and sudu soil series was also completed.

The objectives of this study are:

(a) Identification of the effective root zone of coconut for soil water and nutrient absorption in drought susceptible soil series viz Andigama, Kuliyapitiya, Wariyapola and Sudu.

(b) Identification of major physical constraints for coconut growth in drought proned soils.

(c) Determination of the optimum wetting pattern and optimum flow rates for drip irrigation in drought susceptible coconut lands viz. Andigama series, Kuliyapitiya series and Wariyapola series.

(d) Study the effect of soil/water conservation techniques (i.e. cover crops, mulching, coir dust/husk pit, contour drains) on the soil moisture status and water status of the coconut palm in different soil categories.

(e) Tune up the recommendations of soil moisture and irrigation practices to provide systematic and economical infrastructure based on soil characteristics.

L P Vidhana Arachchi, L L W Somasiri, C S Ranasinghe, H M Ruwan Chaminda & B H B Samantha

4. LABORATORY/MISCELLANEOUS STUDIES

4.1 Comparison of organic and inorganic fertilizers for coconut (1997-2002)

Two sites were selected for this experiment from Poththukulama and Rathmalagara Estates in 1997. The soils at the sites were Ambakelle series and Andigama series in Pottukulama and Rathmalagara respectively. Preliminary soil and leaf samples were taken in February from both sites and different fertilizer treatments were also made in May. The treatments were

T_1 - Control (no fertilizer)
T_2 - APM (800 g urea, 600 g saphos phosphate, 1600 g muriate of potash and 1000 g dolomite)
T_3 - Cattle manure (35 kg) + 1250 g muriate of potash
T_4 - Goat dung (30 kg) + 750 g muriate of potash
T_5 - Poultry manure (30 kg) + 750 g muriate of potash
T_6 - Gliricidia (30 kg) + 550 g saphos phosphate + 1400 g muriate of potash + 250 g dolomite

The chemical analysis of leaf was also completed. The data showed that there were no significant difference between treatments.

N A Tennnakoon, Wasanthi Mala, B C E Perera & W Gunasena

4.2 Rate of release of magnesium from organic manures and dolomite in coconut soils

A field experiment with coconut in two different soil series (Boralu and Madampe), a pot experiment with grass (*Panicum maximum*) as indicator plant in Boralu and Madampe soil series and a pot experiment without grass in above soil series were carried out to assess the rate of release of magnesium from different types of organic manures and dolomite.

The field experiment was established at Bandirippuwa Estate, Lunuwila located in Low Country Intermediate Wet Zone of Sri Lanka. The two pot experiments were established in the green house of Coconut Research Institute. Seven different treatments viz. T_1 - control, T_2 - dolomite, T_3 - cattle manure, T_4 - goat manure, T_5 - poultry manure (layer), T_6 - poultry manure (broiler) and T_7 - gliricidia were tested. The design of the experiment was Randomized Block Design

with 3 replicates. The soil samples were taken at monthly intervals for a period of 3 months for the assessment of the rate of release of Mg.

Soil exchangeable magnesium concentrations of all 3 experiments showed that there were significant differences ($p \leq 0.001$) between treatments, three sampling times and soil types. Significantly higher rate of magnesium release was observed in Boralu soil series than in Madampe series in all treatments . There was significantly higher ($p \leq 0.001$) rate of magnesium release in organic manure treated soil than inorganic fertilizer (dolomite) treated soil. Among the organic manures, poultry manure showed the highest magnesium concentration in both soil types. Between poultry manure from layer and broiler chicken, broiler poultry manure treated soil showed the highest rate of magnesium release than layer poultry manure treated soils. The overall results showed that the rate of release of magnesium from organic manures was higher than from dolomite. The highest rate of Mg release was observed in the 3rd month after the application, irrespective of the source. Tables 11 and 12 shows the exchangeable Mg in the soils of field experiments in Madampe and Boralu soil series respectively.

Table 11. *Exchangeable Mg in soils of field experiment (μg/g) - Madampe Soil*

Treatments	Month		
	1	2	3
Control	0.5	0.5	0.7
Dolomite	0.7	0.6	0.8
Cattle manure	0.4	0.7	1.2
Goat dung	0.6	0.7	1.4
Poultry (layer)	0.6	0.7	1.6
Poultry (broiler)	0.6	1.0	1.3
Gliricidia	0.5	0.6	0.9

The field experiment was continued and soil samples were taken at monthly intervals upto one year period. Also at the end of one year period, organic manure treated soils showed significantly high ($p \leq 0.001$) Mg concentrations compared to dolomite treated soils in both soil series i.e. Boralu and Madampe. The highest Mg release was observed 6 month after the fertilizer application in both Boralu and Madampe soil series.

Table 12. *Exchangeable Mg in soils of field experiment (μg/g) - Boralu Soil*

Treatments	Month		
	1	2	3
Control	0.6	1.2	1.4
Dolomite	1.0	1.3	1.6
Cattle manure	1.2	1.4	2.0
Goat dung	1.2	2.2	2.0
Poultry (layer)	1.2	1.4	1.8
Poultry (broiler)	1.2	2.2	2.5
Gliricidia	1.3	2.5	2.0

4.3 Study of the decomposition rates of plant leaves

Coconut (fresh), coconut (dry), acacia (fresh) and gliricidia (fresh) leave were packed in nylon mesh (0.05 mm) bags. The size of bags containing coconut leaves was 90x10 cm^2 and the size of the other bags was 30x10 cm^2. The bags were filled with known weight of leaves (50 g fresh materials) and closed.

In each treatment twelve such bags were buried in the manure circle of the coconut palm in Bandirippuwa Estate (Madampe soil series) and one bag was withdrawn in each month over a period of one year. There were five replicates of bags (60 bags in each treatment for the 12 months) in each treatment.

Three samplings were completed upto the end of year. Chemical analysis of the leaf materials for determination of the decomposition rate of the leaf materials is in progress.

S D Hemamala, M H Danasena & N A Tennakoon

4.4 Use of neutron scattering technique to evaluate water extraction pattern of coconut seedlings (*Cocos nucifera L.*)

A study was conducted to evaluate the ability of seedlings of two coconut cultivars (CRIC 60 and CRIC 65) for soil water absorption in the coir dust and top soil potting medium. Neutron probe was calibrated for soils of Madampe series and

potting medium to implement the neutron scattering technique. Results of field calibration of neutron probe with respect to soil physical properties of Madampe soil series revealed that bulk density and clay fraction increased gradually with the depth of soil profile and these physical parameters are directly involved in enhancing water retention capacity of soils. Results also showed that values of the co-efficient of neutron probe calibration graphs mainly depended on the texture and bulk density of soil. Evaluation of water extraction pattern of two cultivars of coconut seedlings grown in potting medium showed that soil water depletion was significantly ($p \leq 0.05$) higher in the pots with coconut seedlings compared to the control pots without seedlings. Further, results suggested that the cultivars of CRIC 65 (DxT) has a great ability to extract water from rooting media compared to the CRIC 60 (TxT). It is evident from the results, that water absorption efficiency of CRIC 65 (DxT) was significantly higher than that of CRIC 60 (TxT) and therefore, the cultivar CRIC 60 is more suitable for drought-prone areas than CRIC 65.

A M S K Adikari, L P Vidhana Arachchi & C S Ranasinghe

4.5 Laboratory analysis

Following analyses were carried out in the Division during this year.

(i) Leaf analysis

		No. of samples
(a)	Divisional research programme	1362
(b)	DFR	1073
(c)	Others (other Research Divisions and Advisory samples)	229

(ii) Soil analysis

(a)	Chemical parameters	1706
(b)	Physical parameters	1060
(c)	Microbiological parameters	992

(iii) Fertilizer analysis

(a)	Inorganic fertilizer	48
(b)	Organic manure	38

(iv) Miscellaneous analysis

(a)	Coir dust	-	184
(b)	Water samples	-	42
(c)	Nut water	-	22
(d)	Coconut husk	-	36
(e)	Coconut kernel	-	38
(f)	Toddy samples	-	40

G D George, S Sabaratnam, N H R M de Silva, U S S Perera, D M D I Wijebandara, D P Panditharatne, S D Hemamala, E M A T Banda, W A Wasanthi Mala, C P A Kurundumukbura, M T Rasika & N Wijayapala

5. TRAINING AND EXTENSION ACTIVITIES

Differential Fertilizer Recommendation (DFR) services were provided to 414 estates covering 4782 ha during the year. Fifty two percent of the estates were below 8 ha. The demand for DFR by growers increased to 51% compared to the last year. The Coconut Cultivation Board also contributed to the increasing demand for requests from growers for DFR. Figure 1 shows the demand and extent served for DFR. The DFR given vs land size is given in Table 13.

Table 13. *Land size vs extent DFR completed*

Land size	Extent DFR analysis completed (ac)
< 10	818
11 - 20	1747
21 - 35	2183
36 - 50	2761.5
51 - 75	1205
> 75	2447

Dr. N A Tennakoon, Mr. L P Vidhana Arachchi and Mrs. M G F S Jayasundara participated in eight PEP visits during the year.

Dr. L L W Somasiri, Dr. N A Tennakoon, Mr. L P Vidhana Arachchi and Mrs.M.G.F.S.Jayasundara delivered lectures for the Diploma Course in Plantation Extension from 13-18 January, 1997, 24 April - 9 May, 1997 and one day programme on Fertilizer Usage held at CRI auditorium on 27 July, 1997.

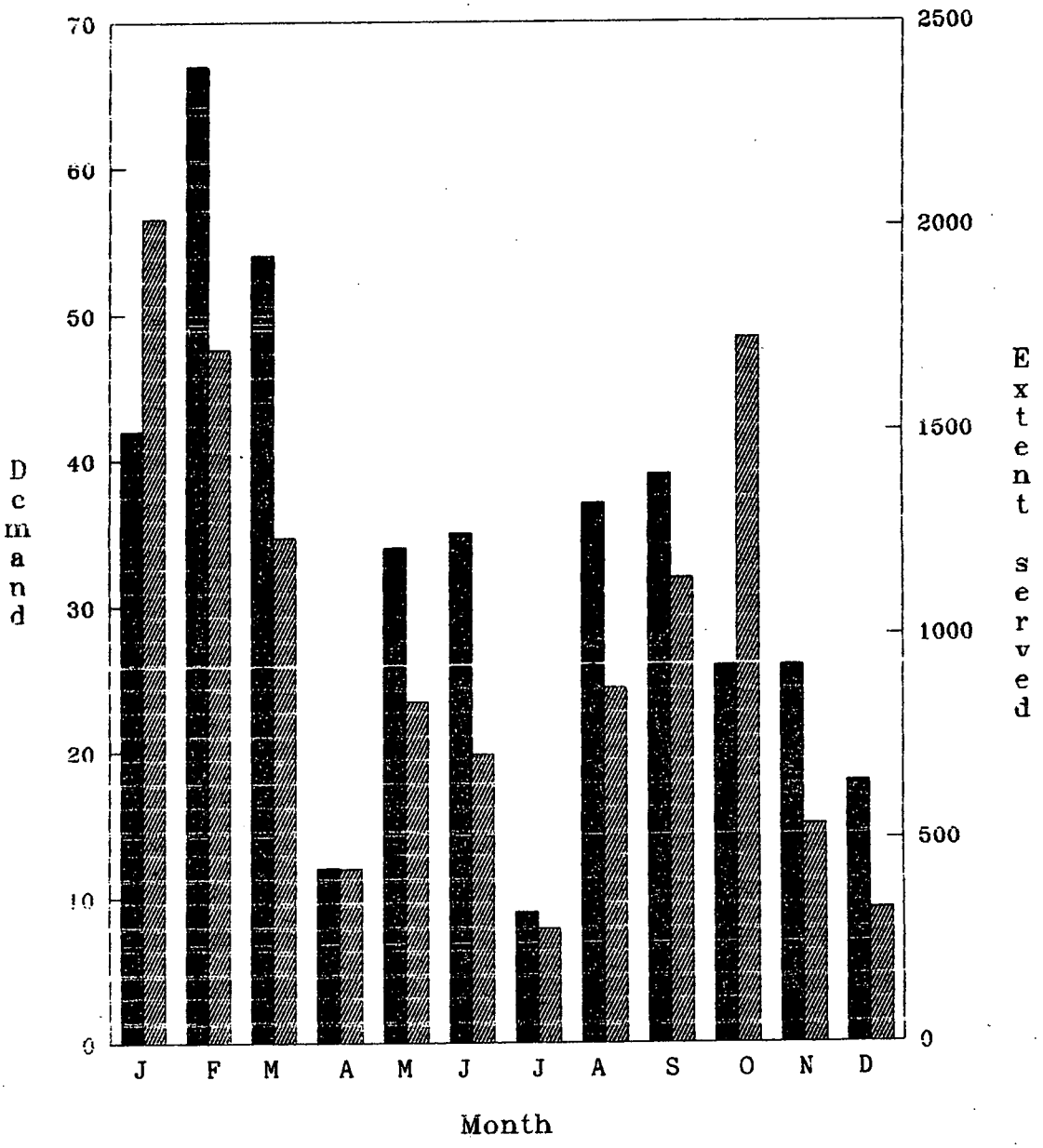

Figure 1 Demand and extent served for DFR

Dr. L L W Somasiri delivered lectures on soil survey and land suitability for Coconut at Coconut Cultivation Board Training Center for the Extension Officers and Coconut Development Officers on 27 March, 1997.

Research, Technical and the Field Staff of the Division actively participated in the workshop and exhibition on Technology Development and Transfer in Coconut held to commemorate the Silver Jubilee Anniversary of Coconut Cultivation Board at the Coconut Development Training Center, Lunuwila from 1-5 April 1997.

Mr. L P Vidhana Arachchi participated as a resource person in one day programme on irrigation for coconut held at Ratmalagara Estate, Madampe on 25 April, 1997.

Dr. N A Tennakoon delivered a lecture on the chemistry and the usage of Eppawela rock phosphate in coconut at the Coconut Development Training Center for Coconut Development Officers of the Coconut Cultivation Board on 13 June, 1997.

Mr. L P Vidhana Arachchi delivered a lecture on soil physical aspects and water management at Coconut Development Training Center for the extension officers on 06 July, 1997.

Mrs. M G F S Jayasundara delivered a lecture on soil fertility and fertilizer recommendation for coconut for the Coconut Development Officers of the Coconut Cultivation Board at Homagama Agrarian Service Center on 13th September, 1997.

Dr. N A Tennakoon delivered a lecture on Differential Fertilizer Recommendation at Coconut Development Training Center, Lunuwila for Coconut Development Officers of the Coconut Cultivation Board on 24 September, 1997.

Dr. N A Tennakoon delivered a talk on Methods for sampling of fertilizers and analysis of fertilizers at the Nalanda Agrarian Service Center, Matale for the Agricultural Officers and fertilizer dealers on 3 November, 1997.

Mrs. M G F S Jayasundara delivered a lecture on Fertilizer usage in coconut for the coconut growers in Divulapitiya area at Co-operative Society on 8 November, 1997.

Mr. L P Vidhana Arachchi participated as a resource person in one day programme on application of recommended soil moisture conservation practices for coconut held at Coconut Development Training Centre for the Extension Officers of 02 December, 1997.

6. ACKNOWLEDGEMENTS

The assistance and co-operation of the Staff of the Soils & Plant Nutrition Division for progress of the research and extension activities is greatly acknowledged. Thanks are due to the Head, Biometry Division for the assistance with design of experiments and analysis of data.

REPORT OF THE CROP PROTECTION DIVISION

Acting Head - L C P Fernando, Ph D

1. GENERAL

Integrated pest management received high priority in the research programme of the Division. Whilst the on-going research projects progressed satisfactorily, two new projects viz. studies on control of vertebrate pests and screening of plant extracts for the control of insect pests were initiated. Highly effective pheromone and food baited trap was designed to control red palm weevil. Investigations at the Angunakolapalessa Research Laboratory were terminated revealing that bleeding palms with no sporophores are not associated with a fungus that is known to cause stem bleeding in coconut. The collaborative projects initiated with the International Mycological Institute, United Kingdom on *Ganoderma* studies and with the Natural Resources Institute, United Kingdom on the use of pheromones to forecast and control coconut pests were continued. The division contributed to the multi-disciplinary projects on Leaf Scorch Decline and the newly reported Frond-breaking and rapid decline condition.

2. RESEARCH PROJECTS

PROJECT 14.1: **TESTING OF A SUITABLE TRAP FOR RED PALM WEEVIL (1995)**

Experiment 14.1.3: **Evaluation of different pheromone release devices to use in the pheromone traps for red weevil, *Rhynchophorus ferrugineus* (1997)**

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. Therefore, different slow release dispensers were evaluated in the laboratory and in the field. Tested pheromone dispensers were polyethylene sachets and two sizes of polyethylene vials. Release rates of the pheromone and catches in the traps using these dispensers were compared with those of the capillary tubes in the Isolated seed Garden Ambakelle and in a 25 ha coconut plantation at Dummalasuriya. Ferrugineol was filled at the rate of 200 μl in each dispenser and fixed to the open bucket traps separately. The pheromone content in the two types

of polyethylene vials declined gradually releasing a constant amount of pheromone daily. The catches in traps with these two types of vials were very high (Figs. 1 & 2). Further studies in ISG revealed that some of the small polyethylene vials (20×15×1.0 mm) got thickened over time due to heat during daytime which adversely effects the release rate of the pheromone. Because of the constant release rate over a longer period and the high trap catches, the big polyethylene vial (20×16×1.5 mm) can be recommended as a suitable pheromone release device to be used in the pheromone trap of the red weevil.

C N K Rajapakse, D R Hall (NRI, UK)
K F G Perera & W W N Fernando

Experiment 14.1.4: **Evaluation of different foods to use in the pheromone traps for red weevil (1997)**

It is believed that red weevils find their host by the fermenting sap oozing out from the wounded parts of the coconut palm. Therefore, adding a food source of the weevils in pheromone traps could outcompete the natural host volatiles thus preventing the palms from weevil damage. To investigate this possibility two experiments were conducted incorporating sugarcane and toddy to pheromone traps separately.

The first experimental plot consisted of 1000 young palms of 10-15 years old, which is the most vulnerable age for red weevil attack. A survey of individual palms prior to experiment revealed that there were 15 infested palms in the plot. Each treatment replicated 10 times comprised of ferrugineol, 4 cm pieces of sugarcane stem cuttings and ferrugineol and sugarcane together. Both 200 μl ferrugineol filled polyethylene vials and plastic cups containing sugar cane were suspended on the brim of 5*l* plastic buckets. Buckets baited with each treatment were hung on palm trunks at 1 m height and 50 m apart. Adult red weevils captured in traps were separated into sexes and counted weekly for 2 months. Results revealed that four times more weevils were captured in the pheromone traps with sugarcane stem cuttings than in the traps baited with either sugarcane or ferrugineol alone (Table 1). Red coloured traps attracted a significantly higher number of weevils than that of blue colour. Results also proved that female weevils were much more attracted to the pheromone and food baited traps than male weevils. No damaged palms were found in the experimental area during trapping and for 3 months after removing the traps.

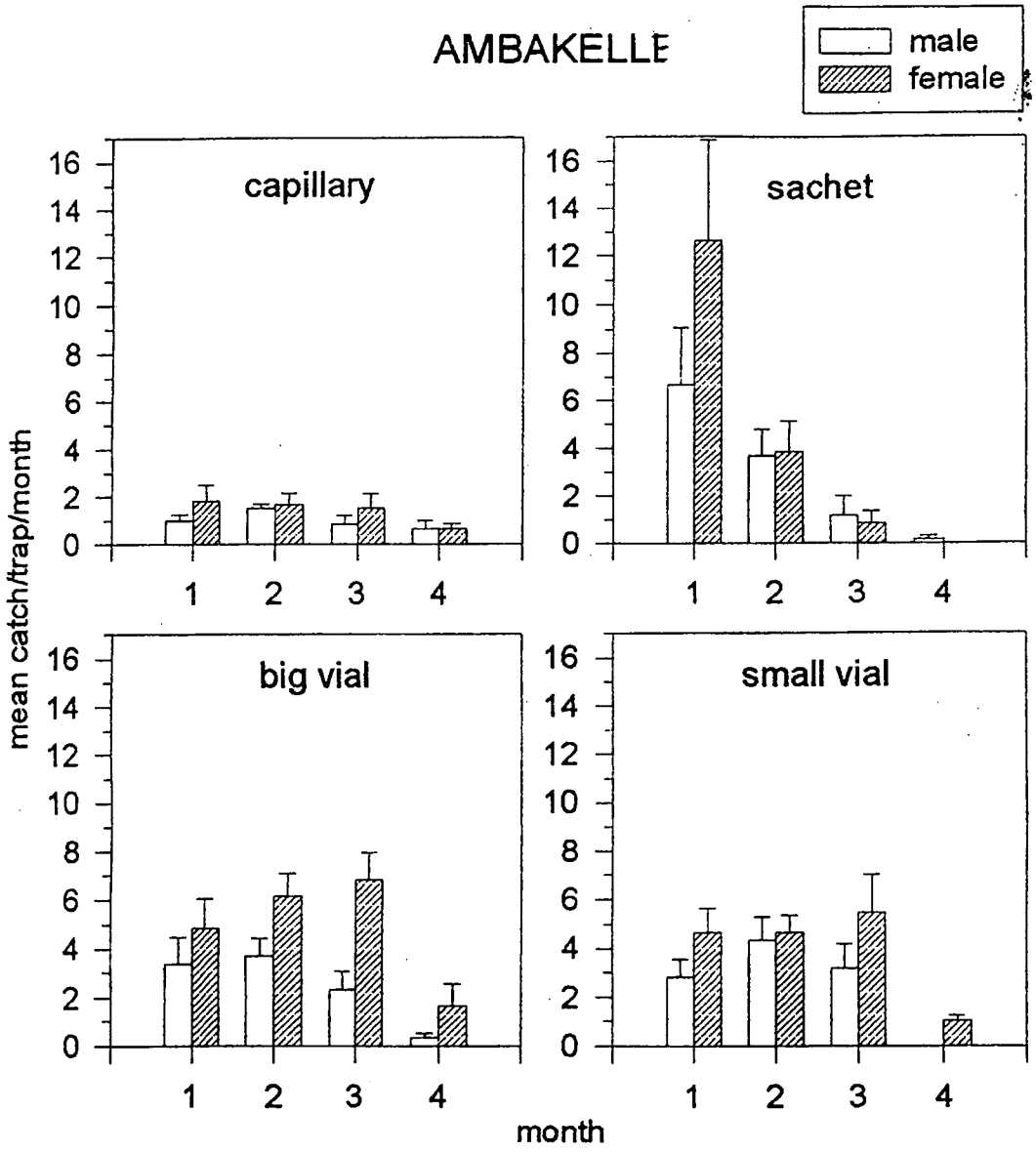

Fig. 1 Mean No. of insects trapped in the traps with different dispensers at Isolated Seed Garden, Ambakelle

