

**COCONUT RESEARCH BOARD**

**COCONUT RESEARCH INSTITUTE  
OF SRI LANKA**

**REPORT FOR 2000**

**COCONUT RESEARCH INSTITUTE - REPORT FOR 2000**

# COCONUT RESEARCH BOARD



*M. Jayasingh*  
7-9-02

## REPORT OF THE COCONUT RESEARCH INSTITUTE FOR 2000

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## CONTENTS

	<b>Page</b>
The Staff	01
Report of the Acting Director and Deputy Director (Research)	12
Report of the Agronomy Division	33
Report of the Genetics and Plant Breeding Division	61
Report of the Soils and Plant Nutrition Division	81
Report of the Crop Protection Division	138
Report of the Biometry Division	156
Report of the Tissue Culture Division	169
Report of the Coconut Processing Research Division	181
Report of the Plant Physiology Division	191
Report of the Extension Services Division	211
Report of the Library	216
Report of the Estates Management Division	219
Report of the Administration Division	233
Staff Matters	235
Staff Publications and Communications at Scientific Meetings	248

# COCONUT RESEARCH INSTITUTE OF SRI LANKA

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A Thavaratnarajah

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**Ratmalagara Estate**

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A N Ekneligoda

***Supervisors***

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T M Keerthiratne

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R P Victor

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***Lab & Field Assistant***

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**Maduruoya Seed Garden**

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M A S Fernando

***Lab/Field Assistant***

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**Pallama Seed Garden**

***Superintendent***

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Piyal Ranjith Fernando

- 
- \*\* On Study Leave
  - \*\*\* On Overseas No-pay leave
  - \*\*\*\* Sabbatical Leave

**REPORT OF THE ACTING DIRECTOR AND  
DEPUTY DIRECTOR (RESEARCH)  
C Jayasekara, Ph D (QLD)**

**1. GENERAL**

National coconut production during the year continued to increase and recorded a peak production of 3080 million nuts. This was the first time since 1986 that national coconut production reached the 3000 million mark. This was an approximately 7% increase over the previous year. Favourable weather conditions that prevailed during the year in most of the coconut growing areas, and the lag effect of the well-distributed rainfall during the previous two consecutive years, contributed to this high production. In addition, improved coconut prices since about 1993 leading to improved crop management, effective extension carried out by the Coconut Research Institute (CRI) and Coconut Cultivation Board (CCB), a marginal increase in the extent under coconut cultivation, supply of improved planting material since 1980 and an accelerated home garden programme also contributed to this upward production trend which is expected to continue further.

Consequent to this increased output of nuts, the export volume of most of the kernel based products, specially desiccated coconut recorded the highest level of 80,000 MT. According to APCC statistics, Sri Lanka has exported the highest volume of desiccated coconut compared to other major coconut producing countries this year. However, the total foreign exchange earnings from the coconut industry remained at almost the same level of Rs.10,715 Mln. up to November due to a decrease in world market price of many coconut products such as DC and coconut oil, largely due to an over supply of these products.

Coconut prices declined sharply during the first quarter of the year to nearly half of that of the latter part of the previous year. There were corresponding decreases in the desiccated coconut and coconut oil prices. The coconut oil price was also badly affected by increased production of palm oil and palm kernel oil. Considering the current estimates of utilization of nuts for processing and consumption, the CRI prediction was that, there would be 300 - 400 Mln. nuts in excess in the Island by the first quarter of year 2000. This situation was mainly attributed to the lack of large-scale industries (other than DC and coconut oil) to absorb excess production, and a drop in coconut oil manufacture due to the high cost of production and competition from imported cheaper vegetable oil substitutes. In view of this situation, the Coconut Research Institute jointly with the Coconut Development Authority and the Coconut Cultivation Board organized a Conference under the theme "Coconut Industry - Meeting the New Challenges". The main objective of this one-day Conference was to address the current problems of the industry, to draw up strategies and policy initiatives for the Government to tackle the situation, and to safeguard the industry. Pursuant to this initiative and others, the tariff level of imported vegetable oils was increased by the Government with a view to encouraging manufacture of coconut oil and also coconut oil consumption.

Following the outbreak of the coconut mite (*Aceria guerreronis*) infestation in the Puttalam District in March 1999 and its satisfactory control, a decision was taken to hold an International Workshop inviting world-renowned acarologists to review the current knowledge of the biology, ecology and control of coconut mite. This Workshop was organized by the Coconut Research Institute in collaboration with the United Nations Development Program and held at the CRI Auditorium from 6 - 8 January. Well known

acarologists from United Kingdom, USA, Brazil, Cuba, and India attended this meeting. As an outcome of this workshop, a research proposal was submitted to the FAO and one Research Officer was trained on predator mite rearing at the International Institute of Tropical Agriculture (IITA), Benin.

The three Seed Gardens maintained by the Coconut Research Institute (CRI) recorded a total production of 1.69 Mln. seed nuts during the year, which represents a 13% increase over the previous year. Seed nut supply from Makandura Seed Garden was discontinued due to the prevalence of the 'Rapid Decline Syndrome'. Of the total number of seed nuts, as much as 96% was supplied to the CCB from Ambakelle and Maduru Oya Seed Gardens.

With the objective of developing a new five-year research program, a series of in-house discussions were held with Research and Extension staff to identify new researchable areas. The Research Committee Meetings scheduled for November 2000 were postponed to January 2001. Comprehensive reports on on-going experiments submitted by Research staff were evaluated and new proposals were appraised and approved.

Sri Lanka (through CRI) has been able to reach an understanding with five countries - India, Fiji, Papua New Guinea, Ivory Coast and Indonesia for exchange of germplasm, and the Coconut Research Board has already approved exchanges with the first four countries. This is a major achievement in the annals of coconut breeding in Sri Lanka, as current breeding efforts have been constrained by the narrow genetic base of local varieties.

The Council for Agricultural Research Project (CARP) continued to provide assistance to the Institute by funding individual research projects and improving electronic library facilities. The Institute benefited much from the Cess Fund for strengthening infrastructure facilities for molecular biology research and upgrading the professional skills of Research staff. Further, the Cess Fund assisted substantially in the development of Maduru Oya Seed Garden and the newly established Pallama Seed Garden. The Molecular Biology laboratory built with the assistance of the Cess Funds was completed and handed over to the Institute. Part of the old Toddy Tappers Training Center was refurbished with the assistance of the Cess Fund, for the training of Farm Managers.

Two Scientists at the CRI were able to secure National Research Council grants worth over one million each for research in the area of biotechnology.

The CRI continued to provide technical assistance and advisory services to both plantation companies and estates and the smallholder sectors with regard to differential fertilizer recommendations (DFR) and management of pests and diseases. The Persuasive Extension Program (PEP) received a good response from the growers and advice was provided for the development of coconut farms. In addition to providing technical support, the Divisions continued to monitor the progress of farm development. These services enabled the CRI to maintain a close interaction with the coconut growing community.

During the year, CRI conducted two regional technical seminars for growers in collaboration with the CCB in Puttalam and Galle. One research extension dialogue was held in Kegalle with active participation of Extension Staff of the CCB.

The CRI estates were maintained in good order. An average increase of 10% in coconut production was recorded from Rathmalagara, Bandirippuwa, Makandura and

Walpita estates compared to last year. Nevertheless, coconut production at the Isolated Seed Garden, Ambakelle and Pottukulama Research Station was 10% less this year due to low rainfall experienced towards the latter part of the previous year. Development of Pallama Seed Garden is being continued. By the end of year 2000 more than 100 acres in the Seed Garden area were planted with hand pollinated T x T and San Ramon seedlings. Construction of agro-wells and installation of a drip irrigation system is being initiated to provide supplementary irrigation to the seedlings during dry spells.

The CRB appointed a one-man committee to revise the manual of procedure, the promotional scheme and salary structure of the staff. A team of Scientists from ISNAR conducted a series of Workshops to develop performance evaluation criteria. They will continue to work with CRI to develop criteria for strategic planning.

During the year, in-house seminars were conducted for Research and Technical Staff. Two general seminars were conducted for all the staff to improve awareness of on-going research activities at the CRI.

## 2. RESEARCH & DEVELOPMENT

A brief account of the research and development activities of the CRI is given below:

### 2.1 Agronomy

The research program of the Agronomy Division was aimed primarily at increasing coconut production and the productivity of coconut lands. In addition, four agricultural economic studies were carried out on important issues associated with the coconut industry.

Growth of coconut seedlings established in degraded coconut soils (Andigama series) was significantly better in 1.3 m x 1.3 m x 1.3 m holes and 1.3 m x 1.0 m trenches than normal planting holes (1.0 m x 1.0 m x 1.0 m). It was found that application of dead mulch as coir dust cover (5 cm thickness) and *Pueraria* live cover increased coconut yield by 35% and 20% respectively over ground cover of *Bracharia brizantha* (unmanaged). A study was initiated on the use of medium term forest planting on degraded shallow lateritic soils. Preliminary growth of the thirteen different tree species planted, showed that *Macaranga peltata* (Kenda) has the fastest growth followed by *Acacia mangium* and *A. auriculiformis*. *Calophyllum inophyllum* (Domba) showed the slowest growth.

Multilocational trials aimed at determining the effects of inter-planted nitrogen fixing trees on coconut yield showed no significant effect on the nut yield due to inter-planting *Gliricidia* and *Acacia* (density 2496-3744 plants per ha). These trees produced 10 and 15 mt. of biomass/ha/year respectively. Two cover crop trials were established at Pallama Seed Garden and Melsiripura to study the possibility of substituting *Pueraria* as nitrogen fertilizer source.