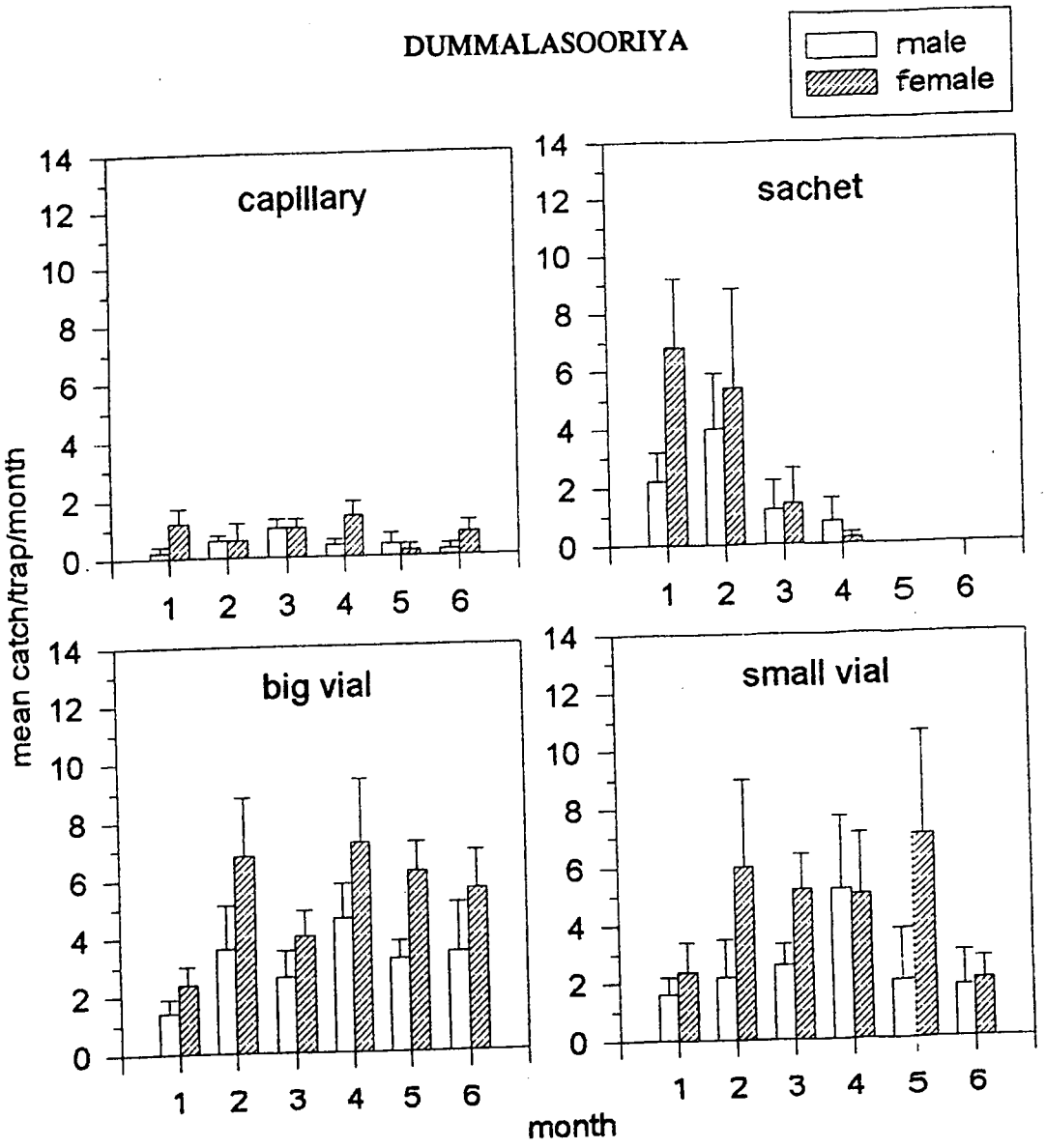

Fig. 2 Mean No. of insects trapped in the traps with different dispensers at Dummalasuriya

Table 1. *Number of male and female weevils caught in plastic bucket traps baited with ferrugineol, sugarcane and combination of ferrugineol and sugarcane over a 2-month period.*

Treatment	No. of female weevils	No. of male weevils
Ferrugineol	95	62
Sugarcane	35	28
Ferrugineol +sugarcane	226***	124

(P<0.001, Kruskal Wallis test)

A similar experiment was conducted in Pothukulama Research Station to find out the effect of toddy in pheromone traps. Ferrugineol, toddy and combination of ferrugineol and toddy were tested separately. Fifty milliliters of fresh toddy was used in pheromone traps in plastic cups as described in the previous experiment. Toddy was replaced every week. The survey in the 10 ha experimental block revealed 40 damaged young hybrid palms prior to the experiment. Adult weevils captured in the traps were separated into sexes and counted weekly. Results showed that three times more weevils were caught in toddy and pheromone traps than in the pheromone and toddy traps alone.

Table 2. *Number of male and female weevils caught in plastic bucket traps baited with ferrugineol, toddy and combination of ferrugineol and toddy over a 2 month period.*

Treatment	No. of female weevils	No. of male weevils
Ferrugineol	75	39
Toddy	38	20
Ferrugineol+Toddy	187 ***	164

(P<0.001, Kruskal Wallis test)

Results of both experiments proved that more weevils, especially females were attracted to traps containing pheromone and food. Therefore, a sufficient control of red weevil can be achieved by placing an adequate number of food- baited pheromone traps in a given infested area at a given period of time.

C N K Rajapakse, D R Hall (NRI, UK), K F G Perera & W W N Fernando

Experiment 14.1.5: Investigation of the role of ferrugineon in combination with ferrugineol in red weevil trapping (1997)

In the natural aggregation pheromone emitted by male red weevil consists of (4S, 5S)-4-methyl-5-nonanol (ferrugineol) with less than 1% of the corresponding ketone, 4 methyl-5- nonanone (ferrugineon). Earlier studies indicated that a combination of ferrugineol and ferrugineon could enhance the trap catches. An experiment was conducted to compare the effectiveness of traps baited with different combinations of ferrugineon.

Treatments comprised of purified ferrugineol with no ferrugineon, ferrugineol with 1%, 5% and 10% ferrugineon. The chemicals were filled into big polyethylene vials and suspended in the bucket traps. Adult weevils captured in traps were counted weekly for 30 weeks.

Results showed that ferrugineon with different combinations of ferrugineol had no significant effect on trap catches ($P<0.05$). Therefore, addition of ferrugineon to ferrugineol has no added advantage for red weevil trapping.

Table 3. *Number of male and female red weevils caught in traps with pure ferrugineol and ferrugineol with different combinations of ferrugineon over a 30 week period.*

Treatment	Total number of females	Total number of males
Purified ferrugineol	91 [a]	67
Ferrugineol+1% ferrugineon	49 [b]	34
Ferrugineol+5% ferrugineon	83 [a]	45
Ferrugineol+10% ferrugineon	77 [a]	57

(No significant difference in the treatments followed by the same letter, $P<0.05$, Kruskal Wallis test)

C N K Rajapakse, D R Hall (NRI, UK), I R Wickramananda, K F G Perera & W W N Fernando

PROJECT 15.1. STUDIES ON ACTIVITY PATTERNS OF LARVAL AND PUPAL PARASITOID SPECIES OF COCONUT CATERPILLAR (1994)

Experiment 15.1.6: Pre-ovipositional duration of the pupal parasitoid, *Brachymeria nephantidis* (1997)

B. nephantidis has a pre-ovipositional duration of one to two days. Fourty percent of the females oviposited on the day of their emergence while rest oviposited on the second day.

L C P Fernando & K A S Chandrasiri

Experiment 15.1.7: Daily fecundity and longevity of the larval parasitoid, *Bracon hebetor* (1997)

Daily fecundity of 30 females of *B. hebetor* on *Corcyra ceyphalonica* was recorded from their first day of emergence until death. Females had a total mean (±S.E) fecundity of 133.2±10.7 eggs. Females lived an average (±S.E.) of 17.8±1.3 days.

L C P Fernando & D C L Hapuarachchi

Experiment 15.1.8: Timing of oviposition and daily activity pattern of *Bracon hebetor* (1997)

An experiment was conducted to study whether laboratory bred females of *B. hebetor* oviposit on *C. cephalonica*, the alternate host and on coconut caterpillar during day and night. Results revealed that females oviposit during day and night on *C. cephalonica* and the ovipositions were higher at night (mean = 75.0) than during daytime (mean = 27.6). Only one female (n= 10) oviposited on coconut caterpillar during the three day experimental period. Nevertheless mortality of coconut caterpillar had occurred due to host feeding and paralysis. Results suggest that either coconut caterpillar is not the preferred host of the *B. hebetor* population bred in the laboratory or it consists of a mixed culture.

Daily activity pattern of 4 females were recorded continuously for 7 h each day for 3 consecutive days. The activities of the females during the observation period were oviposition, host feeding, resting and walking. Only 4% of the total time were used for oviposition. A single female lays 2-3 batches of eggs per day

either on the same host or on different hosts. Mean number of 6.5 eggs are laid per batch.

S D U S Sirimanne (Aquinas College) & L C P Fernando

Experiment 15.1.9: Effect of the release of laboratory-bred *B.hebetor* females on the field population of coconut caterpillar (1997)

The role of laboratory-bred *B. hebetor* and the spatial distribution of parasitism in the field were studied at two infested sites in Thalawila. Twenty thousand gravid females were released at each site to a single palm. Pest and parasitoid population levels in the first, second, fourth, seventh and eighth palms from the released palm were monitored after 10, 21, 33 and 50 days of release. Results revealed that in both sites parasitism levels did not increase considerably after the release of parasitoids. Nevertheless, pest population dropped drastically indicating that parasitoids had attacked the hosts by host feeding and paralyzing them (Table 4). The results further indicated that the parasitoids could not survive to parasitize the hosts of the next generation due to the discrete nature of the pest population. Therefore the results suggest that the number of parasitoids released was insufficient to control a high pest population or coconut caterpillar is not a preferred host of laboratory-bred *B. hebetor* population or it is a mixed population or a combination of above factors.

Table 4. *Population levels of coconut caterpillar and parasitism rates of B. hebetor (n = 13, 20 leaflets per sample) before and after release of gravid females of B. hebetor in a Thalawila Estate.*

Days after release	No. larvae			No. live pupae	No. Parasitized	
	Alive	Dead	Paralysed		Alive	Emerged
0	835	7	0	0	2	4
10	485	14	16	65	0	9
21	28	11	52	68	17	15
33	329	10	0	0	0	18
50	745	14	0	0	0	23

To determine whether the reduction of pest population after the release was due to environmental factors or host-feeding and paralysis, a study was conducted in Kiriibbanara, Ambilipitiya. Two coconut caterpillar infested sites, about 1 km away from each other were selected and over 10,000 *B. hebetor* females were released at one site. Pest and parasitoid populations in both sites were monitored one and two months after release. Results confirmed that the pest reduction was not due to climatic effects but due to the activity of the parasitoids (Table 5). Similar to the Thalawila experiment parasitism was not observed in the subsequent generation.

Table 5. *Comparison of population levels and parasitism rates of B. hebetor in a released site(R) and a non-released site (NR) at Kiriibbanara, Ambilipitiya*

Days after release	Site R/NR	No. larvae			No. alive pupae	No.parasitized	
		Alive	Dead	Paralysed		Alive	Emerged
0	R	235	4	1	0	0	3
	NR	167	6	2	0	0	5
30	R	60	0	4	4	3	12
	NR	167	0	2	0	0	2
63	R	10	0	0	0	0	16
	NR	38	2	0	0	0	4

L C P Fernando, K A S Chandrasiri & D M Jayakody

Experiment 15.1.10: Comparison of laboratory-bred and field-collected populations of *B.hebetor* (1997)

A laboratory study was carried out to study the host- parasitoid relationships of lab-bred and field-collected populations of *B. hebetor*. Each of 10 newly emerged and mated laboratory-bred females and females bred from the field-collected culture were offered to abundance of *C. cephalonica* and coconut caterpillar hosts separately for 3 days. Results revealed that females from both cultures parasitized and paralysed a higher number of *C. cephalonica* larvae than coconut caterpillar. The parasitism rates of the field culture were higher than that of lab culture (Table 6). Although results revealed that coconut caterpillar is not the preferred host of *B. hebetor* further studies are necessary to confirm the prediction.

Table 6. *Comparison of parasitism rates of laboratory and field cultures of B. hebetor females on Opisina arenosella and Corcyra cephalonica (n= 10 each, 5 hosts per female)*

Culture	Host	% females		No. hosts	
		Oviposit	Paralyse hosts	Parasitized	Paralysed
Lab.	Corcyra	60	90	9	29
	Opisina	10	50	1	7
Field	Corcyra	100	70	15	20
	Opisina	50	40	6	5

L C P Fernando & D C L Hapuarachchi

Experiment 15.1.11: Host-parasitoid relationships of *Goniozus nephantidis*, a larval parasitoid of coconut caterpillar (1997)

Previous studies have shown that *G. nephantidis* has a low parasitism rate in the field. To understand whether coconut caterpillar is not the preferred host of the parasitoid, a study was conducted in the field by offering the females laboratory host, *C. cephalonica* and coconut caterpillar separately. Results showed no difference in the parasitism rates between *C. cephalonica* and coconut caterpillar.

L C P Fernando, D C L Hapuarachchi & N G Premasiri

PROJECT 15.3: DEVELOPMENT OF A PHEROMONE TRAP TO FORECAST OUTBREAKS OF COCONUT CATERPILLAR (1996)

Experiment 15.3.2: Attraction of males to different blends of the synthetic pheromone of the coconut caterpillar (1997)

The objective of the experiment was to determine the optimum blend of the synthetic analogue of the sex pheromone of coconut caterpillar most attractive to male moths since the pheromone consists of one major compound and two minor compounds. Vials containing four different blends of the pheromone and virgin females were caged separately and placed in horizontal traps in an estate infested

with coconut caterpillar in Mampury. Traps with two blends of the pheromone caught a higher number of males than other traps. The experiment is being continued.

L C P Fernando, D R Hall (NRI, UK) & K A S Chandrasiri

PROJECT 16.4: DEVELOPMENT OF AN ATTRACTANT TRAP TO CONTROL BLACK BEETLE IN COCONUT LANDS (1996)

Experiment 16.4.1: Evaluation of the efficacy of ethyl-4-methyloctanoate as a lure for black beetle (1996)

To confirm the effectiveness and field activity of ethyl 4- methyloctanoate, the synthetic aggregation pheromone analogue of *Oryctes rhinoceros* another experiment was repeated in Bandirippuwa estate using pitfall and vane traps buried in the ground near the palms. The methodology used was as described in the previous year. Female and male catches in pitfall and vane traps were 30, 20, 28, and 17 respectively. It was evident that the pheromone analogue can be effectively used in the coconut plantations to suppress the black beetle population.

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

Experiment 16.4.2: Evaluation of different trap types and positions for the use of the synthetic pheromone of black beetle (1997)

An experiment was carried out in a black beetle infested Estate in Sandalankawa (NWP) to determine the most efficient trap design and its position to catch adult black beetles. Pitfall trap, modified pitfall trap and vane traps baited with ethyl 4-methyloctanoate were evaluated when buried in the ground and placed 2 m above ground level in the centre of coconut square. Five traps per treatment were set in a randomized block design and weekly beetle catches were recorded. The results are being analysed.

L C P Fernando, D R Hall (NRI, UK), D C L Hapuarachchi & W W N Fernando

PROJECT 17.1: STUDIES ON THE CONTROL OF BOLE AND ROOT ROT DISEASE OF COCONUT (1993)

Experiment 17.1.3: Studies on the infectivity of coconut seedlings by *Ganoderma boninense* when filling vacancies in disease affected estates (1997)

The aim of the study was to determine the survival and infectivity of *G. boninense* in the soil for varying periods of time. Each of 10 vacancies that occurred by the death of diseased palms 2, 3, 4, and 5 years before were planted with healthy seedlings at Sitrakala estate, Ambalantota.

H T R Wijesekara, I R Wickramananda, L C P Fernando, S P Manoher & N G Premasiri

Experiment 17.1.4: Studies on the infection of coconut seedlings by *G. boninense* when seedlings are raised in nurseries of diseased estates (1997)

Two nurseries of 50 nuts each were established in Dehigahalanda and Sitrakala estates at Ambalantota to investigate whether seedlings raised in Ganoderma affected estates could be infected by the fungus.

H T R Wijesekara, L C P Fernando, S P Manoher & N G Premasiri

Experiment 17.1.6: Vegetative compatibility of Sri Lankan *Ganoderma* isolates from Hambantota district (1997)

The experiment was conducted to investigate the diversity of *G. boninense* in Sri Lanka. Eighteen Ganoderma isolates collected from coconut palms in 4 different sites were grown on Ganoderma semi selective medium and maintained on 3% malt extract agar. When mated with each other compatible isolates merged readily while incompatible isolates showed different reactions such as barrier formation, pigment production and sparse mycelium at the area of meeting. Results indicated that there were several vegetatively compatible isolates present in the 4 sites sampled. Only isolates from Akkarakala estate were incompatible with isolates from other three sites (Table 7). Results further revealed that there were no multiple infections in affected palms.

Table 7. *Vegetative compatibility of ganoderma isolates from coconut palms in Hambantota District*

Sampling site	Isolate number	Number of compatible isolates
Sitrakala estate	5	0
	6	0
	7	1
	8	1
Dahapela, Beminiyanwela	K20	0
	21	0
	K21	1
	22	2
Rohana watta, Dehigahalanda	28A	1
	28B	2
	K28B	2
Akkarakala estate, Ambalantota	33	1
	K33	1
	35	0
Ovilana Temple, Beliatta	K62	0
	63	6
	K63	1
	64	1

H T R Wijesekara, P M Kirk (IMI, UK), H Rolph (IMI, UK) & J Flood (IMI, UK)

Experiment 17.1.7: Isozyme activity of Ganoderma isolates from different geographical regions and different host plants (1997)

The diversity in biochemical characters of Ganoderma isolates from different host plants and geographical regions was studied. Eighteen Sri Lankan isolates, 3 Indian isolates, 3 Malaysian isolates from coconut palms and 3 Malaysian isolates, 2 West Malaysian isolates, one Indonesian isolate and 2 Solomon Island isolates

from oil palm were used in the tests. Four banding patterns were observed for esterase include esterase instead of superoxide dismutase and there was no relationship between host plant or geographical region with the banding pattern. No banding pattern was observed for acid phosphatase, and it may be due to destruction of enzyme during the process of extraction or acid phosphatase activity was low in the samples.

H T R Wijesekara, H Rolph (IMI, UK), P D Bridge (IMI, UK) & J Flood (IMI, U K)

PROJECT 17.2: STUDIES ON STEM BLEEDING DISEASE OF COCONUT (1997)

Experiment 17.2.1: Studies on the pathogenicity of the fungi *Hymenomycetes* spp. Isolated from decayed roots of stem bleeding palms in Hambantota district (1997)

Two species of the fungus *Hymenomycetes* species were isolated from decayed roots of many palms showing bleeding symptoms in Hambantota District. In order to investigate the pathogenecity of these fungi 18 palms in Goyambokka estate, Tangalle were selected and two species of the fungus were inoculated to the roots and stems.

H T R Wijesekara, I R Wickramananda, L C P Fernando and S P Manoher

PROJECT 18.1: INVESTIGATION OF BEE HONEY PRODUCTION IN DIFFERENT COCONUT-BASED CROPPING SYSTEMS (1996)

Experiment 18.3.1: Determination of coconut-based cropping systems suitable for establishing bee colonies (1997)

Three sites (Nalla Plantation, Divuldeniya; Welikumbura, Mahawatta, Metiyagane and CRI land, Tabbowa, Nattandiya) were selected to initiate experiments to determine the coconut based cropping systems in which bee colonies could be well established to produce high yields of bee honey.

H T R Wijesekara, L C P Fernando, S P Manoher & W W F N Fernando

PROJECT 24.1: ASSESSMENT OF YIELD LOSSES OF COCONUT DUE TO PEST INFESTATIONS (1995)

Experiment 24.1.1: Effect of coconut scale infestations on the yield of coconut (1995)

Yield record of scale infested palms at Randeniya estate and Andigama estate is being maintained.

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

Experiment 24.1.1: Estimation of yield losses in coconut caterpillar infested palms (1996)

Records are being maintained in both Mangalaweli and Silverine Estates. The experiment was repeated in another location, Wadumunnegedara, where there was heavy infestation.

C N K Rajapakse, I R Wickramananda, K A S Chandrasiri, D M Jayakody & R Wijetunga

PROJECT 25.1: DEVELOPMENT OF METHODS TO CONTROL VERTEBRATE PESTS IN COCONUT (1997)

Experiment 25.1.1: Evaluation of mechanical barriers to protect coconut seedlings from rat damage (1997)

An experiment was commenced in Yatawatte estate, Yatawatte where heavy rat and bandicoot damage to coconut seedlings has been reported, to evaluate different mechanical barriers to protect the seedlings. Barbwire, tiles, wire mesh and polythene were placed around the collar regions of seedlings. Each treatment consists of 36 replicates in a complete randomized block design. Monthly records on dead and damaged palms are being maintained.

L C P Fernando, I R Wickramananda, D M Jayakody & N G Premasiri

B 12: IDENTIFICATION OF INDIGENEOUS PLANT SPECIES/EXTRACTS FOR CONTROL OF MINOR PESTS IN COCONUT (1994)

Experiment B 12.1: Laboratory Screening of plant extracts for antifeedancy against yellow spotted locust *Aularchis miliaris* in coconut (1997)

In classical bioassays where activity of insecticides is tested, parameters like mortality are taken into consideration. However compounds derived from plants have a host of other effects such as antifeedancy and repellance against insects which could be applicable in pest control. Therefore behavioural changes in feeding, oviposition and repellnace can also be measured. Thus the objective of this experiment was to establish methods to bioassay the plant extracts for their biological activity against coconut pests using behavioural assays.

Methodologies were established to screen plant extracts using antifeedancy index as one measure for screening in CRI laboratories. *Aularchis miliaris* collected from infested fields in Mawathagama and Keppitigala was used as the testing insect. Experiment is in progress.

I R Wickramananda & N G Premasiri

3. CROP PROTECTION SERVICES

Incidence of pests and diseases: Over 300 pest and disease incidences reported during the year were investigated and appropriate control measures were recommended.

3.1 Biological control

a. Coconut caterpillar: Heavy infestations of coconut caterpillar were recorded during the year. They were successfully controlled by timely surveillance , continuous monitoring and release of parasitoids. Parasitoids of the coconut caterpillar were mass dispatched to reported infestation sites. In certain areas releases were done under the personal supervision of the Divisional staff. The numbers of parasitoid releases are given in Table 9.

b. Black beetle: Many consignments of Baculovirus infected larvae were released to plantations in Western and North Western provinces for the control of black beetle.

Table 8. *Reports of insect pests and diseases in 1997*

Pest/ disease	WP	NWP	NCP	CP	EP	SP	SaP	Total
Insect pests								
Red weevil	19	37	02	02	02	02	01	65
Black beetle	06	18	-	01	-	-	-	25
Coconut caterpillar	15	34	-	-	93	43	-	187
Coconut scale	01	02	-	-	-	-	-	03
Minor pests								
Locust	-	08	02	01	-	-	-	11
Diseases								
Stem bleeding	-	02	-	-	-	-	-	02
Bud rot	02	10	-	-	-	-	-	12
Leaf blight	01	01				02	01	05

WP - Western Province
NWP - North Western Province
NCP - North Central Province
CP - Central Province
EP - Eastern Province
SP - Southern Province
SaP - Sabaragamuwa Province

Table 9. *Releases of parasitoids in different provinces for the control of Coconut caterpillar in 1997*

Parasitoid	WP	NWP	SP	EP	SaP	NCP
P1	7750	20850	19750	6000	1000	-
P2	68000	300100	97600	112500	56500	7000
P3	6350	12800	11000	6200	1800	650
P4	94200	23200	-	-	-	-
P5	3200	29825	18925	1300	1550	-
Total	179500	386775	147275	126000	60850	7650

P1 – *Goniozus nephantidis*
P2 – *Bracon hebetor*
P3 – *Eriborus trochanteratus*
P4 – *Trichospilus pupivora*
P5 – *Brachymeria nephantidis*

WP – Western Province
NWP - North Western Province
SP - Southern Province
EP - Eastern Province
SaP - Sabaragamuwa Province
NCP - North Central Province

c. Weeds: The demand for the biological control agent, *Pareuchaetes pseudoinsulata* of the weed Podisinghomaran (*Chromolaena odorata)* continued during the year. A total of 10450 larvae, 300 pupae and 640 adults were issued to plantations in North Western and Western provinces.

Synthesis of red weevil pheromone

Following the development of a successful trapping system for red palm weevil based on the aggregation pheromone, the principle component in the trap which is the natural aggregation pheromone, ferrugineol (4-methyl 5 nonanol) was synthesized in the CRI laboratories. This will be provided to the growers for the use in the field for red weevil trapping.

3.2 Chemical control

Trunk injection of 60% Monocrotophos was done in severe pest outbreaks. Total of 2105 palms in 7 estates and 185 palms in one estate were treated against coconut caterpillar and coconut scale respectively.

The Registrar of Pesticides has allowed CRI to use Monocrotophos for trunk injection in pest outbreaks in coconut. Purchase and issue of the insecticide was authorized to the Coconut Research Institute.

4. TRAINING AND EXTENSION ACTIVITIES

An intensive training on breeding of parasitoids of coconut caterpillar was given to Mr. A Paskaran, Technical officer of the Eastern University, Batticoloa from 08.08.97 to 05.10.97.

A three week laboratory and field training on identification and management of coconut pests were provided to Mr. M Afeef, Field officer of the Ministry of fisheries and Agriculture, Maldives from 17.11.97 to 29.11.97.

One day programme for regional Managers and Assistant Regional Managers of the Coconut Cultivation Board was conducted to brief on the management of red weevil and the use of pheromone trap.

One day training programme on pest management of coconut was conducted for coconut growers.

Demonstrations on the use of pheromone traps for the control of red weevil were conducted to the coconut Development Officers of the Gampaha and Puttalam regions.

One day training programmes on pests and diseases of coconut were provided to the final year students of the Universities of Sri Jayawardenapura and Colombo on 20.02.97 and 16.12.97 respectively.

One day familiarization programmes on pest management in coconut were conducted to the trainees from the National Apprentice and Industrial training Authority on 10.04.97, 08.08.97 and 10.12.97.

One day training programme on pests and diseases was provided to the diploma holders of the National Institute of Plantation Management on 25.05.97.

Vacation training was provided to two undergraduate students of the University of Colombo on 17.04.97 and 18.04.97.

Demonstrations on pests and diseases were made to 9 study tour groups.

Miss. S D U S Sirimanne, a final year student of the Aquinas College completed a 2 month research project on "Activity patterns of *Bracon hebetor*".

Research staff participated as Resource personnel in many training programmes for Agricultural teachers, Agricultural extension officers and Coconut Development officers organized by the Coconut Development Training Centre.

5. ACKNOWLEDGEMENTS

The co-operation and assistance extended by the staff of the Crop Protection Division in the research and other activities during the year are gratefully acknowledged. Sincere thanks are due to the Head and the staff of Biometry Division for the assistance in designing of experiments and analysis of data. Special thanks are extended to Head and staff of Department of Chemistry, University of Kelaniya and Mrs. P Hewavitharanage (CPRD, CRI) for helping in the synthesis of red weevil pheromone .

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 consultancy, selection of lands, layout of experimental designs, design field surveys and questionnaires, and analysis and interpretation of data.

Number of undergraduate and post graduate students from various Universities were provided with special assistance in respect to their projects.

3. RESEARCH PROJECTS

PROJECT 20: APPLICATION OF BIOMETRY IN COCONUT RESEARCH

Experiment 20.0.3:

(a) Calibration trial at Walpita Estate (Wet Zone)-(1984).

The bimonthly recording of vegetative and yield characters was carried-out during the year. Variation in yield parameters and general status of yield pattern in the area between the six picks of 1996 and 1997 is given in Tables 1 and 2. The total number of bunches for the year showed an increase of 11.2% over 1996, while number of nuts per palm, showed an increase of 21.0%. The recorded yield was 15385 nuts/ha compared to 12710 nuts/ ha in 1996. The copra yield per hectare was 3033.9 Kg/ha as against 2548.5 kg/ha recorded in 1996.

(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 at monthly intervals for the other group. The number of nuts and

Table 1. *Average yield components of palms at Walpita Estate in 1997*

Pick Number	Number of bunches/palm		Number of nuts/palm		Number of nuts/ha		Number of nuts/bunch	
1	2.5	(1.9)	8.2	(6.8)	1291	(1074)	3.3	(3.6)
2	2.4	(2.4)	21.7	(10.6)	3428	(1669)	9.1	(4.4)
3	1.9	(2.0)	18.6	(18.3)	2940	(2890)	10.0	(9.2)
4	2.4	(2.3)	21.9	(23.2)	3466	(3668)	9.1	(10.2)
5	2.1	(1.7)	14.9	(11.6)	2350	(1827)	7.1	(6.9)
6	2.6	(2.2)	12.1	(10.0)	1910	(1582)	4.6.	(4.6)
Total	13.9	(12.5)	97.4	(80.5)	15385	(12710)		

(Figures in paranthesis are those recorded in 1996)

Table 2. *Average weight of husked nut and Copra yield of palms at Walpita Estate in 1997*

Pick	Weight of husked nut (g)		Copra (kg/ha)	
	1997	1996	1997	1996
1	640	682	264.4	234.4
2	687	747	753.6	399.0
3	643	667	604.9	616.8
4	635	592	704.3	694.9
5	500	523	376.0	305.8
6	541	588	330.7	297.7
Total/Ave.	611	625	3033.9	2548.6

Copra Yield = husked nut weight x 0.32

number of bunches per palm recorded since the year 1990, for the two groups are shown in Tables 3 and 4. The results indicated an increased yield for monthly harvesting for all the 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. For the year 1997 monthly harvesting, recorded 20.6% increase in nut yield as against bimonthly harvesting. During the year 1997, monthly harvesting recorded an increase of 22.0% over the year 1996, while the comparative figure for bimonthly harvesting is 19.8%. During the 5 year period 1993-1997 the average increase for monthly harvesting over that of bimonthly harvesting is 24.5%. Harvesting at 30 day intervals showed 19.3% fallen nuts as against 35.6% for harvesting at 60 day intervals.

Table 3. *Average number of nuts per palm/year*

Frequency of Harvesting	Year							
	1990	1991	1992	1993	1994	1995	1996	1997
Monthly	99.5	107.1	100.5	50.0	123.3	97.6	87.3	106.6
Two monthly	87.0	98.2	93.1	38.9	93.2	79.6	73.7	88.4
Difference								
No.	12.5	8.9	7.4	11.1	30.1	18.0	13.6	18.2
%	14.4	9.0	7.9	28.5	32.3	22.6	18.4	20.6

Table 4. *Average Number of bunches per palm/year*

Frequency of harvesting	Year 1990	1991	1992	1993	1994	1995	1996	1997
Monthly	14.2	12.6	13.8	11.6	13.5	14.3	13.2	15.1
Two Monthly	13.1	12.0	12.9	8.2	12.0	12.3	11.6	12.6
Difference								
No.	1.1	0.6	0.9	3.4	1.5	2.0	1.6	2.5
%	8.4	5.0	7.0	41.5	12.5	16.3	13.8	19.8

D T Mathes, Ranjith Fernando, W M L G Fernando, Kingsley Herath & P Fernando.

PROJECT 13: DEVELOPMENT OF A NEW HARVESTING FREQUENCY TO INCREASE COCONUT PRODUCTION

Experiment 13.0.1: Frequency of harvesting

During the year two experiments were commenced. It is yet, premature to report any results.

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

Research Thrust: 20.1 APPLICATION OF CLIMATOLOGY IN COCONUT RESEARCH

Experiment Number: 20.1.1 Analysis of rainfall in coconut growing areas in Sri Lanka

The analysis of rainfall data for 30 years (1962-1991) from 12 locations within the coconut triangle and three locations in the mini coconut triangle in the Southern Province was continued (Annual report, 1996). The important findings are given below.

1. The annual rainfall in main coconut growing areas in the low country intermediate and wet zones significantly declined over the past 30 years, while that in low country dry zone showed no significant decline.

2. The rainfall during March/April, May/June and October/November showed a decrease over the 10 year periods (62-71, 72-81, 82-91) in all the locations except that in low country dry zone.

3. The peak of the monthly rainfall distribution generally expected during March/April showed a shift towards April/May.

4. The rainfall in all the locations, during December has declined significantly over the 10 year periods.

5. The number of dry days with a mean of 50 days, during January/February was not significantly different between locations.

6. The number of dry days during July/September has significantly increased over the years. The range being 50-80 days.

7. The first inter-monsoon rain in Low Country Dry Zone has commenced later than that in Low Country Intermediate Zone and Wet Zones.

The results suggest, it would be more beneficial to do cultural practices on coconut lands, during March and April, rather than the common practice during May and June. The study further indicated, the need to split the agro-ecological regions into more homogeneous smaller units.

This study is being continued. It is expected to, include data up to 1997 for

an indepth analysis and prepare a comprehensive report on rainfall variability in the coconut growing areas.

T S G Peiris & D T Mathes

Research Thrust: 20.1 APPLICATION OF CLIMATOLOGY IN COCONUT RESEARCH

Experiment Number: 20.1.2 Modelling the impact of climate on the nut yield and growth of the palm

Exploratory techniques were used to relate pick-wise crop yield of TxT and DxT (nuts/ha/year) collected during 1982 to 1996 from Isolated Seed Garden (ISG), with four weather variables; rainfall (RF), relative humidity in the afternoon (RHPM), maximum air temperature (TMAX) and minimum air temperature (TMIN) during the 44 months development cycle with respect to the bunches of each pick. This period was divided into 44 months and these were taken as lags 1 to 44.

The 'lag 1' is referred to the period during the first month before the harvest, 'lag 2' as the period during the second month before the harvest, and so forth. Thus the lags 1-12 for a given pick correspond to the visual cycle of the development phase while lags 13-44 correspond to the non-visual cycle. For example, the pick 1, is harvested during January and February. Thus the lag 1 for pick 1 was taken as the month of December in the previous year and the lag 2 of pick 1 as the month of November, and so on.

The study showed that yield variability within years in both varieties was less than the yield variability between years. Based on the long-term average of nut yield of the picks 1 - 6, the ranking order of picks for T×T was P3 > P4 > P5 > P2 > P6 > P1 and that for D×T was P3 > P2 > P4 > P5 > P1 > P6.

The results showed that the contributory variables vary among lags within a pick and among picks within a lag. This is an indication that the important significant variables of a given pick depend upon the lag period of the pick. Further it was found that the effect of climate is different, for the two varieties. Of the 44 models fitted to each lag of the picks, some models explained the yield variability adequately while other models were inadequate to explain a sufficient amount of the yield variability. Thus having identified the best five models, a single model was developed by pooling all the variables with respect to the identified lags for each pick.

The identified models explained well, the pick-wise yield variability (R^2 > 80%). Rainfall, minimum air temperature and relative humidity in the afternoon were the most influential climatic variables in determining total yield of variety T×T, while rainfall and minimum air temperature are the two most significant variables in respect of variety DxT. The over all results showed that most of the critical periods for all picks with respect to climate variability were within the non-visual phase in the development cycle of a bunch of coconut.

The study continues.

T S G Peiris

Research Thrust: 20.1 APPLICATION OF CLIMATOLOGY IN COCONUT RESEARCH

Experiment Number: 20.1.3 Yield forecasting for Sri Lanka

A stochastic process, autoregressive model was fitted to estimate the annual coconut production in Sri Lanka. The model is: $X_t = (1+\phi_1)X_{t-1} + (\phi_2 - \phi_1)X_{t-2} - \phi_2 X_{t-3}$, where $\{X_t, t \geq 1\}$ is the annual yield of the year 't' and ϕ_1 and ϕ_2 are the partial autocorrelations of the first differences of the series of lag 1 and lag 2 respectively.

The fitted model was tested for its efficiency by comparing the percentage errors shown between the actual production and the estimated forecast. The Table 5, shows the actuals and the forecasted values and the percentage errors. The errors are low and hence the model could be used reasonably well in the forecast of coconut production for Sri Lanka. The estimated National yields for the years 1997 and 1998 are 2323 and 2508 mln. nuts.

T S G Peiris

Table 5. *Validation of the model fitted to estimate the annual national coconut production*

Data used	Year	Actual (mln. nuts)	Forecast (mln. nuts)	% Error
1950 - 1989	89	2484	2589	+ 4.2
	90	2532	2683	+ 6.0
	91	2184	2170	- 0.6
1950 - 1990	90	2532	2600	+ 2.7
	91	2184	2162	- 1.0
	92	2296	2194	- 4.4
1950 - 1991	91	2184	2117	- 3.1
	92	2296	2192	- 4.5
	93	2164	2478	+ 14.5
1950 - 1992	92	2296	2243	- 2.3
	93	2164	2483	+ 14.6
	94	2455	2375	- 3.3
1950 - 1993	93	2164	2513	+ 16.1
	94	2455	2375	- 3.3
	95	2617	2357	- 9.9
1950 - 1994	94	2455	2122	- 13.6
	95	2617	2227	- 14.9
	96	2546	2327	- 8.6
1950 - 1995	95	2617	2469	- 5.7
	96	2546	2258	- 11.3
	97	n/a	2306	
1950 - 1996	96	2546	2307	- 9.4
	97	n/a	2323	
	98	n/a	2508	

4. 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.

D T Mathes, T S G Peiris & H P De Zoysa

(b) Computerization of experimental data continued throughout the year.

D T Mathes, T S G Peiris & W E R C Fernando

(c) Computerization of all the weather variables recorded at four stations continued throughout the year. The computerized data sent to the Meterology department, Colombo in every month.

T S G Peiris, J D J S Kularatne, K Herath, P Fernando & B Perera

(d) Assistance was provided to all Divisions on the use/application of data base packages and statistical packages.

H P De Zoysa, D T Mathes & J D J S Kularatne

(e) Assistance in computerizing and processing of information of the Medical Aid Scheme.

T S G Peiris

(f) Analyses were done for Information for Research Management (INFORM) at the Institute and was submitted to the CARP.

T S G Peiris

(g) Assistance was provided for the installation of computers and maintenance of hardware and software.

H P De Zoysa

(h) Assistance was provided to Coconut Development Authority in respect of their computer requirements and evaluation.

H P De Zoysa

5. YIELD RECORDING

The recording of yield components of 28 experiments, conducted by the Research Divisions, 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 recordings were computerized for each harvest and computer prints of the raw data and summary data were sent to the officer in charge of each experiment.

6. 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.

7. 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 all daily information on monthly basis to Department of Meteorology and other Institutions continued throughout the year.

Protus Fernando, J D J S Kularatne & D T Mathes

7.1 Bandirippuwa Estate

(a) Rainfall (Table 6) All months recorded rainfall. On the whole this year recorded the lowest rainfall since 1992, with 60% of the rainfall being received for the 2nd half of the year.

Heavy rainfall was recorded for the months October and November (866.9mm). This is 1905.6 mm and about 45% of the total rainfall of the year. The total rainfall for the second half of the year was 1359.6 mm.

(b) Temperature (Table 7) The monthly maximum temperature ranged from 30.3 (September) to 32.5°C (March). The monthly minimum temperature ranged from 20.8 (February) to 24.7°C (May). Compared to 1996 a slight increase in the day temperature was recorded.

(c) Sunshine (Table 7). Longer sunshine hours were observed during the early part of the year with a maximum of 9.7 hrs per day in January. The average for the year was 7.6 h.

(d) Evaporation The lowest and highest evaporation was recorded in April and May. The range being 3.3 to 4.9 mm respectively.

(e) Relative Humidity The average relative humidity in the morning fluctuated around 83% during the year. In the afternoon it varied from around 60% in January to around 81% in September.

(f) Soil Temperature (Table 8). The average temperatures recorded at depths 5, 10, 20, 30, 60 and 120 cm during the morning were 27.7, 28.1, 28.5, 29.0 29.8, 29.8°C while those for the afternoon were 32.8, 31.6, 30.1, 29.6, 29.8, 29.8°C respectively.

(g) Wind velocity The wind velocity varied from 2.6 km/hr in November to 5.4 km/hr in August with the mean of 4.0 km/hr.

7.2 Ratmalagara Estate (Table 9)

All months recorded rainfall, except January. Since 1988 an all time high rainfall was shown for the year. The total being 2075.3, out of which the last four months experienced a rainfall of 1566.6 mm.

7.3 Isolated Seed Garden (Table 10)

Except for the month of January all the months recorded rainfall. The total rainfall for the year was 1767.5 mm as against 1195.0 recorded in 1996. The rainfall observed is the highest recorded since 1987. The total rainfall for the last four months was 1306 mm.

7.4 Maduruoya Seed Garden (Table 11)

All the months recorded rainfall. Axcept in August a fairly well distributed rainfall was shown for the rest of the months. The total rainfall recorded for the year was 1521.9 mm.

Table 6. *Rainfall (mm) for the last 10 years and in 1997 (Bandirippuwa Estate)*

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	87-96 Ave	1997
Jan	31.2	0.0	25.4	201.8	37.7	5.3	3.8	122.4	45.3	94.1	56.7	14.6
Feb	0.0	111.4	0.0	16.8	12.2	0.0	20.6	195.7	51.6	68.8	47.7	35.0
Mar	118.3	87.4	65.7	84.3	97.5	0.0	63.5	71.4	100.8	0.0	68.9	15.4
April	237.6	283.0	234.9	74.8	90.3	54.5	191.4	132.9	276.6	355.5	193.1	145.2
May	187.2	109.9	52.3	227.7	481.5	413.5	255.2	262.9	399.1	76.8	246.6	210.5
Jun	61.6	255.8	153.4	29.0	269.4	260.2	49.2	70.4	207.2	84.3	144.1	125.3
Jul	6.4	151.8	99.0	156.3	105.8	78.0	73.6	60.6	35.2	58.4	82.5	138.1
Aug	156.5	105.2	20.4	0.3	22.6	57.3	56.7	37.5	35.4	223.5	71.5	39.0
Sept	410.7	303.4	222.1	11.9	59.3	362.6	200.9	279.6	41.1	234.4	212.6	217.1
Oct	579.3	88.8	395.9	395.1	309.2	443.7	324.7	378.3	194.5	192.1	330.2	412.1
Nov	194.7	370.7	379.4	623.3	161.4	317.9	301.6	284.2	558.3	216.5	340.8	454.8
Dec	79.9	19.1	50.3	90.2	29.1	60.7	237.6	9.1	18.8	137.1	73.2	98.5
TOTAL	2063.4	1886.5	1698.8	1911.5	1676.0	2053.7	1778.8	1905.0	1963.9	1741.5	1867.9	1905.6

Table 7. *Summary of meteorological observation in 1997 (Bandirippuwa Estate)*

	Temperature (°C) max	min	Evaporation (mm) per day	Relative Humidity(%) a.m.	p.m.	Sunshine(hrs)	Wind Velocity (km/h)
Jan	31.9	20.9	4.5	80	60	9.7	5.3
Feb	32.1	20.8	4.7	78	64	9.0	4.3
Mar	32.5	22.7	4.5	79	66	9.0	3.7
April	32.8	23.6	4.9	78	69	7.7	3.8
May	31.4	24.7	3.3	83	78	7.2	4.1
June	30.8	24.6	3.4	85	79	7.9	4.1
July	30.3	24.7	3.4	86	79	6.0	4.8
Aug	30.4	24.7	4.1	83	78	7.7	5.4
Sept	30.3	24.0	3.5	86	81	6.6	4.3
Oct	30.9	23.3	3.4	86	79	7.1	2.7
Nov	30.9	23.4	3.3	87	79	6.8	2.6
Dec	31.4	22.9	3.4	84	74	7.0	3.2
Ave.	31.3	23.4	3.9	83	74	7.6	4.0

Table 8. *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.	25.4	26.0	26.5	27.2	28.1	28.2	30.4	29.5	28.0	27.7	28.0	28.2
Feb.	25.8	26.5	27.2	28.0	28.8	28.8	32.5	31.5	29.4	28.8	28.7	28.8
Mar.	28.8	29.2	29.9	30.6	30.8	30.2	38.0	35.4	32.1	31.3	30.8	30.2
Apr.	29.8	30.0	30.7	31.5	32.1	31.6	37.6	35.7	33.1	32.2	32.0	31.6
May	28.7	28.8	29.0	29.5	30.5	30.6	32.4	31.7	30.6	30.1	30.5	30.5
Jun.	28.3	28.5	28.7	29.1	30.1	30.2	31.2	30.6	30.0	29.6	30.0	30.2
Jul.	28.0	28.4	28.6	29.0	29.8	29.8	32.2	31.3	30.0	29.5	29.7	29.8
Aug.	28.3	28.6	28.9	29.3	30.0	30.0	32.9	31.6	30.4	29.9	30.0	30.0
Sep.	27.9	28.2	28.5	28.9	29.8	29.9	31.5	30.9	29.8	29.3	29.8	29.9
Oct.	28.0	28.2	28.5	28.9	29.8	29.8	32.8	31.4	30.3	29.6	29.8	29.8
Nov.	27.2	27.4	27.7	28.2	29.1	29.2	30.9	29.6	28.9	28.6	29.2	29.2
Dec.	26.7	26.9	27.3	27.8	28.9	28.9	31.1	30.0	28.9	28.4	28.9	28.9
Ave.	27.7	28.1	28.5	29.0	29.8	29.8	32.8	31.6	30.1	29.6	29.8	29.8