In order to increase genetic diversity of cover crop species/provenance, seeds of 20 leguminous cover crops were received from CIAT and screening trials were established at Bandirippuwa Estate under coconut shade and in an open field. Amongst these covers, *Pueraria phaseoloides* (CIAT numbers 32118, 7182, 8042 and the local provenance) *Centrosema macrocarpum* (CIAT 25552), *Calapogonium mucunoides* (CIAT 17856),

*Arachis pintoi* (CIAT 18744) and *Desmodium rensonii* (cv Davao) were able to produce over 5000 kg of biomass/ha/year. *Mucuna pruriens* was the fastest growing provenance and produced approximately 10,000 kg of biomass/ha in the first ten months but after that its productivity declined.

Moisture conservation practices such as husk burial and mulching on land suitability classes S<sub>2</sub>, S<sub>3</sub> and S<sub>5</sub> did not show any favourable effect on the yield of coconut probably due to well distributed rainfall during the year and a lag effect of favourable soil moisture status in previous years.

The application of glyphosate was more effective and economical than slashing for the control of *Imperata cylindrica*, *Pennisetum polystachyon* and *Panicum repens*. Nut yield was improved by 40% in plots where weeds were controlled with glyphosate over unweeded and slashed plots.

Intercropping trials with bud-grafted cashew under a 45 years old mature stand of coconut in the Intermediate Dry Zone yielded 3.4 kg/tree/year in the fourth year. Coconut yield was not affected by cashew. In another intercropping trial at Nikaweratiya, it was concluded that planting of seedling cashew is also possible with new planting of coconut when planted in 12 m x 6 m spacing (coconut 138 palms/ha and cashew 69 trees/ha) in the Dry Zone. Tea was an attractive intercrop with coconut among farmers in the Galle and Matara Districts due to high tea prices (average Rs.24/- per kg of fresh leaves) and consequent high net returns (Rs.6200/- per ha/month). However, Mg deficiency of coconut palms was prevalent lands intercropped with tea and annual application of 1 kg of kieserite per palm was recommended. As the market price of ginger increased up to Rs.60/- per kg, this crop was included in several models to achieve high returns. Several perennial intercrops such as rambutan, mango and lime produced off-season fruits, probably due to the unusual rainfall distribution pattern.

Under the coconut based adaptive research program funded by the Second Perennial Crop Development Project, 81 farmer participatory adaptive research sites were established. Cocoa, pepper, cinnamon, rambutan, lime, avocado, orange, cashew, mango, pineapple, banana and passion fruit are the tested intercrops. Among those crops, priority has been given to popularize cinnamon in the Southern Province and bud-grafted cashew in the North-Western Province. Non-traditional crops (eg: rambutan in Akuressa area and bud-grafted orange in Hambantota and Anuradhapura areas) were introduced.

A study was continued with buffalo grazing in coconut lands in comparison with cover cropping and normal slashing to control weeds. Buffalo-grazed plots, yielded 94 nuts/palm/year, as against 81 and 89 nuts for cover crop plots and slashed plots respectively.

The animal production program carried out with assistance from the Coconut Cess Fund continued successfully. At the end of the year the number of buffaloes had increased to 15 males and 32 females at ISG and Makandura. At PRS the number of goats increased to 102 of which 22 animals were sold to farmers identified by the regional Veterinary Surgeon.

## **Agricultural Economics:**

A study was done on the impact of import duty reduction of substitute vegetable oils on the local coconut oil (CNO) industry. The major conclusions were : (a) that some 80 percent of CNO mills were closed down or irregularly worked, mainly due to the unprofitability of CNO manufacture at the low market prices dictated by cheap substitute oils; (b) that the foreign exchange expenditure on importation of an incremental volume of substitute oils was greater than that earned from the incremental exports of D.C., thus making the country a net loser of foreign exchange and (c) that import duty levels have to be continually reviewed if the local CNO industry is to be protected. However, the scope for such continuous protection is limited in practice by the ever declining world market prices for the competing palm oil. Protection should not be considered as a permanent solution. The future of the CNO industry has to be based on improved technology for CNO manufacturing (e.g. alternatives to the copra route) diverting part of the CNO production for oleochemical production, and launching a campaign to re-popularize local CNO consumption.

The economics of interplanting *Gliricidia* with coconut as an energy source for dendro-thermal power-plants were investigated using data collected from on-farm trials established by the fuelwood project. This investment appears to be economically feasible for farmers assuming a power-plant delivered price of Rs.1250 per MT of dry *Gliricidia* wood, but not as lucrative as mixed cropping alternatives such as coconut-based pineapple, banana and ginger etc. However, for land suitability classes S<sub>5</sub> and below, where rehabilitation of lands by Nitrogen Fixing Trees is necessary and other mixed cropping practices are not profitable, this investment seems attractive. Moreover, for those absentee landlords who do not wish to grow other intercrops due to management demands of material inputs and intensive labour, *Gliricidia* seems to be an attractive option because of its relatively less labour and material input demand.

The relationship of national coconut production with different input variables was examined employing a regression analysis and using time series data. It was revealed that the soil moisture (rainfall) and the technology (R & D and management) were significantly affecting national coconut production while fertilizer use also has a positive impact.

A survey of distilleries was carried out to examine the current status of this industry and the potential for its improvement. Seven distilleries, including those using coconut spirits and cane spirits for manufacture were visited during May and June 2000 and the results of the interviews are to be published.

## **2.2 Genetics and Plant Breeding**

The highlight of the year was the production and distribution of CRISL 98, (Tall x San Ramon) the new release, for adaptive trials. The response to CRI's call for grower's participation on evaluating CRISL 98 in farmer's fields was very encouraging. In the year 2000 alone, a total of 2848 seedlings was distributed in 10 Districts, representing a range of agro-ecological environments in the country. The production of CRISL 98 seed by hand pollination of selected tall palms at the Isolated Seed Garden, Ambakelle (ISG) with San Ramon Pollen was continued. The number of CRISL 98 seed nuts produced during the year was 9169. These seed nuts are being raised at the ISG nursery for distribution among growers.

Establishment of the Pallama Seed Garden (PSG) for mass production of CRISL 98 progressed steadily during the year despite heavy casualties from Black Beetle damage and water logging. During the year, 1442 tall palms and 107 San Ramon palms were planted making up the final tally to date of 4507 (3004 tall and 1503 San Ramon palms). Production of the superior tall and San Ramon for raising seedlings for the expansion of PSG was continued at ISG and from a newly selected palm pool at the PSG itself.

Steady increases in nut yield were evident in all treatments in the multi-locational cultivar comparison at the two sites at Bandirippuwa (Lunuwila) and Suriyapura (Gampaha). This trial is now in the 17<sup>th</sup> year after establishment and up to this stage in all the sites, the inter-varietal hybrids DG x T and DY x T out performed pure tall cultivars, Tall x Tall, Moorock and Plus Palm selections. DG x T recorded high yields at Bandirippuwa, 78 nuts/palm/year and Suriyapura, 61 nuts/palm/year (5 picks) compared to the tall cultivars that averaged 60 and 38 nuts/palm/year at the two respective sites. This year however, the performance of all the five cultivars were poor at Thammenna Estate, all recording yields less than 35 nuts/palm/year with no significant differences. Unevenly distributed rainfall and lack of proper field management to arrest soil moisture depletion would have probably caused the poor yield at this site. The outbreak of *Aceria* mite in the Puttalam District also caused substantial loss of crop at this site.

The copra out turn per nut varied vastly between cultivars and sites showing a clear genotype x environment interaction with plus palms recording the highest of 298 g/nut at Suriyapura and DG x T recording the lowest of 188 g/nut at Thammenna Estate. However, DG x T accounted for the highest per palm copra yield, 18.7 kg/palm/year at Bandirippuwa and Moorock Tall recorded the lowest, 5.43 kg/palm/year at Thammenna Estate. The experiment is to be continued for another five years, as it is likely to provide useful information to establish the potential of hybrids for more extensive planting.

The triats established to assess the performance of F<sub>1</sub> progeny from crosses between selected tall palms at ISG, Dwarf Green and San Ramon, were maintained successfully at all locations for the 15<sup>th</sup> year. All the three crosses recorded yields above 54 nuts/palm at the two sites, Bandirippuwa and Ratmalagara Estates. The best yields were 90 and 74 nuts/palm/year recorded by T x DG at the respective sites, Ratmalagara and Bandirippuwa. The results also revealed the excellence in the combining ability of Tall x San Ramon for the important trait, copra/nut. T x SR recorded a copra out turn of 336 and 329 g/nut at Bandirippuwa and Ratmalagara respectively both being significantly higher than that of T x DG (average, 246 g/nut) and T x T (average, 290 g/nut). These progeny trials too will be continued for another five years, as they have not yet stabilized in yield.

Collection and conservation of coconut germplasm continued at a rapid pace with the financial assistance of COGENT/ADB. The field gene banks at Bandirippuwa, Pottukulama, Lenawa and Raddegoda were maintained successfully while a new gene bank was established at the Pallama Seed Garden (12 accessions). Characterization of the conserved germplasm was undertaken in all the gene banks. The Coconut Genetic Resources Database (CGRD) of the COGENT was updated with the progress of expansion of germplasm accessions in the field gene banks. The preparation of a catalogue of all conserved germplasm was commenced in order to collate ours with the world collection of coconuts to be documented by COGENT in 2001. The trials established for evaluation of germplasm and crosses generated from germplasm accessions were maintained and early growth rates so far have not revealed any exceptional findings.