Table 9. *Rainfall (mm) for the last 10 years and in 1997 (Ratmalagara Estate)*

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	87-96 Ave	1997
Jan.	13.6	0.0	77.7	185.5	36.2	0.0	17.5	101.5	16.6	41.1	49.0	0.0
Feb.	0.0	101.3	0.0	8.3	12.2	0.0	22.9	63.4	55.7	104.8	36.9	4.8
Mar.	72.0	53.3	117.4	96.2	88.8	0.0	85.1	21.0	85.6	0.7	62.0	14.8
Apr.	120.4	231.4	204.2	37.7	104.4	236.9	278.9	218.2	287.3	133.2	185.2	81.7
May	141.5	68.0	54.2	114.6	375.7	275.2	216.4	281.8	257.9	54.5	184.0	177.8
Jun.	65.1	221.9	126.5	12.6	264.2	191.2	23.5	64.5	121.0	93.1	118.4	73.3
Jul.	16.9	57.9	124.2	92.7	38.1	71.5	25.8	55.9	19.9	31.8	53.5	143.1
Aug.	139.5	158.1	10.0	0.0	16.1	11.5	22.7	22.1	17.3	91.0	48.8	13.2
Sep.	190.0	259.7	161.4	17.4	43.0	192.8	198.3	132.7	13.5	238.2	144.7	219.8
Oct.	502.8	58.0	238.9	389.2	211.3	326.9	281.4	545.8	148.1	204.9	290.7	486.2
Nov.	195.9	230.1	298.7	434.6	175.8	505.5	393.5	204.4	584.3	164.5	318.7	670.1
Dec.	53.2	88.8	24.4	76.7	82.2	56.4	197.6	6.4	22.5	41.5	65.0	190.5
TOTAL	1510.9	1528.5	1437.6	1465.5	1448.0	1867.9	1763.6	1717.7	1629.7	1199.3	1556.9	2075.3

Table 10. *Rainfall(mm) for the last 10 years and in 1997 (Isolated Seed Estate)*

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	87-96 Ave	1997
Jan.	5.9	3.3	58.4	221.6	44.0	0.0	9.4	110.5	51.2	127.7	63.2	0.0
Feb.	0.0	135.0	0.0	0.0	0.0	0.0	2.0	71.6	32.6	91.2	33.2	3.6
Mar.	21.7	77.4	29.5	34.0	116.0	0.0	53.5	79.6	59.5	0.0	47.1	2.5
Apr.	141.1	233.3	81.7	38.8	147.9	217.8	164.0	141.4	348.2	105.0	161.9	101.7
May	100.2	71.7	16.0	145.6	182.5	207.3	136.3	184.3	337.7	7.4	138.9	179.3
Jun.	49.8	129.7	112.2	8.4	236.5	239.5	2.4	85.5	81.1	133.6	107.9	70.3
Jul.	4.5	91.4	72.1	67.7	29.2	116.9	35.0	39.4	27.7	10.4	49.4	97.1
Aug.	48.1	60.1	1.7	0.0	17.1	28.4	17.5	4.9	13.8	66.6	25.8	7.0
Sep.	270.8	272.2	34.0	9.5	25.8	62.3	89.3	115.9	2.7	159.1	104.2	256.3
Oct.	467.6	61.3	221.9	288.6	221.6	342.3	239.6	274.6	178.2	263.4	255.9	387.9
Nov.	143.2	319.5	214.7	306.7	208.1	406.0	242.8	165.5	666.5	139.7	281.3	448.6
Dec.	49.5	64.8	8.0	59.2	151.5	75.9	304.5	12.8	34.9	90.9	85.2	213.2
TOTAL	1302.4	1519.7	850.2	1180.1	1380.2	1696.4	1296.3	1286.0	1834.1	1195.0	1354.0	1767.5

Table 11. *Rainfall (mm) - Maduru Oya (1997)*

	1995	1996	1997
January	241.0	211.7	12.1
February	125.4	123.2	36.9
March	4.8	2.3	16.4
April	162.7	122.7	211.6
May	48.7	3.9	121.1
June	6.9	71.8	23.0
July	11.2	0.0	20.9
August	69.9	162.8	1.7
September	248.3	9.3	109.7
October	82.2	149.5	329.5
November	147.4	334.7	327.4
December	175.6	240.6	311.6
Total	1324.1	1432.5	1521.9

REPORT OF THE TISSUE CULTURE DIVISION

Head - L K Weerakoon, Ph D

1. GENERAL

The Division focussed on the development of a clonal propagation method for coconut. Culture conditions were refined further to improve callogenesis, somatic embryogenesis and shoot regeneration from various explants. Plant regeneration was achieved with immature embryo, immature inflorescence and shoot meristem explants. Preliminary investigations on the development of a charcoal-free protocol for callogenesis in immature embryo explants gave encouraging results. Experiments on plumule and anther culture were commenced. Studies on cell suspension culture were initiated as an attempt to mass produce embryogenic calli and somatic embryos.

2. RESEARCH PROJECTS

PROJECT 18: STUDIES ON THE VEGETATIVE PROPAGATION OF COCONUT

Experiment 18.1: In vitro culture of mature zygotic embryos of local forms and varieties of coconut

Experiment 18.1.1: Propagation of *dikiri* pol using embryo culture technique (1992)

Embryo culture technique was applied successfully to rescue embryos of *dikiri* coconuts. Eighty six of the *in vitro*-raised *dikiri* seedlings were planted at Bandirippuwa Estate for field evaluation. Experiments are in progress to improve the survival rate of dikiri seedlings during acclimatization.

L K Weerakoon, S C Fernando, V R M Vidhanaarachchi, 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 for drought-tolerance were continued using polyethylene glycol (PEG) as the water stress simulant. Seedlings derived

from zygotic embryos of variety T X T (Ambakelle special) were used as experimental material. Seventy seedlings which tolerated stress conditions caused by different levels of PEG were planted at Lenawa Estate 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 Poththukulama Research Station was found to be satisfactory.

L K Weerakoon, S C Fernando, V R M Vidhanaarachchi & E S Santha

Experiment 18.1.3 Studies on the improvement of embryo culture technology (1994)

Changes to the acclimatization procedure were done in order to improve the soil establishment of *in vitro*-raised coconut seedlings. Embryo-cultured seedlings were transplanted in different potting mixtures (containing different combinations and proportions of river sand, compost, dried cow dung and coir dust). The growth of seedlings in each type of potting mixture is being assessed in order to select the most suitable potting mixture.

The effect of *in vitro* acclimatization (i.e. acclimatization of vitro-plants while they are still in the culture vessel) on the survival of *in vitro*-raised plants is also being assessed.

L K Weerakoon, S C Fernando, V R M Vidhanaarachchi, E S Santha & C K A Gamage

Experiment 18.1.5: Studies on *in-vitro* preservation of mature zygotic embryos of coconut (1996)

An experiment was undertaken to develop suitable culture conditions for medium-term storage of mature embryos of coconut with the view of establishing *in vitro* techniques to facilitate germplasm exchange.

Two basal media [modified Eeuwens Y3 medium formulated by Karunaratne *et al.* (1985) and the medium defined by Assy-Bah *et al.* (1989)] supplemented with different concentrations of sucrose (0, 20, 40, 60 g/l) and 2 different anti-browning agents (activated charcoal and L-Cysteine-HCl) were tested. Mature zygotic embryos of the variety T X T were cultured on the above media. After 3 and 6 months of *in vitro* storage, embryos were recovered by culturing them in

germination medium and the germination percentages were recorded (Tables 1 & 2).

Table 1. *Germination percentage of embryos after 3-month storage period in different culture media*

Basal Medium	Anti-browning Agent	Sucrose Levels (g/l)			
		0	20	40	60
Y3	Activated Charcoal	0	56	75	81
	Cysteine-HCl	0	13	44	44
AS	Activated Charcoal	0	19	75	56
	Cysteine-HCl	0	0	56	75

Y3 = modified Eeuwens Y3 medium AS = medium defined by Assy-Bah *et al.* (1989)

The results clearly showed that a higher concentration of sucrose (40-60 g/l) is required for successful storage of embryos. Total inhibition of germination (0 %) was observed when embryos were stored in media devoid of sucrose (Tables 1 and 2). The germination of embryos stored in media containing low levels of sucrose (20 g/l) was poor. As shown in Tables 1 and 2, preservation of embryos in media containing higher levels of sucrose (40-60 g/l) led to a higher germination rate. In most of the treatments, the germination percentage of embryos after 3 months storage was much higher than that of 6 months storage indicating a considerable loss of viability with prolonged storage period.

Table 2. *Germination percentage of embryos after 6-month storage period in different culture media*

Basal Medium	Antibrowning Agent	Sucrose Levels (g/l)			
		0	20	40	60
Y3	Activated Charcoal	0	19	13	25
	Cysteine-HCl	0	6	44	50
AS	Activated Charcoal	0	0	31	44
	Cysteine-HCl	0	0	0	31

Y3 = modified Eeuwens Y3 medium AS = medium defined by Assy-Bah *et al.* (1989)

Both the basal media tested were shown to be suitable for preservation of embryos and both activated charcoal and L-Cysteine-HCl effectively minimized browning of embryos.

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)

The experiments conducted on immature embryo culture gave promising results. The culture conditions for callogenesis were refined further and consistent callus production at a high frequency was achieved. The culture conditions for somatic embryogenesis and plant regeneration were also improved and plantlets were regenerated in a consistent manner. Several of the clonal plants were transferred to soil.

The use of pluronic F 68 (a non-ionic, co-polymer surfactant) has shown to be beneficial for tissue cultures of several crop species. Therefore the effect of pluronic on immature embryo culture of coconut was investigated. Preliminary results showed that the incorporation of pluronic (at 0.01-0.001%) enhanced the callus production in immature embryos. Previous experiments have shown that certain types and brands of activated charcoal are not suitable for induction of callus in immature embryo explants. However, use of such unsuitable types of charcoal in combination with pluronic resulted in callus production in immature embryos. Further experiments are in progress to confirm the above results.

In order to reduce the cost of culture media, the possibility of substituting analar grade sucrose in the callus induction medium with commercial grade sucrose was studied. The results revealed that the use of commercial grade sucrose in callus induction medium had a positive effect on callusing. 82% of the explants produced callus in media containing commercial grade sucrose whereas only 69% of the explants produced callus when cultured in media containing analar grade sucrose. Further experiments will be conducted to study the possibility of using commercial grade sucrose in the regeneration medium.

Previous experiments have shown that somatic embryogenesis in coconut is significantly improved by the use of Abscisic acid (ABA). Experiments are in

progress to determine the optimum concentration and duration of ABA application in order to optimize the regeneration protocol.

The effect of high agar concentration (2%) on somatic embryogenesis of coconut was also studied. The results revealed that the stress conditions induced by the incorporation of high concentrations of agar in the medium promoted somatic embryogenesis and plant regeneration.

Activated charcoal is often used in coconut tissue culture media for its beneficial effects. However, the use of activated charcoal led to variable results as it adsorbs growth regulators from the culture medium. Therefore the feasibility of developing a charcoal-free protocol for immature embryo culture of coconut was studied. Four different antioxidants namely ascorbic acid, polyvinylpyrrolidone (PVP), citric acid and L-Cysteine-HCl were tested for their ability to replace charcoal in the callus induction medium of immature embryo culture.

As shown in Table 3, thirty six treatments comprising of different concentrations of the 4 antioxidants in combination with different concentrations of 2,4-D were tested against 0.25% activated charcoal with 24 μM 2,4-D (control). After culturing into different treatments, the intensity of browning, percentage of callus production and the size of the callus formed in immature embryo explants were assessed. The results showed that all 4 antioxidants were effective in minimizing browning in immature embryo explants. The highest percentage of callus production (78.2 %) was observed in the medium containing activated charcoal. However, callus production in several other treatments with PVP, ascorbic acid and citric acid (in combination with 0.5 μM 2,4-D) were fairly high (Table 3).

Apart from the control,the most effective treatments for callus production were PVP at 20,000 mg/l and ascorbic acid at 1100 μM (in combination with 0.5 μM 2,4-D) in which 60 % of the explants produced callus. The feasibility of inducing somatic embryogenesis in immature embryo-derived callus in a charcoal-free medium was also tested. Some of the callus cultures containing 20,000 mg/l PVP (with 0.25-0.1 μM 2,4-D) produced somatic embryos. The results of this preliminary investigation indicated that the development of a charcoal-free protocol for immature embryo culture is feasible. Further refinements to the charcoal-free media are being investigated to improve callogenesis and somatic embryogenesis.

S C Fernando, L K Weerakoon & C K A Gamage

Table 3. *Mean % of callus production in immature embryo explants cultured on media with different concentrations of antioxidants and 2,4-D*

Antioxidant	Level of Antioxidant	2,4-D Concentration (μM)		
		1.5	1.0	0.5
Ascorbic acid	400 μM	11.7	48.2	23.5
	800 μM	18.2	36.5	48.2
	1100 μM	11.7	30.0	60.0
PVP	1000 mg/l	18.2	30.0	35.2
	10,000 mg/l	41.7	41.7	18.2
	20,000 mg/l	23.5	23.5	60.0
L- Cysteine HCl	600 μM	11.7	11.7	30.0
	1200 μM	11.7	11.7	30.0
	1600 μM	11.7	23.5	18.2
Citric acid	10 mg/l	18.2	11.7	48.2
	50 mg/l	0.00	11.7	41.7
	100 mg/l	11.7	30.0	18.2

[Control (0.25 % activated charcoal with 24 μM 2,4-D) = 78.2]

Experiment 18.2.2: Culture of leaf explants (1983)

Studies were undertaken to develop culture conditions for callogenesis and somatic embryogenesis in leaf explants. Tender leaf explants obtained from 18-24 month old seedlings were cultured in the callus induction medium (medium 72 with 24 μM 2,4-D and 0.25% activated charcoal) which was initially developed for immature embryo culture. A small proportion of the explants (about 10%) produced embryogenic callus within 2-3 months of culturing.These callus tissues were similar to immature embryo-derived callus in appearance. In order to induce somatic embryo formation, the callus was transferred to the regeneration medium containing 5 μM ABA. Some of the callus produced globular somatic embryos when cultured in the above medium. However, the frequency of somatic embryogenesis was much lower than that was achieved in immature embryo culture. A few of the somatic embryos sprouted in culture to produce tiny shoots. Further experiments are underway to improve callogenesis and somatic embryogenesis from leaf explants. The feasibility of inducing callus in charcoal-free culture media is being studied.

S C Fernando, L K Weerakoon & E S Santha

Experiment 18.2.3: Culture of root explants (1991)

Secondary roots obtained from *in vitro*-grown seedlings were cultured into several culture media for the induction of callus. However, callus production was not observed in any of the media tested. Attempts were also made to culture roots obtained from mature , field-grown plants. However, the contamination rate was very high when such roots were used. Several sterilization procedures with different combinations and concentrations of Benlate, streptomycin and Chlorox were tested but none of them were effective enough to control the heavy contamination in root cultures. Further experiments are in progress to establish a suitable sterilization technique to prevent the contamination of cultures.

S C Fernando, V R M Vidhanaarachchi & L K Weerakoon

Experiment 18.2.4: Culture of floral meristem explants (1995)

The culture conditions developed for callogenesis and somatic embryogenesis in immature embryo explants were found to be suitable for immature inflorescence explants as well. The developmental stage of the inflorescence was found to be critical for callogenesis. The most suitable explants for callogenesis were obtained from 10-12 cm long inflorescences (which usually corresponds to the inflorescence at the 4th leaf axil after the central spindle). Pre-culturing of inflorescence explants in a hormone-free medium for 2 days enhanced callus production. About 40% of the pretreated explants produced embryogenic callus when cultured in the callus induction medium containing 24 μM 2,4-D and 0.25 % activated charcoal. The inflorescence tissues were subjected to several other pretreatments (heat and cold pretreatments, pulse treatments in IBA and zeatin) but none of them had any positive effect on callusing. No callusing was observed when sucrose in the callus induction medium was replaced by alternate carbohydrate sources such as glucose and maltose.

When cultured in the regeneration medium containing 5 μM ABA, some of the callus tissues produced somatic embryos. A few of the somatic embryos germinated and produced shoots. In cases where spontaneous root formation did not occur, rooting were induced (by an IAA pulse treatment) to obtain complete plantlets. Some callus gave rise to incomplete or deviated somatic embryos. Further development of these structures led to the formation of shoot-like structures or other abnormal structures. Adventive root formation and development of haustorial-type tissues were also common.

Direct regeneration of shoots from flower primordia occurred at a very low

frequency in the medium formulated by Verdeil et al. (1994) which contained 200 μM 2,4-D and 0.2 % activated charcoal. These shoots continued to grow when transferred to modified Eeuwens Y3 medium. Induction of roots on the shoots led to the development of complete plantlets.

Further refinements to the regeneration medium are being done to optimize somatic embryogenesis and subsequent plant regeneration. The feasibility of developing a charcoal-free culture medium for callus induction is also being tested.

V R M Vidhanaarachchi, L K Weerakoon & S C Fernando

Experiment 18.2.5: Culture of plumule explants (1997)

Similar to immature zygotic embryo explants, plumular tissues excised from mature zygotic embryos of coconut have a considerable potential for micropropagation of improved seed material. As plumules are excised from mature embryos, it has an advantage over the use of immature embryos which are difficult to find at their correct developmental stage.

Initial investigations on plumule culture were conducted and two of the published media and medium 72 (supplemented with 24 μM 2,4-D) were tested for callus induction in plumule explants. After 3 months of culturing, more than 50% of the explants in medium 72 produced embryogenic callus indicating that the culture conditions developed for callogenesis in immature embryos were suitable for plumule explants as well. About 30% of the explants produced callus in one of the published media tested whereas no callus was formed in the other medium.

Further experiments are in progress to identify the optimum 2,4-D concentration for callusing and to induce somatic embryogenesis in plumule-derived callus.

S C Fernando & L K Weerakoon

Experiment 18.2.6: Studies on cell suspension culture of coconut (1997)

Lack of somatic embryo multiplication phase is a major limitation to the development of a regeneration protocol. Establishment of embryogenic cell suspension cultures would facilitate mass production of embryogenic callus and somatic embryos. Therefore preliminary studies on cell suspension culture were conducted. Compact callus (chopped into small pieces) derived from immature embryos were used for the initiation of callus. Two different basal media with

varying concentrations of 2,4-D (0.5-24 μM) were tested. Within a week, the callus tissues in all the treatments turned brown and became necrotic. A small fraction of the callus tissues (in media containing 0.5 μM 2,4-D) recovered and continued to grow but callus multiplication was not observed.

As friable callus is more suitable for cell suspension initiation, experiments were directed towards obtaining friable callus from immature embryo and immature inflorescence explants. Repeated subculture of calli, application of higher levels of 2,4-D (50- 100 μM) and incorporation of casein hydrolysate in the callus induction medium were some of the treatments used to obtain friable callus. When compact callus was repeatedly subcultured in media containing 24 μM 2,4-D slightly friable callus was produced. Experiments are in progress to improve the culture conditions to obtain completely friable callus for initiation of suspension cultures.

S C Fernando

Experiment 18.2.8: Studies on coconut anther culture (1997)

Preliminary studies on coconut anther culture were initiated with the objective of regenerating haploid plants via *in-vitro* culture.

Attempts were made to induce callusing in cultured anthers. Anthers were obtained from inflorescences of -1 stage (considering the youngest open inflorescence as 0). Two different basal media (both solid and liquid) with varying concentrations of sucrose and different levels of pH were tested for the induction of callus in coconut anthers. In addition to the above treatments, the effects of sucrose starvation , heat and cold pre-treatment of explants on callogenesis were studied. None of the above treatments was able to induce callus in the cultured anthers. Intense browning and necrosis of explants were observed under all the culture conditions tested. Further experiments are in progress to define suitable culture conditions for callogenesis in *in vitro*-cultured anthers.

V R M Vidhanaarachchi, S C Fernando & L K Weerakoon

Experiment 18.2.9: Culture of shoot meristems (1997)

Preliminary studies to develop suitable culture conditions for callogenesis and somatic embryogenesis in shoot meristem explants were commenced. Shoot tips were excised from 18-24 month old seedlings, chopped into small pieces and cultured in the callus induction medium containing 24 μM 2,4-D and 0.25 %

activated charcoal. About 15 % of the explants produced embryogenic callus in the above medium. Induction of somatic embryos in meristem-derived callus was done by culturing them into the regeneration medium containing 5 μM of ABA. Some of the somatic embryos germinated and produced shoots. In cases where spontaneous rooting did not occur, roots were induced on these shoots by an IAA pulse treatment. A few of the well developed clonal plants were transferred to soil for acclimatization.

Investigations are underway to induce callus in shoot meristems excised from mature palms.

S C Fernando, L K Weerakoon & E S santha

3. TRAINING AND EXTENSION ACTIVITIES

Mrs. C. Navaratne, a M.Sc. candidate from the Faculty of Science, University of Colombo completed her thesis research on the "Development of a charcoal-free protocol for callogenesis and somatic embryogenesis in immature embryo explants of coconut", under the supervision of Dr L K Weerakoon.

4. ACKNOWLEDGEMENTS

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 and statistical analysis of data.

REPORT OF THE COCONUT PROCESSING RESEARCH DIVISION

Officer-in-Charge - C Jayasekara, Ph D

1. GENERAL

The chemical composition of developing kernel at different stages of maturity was investigated with open pollinated tall (OP), Tall x Tall, Dwarf x Tall and Tall x San Ramon (TxSR) to gather basic information on fatty acids, amino acids and sugar profile of developing nuts to complement kernel-based value added product development. These studies revealed that significant differences in fatty acid composition exist between T x T, two colour formes of Dwarf x Tall and with different stages of maturity. A study conducted to determine industrial scale extractable oil content in OP, DxT, TxT and TxSR revealed that they were having 740,666,740 and 776 ml of oil/1 kg of copra respectively. Hence T x SR new hybrid gave the highest oil content than that of OP and TxT.

ADB assisted Science and Technology Personnel Development Project agreed to provide US $ 112,500 for Food Processing Research and Development.

2. RESEARCH PROJECTS

Experiment 40. 0: Kernel formation and its constituents

Experiment 40.0.1: Biosynthesis of coconut kernel (T x T)

The actual maturity stage of the nuts was obtained by tagging the newly emerged inflorescences.

Kernel formation in developing fruits starts between the fifth and sixth month of maturity.

Oil content is ~ approximately 1% (wet basis) at the sixth month and it increases with maturity, and reached ~ 32% at the eleventh month.

Lauric (C 21:0), myristic (C 14:0), palmitic (C 16:0), oleic (C 18:1) and linoleic (C 18:2) acids are the most prominent fatty acids in six months old mature nuts. lauric acid (C 21:0) content increases with maturity while palmitic, oleic and linoleic acid contents were decreased. However, myristic acid content stabilized at the seventh month.

Statistical analyses of the above results are in progress.

P Hewavitharanage & C Jayasekara

Experiment 40. 1: Fatty acid composition of coconut oil, preservation and value addition to coconut oil

Experiment 40.1.1: Fatty acid composition of different coconut cultivars and hybrids of coconut

Analysis of mature nuts of cultivar T x T and two colour forms of hybrids (DG x T and DY x T) which were collected from the Isolated Seed Garden (ISG), Ambakelle, revealed that the hybrid DG x T contains approximately 8% less oil than other two.

In order to find out the fatty acid profile, fatty acid methyl esters of the above three types were analyzed using gas-liquid chromatography. Comparison of T x T , DG x T and DY x T revealed that there is a significant difference among fatty acid contents (Table 1). Variety T x T has the highest percentage of lauric acid (54.1%) and the lowest percentage of palmitic acid (6.28). However, lauric acid content of hybrids is less than that of T x T and 45.1% and 46.5% in DG x T and DY x T respectively.

Comparison of T x T with hybrid DY x T revealed that there is no difference in caprylic acid and oleic acid content.

Comparison of T x T with hybrid DG x T revealed that except linoleic acid percentage of all the other fatty acids is significantly different. Percentage of unsaturated fatty acids is less in T x T and DY x T.

Cultivar T x T has the highest percentage of medium and short chain fatty acids (68.8%).

Comparison of two colour forms of hybrids shows that except lauric and palmitic acid all the other fatty acids are different. Short chain fatty acid content in DG x T and DY x T were 55% and 61.3% respectively.

Since medium and short chain fatty acids give substantial health benefits, oil of var. T x T is important as a cooking oil.

P Hewavitharanage & C Jayasekara

Table 1. *Fatty acid composition of three improved coconut cultivars of sri lanka*

Cultivar	Caproic C 6 : 0	Caprylic C 8 : 0	Capric C 10:0	Lauric C 12:0	Myristic C 14:0	Palmitic C 16:0	Stearic C 18:0	Oleic C 18:1	Linoleic C 18:2
T x T	Trace	7.8	5.9	54.1	18.6	6.3	1.6	3.9	1.48
DG x T	Trace	5.5	4.2	45.2	21.1	10.2	2.9	7.1	1.79
DY x T	Trace	8.1	6.7	46.5	17.2	9.5	2.3	4.7	0.81
Signifi-cance		P=0.0001	P=0.0001	P=0.0001	P=0.0001	P=0.0001	P=0.0918	P=0.0027	P=0.0027
CV		13.2	11.5	4.18	6.16	18.69	47.17	24.09	34.16
LSD		0.98	0.68	2.12	1.22	1.68	-	1.37	0.50

Experiment 41.0: Development Research on Kernel Products

Experiment 41.2: Development Research on Copra Production

Experiment: 41.2.1: Investigation of Copra Characters of different cultivars and hybrid crosses

It is important to study varietal differences in copra characters in order to identify those which produce high quality copra. From the processing point of view, high oil content, high crude fibre content, firmness or rigidity of the dried kernel are considered desirable characters for copra manufacture.

In this study, varieties DxT, TxD, TxT, TxSR and ordinary T were used to process copra. Nuts were processed after seasoning for three weeks. The preliminary studies show the following results.

(i) Copra Yield

According to the preliminary studies, both the average husked nut weight and the copra yield are highest for ordinary Tall variety. This may be due to the highest average husked nut weight observed for ordinary Tall. However when compared with the copra yield of varieties on the basis of per gram husked nut weight, the highest per cent yield was recorded for TxSR. This further indicates that copra conversion rate is not always 32% of the fresh nut weight and is variable among different varieties. Results are summarised in Table 2.

Table 2. *Varietal Difference in Husked Nut Weight and Copra Yield*

Variety	No.of Nuts Processed	Average Husked Nut Wt/Nut(g)	Copra yield/Nut(g)	Percentage Yield of Copra
TxT	80	546	172.2	31.53
TxD	80	634	169.0	26.65
DxT	80	654	187.0	28.59
TxSR	40	590	187.0	31.69
Ord.Tall	80	718	205.8	28.66

(ii) Oil Extraction

According to oil extraction efficiency studies conducted in an industrial scale mini oil expeller, both the amount of oil extractable and the total available oil per kilogram of copra are highest for TxSR.

Results of the preliminary studies are presented in Table 3.

J M N Marikkar & U Samarajeewa

Experiment 43.0: Development Research on Sap Products

Experiment 43.1.1: Production of Refined Jaggery, Treacle, Golden Syrup and Sugar Candy

It is proposed to study factors which affect the quality of jaggery, treacle, golden syrup and sugar candy. In the present study we are interested in determining the quality of the above mentioned sap products in respect of the following.

(a) pH of the coconut sap

(b) Use of various additives to control fermentation of coconut sap in the collection pot

It is observed that pH of the sap has a direct influence on the quality of the final products (Table 4). High quality jaggery is produced when the sap pH is 5.5 or more. In the case of treacle, sap with pH 4.5 or more was found to yield treacle of attractive brown colour and free from any sour taste.

J M N Marikkar & D B T Wijeratne

3. ACKNOWLEDGEMENT

Fatty acid analysis by gas chromatography and amino acid analysis by HPLC were carried out at the Ceylon Institute of Scientific Research. Useful guidance and cooperation received from Dr Nandani Ediriweera and rest of the staff at CISIR is gratefully acknowledged. Invaluable suggestions received from Prof. U Samarajeewa, University of Peradeniya and Dr D B T Wijeratne, Dept. of Agriculture also acknowledged.

Table 3. *Oil extraction efficiency of copra from different varieties of coconut*

Variety	Moisture % of copra	Copra wt(Kg)	Amount of oil extracted (ml)	Amount of oil extracted Kg of copra(ml)	% of oil left in copra meal	Total available oil/Kg of copra (ml)	Amount of copra meal/Kg of copra (g)
Ord Tall	4.9	10.0	7400	740	9.7	820	303
DxT	5.3	10.0	6660	666	11.0	748	270
TxD	5.9	10.0	7400	740	7.4	799	303
TxT	5.4	10.0	7400	740	9.9	821	308
TxSR	4.3	6.0	4660	776	9.6	858	265

Table 4. *Observed variations in taste and texture of treacle and jaggery with the pH of sap*

Sap pH	Additive	Product	Yield/L (ml/g)	Colour	Taste	Texture
4.0	Hal bark	Treacle	102	Pale brown	Sour taste	-
4.3	-do-	-do-	117	Light brown	-do-	-
4.5	-do-	-do-	124	Brown	Good	-
4.8	-do-	-do-	123	-do-	-do-	-
5.0	-do-	-do-	132	-do-	-do-	-
5.5	-do-	-do-	141	-do-	-do-	-
5.5	-do-	Jaggery	139	Brown	-do-	Good
5.8	-do-	-do-	156	Brown	-do-	-do-
6.0	-do-	-do-	158	Light Brown	-do-	-do-
6.4	-do-	-do-	124	-do-	-do-	-do-
6.5	-do-	-do-	125	-do-	-do-	-do-
6.7	-do-	-do-	132	-do-	-do-	-do-

REPORT OF THE PLANT PHYSIOLOGY DIVISION

Officer-in-Charge - C S Ranasinghe, Ph D

1. GENERAL

During the year, greater attention was given to research on toddy tapping and development of post harvest storage technique/s for king coconut (whole nut and semi-processed nut). DxT was found to be more suitable cultivar for toddy than ordinary tall. Best storage condition, temperature regime and wrapping material, were identified for improving shelf life of king coconuts.

Water use efficiency studies were continued with F2 generation of Ambakelle Special palms. A new experiment was commenced to screen drought tolerant palms using xylem sap Abscisic acid content. Canopy and root modification experiment was terminated after eight years of data collection.

The experiments carried out on Leaf Scorch Decline revealed some valuble information on biochemical and anatomical aspects. Possibility of artificial stimulation of inflorescence of affected palms was explored to improve assimilate partitioning.

Collaborative research was commenced with Agronomy, Soils and Plant Nutrition and Genetics and Plant Breeding Divisions.

2. RESEARCH PROJECTS

PROJECT 16: PHYSIOLOGY OF THE COCONUT PALM

Experiment 16.9: Studies on vegetative growth and physiology of Ambakelle special seedlings grown under field conditions 1988

A comparison of the yield between two cultivars, Ambakelle Special and TxT seedlings, was continued. The percent palms in flower and mean annual yield during the first and second years of harvest are given in Table 1.

Table 1. *Percent palms in flower and average number of nuts per palm in Ambakelle Special (AS) and TxT palms during the current year and previous year*

Cultivar	Percent flowering (ninth year)	Avg no of nuts per palm per year	
		96	97
AS	86 %	23	21
TxT	94 %	15	19

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 eight 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. There wasn't any effect of either root modification or canopy modification on fresh nut weight, husked nut weight, split nut weight and kernel fresh and dry weight. The experiment was terminated.

R Wimalasekara, C Jayasekara, C S Ranasinghe, L R S Silva & P S A de Saram

Experiment 16.13: Studies on water-use efficiency of different ecotypes of coconut in relation to the stable carbon isotope discrimination ratio - 1992

In order to analyse carbon isotope discrimination ratio, leaf samples were collected from 60 controlled pollinated Ambakelle Special palms (F_2 generation). Intercellular CO_2 concentration and assimilation rate of the same leaves were also measured.

C Jayasekara, R Wimalasekara, N P A D Nainanayake & P S A de Saram

Experiment 16.14: Importance of root-to-shoot communication in drying soil: role of Abscisic acid in drought tolerance in coconut 1997

This experiment was commenced with a view to develop an efficient protocol for screening drought tolerant palms in the field using xylem sap Abscisic acid (ABA) content as a screening tool. Preliminary studies were done in the Plant House using a drought sensitive (DxT) and a drought tolerant (TxT) cultivar. Drying cycles were imposed and xylem sap was collected for ABA analysis. Soil moisture depletion pattern, reduction in leaf area development, variation in stomatal resistance, transpiration, photosynthesis, leaf water potential and leaf epicuticular wax content were measured during the period of water stress.

C S Ranasinghe, R Wimalasekara, P S A de Saram, R D N Premasiri, L R S Silva & W P K K Fernando

Experiment 16.15: Sap exudation in different cultivars of coconut - 1996

To select most suitable cultivars for toddy tapping, the experiment was repeated with the same cultivars, Tall, DxT, Nawasi and Bodiri, as in the previous year. The volume and biochemical constituents of the sap were compared. The data collected over eight months revealed that DxT produced significantly higher volume of toddy and Bodiri produced significantly lower volume compared to control, TxT (Table 2). Since the Bodiri inflorescence was very short and half empty it cannot be recommended as a suitable cultivar for sap production. DxT has been found to be a better cultivar than tall for toddy tapping in areas with well distributed rainfall.

Table 2. *Average volume of toddy and percent sugar contents in different cultivars of coconut*

Variety	Sap vol/inflor (lit)	Sap vol/day (ml)	% Sugar (g/100ml)
Tall	18.57	689	17.4
Bodiri	10.40	581	16.1
DxT	27.03	1214	17.1
Nawasi	16.34	631	16.6

No significant difference was observed in total sugar and sucrose contents among the four cultivars.

C S Ranasinghe, R Wimalasekara, W P K K Fernando & P S A de Saram

Experiment 16.16: Changes in the carbohydrate content of trunk and subtending leaf in relation to sap production in coconut 1996

The experiment was continued to develop a rapid biochemical technique to select palms with high toddy yield. Analysis of starch and total soluble sugar content in the trunk and subtending leaf of twenty ordinary tall palms was done to determine the initial carbohydrate content (Table 3). The same palms have been used for toddy tapping while monitoring changes in the above biochemical parameters.

Table 3. *Mean carbohydrate contents (mg/g dry wt) in the trunk and subtending leaf before tapping*

	March		April		May	
	sug	sta	sug	sta	sug	sta
trunk	61.21	23.69	57.48	16.44	43.94	28.71
leaf	55.75	17.69	56.60	14.07	58.40	22.60

sug - total soluble sugars sta - starch

Starch content of the trunk and subtending leaf varied between 10.53-43.20 and 8.55-28.63 mg per g dry wt, respectively. Total soluble sugar content of the trunk and leaf varied between 28.52-79.98 and 31.89-80.70 mg per g dw, respectively.

C S Ranasinghe, R Wimalasekara, L R S Silva & W P K K Fernando

Experiment 16.17 : Sequential toddy tapping and nut production in coconut 1996

To obtain maximum income from the coconut palm, the sequential production of two products, toddy and nuts has been investigated. Sixty four tall palms were selected at Bandirippuwa Estate and separated into four groups.

T1 - Sap production only
T2 - Nut production only
T3 - Sequential sap and nut production from the same spathe
T4 - Sequential sap and nut production from the same palm (three month tapping and three month nut production intervals)

Volume and sugar content of toddy, number of nuts and nut components are being recorded.

C S Ranasinghe, R Wimalasekara,
P S A De Saram & W P K K Fernando

Experiment 16.18: Yield stimulation and sustainability of coconut sap using yield stimulants - 1996

The experiment was continued to identify a suitable yield stimulant and an anti-oxidant to improve toddy yield without reducing the quality of sap. The following treatments were imposed on inflorescence of tall palms.

T1 - Control
T2 - 2.5% Ethrel
T3 - 250 ppm (Ascorbic acid + Citric acid)
T4 - Paste (chillie powder, pepper powder, garlic, coconut husk ash, salt and lime) used for 'Kitul'palm

Preliminary studies revealed that application of 2.5% Ethrel at the axis of the inflorescence and application of 250 ppm Citric + Ascorbic acids on the cut surface of the inflorescence increase the daily toddy volume without changing the sugar content and composition of the sap. Toddy volume per inflorescence was also increased by ethrel application (Table 4).

Table 4. *The impact of yield stimulants on toddy yield and percent sugar contents in tall cultivar*

Treatment	Toddy volume ml/day	l/infl	% Sugars Sucrose	Total
Control	830	25.61	12.40	13.96
Ethrel	1116	32.17	14.30	16.90
Asc+Cit	1113	24.35	14.12	17.60
Paste	826	23.46	12.60	15.10

C S Ranasinghe, R Wimalasekara, W P K K Fernando & P S A de Saram

PROJECT 22: ROOT SYSTEM OF THE COCONUT PALM

Experiment 22.1: Morphology, growth and distribution of roots in different varieties of coconut under different land suitability classes - 1995

TxT, Ambakelle Special (AS), DxT, and San Ramon (SR) seedlings grown under S1, S2 and S4 land suitability classes were sampled and number of primary and secondary roots, root colour, number of live and dead roots, root length and dry weight were measured using soil core samples. Preliminary studies showed that all the four varieties performed well in S1 and S2 than in S4 land suitability class on root dry weight basis. Of the four varieties San Ramon showed the lowest root dry weight in all the soil types (Table 5).

Table 5. *Changes in total root dry mass of different varieties under different land suitability classes*

Variety	Land suitability class		
	S1	S2	S4
	Total root dry wt. (g)		
T x T	2.13	3.85	1.54
D x T	1.74	3.37	1.03
AS	0.94	2.77	1.90
SR	0.44	1.14	0.96

R Wimalasekara, N P A D Nainanayake, C Jayasekara & R D N Premasiri

Experiment 22.3: Morphology, growth and distribution of roots in adult palms of variety TxT under different land suitability classes - 1995

Parameters such as number of primary and secondary roots, root colour, number of live and dead roots, root length and root dry weights were measured in TxT adult palms under 4 different land suitability classes using soil core samples. The highest root dry weight was observed in S3 soil compared to S1, S2 and S4. In S3 and S4 soils, 64.15% and 68.88% of total roots were distributed in 0.5 m distance from the bole whereas in S1 and S2 it was 47.39% and 47.69% respectively. In S3 and S4 soils, only 4.27% and 7.84% of total roots were found in 1.5-2.0 m area whereas in S1 and S2 it was 16.22% and 18.04%, respectively.

R Wimalasekara, 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 month old king coconuts collected from Bandirippuwa Estate, Walpita and Marawila were tested for keeping quality with;

(a) Waxing the perianth region, wrapping with cling film and storing at 14°C

(b) Without waxing the perianth region, wrapping with cling film and storing at 14°C

Analysis of liquid endosperm for sugars revealed that there was no change in sugar content in both treatments after 5 weeks of cold storage, compared to initial sugar content (Table 6).

Table 6. *Mean sugar contents in liquid endosperm of king coconut (whole nut) after 5 weeks, storage temp 14°C*

Location	Sugar	Sugar content (g/100ml)		
		Init	+wax	-wax
Walpita	Glucose	2.86	2.13	2.04
	Fructose	2.56	1.98	2.11
	Sucrose	0.15	0.15	0.13
	Total	5.72	5.34	5.29
Marawila	Glucose	2.56	2.14	2.49
	Fructose	2.28	1.89	1.76
	Sucrose	0.18	0.18	0.13
	Total	5.24	4.90	5.06
BE	Glucose	2.55	2.63	2.41
	Fructose	2.41	2.47	2.20
	Sucrose	0.17	0.17	0.13
	Total	5.52	5.54	5.50

Init, initial +wax, with waxing -wax, without waxing

Semi-processed (shaved) nuts were also tested for keeping quality. To avoid browning of the cut surface and fungal growth, citric acid, bleach and sodium metabisulphite in different concentrations were applied on the cut surface. The nuts were wrapped with cling film and stored at 14°C. Percent Brix, pH and taste of the liquid endosperm and cosmetic appearance were tested after 3 weeks. There was no significant change in % Brix, pH after 3 weeks of storage (Table 7). Taste of nut water and cosmetic appearance were also not affected. None of the treatments were effective to control fungal growth on the cut surface of king coconuts. To overcome browning 25% Citric was found to be the most effective treatment.

Table 7. *Mean values of % Brix and pH in liquid endosperm of king coconut (semi-processed) after 3 weeks, storage temp 14°C.*

Treatment	Initial		After 3 weeks	
	% Brix	pH	% Brix	pH
5% bleach + 5% citric	5.05	4.58	5.20	4.84
5% bleach + 10% citric	5.00	4.65	5.17	4.70
10% bleach + 5% citric	5.00	4.58	5.47	4.83
10% bleach + 10% citric	5.00	4.65	5.18	4.78
25% citric	5.24	4.92	5.30	4.76

R Wimalasekara, C S Ranasinghe, C Jayasekara, P S A de Saram & W P K K Fernando

3. MISCELLANEOUS STUDIES

Experiment: Effect of water stress and soil texture on photosynthesis, carbon metabolism, biochemistry and cellular structure of coconut-1997

The experiment was commenced in a plant house with the objective of investigating the influence of soil water stress on photosynthesis, water relations, cell growth and biochemistry in coconut seedlings of the commercial cultivar CRIC60. Twelve different treatment combinations have been imposed on seedlings, below one year, grown in pots, under plant house conditions as follows.

Treatments:

Stress regimes	W_1 - Maintained at field capacity
	W_2 - Continuous withholding of water for 8 weeks
Soil textural classes	ST_1 - Sandy soil (Weliketiya series)
	ST_2 - Loamy soil (Wilpattu series)
	ST_3 - Clayey soil (Mavillu series)
Compaction levels	C_1 - Bulk density 1.3 g cm^{-3}
	C_2 - Bulk density 1.6 g cm^{-3}

Replicates: 6 seedlings per treatment
Design: Factorial experiment with CRD design

Physiological, biochemical, vegetative growth, anatomical and root growth parameters are being taken after establishment of seedlings at field capacity, during the period of drying and recovery after rewatering.

The results of the experiment would lead to a better understanding of physiological and biochemical processes that determine the growth of coconut seedlings under moisture stress and different soil compaction levels in the different soil textural classes.

N P A D Nainanayake

4. TRAINING AND EXTENSION ACTIVITIES

Plant Physiology Divison actively participated in training programmes for Plantation Management Diploma courses conducted by the National Institute of Plantation Management (NIPM). Coconut growers, undergraduates, Agriculture Diploma students and school children were briefed on research activities and findings of the division.

5. 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 assisting statistical analysis of data.

MULTI-DISCIPLINARY PROJECTS

PROJECT 17 - PREMATURE DECLINE OF PALMS

Project Coordinator - L C P Fernando, Ph D

Divisions participated :

Plant Physiology Division
Crop Protection Division
Tissue Culture Division
Survey Group (Crop Protection Division, Soil and Plant Nutrition Division, Plant Physiology Division, Agronomy Division, Genetics and Plant Breeding Division)

General Remarks :

The multi-disciplinary research programme continued satisfactorily with studies on the physiology of Leaf Scorch Decline (LSD) affected palms. A new experiment was commenced to determine the effect of oxytetracycline treatment on LSD and Premature Decline (PMD) affected palms. Investigations of the Overseas Development Authority (ODA) funded project confirmed that LSD and PMD of coconut in Sri Lanka are not associated with phytoplasmas and viroids.

Survey: Incidence of LSD and PMD in Gampaha district (1996)

The survey initiated to estimate the incidence of LSD and PMD in the coconut lands in Gampaha district progressed satisfactorily. Of the total area cultivated under coconut in the 15 Coconut Development Officer's ranges of the district, approximately 1% of area was selected and categorized randomly into 4 groups of different extents. Determination of the soil type, number of LSD and PMD affected palms in 13 Coconut Development Officers' ranges were completed.

L C P Fernando, W M U Fernando, H T R Wijesekara, G D George, R D N Premasiri, N G Premasiri, A Jayatilake & N Hemasiri

Experiment 17.1: Studies on leaf area development, leaf cell production and cell expansion rates on LSD-affected palms (1996)

Experiment 17.2: **Studies on stomatal physiology and cell water relations on LSD-affected palms (1996)**

Experiment 17.3: **Determination of net assimilation rates, enzyme activities, photosynthetic pigments, proteins and phenolic compounds on LSD-affected palms (1996)**

The data collected at six monthly intervals revealed that the functional leaf area, epidermal cell production and stomatal density were significantly reduced in moderate and severe LSD-affected palms compared to controls (Table 1). Epidermal cell expansion was not affected.