DNA assay procedures were used for the first time to assess the genetic diversity of coconut germplasm in the country. The results indicated the population structure of coconut in Sri Lanka and how the genetic variation is dispersed. The data revealed that the existing variation has been exploited to a great extent and stressed the need for germplasm enrichment by exotic introductions for further genetic improvement of the coconut. Negotiations have already commenced for the importation of 23 germplasm accessions, nine from India, six from Ivory Coast and eight from Fiji and PNG.

A preliminary study was undertaken to map the coconut genome using molecular markers and a foundation was laid for a long term program for generating a high density map of coconut for use in marker assisted breeding. F<sub>2</sub> families were obtained by selfing F<sub>1</sub> established at the Progeny Trial at Bandirippuwa, which arose from known Tall and Dwarf parents at ISG. These families have been screened for detection of DNA polymorphisms at heterozygous loci in F<sub>1</sub> and their segregation in F<sub>2</sub> constructs.

The successful completion of the IFAD assisted project, collaborating with the Plant Physiology Division, continuation of the ADB Phase III Project collaborating with Plant Physiology and Tissue Culture Divisions, active participation in the ADB Science and Technology Project for manpower and infrastructure development and CESS project for expansion of biotechnology research, are also noteworthy contributions of the GPB Division during the year 2000. The Division also secured two NRC grants for molecular pathogen diagnosis and development of DNA markers during the year.

### **2.3 Soils and Plant Nutrition**

The research program of the Division was aimed at refining soil moisture conservation and nutrient management technologies, particularly with locally available organic material and inorganic fertilizers, evaluating micronutrient requirement for coconut and developing irrigation techniques for coconut. During the year, the Division maintained 19 on-going field experiments comprising 15 trials on coconut nutrition and 4 trials on irrigation and soil moisture. The deep ground water survey in the Kurunegala District was also continued with the assistance of the Cess Fund.

The on-going field experiment on the comparison of Eppawela Rock Phosphate (ERP) with Imported Rock Phosphate (IRP) and Triple Super Phosphate (TSP) showed that leaf phosphorus concentration of all the treated palms continued to be in the sufficiency range (>0.11) during the year, irrespective of the phosphate source. There was no significant difference in the percentage of palms in bearing between phosphate sources or levels. Data from this experiment showed that ERP is a promising source of phosphate for young palms in the Wet-Intermediate Zone.

The experiment on substitution of sodium chloride (common salt) for muriate of potash as a coconut fertilizer showed that there was a decreasing trend in nut yield of sodium chloride-treated palms compared to muriate of potash-treated palms this year. The leaf potassium concentration of the sodium chloride-treated palms was in the deficiency range (1.2%) whereas that of muriate of potash treated palms was in the sufficiency range. Thus the yield decline seemed to relate to potassium nutrition of the palms.

The on-going fertilizer experiment on the evaluation of the effect of different NPK combinations on the yield of king coconut showed an increasing trend of nut yield in response to NPK treatments irrespective of combinations compared to the control (no-fertilizer). The response was more promising in lateritic gravel soils than in sandy soils.

The experiment on the evaluation of the effect of fertilizer, ethrel application and irrigation on toddy yield showed that the yield increased by 80% due to application of NPK fertilizer. However, the toddy yield did not show significant response to irrigation treatments this year perhaps due to well-distributed rainfall. There was apparently also no response to ethrel application.

The field experiment to evaluate the effect of seasoning of poultry manure on the performance of the coconut palm showed that fresh poultry manure was harmful to coconut roots up to a depth of 30 cm. The effect could be mitigated by open air seasoning of the manure for 3 months.

Another experiment on the use of different kinds of organic manure (cow dung, goat dung, poultry manure and *Gliricidia*) as nitrogen sources showed no significant difference on coconut yield between treatments.

Application of zinc sulphate and copper sulphate in addition to NPK fertilizer showed no increase in coconut yield in response to the trace elements. However, Zn, and Cu concentration in leaf increased due to above applications.

Comparison of different fertilizer placement techniques on coconut yield for five years showed that application of fertilizer in bore holes in the manure circle was not significantly different from broadcasting.

The on-going experiment on evaluation of the effect of spatial separation of potassium and magnesium fertilizer placement in the manure circle of the coconut palm for correction of Mg deficiency showed that leaf magnesium concentration of palms did not increase due to the different application techniques. However, soil analysis revealed that magnesium concentration in sandy soils could be maintained at 0.8 me/100 g throughout the year by spatial separation of K and Mg fertilizer. Simultaneous application of potassium and magnesium fertilizer resulted in decreasing soil Mg concentration to 0.6 me/100 g.

Under the nutrient mapping project, 1000 soil samples collected from Kurunegala soils and 400 leaf samples collected from Boralu soils were analyzed. The data indicated that soil chemical properties were highly variable even within a soil series. Majority of coconut palms on the Boralu soils were deficient in magnesium. Soil analysis data of the Kurunegala samples also showed that there was a trend of Zn and Cu depletion from the soils in the manure circle. It indicated that application of Zn and Cu fertilizer could be needed in the future.

For quantification of plant nutrient depletion from soils by coconut palms, all plant residues and nuts from 10 coconut palms yielding in the range of 100 nuts/palm/year were collected, weighed and analyzed for all plant nutrients for a period of one year. The result showed that the total removals of N, P, K and Mg by plant residues and nuts were 0.7, 0.08, 1.6 and 1.2 kg/palm/year respectively. It showed that application of 3 kg of Adult Palm Mixture (APM) which contained only 0.36 kg of N, 0.72 kg of P and 0.8 kg of K, was not

sufficient to sustain high yielding coconut plantations. The above study also showed that the annual removal of each trace element through nuts did not exceed 1 g per palm.

The Division in collaboration with the Water Resources Board continued the survey of deep ground water in the upland areas of the Kurunegala District. Hydro-geological survey of about 40% of the area was completed this year. Three test wells were also completed during this year. This project is being implemented with assistance of the cess fund.

The laboratory facilities of the Division were also improved by installing several automated and semi-automated items of equipment for expediting the routine soil and leaf analyses involved in Differential Fertilizer Recommendation (DFR) and other research projects. Equipment were purchased from the cess fund.

Arrangements were made for digitizing the soil maps of the coconut triangle area and for preparation of a database for nutrient mapping. A GIS software package was also installed in the computer of the Division for this purpose.

As service functions, the Division provided Differential Fertilizer Recommendations (DFR) to 637 growers during the year. 178 inorganic fertilizer samples, 23 organic manure samples and 198 coir dust samples were quality tested. In addition, soil surveys for land use evaluation covering about 1000 ha were carried out. The Divisional staff also made 20 advisory visits at the request of coconut growers. In addition, the staff participated in four visits under the Persuasive Extension Program (PEP).

## 2.4 Crop Protection

An outbreak of a leaf rot disease caused by a complex of fungi was reported from Matara and part of Galle Districts. Preliminary field studies with different fungicides indicated that drenching with tebuconazole (folicur) and tridemorph (calixin) was effective in controlling the disease on a short-term basis. However repeated treatment is necessary. These chemicals have been recommended, and long-term studies are being continued.

An experiment was initiated for mass trapping of red weevil, *Rhynchophorus ferrugineus* using trap densities of 6, 4 and 3 per hectare to determine the optimum density. The electronic device developed to detect palms infested by red weevil was further improved to amplify only the crunching noise of red weevil larvae.

The effect of placing pheromone traps in a field containing breeding grounds of black beetle; *Oryctes rhinoceros* was tested. The traps placed at a rate of 2 traps per acre reduced the fresh bud damage of seedlings by 27% to 30% in a three month period, and continued at the same level. Removal of traps after 9 months increased the damage again. A trial evaluating the efficacy of different chemicals against black beetle was not successful due to high incidence of *Baculovirus* and *Metarrhizium* infection of breeding larvae in artificial breeding places resulting in poor survival of beetles and no damage to the seedlings. Therefore, this experiment will be repeated in another site where there are natural breeding places.

The effect of releasing the parasites *Eriborus trochanteratus* and *Brachymeria nephantidis* separately and in combination for controlling coconut caterpillar was tested.

Singly, both species reduced the pest population by more than 90% within 4-5 months after release, while the reduction in the population occurred in 2.5-3 months when both species were released together. However, parasitism did not increase over time due to the lack of suitable hosts between pest generations.

The study on the infectivity of the fungus *Ganoderma* was continued. The seedlings planted in the vacancies created by the death of *Ganoderma* infected palms after different intervals remained unaffected up to 2 years. No infection was detected in seedlings raised in nurseries from seednuts of disease affected estates up to the end of the nursery period.

The study to determine whether nesting sites are a limitation for the presence of honeybees in coconut plantations was continued. The occupancy rates of pots at the end of the year were 53.3%, 20% and 6.7% in Walpita, Nalla and Bandirippuwa respectively. The variations could be due to differences in food availability and/or climatic conditions at the three sites.

The staff of the Division continued to assist growers and the Coconut Cultivation Board in managing pests and diseases.

## 2.5 Plant Physiology

The Division continued to devote attention to research activities related to shelf-life improvement of tender nuts, tapping coconut palms for toddy, water relations of the coconut palm and disorders of unknown etiology.

Experiments on the preservation of tender bodiri nuts were continued under laboratory conditions. When the whole nut was disinfected with Benlate (0.6g/L), completely wrapped in cling film and stored at 14-15<sup>o</sup> C and 70% RH, the sugars, minerals and taste of nut water and the external appearance of the nut were maintained for a period of 3 weeks.

Application of 3.0 ml of 2.5% ethrel at three-monthly intervals to the base of the axis of the tapping spadix increased the daily toddy yield consistently for a period of four years. The increase was 35% during the first two years, 20% in the third year and 11% in the fourth year compared to untreated palms. The sugar content in the sap of ethrel treated palms was also higher than that of untreated palms. Studies were commenced to determine the mode of action of ethrel in simulation of toddy yield and sugar content.

The biological feasibility and economic viability of using coconut palm for the dual purpose of nut and toddy production was compared with nut or toddy production alone. A sap-producing palm was estimated to remove 187 L of water (excluding evapotranspiration), 14.74 kg of carbon (C), 124 g of nitrogen (N), 25 g of phosphorus (P), 546 g of potassium (K) and 1 g of magnesium (Mg) and returned a net income of Rs.1250.00, annually. A nut-producing palm removed 20 L of water, (excluding evapotranspiration), 23 kg of C, 467 g of N, 97 g of P, 896 g of K and 127 g of Mg and returned a net income of Rs.400.00, annually. Whereas, a palm used for periodic tapping and nut production for a period of three months removed 125 L of water, 21 kg of C, 332 g of N, 58 g of P, 584 g of K and 70 g of Mg and returned a net income of Rs.980.00, annually. A palm with sequential production of sap and nuts in the same spathe removed 86 L of water, 22 kg of C, 393 g of N, 81 g of P, 870 g of K and 94 g of Mg and returned a net income of Rs.700.00, annually.

A new experiment was started with Green and Yellow Dwarf palms at Bandirippuwa Estate, to determine the economic viability of tapping dwarf coconut palms for production of treacle in home gardens.

Studies on water relations and stress-sensitive hormone accumulation of different coconut germplasm accessions revealed that Brown Dwarf, Ambakelle Special and Bodiri palms maintained the highest rates of transpiration compared to others, following exposure to 25 days of a rain free period whilst Cameroon Red Dwarf and Moorock Tall had the lowest. The latter two varieties had the highest stomatal resistance, but it was not always correlated with abscisic acid content in the xylem sap of those palms. A plant house study was started to evaluate the genotypic variation in the sensitivity of coconut seedlings to soil drying and the pattern of abscisic acid production. Seedlings of CRIC60, CRIC65 and CRISL98 are grown under three soil moisture regimes for this study.

In Leaf Scorch Decline (LSD) affected palms, the leaf Zn content was lower than in apparently healthy palms. Therefore, some of the affected palms at Bandirippuwa, Walpita and Poththukulama estates were root fed with 100 ml of 1% ZnSO<sub>4</sub> solution to determine the effect of Zn on the appearance of LSD symptoms. Rapid Decline (RD) affected palms at Makandura Seed Garden were treated with micronutrient, common salt, nematicide, fungicide and tetracycline to assess the progress of 'Rapid Decline Syndrome' following treatment. Young and mature leaves, mid ribs (ekel) and root samples of RD affected palms were sent to the University of Sussex, (UK) for Transmission Electron Microscopic (TEM) studies.

In collaboration with the Genetics and Plant Breeding Division, two catalogues on coconut food recipes and value added coconut products in Sri Lanka were prepared.

## **2.6 Tissue Culture**

During the year, greater attention was given to plant regeneration in immature embryo plumule and immature inflorescence explants.

Twelve tissue-cultured (clonal) plants were established at Bandirippuwa Estate to evaluate their performance in the field. The growth of the 4 tissue-cultured plants which were planted at Bandirippuwa Estate in the previous year was found to be satisfactory. Fifteen more clonal plants were fully acclimatized and are ready for field planting.

The ploidy of a few clonal plants derived from plumule explants was tested using flow cytometry and no variations were detected.

The effect of palm maturity on callogenesis in immature inflorescence explants and the feasibility of using morphological characters of the palm as an index to select suitable inflorescences to obtain explants were investigated. The results revealed that there was no significant effect of palm maturity on callusing frequency. Furthermore, there was no significant correlation between callus production and morphological characteristics of the palm, indicating that use of such characters as a guide in selecting suitable immature inflorescences for culture is not feasible.

The DFID-funded product on "Increasing the efficiency of embryo culture technology to promote coconut germplasm collection and exchange" was completed. Some of the important findings of the study include the development of a better growth medium for embryo culture, the positive effect of gibberellic acid (GA<sub>3</sub>) on embryo germination and the possible use of abscisic acid (ABA) for embryo maturation. These findings made a significant contribution towards the improvement of the current embryo culture protocol.

The *in vitro* screening of 3 germplasm accessions (Sri Lanka Green Dwarf x Sri Lanka Tall, Sri Lanka Green Dwarf and Sri Lanka Yellow Dwarf) for drought-tolerance was completed. The results indicated that there was no significant difference between Sri Lanka Green Dwarf and Sri Lanka Yellow Dwarf in regard to the degree of tolerance to polyethylene glycol (PEG). However, the level of tolerance to PEG was significantly higher in Sri Lanka Green Dwarf x Sri Lanka Tall when compared to the other two cultivars.

The propagation of "dikiri" coconut through embryo culture was continued and 26 embryo-cultured plants were distributed among farmers in Weligama.

The feasibility of using a charcoal-free culture medium for induction of callus in plumule explants was tested. Even though it was possible to produce callus in charcoal-free media, the frequency was relatively low when compared to charcoal-containing media.

Biochemical analysis of zygotic embryos (at different stages of maturity), plumule callus, embryogenic and non-embryogenic structures derived from plumule callus was initiated and the contents of total sugar, starch and proline in the above tissues were determined. Preliminary results reveal that the proline content in zygotic embryos decreased with maturity. The proline level in callus was much higher than that in embryogenic and non-embryogenic structures.

## 2.7 Biometry

The Division continued to assist the Research Divisions in designing field experiments and questionnaires for field surveys; recommending sampling methods for socio-economic surveys; assisting in statistical analyses and interpretation of results, use of computers and software packages, and database management.

Training courses on computer applications were conducted for the staff in Non-Research Divisions. In addition, recommendations were made towards effective and efficient ways of using computers in the Institute.

The 'INFORM' database on Management Information System was updated and the relevant analyses were submitted to CARP. Computerized database management systems for storing and retrieving data from field experiments, climatology and the medical aid scheme of the employees were maintained and updated regularly.

The calibration trial at Walpita Estate recorded a 3.4% increase in the total number of bunches as compared to 1999. The number of nuts per hectare recorded was 13710 as against 13835 recorded for the year 1999. The copra yield was 3014 kg/ha as against 2975 kg/ha recorded for 1999.

The experiment on monthly harvesting at Walpita Estate showed 25.1% and 32.3% higher number of nuts and copra yield per hectare respectively, as compared to two monthly harvesting. The three extended experiments established in 1997 to compare coconut yields under four frequencies of harvesting and two yield levels, showed promising results. The frequencies of harvesting tested are monthly, two-monthly, four-monthly and no harvesting (but collecting fallen nuts).

The time series model developed to predict the national coconut yield was updated based on data for the period 1950-1999. The predicted national coconut production for 2000 was 2896 Mln. nuts as against the realized value of 3080 Mln. nuts. The percentage error of estimation is 5%.

A model developed using drought indices to predict national coconut production was also modified. The significant variables identified were drought indices at Lunuwila, Rajakadalawa, Kirama, Nikaweratiya and Polanthalawa. The model however, explained only 65% of the total variation.

## **2.8 Coconut Processing Research**

During the year, attention was paid to the improvement of quality and nutritional status of coconut oil.

In view of increasing recognition of nutritional value of coconut oil (essential fatty acid content), coconut oil was blended with gingelly oil in the proportions of 10, 25, 50 and 75 percent. Foods prepared with gingelly oil blends were sensory evaluated and the stability of oil blends were chemically determined. This study revealed that 20% gingelly oil blend was most acceptable as a cooking oil. Similarly Soya oil was blended with coconut oil in the proportions of 10, 20, 25 and 50 percent Soya oil. Soya blends did not exhibit good cooking properties in the preparation of food. Chemical analyses of these blends revealed that Free Fatty Acid (FFA) content did not show significant change during storage. Peroxide value increased with increasing proportions of gingelly and Soya oil, but no significant change in iodine value was observed. The stability of oil blends after 3 months showed that these blends could be stored for more than 3 months.

Similarly, frying and keeping qualities of palm oil were compared with coconut oil and the adulteration of coconut oil with palm oil was examined. This study revealed that keeping quality was the same for both oils, however time taken for frying was higher for palm oil.

Carotene in palm oil reacts with antimony chloride giving a blue colour. This test could be used to detect adulteration and also to estimate the degree of adulteration of coconut oil with palm oil or other vegetable oils.

Keeping quality and consumer acceptability of milk/cream extracted using a hydraulic press were tested with coconut milk extracted and packed in plastic sachets without adding any preservatives. These milk/cream containing sachets could be stored at room temperature for more than 3 hours and in a refrigerator for 3 days without changing their appearance and taste.

Coconut yoghurt was prepared by mixing coconut milk and non-fat milk powder at

the ratio of 50:50. Similarly, ice cream was prepared with Dikiri coconuts. Consistency and texture of the products were good. Further work to improve these products is in progress.

## **2.9 Extension Services**

The Division continued to assist growers by continuing technology transfer, grower education and training programs effectively during the year. Seven programs of the One-day training series were conducted with the assistance of other relevant Institutions. The average number of participants for each program was 130. Several Seminars, Workshops and Meetings were conducted during the year in order to educate growers and to assist them to find solutions to their field problems. Several educational programs were also conducted for officials from different organizations and educational Institutions. To strengthen the linkage between the research staff of CRI and the extension staff of CCB, a research extension dialogue was conducted in Kegalle.