Photosynthetic rate (measured ex-situ) was not affected except in middle and lower whorls of severe LSD-affected palms (Table 1). Similarly, the biochemical constituents such as leaf polyphenols, chlorophyll and Nitrate Reductase enzyme activity were significantly reduced in severe palms compared to controls.

C S Ranasinghe, R Wimalasekara, R D N Premasiri, P S A de Saram & W P K K Fernando

Table 1. *Variation in functional leaf area (LA, cm^2), abaxial epidermal cell number (AECN), stomatal density (SD, No. cm^{-2}), epidermal cell area (ECA, um^2) and net assimilation rate (NAR, $\mu mol\ m^{-2}\ s^{-1}$) on healthy and LSD-affected palms*

	Healthy		Mild	Moderate	Severe
LA	159		138	101	32
AECN	$23x10^6$		$21x10^6$	$16x10^6$	$5x10^6$
SD	Up-	172	172	173	158
	Mi-	170	173	155	158
	Lo-	170	159	162	159
ECA	Up-	678	689	673	676
	Mi-	704	660	644	687
	Lo-	662	629	637	648
NAR	Up-	10.6	11.1	11.1	7.2
	Mi-	10.6	8.70	8.30	5.8
	Lo-	8.90	7.60	8.90	4.4

Up - upper whorl, Mi - middle whorl, Lo - lower whorl

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)

The impact of tapping mild and moderately affected LSD palms for toddy (creating an artificial sink) on expression of symptoms was explored in detail. Initially, the duration of sap flow, daily volume and volume per spathe were significantly lower in mild and moderately affected palms compared to controls (healthy palms). But from the fifth tapping spathe daily toddy volume and volume per spathe started to improve, and at the seventh spathe stage the volumes were similar to healthy palms (Figure 1). Vascular bundles of flower stalks were smaller and more closely packed in moderate palms compared to controls. Pre- and post-tapping symptoms of the palms (number of nuts, number of inflorescence and female flowers, number of fronds and severity of symptoms) have been recorded.

From first tapping spathe to sixth, no significant difference in the solute potential of toddy was observed between control and LSD-affected palms. But in the latter part, in spathe seven and eight, despite the similarities observed in daily volumes, the solute potential of the affected palms was significantly higher than that of controls.

Total polyphenol content in the sap of healthy and mild palms was 500 mg ml^{-1}, and the concentration remained almost constant throughout the period. In moderate LSD-affected palms, the polyphenol content was significantly higher, 630 mg ml^{-1}, in spathes one to four and thereafter, parallel with the increasing daily toddy volume, there was a sharp decrease of polyphenols and reached an average value of 350 mg ml^{-1} at the eighth spathe stage.

Samples analysed over the same period for total soluble sugar concentration in the sap also revealed that there was no appreciable difference in sugars between the LSD-affected and healthy palms (controls).

C S Ranasinghe, R Wimalasekara, W P K K Fernando, L R S Silva, P S A de Saram

Experiment 17.6: Effect of Oxytetracycline on symptom production of LSD and PMD affected palms (1997)

Twenty palms showing mild and moderate symptoms of LSD in Walpita estate were selected and half of them were each injected with 1.6 g of

oxytetracycline in 5 ml of sterilized water. The rest of the palms were injected with 5 ml of sterilized water. In another site at Divulapitiya area 6 palms showing symptoms of PMD were treated with the chemical at the same rate and 3 palms were injected with water. The total number of fronds and the number of scorched fronds in each LSD-affected palm were counted and the uppermost affected frond was marked before the treatment. In PMD-affected palms total number of fronds and nuts were recorded before the treatment. The treatments and observations are being repeated every 3 months.

H T R Wijesekara, L C P Fernando & N G Premasiri

ODA project : Investigation of lethal diseases of unknown etiology (1996)

Polymerase Chain Reaction (PCR) assays were employed to determine any association of phytoplasmas with LSD and PMD of coconut. Heart tissues, mature leaves, spear leaves and unopened inflorescences were collected from LSD and PMD affected palms and genomic DNA from these samples were extracted. PCR assays (using oligonucleotide primers for the conserved sequences of the 16s r RNA gene of phytoplasmas) were performed using above DNA's as templates. A total of 124 DNA samples (92 from LSD-affected tissues and 32 from PMD-affected tissues) were repeatedly tested for the presence of phytoplasma DNA using direct and nested PCR assays. None of the samples tested were found to be positive for phytoplasma DNA with any of the phytoplasma -specific primer pairs used.

Ultra-structural studies using transmission electron microscopy failed to detect any phytoplasmas in LSD and PMD affected coconut tissue samples.

Dot blots containing nucleic acid extracted from LSD and PMD affected tissues were sent to WAITE Institute in Adelaide, Australia for the detection of viroids by molecular hybridization techniques. However, no viroids were detected in any of the samples tested. Therefore, it can be concluded that phytoplasmas and viroids are not associated with either LSD or PMD of coconut.

A Tymon, P Jones (IACR Rothamsted), K Weerakoon & L C P Fernando (Coconut Research Institute)

REPORT OF THE EXTENSION SERVICES DIVISION

Head - P A H Nimal Appuhamy, M Sc

1. GENERAL

In order to transfer new technologies and to encourage coconut growers to make optimum use of their lands, the Division implemented various programmes during the year. As a result, the number of coconut growers, grower organizations, plantation managers and extension staff of the Coconut Cultivation Board were able to make closer interaction with the Institute.

2. OTHER ACTIVITIES

Mr J L J G Pinto, Assistant Information Officer retired from the service with effect from 23 December.

Mr P A H Nimal Appuhamy, Head/Extension Services Division served as a member of the Extension and Development Committee of the Coconut Cultivation Board.

3. EXTENSION PROGRAMMES AND ACTIVITIES

3.1 PERSUASIVE EXTENSION PROGRAMME (PEP)

The Persuasive Extension Programme which was conducted with the aim of assisting coconut estate owners to increase the productivity of their lands, gained much popularity among the growers. As a result, the number of growers willing to obtain this service increased progressively. Although, it was planned to cover over 100 estates during the year, only eighty two estates, covering an extent of 5526 acres, were able to provide our services due to the shortage of field staff. Monitoring of development activities of estates was also carried out.

3.2 COCONUT PICKERS AND TODDY TAPPERS TRAINING

Following the success of coconut pickers training programme conducted in the Pannala Divisional Secretariat in 1996, it was decided to conduct similar training programmes in other Divisional Secretariats of the North Western Province with the financial assistance from the North Western Provincial Council and in collaboration with the Divisional Secretaries of the North Western Province. An awareness

programme was held in 27 Secretary/s Divisions in the Kurunegala and Puttalam districts. These programmes were attended by the Divisional Secretaries, the relevant Grama Niladaries, the trainers and their assistants who were to be trained in their vocation. The job description, mode of training, period of payment etc. were explained in detail by the Coconut Research Institute staff and were requested to respond to CRI. Accordingly the following number of trainees and trainers were identified.

Total number of trainees	-	549
Total number of trainers	-	188

Ten trainees were also identified for toddy tapping training which is expected to be conducted at CRI as a residential course. Once their training is completed they are expected to serve as trainers under Division Secretaries to train youths for toddy tapping.

Due to lack of staff to conduct these programmes, arrangements were made to entrust the implementation of these programmes to the Vocational Training Institute, under the supervision of the Coconut Research Institute.

4. PRINTING SECTION

The activities of the printing section started in 1996, were further improved with the acquisition of Apple Macintosh Computer with lacer printer. The printing of the advisory circulars, handouts for various programmes, annual reports, Cocos journal and other occasional publications were carried out in addition to the printing requirements of other divisions.

5. PUBLICATIONS

During the year the following publications were issued.

Annual Report 1995

Cocos Volume 11

A colourful brochure covering the activities of the Institute titled "Guide to Coconut Research Institute of Sri Lanka" was published in Sinhala and in English to be issued to the visitors.

6. ADVISORY ACTIVITIES

A large number of coconut growers visited the Division seeking technical advice for their problems and to familiarize with the technologies developed by the Institute.

Numerous requests seeking advice for their field problems, were promptly attended.

At the request of estate owners to inspect their plantations in order to improve the productivity of their estates, advisory reports were prepared and submitted for implementation.

7. TRAINING PROGRAMMES AND STUDY TOURS

7.1 One Day Training Programmes

In order to improve the knowledge and skills of coconut land owners and the management staff, popular series of one day training was successfully completed during the year. Details of each programme are as follows:

7.1.1 Programme No. 1 was held at the Head Office, Bandirippuwa Estate on the subject of replanting of coconut with the technical guidance of the Genetics and Plant Breeding Division on 18th April. For this programme 83 trainees were participated.

7.1.2 Programme No. 2 On the subject of soil moisture conservation in coconut land was held at the Ratmalagara Estate, Madampe on 13th May with the participation of 90 trainees.

7.1.3 Programme No. 3 was held at Bandirippuwa Estate on 29 June with the participation of 94 trainees on the subject of fertilizer and plant nutrition with the technical guidance of Soils and Plant Nutrition Division.

7.1.4 Programme No. 4 on the subject of Intercropping under coconut with the technical assistance of Agronomy Division was held at Walpita Estate, Kotadeniyawa on 25th July. Seventy trainees participated in this programme.

7.1.5 Programme No. 5 was held at the Head Office, Bandirippuwa Estate on 12 September on the subject of coconut pests and diseases with the technical guidance

of the Crop Protection Division. Seventy two trainees participated in this programme.

7.1.6 Programme No. 6 was held at the Ratmalagara Estate, Madampe on 12 October on rehabilitation of low yielding coconut plantations, with the technical assistance from Agronomy and Soils and Plant Nutrition Divisions. Number of trainees participated were 77.

7.1.7 Programme No. 7 the final programme on coconut estate management was held at the Head Office, Bandirippuwa Estate on 02 November. 77 trainees participated.

7.2 Job Oriented Practical Training Programme

Due to lack of educated and experience personnel for efficient management of coconut estates, a joint programme with the Rajarata University,Industrial Services Bureau, (NWP) North Western Province Provincial Council and the Coconut Research Institute was launched to train unemployed agriculture diploma holders for coconut estate management. A suitable curriculum was drawn up by the Rajarata University, Makandura to cover all technical areas relating to coconut estate management. The duration of the programme was Six months, of which the first three months were allocated for theory and in the last three months trainees were attached to coconut estates for practical training under the guidance of CRI and other relevant Institution. Twenty eight unemployed diploma holders were selected to follow this programme. The module of coconut plantation management was conducted at the CRI from 24 April to 09 May. After successful completion of the course, certificates were awarded. It was encouraging to note that over 60% of these trained personnel have received permanent employment in the coconut estate sector.

7.3 Other Training Programmes

7.3.1 Diploma course in plantation extension organized by the National Institute of Plantation Management from 13th to 18th January.

7.3.2 Coconut Research Institute staff participated in a training programme held at the Coconut Development Training Centre on 14th July for field officers and Regional Managers of the Coconut Cultivation Board on productivity development.

This programme was co-ordinated by National Institute of Plantation Management.

7.3.3 Three trainees of National Apprentice and Industrial Training Authority received 4 months attachment training from 03 January to 03 April.

Four trainees of National Apprentice and Industrial Training Authority received 4 months attachment training from 03 April to 03 July.

One trainee of National Apprentice and Industrial Training Authority received 4 months attachment training from August to November.

7.4 Study Tours

7.4.1 A Team from Asian Development Bank visited the Institute on 28 January.

7.4.2 A group of 30 students from Dambadeniya Development Foundation visited the Institute on 18 February.

7.4.3 Rev. Fathers and Brothers of the National Seminary, Ampitiya visited CRI on 19 February.

7.4.4 A group of 35 undergraduates from Faculty of Agriculture, Eastern University visited the Institute on 27 February.

7.4.5 A group of undergraduates from the Faculty of Agricultural Science, Uva Campus visited the Institute on 18 August.

7.4.6 A group of second year students from School of Agriculture, Pelwehera visited the Institute on 29 September.

7.4.7 A group of 15 students from School of Agriculture, Pulliyankulama, Anuradhapura visited the Institute on 06 October.

7.4.8 A group of second year students from the Technical college/Kuliyapitiya visited the Institute on 06 November.

7.4.9 A group of 25 students from the Agriculture school, Walpita visited the Institute on 07 November.

7.4.10 A group of 60 Govisevena Niyamaka from Mirigama visited the Institute on 10 November.

7.4.11 Coconut Development Officers and other officers attached to Coconut Cultivation Board Regional Office, Galle visited the Institute on 13 November.

7.4.12 Agriculture Diploma students from Agriculture College, Labuduwa, Galle visited the Institute on 01 December.

7.4.13 A Batch of students from the Agriculture College, Wariyapola visited the Institute on 19 December.

7.4.14 In addition 2926 students visited the Institute from 48 schools during the year, suitable Educational Programme were arranged to show them the activities and the new Technology developed by the Institute.

8. SEMINARS, LECTURES AND EXHIBITIONS

The division actively participated and presented a paper on Persuasive Extension Programme at the Technical Workshop held at the Coconut Development Training Centre from 01 to 03 April to mark the Silver Jubilee of the Coconut Cultivation Board.

The division co-ordinated a Research Extension Dialogue between the research staff of the CRI and the extension personnel of the Coconut Cultivation Board in Marawila and Kuliyapitiya regions which was held on 16th May.

A one day seminar was held at Madampe for coconut growers on 15 March. This programme was sponsored by the Lions Club of Madampe.

A seminar was held at the Head Office, CRI on the subject of training of coconut pickers and toddy tappers with the participation of the Chief Secretary of the North Western Province, Provincial Council and Divisional Secretaries of Puttalam and Kurunegala Districts on 20 May.

A field day on the use of Pheromone Trap to control Red weevil was held at Divulapitiya on 03 November.

A seminar on coconut cultivation organized for coconut growers on 07 November was held at the Divulapitiya Multipurpose Co-operative Society.

The Institute participated in the following exhibitions.

i. Silver Jubilee Exhibition of the Coconut Cultivation Board, held on 05 April at the Coconut Development Training Centre, Lunuwila.

ii. Exhibition at Katuneriya Madya Maha Vidyalaya held from 09 April to 11 April.

iii Science exhibition at Maristella College, Negombo held from 06 to 07 March.

iv Exhibition held at Martin de Fores Vidyalaya at Wennappuwa held on 13 June.

v The division participated for an exhibition held at the Hettirippuwa Vidyalaya organized by the Coconut Cultivation Board Regional Office, Kuliyapitiya on 29 November.

vi Exhibition held at Ihala Kolaeliya Vidyalaya, Pallama from 22 to 23 September.

vii The division participated in a science exhibition held at Gonsalvez Madya Maha Vidyalaya at Bolawatta from 07 to 09 December.

viii The Institute also participated in the exhibition held at Dhammissara Madya Maha Vidyalaya form 19 to 23 December.

9. PHOTOGRAPHY

The division supplied transparencies, photographs and slides requirements for research divisions. Colour slides and enlarged photographs were supplied to Coconut Cultivation Board Regional Offices on their request to be used in their extension programmes.

10. MUSEUM

The exhibits in the Museum were re-arranged in order to comprehend visitors, especially school children.

11. AUDITORIUM

The facilities of the auditorium were improved in order to conduct seminars, workshops, meetings and training programmes more effectively with the addition of new overhead projector and high capacity airconditioner. The seating capacity of the Auditorium was increased from 100 to 150.

REPORT OF THE LIBRARY AND COCONUT INFORMATION CENTRE

Librarian - P A S F Perera, B Sc

1. GENERAL

Information needs of the Institute staff and outside clients were met using resources within and outside the library. A programme was initiated to preserve the material of historical value both to the Institute and the Coconut Industry.

2. ACQUISITIONS

The library stock recorded 5101 books as at 31st December, 1997. The total number of new accessions during the year was 79, of which 8 was purchased while the rest were received on complimentary basis.

The total number of Journal Titles and Annual Reports received during the period under review was 69 and 9 respectively. Twenty two titles were received on subscription while the rest were received on exchange and complimentary basis. A large decrease was observed in the number of Journal Titles and Annual Reports received when compared to the previous year.

Special collection on coconut

The data-base on coconut comprised of six thousand six hundred and ninety nine (6699) references as at 31-12-97. The number of references added during the year was forty nine (49). Complete documents to these references were added to the collection.

3. SERVICES

Reference, lending and inter-library loan services (ILL) were provided regularly to the staff. The literature alert service was further improved to create an awareness of reference material received by the library within the scope of each research officer.

In addition, reference services were made available to students, outside scientists and industrialists etc. on request.

3 Current Awareness Bulletins covering references to literature on coconut and a list of new accessions (monographs) to the library during 1997 were issued during the year.

A new service **'Access to the Internet'** was introduced during the last quarter of the year enabling the staff to search for global information. Facilities for communication through **'electronic mail'** was also made available. The CRI homepage (CRI web site) was created in the World Wide Web providing basic information on the mission and the activities of the Institute. Nineteen literature searches were completed in the COCONUT database for the Institute's staff. The number of searches done for outsiders amounts to 12.

Databases

Two new databases were created using the CDS/ISIS software to maintain the following information.

a) References to contents of all CRI publications commencing from 1929.
b) Publications by the CRI staff. This will be proceeded with an attempt to maintain a depository of these publications in the library.

The following databases were installed into the computer with a view to make the users aware of the location of useful information resources within the country.

1. Union list of S & T periodicals
2. National Agricultural Bibliography
3. Database on Mango

External Services

The library continued to be an active member of the Agricultural Information Network (AGRINET) with a view to sharing of resources. Nine CD-ROM searches were done by the International Irrigation Management Institute (IIMI), (Natural Resources, Energy and Science Authority (NARESA) and Council for Agricultural Research Policy (CARP) libraries on behalf of the CRI staff. Contents pages of 37 journal titles received by the CRI library were supplied to the Institutes' users. The average number of articles requested and received from these contents pages were 66. The CRI library provided contents pages of 24 journal titles regularly to several AGRINET member libraries. The total number of requests

received from the outside libraries for ILL was seventy six (76) out of which thirty nine (39) were supplied satisfactorily. The library also actively participated in the establishment of the National Catalogue Database at the Sri Lanka National Library Services Board (SLNLSB) by providing references to 133 items received by the library recently.

4. MEETINGS, WORKSHOPS AND TRAINING

The Librarian attended 2 AGRINET meetings and the Annual General Meeting of the SLSTINET group, 3 ISIS user club meetings and the Meeting on Compilation of the National Union Catalogue.

Asst. Librarian attended the Annual General Meeting of the Sri Lanka Scientific and Technical Information Network (SLSTINET) services held at NARESA on 31-01-97.

The Librarian attended a 2 day workshop on 'Quality Management' from 08 to 09 September held at the British Council.

The Librarian and the Asst. Librarian attended a workshop on the compilation of the Sri Lanka Union Catalogue on 19-12-97 at the SLNLSB.

REPORT OF THE ESTATES MANAGEMENT DIVISION

Acting Manager (Estates) - H A J Gunathilake, Ph D

1. GENERAL

The following Estates and Seed Gardens were administered by the Division.

1. Bandirippuwa Estate, Lunuwila.
2. Rathmalagara Estate, Panirendawa.
3. Poththukulama Estate, Pallama.
4. Walpita Estate, Walpita.
5. Isolated Seed Garden, Ambakelle.
6. Makandura Seed Garden, Gonawila(NWP)
7. Maduru Oya Seed Garden, Bogaswewa.

The two main functions viz. production of seed nuts for the National Replanting Programme and providing facilities for field research were fulfilled by the Division.

Out of the total planted area of 574.0 ha, about 175.9 ha of palms were immature (Table 1a). All seven estates had 58,886 bearing palms (Table 1b).

A marked increase in rainfall was recorded and the average increase in the amount of rainfall and number of rainy days were 35% and 18% respectively. However, a short dry spell was experienced during the 'Yala' season.

Cumulative coconut yield of all seven Estates was 3,055,262 nuts and showed 9.4 % reduction compared to the yields in 1996 (Table 3). This could be attributed to the low rainfall experienced during the previous year and the first half the current year. Between second and third picks of the year, considerable amount of immature nut fall was observed during the dry spell particularly in Walpita and Bandirippuwa Estates. Coconut yields in Maduru Oya and Makandura seed gardens were increased by 8% and 17% respectively mainly due to the increasing population of bearing palms (Tables 1b & 3).

During the year, 961, 963, T X T and 75,470, D x T seed nuts were produced in three seed gardens. Of the total seed nut production,over 97% was issued to the Coconut Cultivation Board. Issuing of seed nuts from Makandura Seed Garden was temporarily suspended from the sixth pick due to an unknown etiology

symptoms on certain palms. Investigations are being carried out by a team of researchers.

General agronomic practices in all estates were carried out following the CRI recommendations. Adult palms in all seven estates were manured based on Differential Fertilizer Recommendation. Over forty percent of the fertilizer application was completed during the'Yala'.Furthermore much emphasis was given for the use of organic manure. For example, half the coconut area (22.0 ha.) at Walpita Estate was manured with goat manure supplemented with P, K and Mg.

With the aim of reducing the cost of weeding, rearing of ruminant livestock (cattle, buffaloes and goats) was encouraged, particularly in Makandura, Bandirippuwa and Rathmalagara Estates. Makandura Seed Garden was able to save more than 60 percent of its weeding cost by cattle and buffalo rearing in addition to the monetary value of organic manure.

Use of contract labour was reduced to the minimum, except for picking and manuring. It is encouraging to note that picking at Maduru Oya Seed Garden was done by the estate labourers. Several measures were also introduced to increase efficiency of estates labourers. (eg. introduction of a task system)

Food production programme was successfully implemented during the year. For example, 3137 bottles of treacle and 29072 liters of milk were produced in Bandirippuwa Estate. Total revenue collected during the year amounts to Rs.254,987.50 (Table 6).

Coconut crops in four estates was disposed through the auction conducted by the Coconut Development Authority (CDA) mainly as husked nuts. The buyer's rejections were supplied to the Dunagaha Coconut Producer's Co-operative Society. As a result profits were increased three fold, compared to curing of copra in our estates.

2. PERFORMANCE OF INDIVIDUAL UNITS

2.1 Bandirippuwa Estate, Lunuwila.

Superintendent	- Mr A N Ekneligoda
District	- Puttalam
Electorate	- Wennappuwa
Agro-ecological Zone	- Wet-Intermediate

Rainfall: Rainfall received during the year was 1902 mm with 140 wet days representing an increase of 9.5% and 9.4% respectively for the same in 1996. However, amount of rainfall during January- April declined by 60% compared to the same period in 1996. (Table 2)

Nut yield: The total nut yield was 475,658, showing a 1.6% decline compared the yield in 1996, which could be attributed to the low rainfall in 1996 (Table 3).