A progressive increase in the number of school children who visited the Institute to gather information for their project works was observed. Educational programs were also conducted for 4500 school children who visited the Institute from 79 schools.

At the request of coconut growers and plantation companies, 18 visits were made to advice on field problems. About 140 coconut growers visited the Division to obtain advice for their problems in relation to cultivation and processing. A progressive increase in the number of growers who obtained advice through the telephone line allocated for this purpose was noted. During the year, over 200 growers obtained this service. The Division participated in four exhibitions held in different parts of the island.

## **2.10 Library Services**

Routine services of the Library were conducted satisfactorily throughout the year. Collection of literature and databases showed a significant growth compared to previous years. Demand for access to documents not available in the country too increased compared to the previous year. The users were provided better awareness of literature and information sources available in agriculture through the AGRINET User Seminar conducted by the Library in collaboration with the Council for Agricultural Research Policy (CARP). Library opening hours were extended with a view to improving utilization of resources and for the convenience of the Research Staff. However, adequacy of access to Internet by the staff still remains a problem.

Attention was paid to improve the knowledge of the Library Staff too with a view to provide a better service to the Research Staff. Accordingly, the Assistant Librarian attended a Conference held at national level while the subordinate staff too attended a few skill development programs.

## **2.11 Estate Management**

The Division continued to manage four Seed Gardens and four Research Substations. Out of the four Seed Gardens Ambakelle, Maduru Oya and Makandura Seed Gardens are in a productive stage. Issue of seed nuts from Makandura (MSG) was further suspended due to the 'Rapid Decline Syndrome'. The establishment of Pallama Seed Garden (PSG), which was acquired in 1998, is being continued.

The eight estates have 72,314 bearing palms and 7000 partially bearing palms, which produced 5,409,434 nuts during the year showing a 13% improvement in yield compared to the previous year. This increase of yield could mainly be attributed to the well distributed rainfall experienced in 1999, increased number of mature palms and timely adoption of improved cultural practices. However, in the meantime, there was a yield decline at Ambakelle Seed Garden by about 5% compared to the previous year. This may be due to immature nut fall during the previous year between the 4<sup>th</sup> and 5<sup>th</sup> picks caused by the dry spell that prevailed during the later part of the year and also frequent damage by monkeys and giant squirrels harboured by the jungle barrier. Although the total rainfall received at all the substations during the year 2000 was slightly lower than the previous year, it was better distributed.

The planting program of Pallama Seed Garden (PSG) with hand-pollinated Tall and San Ramon seedlings is in progress and about 3500 seedlings have been planted so far. In addition, 1500 seedlings of Ambakelle special were planted. Further, 675 seedlings were planted as a germplasm conservation block by the Genetics and Plant Breeding Division. A severe outbreak of black beetle at Pallama Seed Garden was controlled by installing pheromone traps and by implementing a thorough estate sanitary program. Newly established seedlings were irrigated during the dry spells. Two tube wells were established and the construction of two agro-wells is in progress to improve the water supply for irrigation.

Replanting/underplanting programs at Bandirippuwa and Rattmalagara estates and the new planting program at Maduru Oya Seed Garden were carried out as scheduled.

The use of livestock (cattle & buffaloes) to control weeds was successful and the cost of weeding was substantially reduced by cattle grazing. The buffaloes at Bandirippuwa Estate were transported to Maduru Oya Seed Garden for extending the livestock-based weed control program in that estate. However, other means of weed control ie: mechanical, chemical and manual were also adopted where it was necessary and appropriate.

General management/cultural practices in all eight estates were carried out as planned and according to CRI recommendations. Several fields at Makandura and Walpita Estates were fertilized with organic fertilizer (goat manure) supplemented with P, K and Mg. Cover crops and husk pits were established as part of the soil moisture conservation program. The use of back-hoe machines in opening/closing of husk pits and planting holes appeared more economical than manual labour.

The Division received 7 four wheel tractors, 3 trailers, 4 water bowsers, and 3 two wheel tractors during the year to maintain the estates and seed gardens up to the required standards. Refencing of the major part of the perimeter fence of estates was completed to safeguard the properties. Roads and buildings were maintained in good order. The total revenue collected from sundry sources was Rs.1,449,034.25, mainly from sale of milk, curd, fruits, trees, vegetables and treacle.

## **2.12 Administration Unit**

During the year 11 Executive and 10 Non Executive positions were filled. At the end of 2000, there were 367 employees on the permanent staff of the CRI. Regular staff meetings were held to discuss the implementation of the work program for the year 2000. Every

attempt was made to maintain good employer - employee relationships and the Division continued to assist in all welfare activities.

The budgeted expenses during the year were Rs.136 million made up of 107 million as recurrent and 29 million as capital expenditure. The total revenue (excluding transport) for the year was Rs.30 million. The Government grant was 91.5 million.

The Board's contribution to the Medical Aid Scheme was 2,670,184/-. The Board continued to extend financial assistance to the Seva Vanitha Unit, Co-operative Society, Recreation Club, Art Circle and Day Care Centre run by the Institute.

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

### **3. OUTSIDE FUNDED PROJECTS**

#### **3.1 Cess Funded Projects**

**Project Title :** Persuasive Extension Programme

**Division :** Extension Services Division

Under the Persuasive Extension Programme, 74 coconut estate development plans were prepared and submitted on the request of coconut growers and covering an extent of 5796 acres. These include coconut estates of the National Livestock Development Board and the Namunukula Plantation Company Ltd. in the Southern Province. In order to assess the level of implementation of the proposed development plans and also to provide them necessary advice, 87 monitoring visits were made. Feedback surveys revealed that over 65% of the development activities proposed were implemented successfully by the landowners.

**Project Title :** Studies on the coconut mite *Aceria guerreronis*

**Division :** Crop Protection Division

The distribution pattern of coconut mite, *A guerreronis* and its predator, *Neoseiulus paspalivorus* in infested palms were studied in two sites. Out of the 3-7 months old infested nuts, 46% and 24% did not show symptoms of damage in Kalpitiya and Madurankuliya respectively. The highest mean number of pest and predator was present in 5 to 6 months old nuts. A significantly high variability in the mean number of *A. guerreronis* and *N. paspalivorus* was observed at 3 sites. In all sites, population of the pest and the predator fluctuated over time. The peak population of the pest was between July/August, June/September and August/September at Kalpitiya, Madurankuliya and Vanathavillu respectively. The neem-based product, "Nomite plus" was sprayed on to bunches infested with mites and it reduced the mite population by about 64% in 3 weeks. Field trials for the determination of the optimum frequency of application of Neem oil and garlic mixture and NeemAzal are in progress. During a survey conducted in Gampaha District, the entomopathogenic fungus, *Hirsutella thompsonii* was isolated from dead *Colemerus novaehbridensis*, another nut-infesting mite. The local strain and the imported Ivory Coast

strain of *H. thompsonii* gave about 60% mortality of *A. guerreronis* in the laboratory and their pathogenecity was proved in preliminary field tests.

The arena to rear *N. paspalivorus* was modified. The modified arena consists of a waxed black paper kept on a foam material. The edges of the paper are lined with moist tissue paper to prevent mites escaping. Food is supplied as tender tissues of coconut infested with mites. An experiment is in progress to identify an alternative food source to rear predators.

**Project Title : Deep ground water survey in the Kurunegala District**

**Division : Soils and Plant Nutrition Division**

The deep ground water survey undertaken in collaboration with the Water Resources Board was extended to Kurunegala District this year. The investigation was carried out in a sequence of aerial photo interpretation, resistivity profiling and vertical electrical sounding in the field in four selected soil series viz. Melsiripura, Kuliypitiya, Kurunegala and Wariyapola series. Drilling of two tube wells was completed in Wariyapola and Melsiripura series soils. The work was temporarily suspended in 1999 due to delay in fund release for the project.

In the year 2000, more investigations were carried out by resistivity profiling and vertical sounding. Seven more sites were selected for further investigations by drilling. Three tube wells and two observation wells were done this year. So far, the investigations showed that deep ground water availability in Melsiripura and Wariyapola series was quite low but water availability is relatively high in Kurunegala series.

**Project title : Animal Breeding Program**

**Division : Agronomy Division**

The buffalo stock increased from the initial 11 (2 male and 9 females) to 47 (15 male and 32 female) at two locations; Isolated Seed Garden, Ambakele and Makandura Seed Garden. Total income and expenditure were Rs. 192,405.00 and Rs.177,343.00 respectively showing a net profit of Rs.15,062.00. This figure was calculated disregarding savings from weed control, value of manure and animals.

The goat production program also showed good progress. With the initial number of 12 animals in 1999, there were 95 animals at the end of 2000, in addition to the 22 animals sold to farmers.

However, the cattle and sheep breeding programs are yet to commence.

**Project title : Cultivation of Gliricidia for Dendro-thermal Power Generation**

**Division : Agronomy Division**

An extent of approximately of 18 ha of NFT (14 ha of Gliricidia and 4 ha of Acacia) plantation was maintained during the year. A luxuriant growth of Gliricidia was observed due to the well-distributed rainfall during the year 2000. Ambient temperature measurements

showed that there was a 2-3 °C drop in mean temperature measured at 12 noon to 1.00 p.m. in the Gliricidia inter-planted blocks compared to the coconut monoculture blocks. Trees planted in November 1998 and 1999 were pruned at 1.5 m height and 10-20 mt. of fresh wood per hectare (depending on the age of the trees) was harvested.