Field Operation: Adult palms were manured in accordance to Differential Fertilizer Recommendation (DFR). Palms in field No. 6 were applied with green manure supplemented with P,K and Mg.

All palms were mulched with coconut husks and fronds. Husk burial was completed in field, 35 ac block.

Livestock: Herd strength by the end of the year was as follows.

(a) cows	:	52
(b) Heifers	:	60
(c) Bull calves	:	39
(d) Bulls(stud)	:	01
		152
		==

Milk production and sales:

(a) Milk Collection Centre (16912 l)	-	181,640.00
(b) Sold to staff at subsidized rate(Rs. 4.50 per l) (11477 l)	-	60,614.93
(c) CRI Canteen (44 l)	-	440.00
(d) For milkers (364.5 l)	-	1,810.76
Total (28797.5 l)	-	**Rs. 244,505.69**

Other production activities

4165 bottles of treacle were produced and the sales amount to Rs. 228,290/- Under the food production programme, leafy vegetables, cassava and banana were cultivated and Rs. 26,697/ was earned by selling to the employees.

Cost and returns

Cost of production (COP) for 1000 nuts was Rs. 7320.00 and Net Sales Average (NSA) was Rs.6916 per 1000 nuts. The higher COP was mainly due to the heavy expenditure incurred in maintaining a large extent of immature plantation (Table 1b) an excessive labour used for experiments.

2.2 Rathmalagara Estate, Panirendawa.

District	-	Puttlam
Electorate	-	Chilaw
Agro-ecological Zone	-	Dry Intermediate Zone.

Of the total coconut extent of 98.3 ha, about 65% was in production (Table 3).

Rainfall : The total rainfall was 2075 mm (105 wet days) and it was an increase of 75% compared to the rainfall had in 1996. (Table 2). Similar to Bandirippuwa, only 19 mm of rains were received from January - March during the year.

Net yield : Nut yield showed 6.9% reduction compared to the previous year, This was mainly due to low rainfall experienced in 1996.

Field Operation : All adult palms were manured accordingly to the DFR analysis. In field Nos. 5 and 6, where soil is shallow and poor for coconut,husk burial and mulching with fronds were done and in those fields percentage of nut setting increased by about 50%.

Hundred plants of bud grafted cashew were established in field 04.

General : Electricity was supplied to three labour quarters. Three houses were also colour washed.

Cost & Returns : COP for 1000 nuts was Rs.4900.00

2.3 Poththukulama Research Station, Pallama.

Officer-in-Charge	- Mr. N Gamage
District	- Puttlam
Electorate	- Anamaduwa
Agro-ecological Zone	- Dry Intermediate

Out of the total planted area of 73.2 ha of coconut, about 76.5 was in bearing (Table 1b). This was an increment of 36% compared to the bearing extent in 1996.

Rainfall: Exceptionally there was no difference in rainfall between years of 1996 & 1997, while 10 more wet days in 1997 (67) compared to 57 wet days were in 1996 (Table 2).

Nut yield: The total nut production was 506,555 nuts showing a 28 % reduction in yield compared with the production of 1996 (Table 3).

Field Operations: Husk burial (1000 pits) was done in fields 14 and 15 coupled with the establishment of cover crops.

Weeding was done using disc harrow instead use of grass cutters. Under the food production programme ground nut, long been, radish and cassava were grown and a their total revenue was Rs.11,032/-.

Cost & returns: COP & NAS for 1000 nuts were Rs.4198/40 - and Rs.6863/- respectively.

2.4 Walpita Estate, Walpita.

Officer-in-Charge	- Mr U. Rathnayake
District	- Gampaha
Electorate	- Divulapitiya
Agro-ecological Zone	- Intermediate wet

The total plantation was mature and in production. (Table 1a & b)

Rainfall: The total rainfall was 2402 mm which was 48% percent increase

compared to the same in 1996 (Table 2). However, decline of rainfall in January - March was prominent.

Nut yield: The total crop was 150,602 giving 15.7% increase compared to the production in 1996 (Table 3).

Field Operations: All palms were manured accordingly to the DFR analysis. Further, adult palms in block B were manured with 15 Kg of goat manure supplemented with P, K and Mg..

Husk burial was done in over 200 pits (2.5m x 1.3m x 0.6m), while mulching was common for all palms.

Under the food production programme pepper, coffee, banana, pineapple, rambutan, cassava and leafy vegetables were grown (Table 6).

General: Over 40 dead and weak palms were removed and prepared rafters which could be used for house repairing.

Cost & returns: COP and NSA for 1000 nuts were Rs. 4852/- and Rs 5900/-

2.5 Isolated Seed Garden, Ambakelle, Rajakadaluwa.

Acting Superintendent	- Mr. D M Pathirage
District	- Puttalam
Electorate	- Anamaduwa
Agro-ecological Zone	- Dry Intermediate

Of the coconut area of 140.4 ha, 27.4 ha remained as immature palms. Jungle barriers was remained as 309.8 ha (Table 1a).

Rainfall: Rainfall during the year was 48% more compared to rainfall in 1996. Number of wet days was also increased from 82 (1996) to 108 (1997).

Nut yield: Total nut yield for the year was 980,544 nuts. This was a decrease of 10% compared to the same in 1996 (Table 3). Decline of rainfall in 1996 would be the main cause. Seed nuts production of T x T and D x T was 596,134 and 75,470 nuts respectively.

Field Operation: 16230 palms were manured according to the DFR analysis.

Rest of the 5317 young palms were manured with YPM twice the year.

Husk burial was done (585 pits) in 2.5m x 1.3 x0.6m pits in 11 A & 11 B fields. Other general field activities (weeding, watering, cover cropping) were practised according to the CRI recommendations.

2.6 Makandura Seed Garden, Gonawila.

Officer-in-Charge	- Mr H Upali
District	- Kurunegala
Electorate	- Katugampola
Agro-ecological Zone	- Wet Intermediate

Almost all palms (7089) were in production (Table 1a).

Rainfall: Total rainfall was 2202 mm. with 138 wet days showing 34% of increase in rainfall compared to the previous year (Table 2).

Similar to Bandirippuwa, Walpita and Rathmalagara, the amount of rainfall declined during the period from January March.

Nut Yield: During the year nut yield was increased by 17%, despite the reduction in rainfall in 1996 (Table 2 & 3). The main reason would be the increased number of bearing palms (Table 1b).

Field operations: During the year, a large number of weak palms (1250 palms) were identified in field Nos. 1 & 3 by the Genetics and Plant Breeding Division. Action has taken to remove those palms.

By grazing with ruminants, 137 labour days for weeding was saved during the year compared to 404 labour days in 1996. Fertilizer was applied to the palms with pre-packed individual bags which is much accurate in application compared to the direct application.

2.7 Maduru Oya Seed Garden, Bogaswewa

Officer-in-charge	- Mr M M David
District	- Polonnaruwa
Electorate	- Polonnaruwa
Agro-ecological Zone	- Dry

Of the total coconut extent of 67.2 ha, 26.3 ha was in production. (Table 1a) There was 30% increase of bearing extent compared to extent in 1996.

Rainfall: Exceptionally, there was no difference in amount rainfall between this year and previous year. However, number of rainy days was more (30%) during the year.

Disposal of crops: Of the total nut production of 149,803 nuts, 108,880 T x T seed nuts was issued to the CCB.

Field operations: Infilling (300 seedlings) was done in field 2 with Ambakelle Tall x Tall. Another 10 ha was brought under the cover which reduce the use of glyphosate for control illuk.

Table 1. *General performance of the estates, seed gardens etc.*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
A. Coconut extent (ha)								
Mature	78.6	63.92	56.11	15.5	113.0	46.0	26.32	399.45
Immature	45.3	34.42	17.12	0.0	27.4	08.0	46.85	179.09
TOTAL	123.9	98.34	73.23	15.5	140.4	54.0	73.17	578.54
Nursery	1.6	-	-	-	1.0	-	-	2.6
Other crops	-	1.0	-	-	-	-	-	1.0
Jungle	-	3.24	-	-	309.8	01.0	13.79	327.83
Vacant Land	0.3	5.88	3.05	0.5	3.0	-	-	12.73
Reservoir	-	-	3.00	-	-	01.2	-	4.20
Roads & buildings	22.3	2.02	2.50	1.8	3.0	2.0	4.04	37.66
TOTAL	148.1	110.48	81.78	17.8	457.2	58.2	91.00	964.56
B. Census of palms								
Bearing palms	11085	10657	8694	2292	13439	7089	3575	56831
Young palms	2835	1860	2975	62	5572	273	6535	20112
Seedlings	234	2334	190	-	-	-	228	2986
Dud Palms	215	16	101	17	249	1216	36	1850
Vacancies	3765	679	1663	169	3971	1378	1945	13570
Total	18134	15546	13623	2540	23231	9956	12319	95349

Table 2. *Rainfall (mm) with number of wet days in parenthesis*

Month	Bandirippuwua Estate		Rathmalagara Estate		Poththukulama Estate	
	1996	1997	1996	1997	1996	1997
Jan	94.3(09)	14.1(1)	41.1(5)	0.0	54.5(02)	0.0
Feb	68.1(07)	35.0(4)	104.8(08)	4.8(1)	72.7(05)	0.0
March	0.0(0)	15.0(3)	07.1(01)	14.8(1)	0.0	0.0
April	355.5(16)	145.0(8)	133.2(09)	81.7(7)	142.2(8)	87.7(5)
May	76.1(11)	210.1(18)	54.3(04)	177.8(11)	0.0(0)	144.2(8)
June	84.0(14)	125.0(12)	93.1(08)	73.3(10)	118.3(7)	46.6(5)
July	58.04(14)	138.0(15)	21.8(07)	143.1(10)	13.9(02)	51.3(06)
Aug	223.5(06)	39.0(08)	91.0(04)	13.2(02)	88.8(02)	0.0
Sept	234.0(17)	217.0(18)	228.2(13)	219.8(15)	190.2(08)	200.4(11)
Oct	192.0(14)	412.0(23)	204.8(17)	486.2(19)	257.7(10)	174.8(14)
Nov	216.1(11)	454.1(19)	164.5(11)	670.1(18)	199.9(10)	398.9(15)
Dec	137.1(09)	98.1(11)	41.5(08)	190.5(11)	62.1(03)	177.4(03)
Total	1738.7(128)	1902.4(140)	1185.4(95)	2075.3(105)	1200.3(57)	1281.3(67)

Table 2. *Contd.*

	Walpita Estate		ISG Ambakelle	
	1996	1997	1996	1997
Jan	65.0(04)	09.2(1)	127.7 (03)	0.0
Feb	79.8(06)	03.3(1)	91.2 (06)	3.6(1)
March	0.0	30.4(4)	0.0	2.5(2)
April	349.8(13)	210.0(13)	105.0(11)	101.7(6)
May	64.6(08)	236.7(13)	7.4(02)	179.3(12)
June	112.5(09)	84.3(11)	133.6(09)	70.3(8)
July	100.9(10)	268.0(16)	10.4(06)	97.1(11)
Aug	111.7(06)	79.3(3)	66.0(03)	7.0(3)
Sep	252.4(20)	274.7(15)	159.1(13)	256.3(19)
Oct	194.4(12)	532.0(19)	263.4(13)	387.0(19)
Nov	203.7(7)	513.1(17)	139.7(18)	448.6(19)
Dec	89.7(06)	161.3(07)	90.9(06)	213.2(8)
Total	1624.5(101)	2402.3(120)	1194.4(90)	1766.6108)

Table 2. *Contd.*

	Makandura Seed Garden		Maduru Oya Seed Garden	
	1996	1997	1996	1997
Jan	64.1 (07)	0.0	211.7(12)	9.9(2)
Feb	72.4 (06)	28.0(04)	123.2(07)	7.7(3)
March	2.2 (01)	46.7(04)	2.3(01)	44.4(3)
April	330.6 (12)	146.4(08)	122.7(10)	207.6(7)
May	103.6 (06)	224.7(15)	3.9(01)	118.5(8)
June	88.5 (10)	76.4(11)	71.8(08)	23.0(2)
July	79.8 (11)	279.4(15)	0.0(-)	20.9(5)
Aug	170.2 (06)	69.1(06)	162.8(08)	1.7(1)
Sep	313.8 (21)	244.3(18)	9.3(02)	109.7(10)
Oct	175.3 (16)	393.9(24)	149.0(05)	329.9(20)
Nov	206.2 (09)	484.5(21)	339.7(13)	233.7(19)
Dec	36.6 (06)	209.4(12)	240.6(13)	343.7(24)
Total	1643.3(111)	2202.8(138)	1437.0(80)	1450.7(104)

Table 3. *Crop data (nuts)*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
Pick 1	84035	48739	74060	12808	160925	18661	19329	418557
Pick 2	131952	81529	82640	47456	193749	62258	10769	610353
Pick 3	65575	89911	83891	28280	195749	100298	12920	576624
Pick 4	75516	68515	92487	30848	150292	103268	30565	551491
Pick 5	69859	66928	103848	24024	174436	75374	42372	556,841
Pick 6	48721	47004	69629	7456	105393	29615	33848	341,666
Total - 1997	475658	402626	506555	150872	980544	389474	149803	3055,532
Total - 1996	538095	432287	707668	130155	1092604	333241	3372579	6606629
Average(92-97)	498448	390118	620105	148805	1210031	-	87646	
Nuts/palm -96	51	55	81	58	68	-	57	
Nuts/palm -97	45	55	58	65	63	-	49	
Yield/ha -96	7246	8043	12612	7656	10356	-	-	
Yield/ha -97	6317	8301	9028	8859	8677	-	-	

* Average yield from 1992 - 1995

Table 4. *Crop disposal (nuts)*

	BE	RE	PRS	WE	ISG	MSG	MOSG	Total
Sold	306053	336420	390720	139983	156604	90053	24273	1444106
Converted to Copra	23345	635	6066	-	20224	-	1207	57477
Research	3183	-	3517	642	15711	-	-	23053
Seed Nuts	2951	-	-	-	650899	256946	108880	1019676
Staff issues	39050	12634	3797	1456	9378	4422	2888	73625
Rejections	14489	13745	19568	6079	41510	8915	3095	107,401
Await. dispos.	84881	20361	428548	2153	91736	29135	-	656,814
Others	1706	12771	-	289	2134	-	-	16,900
Total	475658	402566	852216	150602	988196	389471	140343	3399052
C.O.P (Rs/1000 nuts)	7320/-	4900/-	4198/-	4852/-	-	-	-	-
N S A (Rs/1000 nuts)	6916/-	7190/-	6863/-	5900/-	-	-	-	-

Table 5. *Seednuts production of three seed gardens*

Seed garden	1996	1997	Increase/decrease %
ISG, Ambakelle	779734	650899	-16.6
MSG, Gonawila	254699	256946	-0.88
MOSG,Bogaswewa	115860	108880	-6.0
TOTAL	1150,293	1016725	-11.6
Total 1310350 976621	224019	115946	
Nuts/palm 98	71	85	49

Table 6. *Progress of the food production programme*

Estate	Income (Rs)
Bandirippuwa - treacle	228 290.50
- Other food crops	26 697.00
Rathmalagara	20 802.00
Poththukulama	11 032.10
Walpita	8 356.50
ISG, Gonawila	10 686.00
MSG, Gonawila	576.00
MOSG, Polonnaruwa	2,221.00
Total	**308 661.10**

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,1997 is given in Table 1.

Table 1. *Staff position as at 31.12.1997*

Grade	Ungraded	sp cl.	cl 1	cl 11	cl 111	cl 1V	Total
Executive	02	-	06	10	24	08	50
Technical	-	28	09	25	-	-	62
Intermediate	-	01	02	04	-	-	07
Clerical & Allied	-	19	07	16	-	-	42
Operative	-	16	08	29	-	-	53
Minor	-	39	08	49	-	-	96
Driver	-	11	04	15	-	-	30
Watcher	16	-	-	-	-	-	16
Grand Total	**18**	**114**	**44**	**148**	**24**	**08**	**356**

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 42 employees amounted to Rs. 5,440,780/-.

Distress Loans: Distress loans paid to 85 employees amounted to Rs. 3,878,738/-.

Transport Loans: Transport loans paid to 42 employees amounted to Rs. 1,916,000/-.

Loans to Relieve Indebtedness: Loans to relieve indebtedness to 02 employees amounted to Rs. 15,000/-.

Refrigerator Loans: Refrigerator loans paid to 21 employees amounted to Rs. 252,000/.

Medical Aid: A sum of Rs. 2,007,639/- was reimbursed by the Medical Aid Scheme to its members during the year 1997 and an amount of Rs. 325,162/- was debited to members savings accounts.

3.2 Other facilities to employees

(a) 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 1997.

STAFF MATTERS

1. APPOINTMENTS

Eight appointments were made during the year 1997 and the details are shown in Table 1.

Table 1. *Appointments made during the year 1997*

Name	Designation	Division	Date
Mr E P Gunapala	Internal Auditor	Establishment	10.01.1997
Mr R P Nevil	Office Attendant	Establishment	20.01.1997
Mr G R A Dharmasena	Technical Assistant	Plant Physiology	03.02.1997
Mr M T Wimalasena	Mechanical Helper	Engineering	01.08.1997
Miss S A C N Perera	Research Officer	Genetics & Plant Breeding	15.09.1997
Miss M M S P Fernando	Stenographer (English)	Establishment	22.09.1997
Miss H L A Padmini	Technical Assistant	Soils & Plant Nutrition	13.10.1997
Miss B N K Wijayapala	Technical Assistant	Soils & Plant Nutrition	20.10.1997

2. RESIGNATIONS, RETIREMENTS AND VACATION OF POSTS

The details are given in Table 2.

Table 2. *Resignations, retirements and vacation of posts*

Name	Designation	Division	Date
Resignations			
Miss K K I C K Kannangara	Research Officer	Soils & Plant Nutrition	01.03.1997
Mr K G D Priyantha	Technical Assistant	Genetics & Plant Breeding	03.03.1997
Mr K Swaminathan	Driver	Transport	28.03.1997
Mr W K S Fernando	Technical Assistant	Soils & Plant Nutrition	11.06.1997
Mrs C N K Rajapaksa	Head/CPD	Crop Protection	30.09.1997
Mrs K M A Nonis	Book Keeper	Establishment	20.10.1997
Retirements			
Mrs T M Gnanawathie	Garden Labourer	Ratmalagara Estate	04.01.1997
Mr M A Perera	Office Attendant	Establishment	12.01.1997
Mr U T G Fernando	Lab & Field Assistant	Biometry	27.02.1997

Table 2. *Contd.*

Name	Designation	Division	Date
Mr K P de Silva	Asst. Manager (Farm)	Estates Management	01.03.1997
Mr A A Karunasekara	Clerk/Typist	Establishment	04.04.1997
Mr S Samaratunge	Lab & Field Attendant	Plant Physiology	08.04.1997
Mr K K P Mendis	Office Attendant	Engineering	15.07.1997
Mr K L E J Appuhamy	Driver	Transport	18.10.1997
Mr W L B Silva	Lab & Field Assistant	Estates Management	10.12.1997
Mr D S Wijethunge	Lab & Field Assistant	Soils & Plant Nutrition	11.12.1997
Mr J L J G Pinto	Asst. Inform. Officer	Extension Services	23.12.1997
Mr M A Wahid	P. Labourer	Isolated Seed Garden	30.12.1997
Vacation of posts			
Dr (Mrs) M B M N Fernandopulle	Head/SPND	Soils & Plant Nutrition	03.01.1997
Dr D N S Fernando	Head/Agronomy	Agronomy	31.12.1997

03. TRANSFERS

Mr. W A Harold Upali,Supervisor, from Maduru Oya Estate to Makandura Estate on 01 January.

Mr. A Sugathadasa, Supervisor, from Makandura Estate to Pothukulama Research Station on 01 January.

Mr. E A Jayathilaka, Tractor Driver from Pothukulama Research Station to Isolated Seed Garden on 01 January.

Mr. D M Sarathchandra, Lab/Field Assistant from Genetic & Plant Breeding Division to Isolated Seed Garden on 01 January.

Mr. M J David , Supervisor, from Bandirippuwa Estate to Maduruoya Seed Garden on 01 January.

Mr. U V M Fernando Lab/Field Assistant from Isolated Seed Garden to Genetics & Plant Breeding Division on 06 January.

Mr. H A S Perera, Lab/Field Attendant from Crop Protection Division to Angunakola Pelassa on 07 January.

Mr. K D L Gunathilake, Watcher from Makandura Estate to Bandirippuwa Estate on 01 February.

Mr. W A Hemawardane, Lab/Field Attendant, from Agronomy Division to Ratmalagara Estate on 01 March.

Mr. H T R Wijesekara, Research Officer, from Angunakola Pelassa to Crop Protection Division on 03 March.

Mr. A C S Ibrahim, Driver,from Angunakola Pelassa to Transport Unit on 07 March.

Mr. H A Sebastian Perera, Lab/Field Attendant, from Angunakola Pelassa to Crop Protection Division on 01 May.

Mr. Prabath Manohar, Technical Assistant, from Angunakola Pelassa to Crop Protection Division on 01 May.

Mrs. K A P Chandani, Clerk/Typist from Establishment Division to Extension Division on 09 July.

Mr. R B Attanayake, Technical Assistant from Maduruoya Seed Garden to Genetics & Plant Breeding Division on 01 August.

4. NO PAY LEAVE GRANTED FOR EMPLOYMENT ABROAD

Table 4.

Name	Designation	Country	Period
Mr Y H Wijesena	Clerk/Typist	Kuwait	from 28.06.96 to 27.06.98
Mr P David Perera	Electrician	Saudi Arabia	from 01.11.97 to 31.10.99

5. FULL PAY LEAVE FOR STUDY IN SRI LANKA

Table 5.

Name	Period	Purpose	Institute
Miss P H A P Siriwardena Technical Assistant (Crop Protection Division)	from 20.03.95 to 19.03.99	B Sc (Agriculture) Degree	University of Peradeniya
Mr. N P A D Nainanayake Plant Physiologist (Plant Physiology Division)	from 01.10.96 to 30.09.97	M.Phil Degree	University of Peradeniya

6. NO PAY STUDY LEAVE IN SRI LANKA

Table 6

Name	Period	Purpose	Institute
Mr P H P R de Silva Technical Assistant (Crop Protection Division)	from 04.07.97 to 03.07.98	B Sc (Agriculture Degree)	University of Ruhuna

7. TRANSPORT UNIT

The administration of drivers and maintenance of the following fleet of vehicles were done by the Transport Unit during the year, 1997.