### **3.2 National Science Foundation (NSF) Grants**

**Grant No : RG/99/P/004 (April 1999 to December 2000)**

**Project title : Analysis of rainfall distribution in coconut growing areas in Sri Lanka**

**Division : Biometry**

Rainfall data (1962-1997) of 18 locations representing four agro-ecological regions of coconut growing areas: low country wet intermediate region (LCWIR), low country dry intermediate region (LCDIR), low country wet region (LCWR) and low country dry region (LCDR) were analyzed to study changes in rainfall patterns during the recent past.

It was found that the conventional classification of four rainy periods has changed in coconut growing areas. In LCWIR, LCWR and LCDIR, the first peak usually expected during March and April has shifted towards April and May. The first spell of rain in LCWIR, LCWR and LCDIR has merged with FIM and SWM rains and it is not possible to separate the two types of rains. There was no clear rain spell during March to June in LCDR. The months of January, February, July and August should not be included within rainy seasons. Thus, it is proposed to classify rainy seasons within a year into three periods irrespective of the region. The three seasons are March to June (extended southwest monsoon - ESWM), September to November (second inter monsoon - SIM) and December (northeast monsoon). The percentage contribution of rainfall of these eight months to annual rainfall varied between 80 - 90%. It is expected to carry out this research further by incorporating data from more locations and for a longer period. .

**Grant No; RG/98/C/07**

**Project Title : Utilization of coconut water from DC manufacture to develop a beverage and a health drink**

**Division : Coconut Processing Division**

To get rid of the layer separation of the coconut water beverage, 3% belli fruit pulp was added. The sediment previously formed settled down and it could be stored up to three months. The work could not continue further due to the resignation of the Research Officer who handled the project.

### **3.3 ADB funded Second Perennial Crop Development Project**

**Project Title : Coconut Based Farming Systems**

**Division : Agronomy Division**

During the year 2000, 81 coconut based crop models and perennial intercrops were established in on-farm trials. Evaluation of different coconut varieties, levels and types of fertilizer, different soil and moisture conservation practices, planting methods, and rehabilitation were the main areas of concern with regard to coconut as the main crop.

Selected intercrops were pepper, coffee, cocoa, rambutan, avocado, grafted cashew, mango, lime cinnamon, orange, banana, pineapple and passion fruit. These crops were incorporated a variety of crop models at different densities, crop mixtures and planting arrangements considering soil and climatic factors, market facilities and the farmer's desire and ability to maintain the site.

Total allocation	-	Rs.2,000,000.00
Total expenditure	-	Rs.1,187,304.05

### **3.4 Council for Agriculture Research Policy(CARP) Grants**

**Project title : Development of a reliable protocol for clonal propagation of coconut (awarded to Ms W N I S C Fernando)**

**Division : Tissue Culture Division**

The total funds received was Rs.689,200/=

The study helped to develop a protocol for normal plant regeneration from cultured plumule explants of coconut. During the project period, 50 plants were produced. of these fifty percent of plants transferred to *ex vitro* conditions survived the transfer.

Preliminary studies conducted on cell suspension culture of coconut and biochemical analysis of zygotic and somatic embryos provided the basic information for establishing cell suspension cultures and developing biochemical markers for somatic embryogenesis.

The project was completed and the final report submitted.

### **3.5 National Research Council grant**

**Project title : Culture of immature inflorescence explants of coconut (*Cocos nucifera L.*) with a view to clonal propagation (awarded to Dr L K Weerakoon)**

**Division : Tissue Culture Division**

The total amount of funds received was Rs.2,086,700/=

The research carried out during the first year revealed that there was no significant effect of palm maturity on callusing frequency. Furthermore, there was no significant correlation between the callus production and morphological characteristics of plantlets such as number of leaves, indicating that the use of such characters as an index to select suitable immature inflorescences for culture is not feasible. The preliminary results also indicated the possibility of obtaining callus from in vitro-matured explants. The first annual progress report was submitted.

**Project title : Cell suspension and protoplast culture of coconut  
(*Cocos nucifera* L.) for mass propagation of elite  
palms (awarded to Ms. W N I S C Fernando)**

**Division : Tissue Culture Division**

The total funds approved was: Rs.2,337,500/-

The project will be commenced early next year.

### **3.6 IFAD (COGENT) Plant Physiology Division**

The International Fund for Agricultural Development (IFAD) continued to support the on-going project on "Enhancing the income and employment opportunities in the coconut sector through conservation and sustainable use of special coconut ecotypes" which was completed successfully during the year. The final report of the project was submitted and the two catalogues on coconut food recipes and value added coconut products in Sri Lanka were prepared.

## **4. ACKNOWLEDGEMENTS**

The co-operation extended by the Deputy Director (Administration and Finance), Heads of Divisions and Staff of the Coconut Research Institute in successful implementation of the program of work is gratefully acknowledged.

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

Continued support given by the following organizations is also acknowledged:

- \* Ministry of Plantation Industries
- \* Coconut Cess Committee
- \* Coconut Cultivation Board
- \* Coconut Development Authority
- \* Tea Research Institute
- \* Rubber Research Institute
- \* Department of Agriculture
- \* Sri Lanka Council for Agricultural Research Policy
- \* National Science Foundation

- \* National Institute of Plantation Management
- \* National Research Commission (NRC)
- \* Export Development Board
- \* Medical Faculty, University of Colombo
- \* Department of Botany, University of Peradneya
- \* Postgraduate Institute of Agriculture (PGIA)
- \* Industrial Technology Institute (ITI)
- \* National Science & Technology Commission (NASTEC)
- \* Sri Lanka Institute of Development Administration (SLIDA)
- \* Institute of Government Accounts & Finance Planning (INGAF)
- \* Kurunegala Plantations Ltd.
- \* Central Plantation Crops Research Institute, India
- \* Indian Council for Agricultural Research
- \* Coconut Genetic Resources Network
- \* Asian and Pacific Coconut Community, Indonesia
- \* International Service for National Agricultural Research (ISNAR)
- \* International Mycological Institute, UK
- \* International Agricultural Centre, Netherlands
- \* Australian Tree Seed Centre
- \* GTZ/CARP Project
- \* ADB funded Science & Technology Personnel Development Project
- \* ADB & Second Perennial Agricultural Project
- \* Food & Agriculture Organization (FAO)

**REPORT OF THE AGRONOMY DIVISION**  
**Head - H A J Gunathilake, PhD**

## 1. GENERAL

The research program was aimed primarily at increasing coconut production and the productivity of coconut lands. In addition, two agro economic studies were carried out during the year.

Studies on the rehabilitation of low yielding palms in degraded coconut soils clearly indicated that seedlings established in 1.3 m x 1.3 m x 1.3 m holes and 1.3 m x 1.0 m trenches performed better than normal planting in 1.0 m x 1.0 m x 1.0 m holes. It was found that application of dead mulch with coir dust cover (5 cm) and *Pueraria* live cover increased coconut yield by 35% and 20% respectively over ground cover by *Bracharia brizantha* (unmanaged). A study was initiated on the use of medium term forest planting on degraded shallow lateritic soils. Preliminary growth of the thirteen different forest species showed that *Macaranga peltata* (Kenda) has the fastest growth followed by *Acacia mangium* and *A. auriculiformis*. *Calophyllum inophyllum* (Domba) showed the lowest growth.

Multilocational trials aimed at determining the effects of inter-planted nitrogen fixing trees on coconut yield did not show adverse effects on the nut yield due to inter-planting *Gliricidia* and *Acacia* (density 2496 - 3744 plants per coconut ha), which produced 10 and 15 mt. of biomass/ha/year respectively. Two field trials were established in Pallama Seed Garden and Melsiripura to study the possibility of substituting fertilizer nitrogen with *Pueraria*.

In order to increase genetic diversity of cover species/provenances, 20 new leguminous cover species were obtained from CIAT and screening trials were established at Bandirippuwa Estate under coconut shade and under open field conditions. *Pueraria phaseoloides* (CIAT numbers 32118, 7182, 8042 and the local), *Centrosema macrocarpum* (CIAT 25552), *Calapogonium mucunoides* (CIAT 17856), *Arachis pintoi* (CIAT 18744) and *Desmodium rensonii* cv *davao* were able to produce over 5000 kg of biomass per hectare. *Mucuna pruriens* was the fastest growing provenance that produced approximately 10,000 kg of biomass per ha in ten months but it declined later.

Moisture conservation practices such as husk burial and mulching on land suitability classes S<sub>2</sub>, S<sub>3</sub> and S<sub>5</sub> did not have a favourable effect on the nut yield probably due to good rainfall distribution during the year.

Application of glyphosate was the most effective and economical method for control of *Imperata cylindrica*, *Pennisetum polystachyon* and *Panicum repens*, being superior to slashing or harrowing. Nut yield was also improved by 40% over unweeded plots.

Bud-grafted cashew yielded 3.4 kg/tree/year in the fourth year showing its attractive adaptability as an intercrop under a mature stand of coconut in the intermediate dry zone. Coconut yield was not affected by planting of cashew. In another cashew intercrop trial in the dry zone, it was concluded that seedling cashew (at 69 trees per ha) could be established along with the new planting of coconut. Tea was attractive among farmers in Galle and Matara districts due to high green leaf prices and consequent high net returns (Rs. 6200/- per ha/ month). However, Mg deficiency of coconut palms was noticed and an annual application

of 1 kg of kieserite per palm was done. Ginger price (Rs. 60.00 per kg) was also high and hence several crop models were designed with ginger to achieve high returns. During the last year, several perennial intercrops such as rambutan, mango and lime fruited off-season probably due to a uniform rainfall distribution pattern.

Under the coconut based adaptive research programme funded by the Second Perennial Crop Development Project, 81 sites were established. Cocoa, pepper, cinnamon, rambutan, lime, avocado, orange, cashew, mango, pineapple, banana and passion fruit were the selected intercrops. Among those crops, priority has given to popularize cinnamon in the Southern region and bud-grafted cashew in the Northwestern province. Introduction of new crops was also done (eg. rambutan to Akuressa area and grafted orange to Hambantota and Anuradhapura areas).

Under the development of animal husbandry, a study was continued with buffalo grazing in coconut lands in comparison with cover cropping and normal slashing to control weeds. In buffalo grazing plots the yield of coconut was 94 nuts/palm/year whereas in cover crop and slashing plots it was 81 and 89 nuts/palm/year respectively.

Animal breeding programme under cess funds continued successfully, and at the end of the year the number of buffaloes rose to 15 male and 32 female at ISG, Ambekelle and Makandura. The number of goats at PRS, Pallama increased to 102 while 22 animals were sold among farmers identified by the regional veterinary officer.

Two main Agricultural Economics studies were conducted during the year.

The impact of import duty reduction for substitute vegetable oils on the local coconut oil (CNO) industry and the foreign exchange status of the country was investigated. Data were collected by a survey of a stratified random sample of 40 CNO millers, 15 selected CNO/D.C. shippers, and a few key policy makers. The survey was conducted from October 1999 to March 2000. The results revealed the following:- i) some 80 per cent of CNO mills were closed down or working irregularly due to the non-profitability of CNO manufacturing at the low market prices dictated by cheap substitute oils, ii) the foreign exchange expenditure on importation of an incremental volume of substitute oils was greater than the foreign exchange earned from the incremental exports of D.C., thus making the country a net loser in terms of foreign exchange, iii) import duty has to be continuously increased if one desires to protect the local CNO industry. The scope for such continuous protection is practically limited given the ever declining world market palm oil prices. Yet protection is desirable until such time that developing economies like ours successfully integrate into the world economy under the liberalized world trade regime, although protection should not be considered as a lasting remedy. The future of the CNO industry has to be based on the following thrust areas. i) available modern technology for CNO manufacturing (e.g. omission of the copra stage) has to be utilized as a means of reduction of COP, ii) the conventional use of CNO as an edible oil has to be diverted to produce oleochemicals for industry, and iii) a campaign backed by research evidence has to be launched to popularize CNO consumption as a healthy oil.

Economics of growing *Gliricidia* under coconuts as an energy source for dendro-thermal power plants were investigated using input and output data collected from on-farm *Gliricidia* trials established by the fuel-wood project. This investment is economically feasible for farmers given the power plant delivered price of Rs 1250 per MT of dry

*Gliricidia* wood, but not lucrative as compared with mixed cropping alternatives such as coconut-based pineapple, banana and ginger etc. However, for land suitability classes S<sub>5</sub> and below where rehabilitation of lands by Nitrogen Fixing Trees (NFTs) is necessary and other mixed cropping practices are not possible, this investment seems attractive. Moreover, for those absentee landlords who do not wish to grow other intercrops due to intense management demands of material inputs and labour, *Gliricidia* seems to be an ideal choice because of its low labour and material input demand.

## 2. RESEARCH PROJECTS

### PROJECT 2: REHABILITATION OF LOW YIELDING PLANTATIONS

**Experiment 2.3:** Effect of root pruning and fertilizer application on yield of coconut palms with heavy root mat formation on Coastal Regosols (DL<sub>4</sub>/S<sub>2</sub>)

**Experiment 2.3.4:** Madurankuliya – 1995

**Experiment 2.3.5:** Palavi – 1996

Two experiments on a Randomized Complete Block Design (RCBD) with three replicates and nine effective palms/plot commenced at Madurankuliya (1995) and Palavi (1996). The soils at both sites are sandy regosols characterized by a high water table that varies from 60 cm to 150 cm from the surface between the wet and dry seasons. In year 2000, root pruning by disk harrowing (15 cm depth) and application of 3.0 kg of APM + 1.0 kg of Dolomite/palm were continued as treatments as given in Table 1.

At Madurankuliya, no significant differences between treatments were found throughout the experimental period from 1997 – 2000. This site was well managed and fertilized particularly with cattle manure supplemented with P, K and Mg. Hence it could be assumed that fertilisation and harrowing or a combination of both operations failed to produce significant results. This led to a conclusion that harrowing alone or harrowing plus fertilization has no immediate effect on nut yield in well-managed coconut lands in the Kalpitiya area.

However, at Palavi, harrowing plus fertilization produced significantly more nuts than the control (no fertilization and harrowing). However, harrowing or fertilizer application alone improved nut yields equally over the control but less than the combination of both operations. This was an abandoned coconut land prior to 1996 and nut yield in 1996 was only 26 nuts/palm/year, in contrast to Madurankuliya site. Nut yield was progressively improved by harrowing and fertilizer application. The best effect was when the two operations were combined. It can be concluded that fertilizer application and harrowing are beneficial in improving coconut yield in marginal coconut lands particularly in this soil category. Further, fertilizer application followed by harrowing is more beneficial than fertilizer application or harrowing alone.

**Table 1.** *Effect of three different treatments on the yield of coconut (nuts/palm/year) at Madurankuliya and Palavi*

Treatments	Madurankuliya		Palavi	
	1997-99	2000	1997-99	2000
Control (no fertilizer + no harrowing)	79	81	34	46
Harrowing + Fertilizer	76	87	40	56
Harrowing only	89	95	37	51
Fertilizer only	82	88	42	51
Significance	n.s.	n.s.	n.s.	*
LSD (P = 0.05)				6

*H A J Gunathilake and S D J N Subasinghe*

**Experiment 2.4.2: Effect of size of planting hole on the growth of TxT seedlings on the Andigama Soil Series (Shallow Phase): Rathmalagara Estate (IL<sub>1</sub>/S<sub>5</sub>), Madampe -1997**

A 10 acre planted in 1985 was observed to be unthrifty. It was suspected to be due to small planting holes in a poor soil. A soil depth of only 30-60 cm and an underlying hard gravel are unsatisfactory features of this soil.

Therefore a trial was commenced on a degraded land to determine whether the performance of coconut can be improved by providing a larger planting hole. Treatments in the Table 2 were arranged in a Randomised Block Design with three replicates and nine effective palms per plot.

As shown in previous years too, seedlings established in larger planting-holes (1.3x1.3x1.3m) and trenches (1.3m width x 1.3m depth) showed a better early growth than those in standard sized pits (1x1x1m) (Table 2). However, a larger number of seedlings were observed to topple with increased size of planting-holes. It is suspected that the larger pits received more husks resulting in poorer anchorage.

The experiment is in progress.

**Table 2.** *The effect of size of planting holes on early growth of seedlings*

Treatments	Leaf width (m)	Number of leaves	Plant height (m)	Leaf length (m)	% Seedling fall
1. 1x1x1 m pit (standard planting hole)	1.5	4	3.2	2.0	1.9
2. 1.3x1.3x1.3 m, pit (filled with husk/same soil)	1.5	6	3.5	2.2	9.3
3. 1.3x1.3x1.3 m pit (filled with husk/soils brought from out side)	1.7	5	3.6	2.2	9.3
4. 1.3m wide x 1.3m deep trench (filled with husk/same soil)	1.8	5	4.0	2.5	13.0
5. T4 + 20% increased standard density of palms (156/ha)	1.7	6	3.9	2.4	11.1
CV%	3.94	8.21	7.61	9.27	9.56
Sig.	**	**	**	**	*
LSD	0.115	0.439	0.280	0.191	4.02

*K B Dassanayake, A D Samarajeewa,  
H A Abeysona and W R O Fernando*

**Experiment 2.4.4: Effects of deep loosening of lateritic soils on the performance of coconuts grown on Andigama Soil Series (Shallow Phase) at Ratmalagara Estate (IL<sub>1</sub>/S<sub>4</sub>), Madampe - 1997**

The study aimed at deep loosening of shallow lateritic soil by mechanical and biological means in order to facilitate better growth of coconut roots thereby increasing growth and yield of coconuts. Nitrogen fixing trees are expected to act as biological miners here. The treatments in Table 3 were arranged in a Randomized Block Design with three replicates and nine effective palms per plot.

Coconut yield of the whole experimental block further improved compared to the previous year. This could be due to better distributed rainfall during the last three years. However, the different experimental treatments had little impact on nut production. These results suggest the probable benefits of irrigation where practicable.

**Table 3.** *Effects of loosening of sub-soil on the production of coconuts on Andigama Series (Shallow Phase)*

Treatments	Nut yield (Nuts/palm)		
	1998	1999	2000
T <sub>1</sub> - Control (General estate practice)	30	47	70
T <sub>2</sub> - 1.3 x 1.3 m trench cut along coconut rows (and filled with same soil)	30	46	70
T <sub>3</sub> - 1.3 x 1.3 m trench cut along coconut rows (and filled with soils from out side)	30	45	63
T <sub>4</sub> - 1/3 circular trench cut around the manure circle (and filled with same soil).	34	50	60
T <sub>5</sub> - Inter-cultivation of <i>Gliricidia</i>	32	51	65
T <sub>6</sub> - Inter-cultivation of <i>Acacia</i>	30	51	63
Significance	n.s.	n.s.	n.s.
CV%	42	45	32

*K B Dassanayake, H A Abeysoma and Y M Chandrasiri*

**Experiment 2.4.5: Rehabilitation of degraded coconut soils through short rotation forestry in Andigama. Soil Series (Shallow phase) at Ratmalagara Estate (IL<sub>1</sub>/S<sub>5</sub>), Madampe - 1999**

The project investigates the possibility of improving soil quality of degraded coconut lands through short/medium term forestry. A considerable extent of coconut lands under Andigama Series (Intermediate Zone) and Boralu Series (Wet Zone) of Red Yellow Podzolic soils are categorised as degraded or marginal due to poor land management/erosion and characterised by light top soil and underlying soft/hard laterites (lateritic gravel) at varying depths.