Cars	- 06
Buses	- 03
Lorries	- 01
Vans	- 12
Three Wheelers	- 01
Jeeps	- 07
Motor bicycles	- 39

8. FINANCE UNIT

The budget expenses during the year was Rs. 87.8 million made up of Rs. 69.8 million as recurrent and Rs. 18 million as capital expenditure. The total revenue (excluding transport) for the year was Rs. 73 million which is a 4 percent decrease when compared to previous year.

Computer software were used in the entire system and payroll as in 1996, during the later part of the year a new software package was introduced for the payroll with the intention to overcome the problems in the existing package. The package is now run parallel to the existing package and expect to run independently by April 1998.

This year too the stores had played a fair role in serving the Research and other Divisions/Units with all financial difficulties and other restrictions, the Store Keeper and his staff were able to collect all the condemned and obsolete items and to arrange an auction within a very short targeted period.

It was a good effort made by the stores staff.

The entire staff of the unit extended their invaluable support to bring the unit to a high standard and to build a very good relationship with the other Divisions/ Units.

One computer with printer was added bringing the number of computers to three and another printer as a replacement, two officers were sent for introductory training on newly purchased computer and printers.

A Productivity Circle was formed with the intention to increasing the productivity of the unit and to build better understandings among the brother officers and monthly meetings were held to review the progress made the attendance of the officers was fairly satisfactory and the volume of the output showed a remarkable increase compared to the previous year.

9. ENGINEERING UNIT

Maintenance work of Buildings, Electricity, Vehicles and Machinery were carried out by the Engineering Unit.

For the year 1997 the Engineering Unit attended to the following construction and rehabilitation works.

(a) Construction of Boundary wall and fencing at Bandirippuwa Estate.
(b) Rehabilitation to Copra Kiln at Bandirippuwa Estate.
(c) Supply of electricity to circuit Bungalow and watcher's quarters at Maduru Oya seed Garden.
(d) Rehabilitation of three number quarters at Bandirippuwa Estate.
(e) Rehabilitation to the road at 50 Acre. Block at Bandirippuwa Estate.
(f) Supply of Electricity to Office and quarters at Pottukkulama Estate.
(g) Laying of Asbestos Roofing sheets to the Genetics and Plant Breeding Division at Bandirippuwa Estate.

10. LOCAL TRAINING

Mr. N P A D Nainanayake, Plant Physiologist, continued his M.Phil degree conducted at the University of Peradeniya.

Mr. H P de Zoysa, Programmer Analyst continued his M.Sc degree programme at the University of Colombo.

Miss. P H A P Siriwardana, Technical Assistant, continued her B.Sc (Agriculture) degree course at the University of Peradeniya.

Mr. G D George and Mrs. S Sabaratnam, Senior Technical Officers, attended a Workshop on the use of Nuclear Magnetic Resonance held at the University of Colombo on 04 February.

Mr. D P Panditharathne, Technical Officer, attended a seminar on Industrial Measurement at the CISIR on 27 February.

Mr. R M Gunasekara, Assistant Librarian participated in the Workshop on Information Retrieval through Internet & CD-ROM Databases at the Natural Resources Energy & Science Authority of Sri Lanka on 18 March.

Mr. L P Vidhanarachchi, Senior Soil Scientist attended a Workshop on Watershed Management held at Nuwara-Eliya on 24 to 25 April.

Mr. E M A Thilakarathne Banda, Technical Assistant attended a national training course on Radiation Safety in using Radioisotopes for Research and

Industrial Applications at the Atomic Energy Authority Colombo from 05 to 08 May.

Mr. M R D Perera, Technical Assistant, Soils & Plant Nutrition Division attended a National Training Course on Radiation Safety in using Radioisotopes for Research and Industrial Applications at the Atomic Energy Authority Colombo from 05 to 08 May.

Mr. J M N Marikkar, Research Officer, (Coconut Processing Research) attended a training course on Food Safety and Food Processing Industry at AgEnt-USAID on 21 and from 23 to 27 June.

Mr. L P Vidhanarachchi, Mrs. S C Fernando, Mrs. V R M Vidhanarachchi and Miss. R Wimalasekera attended a Workshop on Scientific Writing at the Headquarters of Sri Lanka Association for the Advancement of Science on 15 and 29 August.

Mr. P H P R de Silva, Technical Assistant, commenced his course of study leading to B.Sc (Agriculture) degree at the University of Ruhuna from 04 July.

Dr. (Miss) C S Ranasinghe, Plant Physiologist, participated in a Workshop on project design, management and evaluation of IAEA Technical Co-operation Projects at the Holiday Inn Colombo from 01 to 04 July.

Mr. D R C M Hendalage, Chief Accountant, attended a seminar on Productivity Accounting at the Association of Accounting Technicians of Sri Lanka on 02 August.

Mrs. Anoma de Alwis, Accountant attended a seminar on Productivity Accounting at the Association of Accounting Technicians of Sri Lanka on 02 August.

Mr. E S Santha, Technical Officer, Tissue Culture Division followed a course on Application & Maintenance of Instruments in a Clinical Biochemistry Lab at Postgraduate Institute of Science, University of Peradeniya from 11 to 22 August.

Dr. (Mrs) C Jayasekara, Deputy Director (Research) attended a seminar on Introduction to Employee Empowerment at FCCISL on 15 August.

Dr. L L W Somasiri, Senior Soil Scientist, participated in a Workshop on Chemical Aspects of Environment held at the University of Colombo from 21 to 22 August.

Mr. P Daluwatta, Administrative Officer, attended a Workshop on Disciplinary Procedure at NAITA from 22 to 24 August.

Mr. P A H N Appuhamy, Head, Extension Services Division, attended a seminar on "How to satisfy the customers 100%" and quality through internal customer concept at FCCISL on 25 August.

Mr. M R D Perera, Technical Assistant, Soils and Plant Nutrition Division participated in the training programme on Quality Control and Operation of Nuclear Electronic Equipments held at the Atomic Energy Authority Colombo from 03 to 04 September.

Mr. A L D K Amarasinghe, Works Superintendent, attended a seminar on Productivity through Less Waste using Toyota's Seven Waste Model at FCCISL on 05 September.

Mrs. P A S F Perera, Librarian, attended a Workshop on Quality Management held at the British Council from 08 to 09 September.

Mr. H T R Wijesekara, Plant Pathologist, attended a seminar on "Safety in Pesticide Use" at Sri Lanka Foundation Institute, Colombo on 10 October.

Mr. I R Wickramananda, Entomologist, attended a Training Workshop on "Safe and effective-use of pesticides" at the Faculty of Agriculture, Wayamba Campus from 13 to 17 October.

Mr. K T G N Perera, Clerk/Typist followed a Clerical Development Course at NIPM from 17 to 21 November.

Mr. M A M Perera, Clerk/Typist followed a Clerical Development Course at NIPM from 17 to 21 November.

Mrs. P A S F Perera, Librarian, attended a Workshop on Computer Application for Library Personnel held at the National Institute of Business Management from 03 to 07 November.

Mr. R M Gunasekara and Mrs. P D U C Dharmapala attended a demonstration on Library Automation at NARESA on 05 July.

Miss. A P Illangakoon and Mrs. S N Gunatilake attended a training programme on the use of Windows 97 at Datamini Company on 03 and 28 October.

Mr. Victor Fernando underwent trainig on Book Binding at the University of Colombo from 21 August to 17 September.

11. OVERSEAS VISITS

Dr. U P de S Waidyanatha, Chairman, attended the International Cashew and Coconut Conference held in Tanzania from 17 to 21 February.

Dr. M de S Liyanage, Director, attended the International Cashew and Coconut Conference held in Tanzania from 17 to 21 February.

Dr. (Mrs) L C P Fernando, Senior Entomologist, visited Maldives as a FAO consultant to advice on Coconut Pest outbreak, from 07 to 20 March and 31 May to 10 June.

Dr. M de S Liyanage, Director, attended the Final Research Co-ordination Meeting on the use of Isotopes in studies of biological nitrogen fixation held in Austria from 01 to 05 September.

Dr. N A Tennakoon, Senior Microbiologist, attended the 11th World Fertilizer Congress held in Belgium from 05 to 14 September.

Dr. W M U Fernando, Senior Plant Breeder, attended the Annual Project Monitoring Meeting organised by the International Fund for Agricultural Development (IFAD) from 15 to 18 September and Asian Development Bank/COGENT funded project from 19 - 20 September held in Indonesia.

Messrs. H A Abeysoma, R D N Premasiri, K A S Chandrasiri, Technical Officers attached to Agronomy, Plant Physiology and Crop Protection Divisions, respectively undertook a familiarization visit to the Central Plantaion Crop Research Institute in India from 15 to 28 November.

Dr. (Mrs) L K Weerakoon, Senior Botanist, attended the International Symposium on Coconut Biotechnology held in Mexico from 01 to 05 December.

Dr. T S G Peiris, Principal Biometrician, attended the International Congress on Modelling and Simulation held in Tasmania from 06 to 12 December.

12. OVERSEAS TRAINING

Mr. A A F L K Perera, Geneticist and Plant Breeder, commenced his Postgraduate studies on Molecular Genetics leading to Ph.D in the University of Dundee, UK on 30 September.

Mr. M T N Fernando, Agricultural Economist, continued his Split Programme in Agricultural Economics leading to Ph.D in Aberdeen University UK.

Mr. H T R Wijesekara, Plant Pathologist, attended a short-term fellowship programme on Integrated Pest Management in the Netherlands from 22 March to 06 July.

Mrs. C K Bandaranayake, Plant Breeder, attended a training course on Collection and Conservation of Coconut Germplasm held at the Zamboanga Research Centre, Philippines from 01 to 02 September.

Dr. (Mrs) L C P Fernando, Senior Entomologist attended a Training Programme on Vertebrate Pest Management in Australia from 17 October to 06 November.

Dr. L L W Somasiri, Principal Senior Soil Scientist, received a IAEA fellowship to undertake training in the fields of Soil Science, Irrigation and Plant Nutrition at the Pertanian University, Malaysia for a period of six months from 06 October.

Mrs. V R M Vidhanarachchi, Botanist, attended the International Training Course on Coconut Embryo Culture and Acclimatization held at the Albay Research Centre in Philippines from 26 to 31 October.

Dr. (Mrs) L K Weerakoon, Senior Botanist undertook a Short-term Research Programme on molecular studies of leaf scorch decline and premature decline of coconut at the Rothamsted Experimental Station, UK from 15 November to 14 December.

Mr. H T R Wijesekera, Plant Pathologist, attended a five weeks Training Programme on techniques in *Ganoderma* Research at the International Mycrological Institute, UK from 16 November to 23 December.

13. PARTICIPATION OF CRI STAFF IN OTHER STATUTORY BODIES, COMMITTEES ETC.

Dr M de S Liyanage

Member, Board of Governors, National Institute of Plantation Management, Athurugiriya.

Member, Board of Management, Postgraduate Institute of Agriculture, Peradeniya.

Member, Technical Committee, National Institute of Plantation Management, Athurugiriya.

Member, Editorial Board, Coconut Research and Development (CORD), Journal of the Asian and Pacific Coconut Community.

Member, Agriculture Faculty Board of Studies, University of Rajarata, Wayamba Campus.

Visiting Lecturer, Department of Crop Science, Faculty of Agriculture, University of Ruhuna.

Dr (Mrs) C Jayasekera

Member, Board of Management, Atomic Energy Authority, Colombo.

Member, Academic Committee, National Institute of Plantation Management.

Member, Extension Committee, Coconut Cultivation Board.

Dr T S G Peiris

Member, Board of Study in Biometry, Postgraduate Institute of Agriculture (PGIA), University of Peradeniya.

Member, Working Group of the National Action Plan on Climatic Changes.

Visiting Lecturer in Biometry, Postgraduate Institute of Agriculture, University of Peradeniya.

External Examiner in Biometry and Crop Experimentation, Eastern University, Batticaloa.

CRI Co-ordinator, Management of Information System in Agricultural Research, Sri Lanka Council for Agricultural Research Policy (CARP).

Mrs C N K Rajapakse

Member, Pesticide Technical and Advisory Committee.

Dr (Mrs) L C P Fernando

Member, National Plant Quarantine Committee.

Dr L L W Somasiri

Visiting Lecturer, Department of Chemistry, University of Colombo.

Dr N A Tennakoon

Visiting Lecturer, Department of Microbiology, University of Kelaniya.

Mr L P Vidhanarachchi

Committee Member, Soil Science Society, Sri Lanka.

Mr P A H Nimal Appuhamy

Member, Extension and Development Committee, Coconut Cultivation Board.

Dr W M U Fernando

National Co-ordinator, Coconut Genetics Resources Network (COGENT).

Member, Estate and Nursery Committee, Coconut Cultivation Board.

Visiting Lecturer, Department of Botany, University of Kelaniya.

Mr J M D T Everard

Member, Committee for selecting best coconut nursery, Coconut Cultivation Board.

Dr H A J Gunatilake

Board Member, Mahaweli Development Authority of Sri Lanka.

14. ACADEMIC AND PROFESSIONAL ACHIEVEMENTS

Dr T S G Peiris, Principal Biometrician was awarded the Ph.D Degree by the University of Colombo, Sri Lanka.

Dr M T N Fernando, Agricultural Economist was awarded the Ph.D Degree by the University of Aberdeen, UK.

Mr I R Wickramananda, Entomologist was awarded the M.Phil Degree by the University of Aberdeen, UK.

Mrs S C Fernando, Botanist was awarded the M.Phil Degree by the University of Nottingham, UK.

Mrs D M D I Wijebandara, Senior Technical Officer was awarded the M. Phil Degree by the University of Peradeniya, Sri Lanka.

Mrs S C Fernando, Botanist, won the prize for the best presentation in the Genetics and Plant Breeding Section at the Annual Congress of the Postgraduate Institute of Agriculture.

STAFF PUBLICATIONS AND COMMUNICATIONS AT SCIENTIFIC MEETINGS

(CRI members are shown in bold type)

THESES

Dr T S G Peiris -The Influence of Climate and Weather on the Nut Yield of Coconut (*Cocos nucifera*). Ph.D Thesis, University of Colombo, Sri Lanka.

Dr M T N Fernando - Economic Analysis of Coconut-based cropping/farming systems, Ph.D Thesis, University of Aberdeen, UK.

Mrs D M D I Wijebandara - Comparison and evaluation of laboratory methods for determination of plant available phosphorous in coconut growing soils in the Low Country Intermediate Zone of Sri Lanka. M.Phil Thesis, University of Peradeniya, Sri Lanka.

Mr I R Wickramananda - Insect antifedents, growth regulatory and insecticidal properties of Tissue Culture and plant extracts of Neem (Azadirachta Indica A. Juss) M.Phil, Thesis, University of Aberdeen, UK.

Mrs S C Fernando - Tissue Culture and Gene Transformation Studies of Elite Rice Breeding Lines. M.Phil Thesis, University of Nottingham, UK.

JOURNALS AND SCIENTIFIC MEETINGS

Allan E J, Coventry E, **Wickramananda I R** and Mordue A J (1997). Screening neem plant extracts for biological activity. Paper presented at the International Symposium on Bioassay Methods in Natural Product Research and Drug development at Uppsala University, Sweden from 24 to 27 August.

Fernando W M U, Hayward M D and Kearsey M J (1997). Isozyme and quantitative traitspolymorphisms in European provenances of perennial rye grass (*Lolium perenne L*) *Euphytica* 93:263:269.

Fernando W M U and Rhode W (1997). Genetic diversity of the form San Ramon var Typica of *Cocos nucifera L* detected by the novel ISTR DNA marker technology using coconut specific PCR primers. *Proc. Third Int. Symposium on New Genetical Approaches to Crop improvement*, February 1997 Tando Jam Pakistan.

Fernando W M U and Gamini Gajanayake (1997). Patterns of isozyme variations in Coconut populations used for breeding improved varieties. *Plantations, Research, & Development* 4(4):256-261.

Fernando W M U, Perera L and Peiris R R A (1997). An overview of breeding research in *Cocos nucifera*. The Sri Lankan experience. *Outlook on Agriculture* 26(3):191-198.

Fernando L C P and Walter G H (1997). Species status of two host-associated populations of *Aphtis lingnanensis* (Hynenoptera: Aphelinidae) in citrus. Bulletin of Entomological Research. 87:137-144.

Fernando S C, Power J B and Davey M R (1997). Cell and Tissue Culture of Indica-javanica Elite Rice Breeding Lines IR 65597-134-2 and IR 65598-112-2. Tropical Agricultural Research 9:15-25.

Fernando S C, Davey M R and Power J B. *Agrobacterium*-mediated Gene Transfer into Indica-javanica Elite Rice Breeding Lines. Proc. Sri Lanka Assoc. Advmt. Sci. 53(1) 180.

Jayasekara C, (1997). Photosynthesis and assimilate partitioning characteristics of the coconut palm as observed by ^{14}C labelling. Paper presented at the seminar on Nuclear Technology for better agricultural productivity, held at the Institute of Engineers, Colombo, 05 September.

Jayasekera C, Ranasinghe C S, Wimalasekara R. (1997). Improving Coconut palm characters for increased productivity. Paper presented at the Workshop on *Technology Development and Transfer in Coconut,* held at the Coconut Development Training Centre, Lunuwila, 01 to 05 April.

Juniper S, Abbott L K and **Jayasundara F S** (1997). Approaches to the study of interactions between VA mycorrhizal fungi, In:A new manual on mycorrhizae. Ed A.Varma Springer Verlag, Heiddberg.

Liyanage M de S (1997). The Coconut Industry in Sri Lanka. Paper presented at the International Cashew and Coconut Conference held in Tanzania, 17 to 21 February.

Liyanage M de S and Gunatilake H A J (1997). Agronomy and Farming System Research in Coconut: Sri Lankan Experience . Paper presented at the International Cashew and Coconut Conference held in Tanzania, 17 to 21 February.

Liyanage M de S, Liyanage V, **Dassanayake K B** and **Abeysoma H A** (1997). Role of multipurpose trees in rehabilitating degraded coconut lands in Sri Lanka. Paper presented at the International Workshop on Tropical Forest Rehabilitation in the Asia-Pacific Region held in Brisbane Australia, 02 to 05 December.

Liyanage A C **Fernando W M U**, Wickramasinghe I P, Pathirana K P S K and Abeykoon A M A (1997). Development and application of isozyme technique for the identification of tea clones. Proc. Sri Lanka Assoc. Advmt. Sci 53 (2):123.

Mathes D T (1997). Harvesting Coconuts for high yielding and profitability. Paper presented at the Workshop on Technology Development and Transfer in Coconut, held at the Coconut Development Training Centre, Lunuwila, 01 to 05 April.

Peiris T S G and Thattil, R.O. (1996). Application of Agroclimatology to some aspects of Coconut Research. *J. Plantation Crops (Supplement), 24*, 24-35.

Peiris T S G and Mathes D T (1997). *Rainfall changes scenarios in Coconut growing areas in Sri Lanka.* Proceedings of the National Symposium on Climate Change, 07 to 08 March, Colombo.

Peiris T S G and Thattil, R.O. (1997). *Climate analysis - the effect of climate on Coconut.* Proceedings of the National Symposium on Climate Change, 07 to 08 March, Colombo.

Peiris T S G (1997). *Evaluation of subsidy programmes in Coconut and Technology Transfer.* Paper presented at the Workshop on Technology Development and Transfer in Coconut, held at the Coconut Development Training Centre, Lunuwila, 01 to 05 April.

Peiris T S G and Mathes D T (1997). The analysis of long-term rainfall variability of selected locations in Sri Lanka. Proceedings of the International Congress on Modelling and Simulation, (MODSIM 97), 06 to 11 December, Hobart, Australia.

Rajapakse C N K and Fernando L C P (1997). Leaf Scorch Decline of Coconut in Sri Lanka: A review. Proc. International Workshop on Lethal Yellowing-like diseases of Coconut.Elmina, Ghana, November 1995. Ed. S.J. Eden-Green & F. Ofori. Chatham, UK, N.R.I. 97-104.

Somasiri L L W (1997). Site specific nutrient management in coconut. Paper presented at the Workshop on Technology Development and Transfer in Coconut, held at the Coconut Development Training Centre, Lunuwila, 01 to 05 April.

Tennakoon N A (1997). Effect of application of heavy metal contaminated sewage sludge on long-term nutrient cycling in coniferous forest soils. A poster presentation at the 11th CIEC Fertilizer Congress on "Fertilization for Sustainable Plant Production and Soil Fertility" held in University of Gent, Belgium, 07 to 13 September.

Tennakoon N A and Liyanage M de S (1997). Net nitrogen mineralization in Coconut/Nitrogen fixing tree based system Coconut Research & Development (CORD). Vol XII (1):21-33.

Vivehananthan K, Attanayake D P S T G, Karunanayake E H and **Everard J M D T** (1997). Preliminary studies towards developing molecular markers for Hevea brasiliensis. Proc Sri Lanka Assoc. Advmt. Sci 53(2):179.

Vidhanarachchi L P (1997). An evaluation of different mulches used in soil moisture conservation of Coconut lands. Paper presented at the Seminar on Nuclear Techniques for better Agricultural Productivity, held at the Institute of Engineers, Colombo, 5th September.

Vidhanarachchi L P (1997). 'Soil physical constraints with respect to Coconut Production'. Paper presented at the Workshop on Outreach Activity by "Sricansoil" project on Coconut growing soils, Coconut Research Institute, Lunuwila on 27th March.

Vidhanarachchi L P (1997). Identification of basic design parameters of a drip irrigation system for coconut *(Cocos nucifera L.)* in gravelly soils. Proc. Sri Lanka Assoc. Advmt. Sci. 53 (2):130.

Vidhanarachchi L P and Liyanage M de S (1997). Competitive effect of Coconut/Nitrogen tree based system for soil moisture uptake. Proc. Sri Lanka Assoc. Advmt. Sci. 53 (2):162.

Vidhanarachchi L P and Somasiri L L W (1997). Assessment of oxygen availability in soils of different drainage classes and its effect on coconut root growth. Proc. Sri Lanka Assoc. Advmt. Sci. 53 (2):159.

Vidhanarachchi L P, Yapa P A J, Mapa R B and Somapala H (1997). Effect of soil physical properties on the nutrient inflow in Coconut *(Cocos nucifera L.)* seedlings. Proc. Sri Lanka Assoc. Advmt. Sci. 53 (2):160.

Vidhanarachchi L P, Yapa P A J, Mapa R B and Somapala H (1997). Effect of soil physical properties on ATPase activity, proline and carbohydrate levels of Coconut *(Cocos nucifera L.)* seedlings. Proc. Sri Lanka Assoc. Advmt Sci. 53 (2):161.

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