It is expected that short/medium term forestry would not only rehabilitate soils but also provide economic benefits mainly through fuel wood/timber. Forest plant species used in this study were: Three *Acacia* species (*A. auriculiformis*, *A. mangium*-1, *A. mangium*-2), *Calophyllum elatum* (Domba), *Grewia tilifolia* (Damminna), *Macaranga roxburghii* (Kendha), *Gliricidia sepium* (Gliricidia), *Tectonia grandis* (Teak), *Swietenia macrophylla* (Mahogany) and *Bridelia moonii* (Ketakela).

*Macaranga* (Kendha), *Acacia mangium*, *A. auriculiformis*, and *Gliricidia* were the fastest growing trees, which provided ground cover and reduced weed growth. *Calophyllum* (Domba) was the slowest in growth and was susceptible to drought and pests.

The experiment is in progress.

*K B Dassanayake, H A Abeysoma and P Peris*

**Experiment 1.0.3.6: Competition of pasture on the growth and yield of coconuts on Andigama Series (Shallow Phase) at Ratmalagara Estate (IL1/S4-5), Madampe - 1997**

A field planted with coconut in 1984 was observed to be retarded. It was suspected that rank growth of residual *B. brizantha* would be the cause. Therefore the following ground cover management systems were imposed in 1998.

The soil contained lateritic gravel and hard pan with a very shallow topsoil (30cm).

Treatments: T<sub>1</sub> - Bare ground  
T<sub>2</sub> - Controlled grass cover (*B. brizantha*) (slashing 4 times a years)  
T<sub>3</sub> - Uncontrolled grass (*B. brizantha*) cover  
T<sub>4</sub> - *Pueraria* cover (live mulch)  
T<sub>5</sub> - Coir dust to a 5.0 cm depth (dead mulch)

Irrespective of treatments, nut yield of the experimental block continued to show a marked increase from the pre-treatment data (Table 4). This could be attributed to (a) favourable rainfall that prevailed during 1998-1999, (b) more palms reaching yield stability and (c) generally improved supervision.

There was a significant effect of dead mulch on the nut yield, and the increase in number of nuts/palm in plot with a dead-mulch over T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was nearly 40%. Although it was not statistically significant, dead mulch appeared to have positive effects on the growth of the palms too (Table 5). Further, the measurements on water relations of palms (Table 6) indicate the basis for better growth and yield in plots with dead mulch, as palms on those plots maintained higher rate of transpiration and lower diffusive resistance during dry periods. This could be due to the availability of more moisture under the dead mulch than under vegetative covers.

It is also interesting to note that the palms under *Pueraria* cover were able to maintain a higher yield (20%) against the grass covers and bare-soil.

The experiment is in progress.

**Table 4.** *Effects of ground covers on coconut yield*

Treatments	Pre-experimental block			Number of nuts/palm/year average		
	1995	1996	1997	1998	1999	2000
T <sub>1</sub>				36	60	70
T <sub>2</sub>				31	41	70
T <sub>3</sub>				28	43	71
T <sub>4</sub>				37	50	85
T <sub>5</sub>				35	69	97
Mean	24	20	25	33	53	79
Significance				n.s.	n.s.	*
LSD (p=0.05)						8
CV%				26.3	33.1	24.9

(Pre-treatment yields were based on estate records).

**Table 5.** *Growth of coconut trees as affected by different ground cover treatments*

Treatments	Height increment 1998-2000 (cm)	Girth increment 1997-2000 (cm)
T <sub>1</sub>	98	3.1
T <sub>2</sub>	83	1.8
T <sub>3</sub>	88	2.8
T <sub>4</sub>	87	4.3
T <sub>5</sub>	106	9.6
Significance	n.s.	n.s.
CV%	24	92

**Table 6.** *Effects of different ground covers on water relations of coconut palms during wet and dry periods of the year*

Treatments	Rate of transpiration (ug/cm <sup>2</sup> /s)		Stomatal Resistance (s/cm)	
	Dry	Wet	Dry	Wet
T <sub>1</sub>	0.797	5.60	38.75	4.49
T <sub>2</sub>	0.807	5.33	45.56	3.00
T <sub>3</sub>	0.941	5.52	35.05	2.95
T <sub>4</sub>	0.872	4.69	36.73	3.70
T <sub>5</sub>	1.409	6.27	30.78	2.45
Significance	*	NS	*	ns
LSD (P=0.05)	0.520	3.5	4.73	2.70

*K B Dassanayake, M.J.I Costa and P W A Fernando (Agronomy Division)  
C S Ranasinghe, R D N Premasiri and L R S Silva (PPD)*

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

**Experiment 3.3: Study of the effect of husk burial and mulching on coconut yield**

**3.3.1 Minuwangoda (WL<sub>3</sub>/S<sub>4</sub>) - 1996**

**3.3.2 Hettipola (IL<sub>1</sub>/S<sub>3</sub>) - 1996**

**3.3.3 Kumarakattuwa (IL<sub>1</sub>/S<sub>2</sub>) - 1996**

**3.3.4 Bingiriya (IL<sub>1</sub>/S<sub>4</sub>) - 1997**

Effects of various methods of husk burial and mulching (Table 7) are being tested on a RCBD with three replicates with nine effective palms per plot.

Generally, nut yield of palms with different methods of husk burial and mulching did not show any consistent difference. Water content of leaves measured in Minuwangoda and Bingiriya in August 2000 (after three weeks of a drought period) also failed to establish any difference. Since 1998, rainfall distribution was good and this may explain why there was no response to treatments.

**Table 7. Coconut yield (nuts/palm/year) as affected by different methods of husk burial and mulching**

Treatments	Minuwangoda		Hettipola		Pallama		Bingiriya	
	1997 - 99	2000	1997 - 99	2000	1997 - 99	2000	1997 - 99	2000
T <sub>1</sub> - Control (standard practices)	42	38	40	44	60	39	47	47
T <sub>2</sub> - mulching with 12 fronds	45	39	46	44	54	34	49	47
T <sub>3</sub> - T <sub>1</sub> +1/3 circle trench filled with same soil	46	39	25	37	50	36	50	42
T <sub>4</sub> - T <sub>1</sub> +1/3 circle trench filled with husk/soil	50	42	35	40	51	37	47	38
T <sub>5</sub> - Mulching with husk	50	42	36	41	46	34	50	48
T <sub>6</sub> - T <sub>4</sub> +T <sub>5</sub>	52	42	38	37	47	37	47	46
T <sub>7</sub> - 1.3 x 0.6 m trenches	47	43	35	39	40	32	47	46
T <sub>8</sub> - 2.6 x 1.3 x 0.6 m husk pits between palms	51	44	36	40	47	31	50	54
T <sub>9</sub> - 2.6 x 1.3 x 0.6 m husk pits for each palm	42	45	35	41	40	33	45	46
Significance	n.s.	n.s.	n.s.	n.s.	*	***	n.s.	*
LSD (P = 0.05)								9

Experiments are in progress.

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C S R Ranasinghe (PPD)*

**PROJECT 4: DEVELOPMENT OF A LOW COST MANURING SYSTEM FOR COCONUT UTILIZING ORGANIC/GREEN MANURE**

**Experiment:** Effect of Inter-planting of *Gliricidia sepium* and *Acacia auriculiformis* under coconut and use of loppings for substitution of inorganic nitrogen for coconut palms

**Experiment 4.3.1:** Potthukulama Research Station (PRS), Pallama Series (Sandy loam), (DL<sub>1</sub>/S<sub>2</sub>), Pallama - 1995

**Experiment 4.3.2:** Nilpanagoda Estate, Boralu Series (Lateritic gravel) (WL<sub>1</sub>/S<sub>4</sub>), Minuwangoda - 1996

Treatments given in Table 8 were tested at three sites representing different soil classes and agro-ecological conditions, on a RCBD with three replicates at each site. The site at Horombawa was terminated in 1999 due to a change in tenure.

As in previous years, neither NFT species nor the planting densities affected coconut yields at both sites (Table 8). Palms at PRS (Welipelassa Series-dry zone) produced more than double the nut yield at Nilpanagoda (Boralu Series - wet zone) confirming the influence of soil conditions on productivity of coconuts.

*Acacia* produced markedly higher foliage biomass than *Gliricidia* at both locations (Table 9). Further, *Acacia* had higher foliage to wood ratio (approx. 1) than *Gliricidia* (approx. 0.3). At initial stages re-growth after pruning in *Acacia* was poor compared to *Gliricidia* and thus lighter pruning was employed. Care should be taken at pruning of *Acacia* as complete removal of foliage critically affects re-growth.

The experiments are in progress.

**Table 8.** Effect of NFTs on coconut yield at two different sites

Treatments	PRS			Nilpanagoda		
	1996-98	1999	2000	1997-98	1999	2000
T <sub>1</sub> - Control (APM + standard practices)	80	88	82	24	31	45
T <sub>2</sub> - Gliricidia density 1 (16 trees/coconut square)	90	68	81	23	28	42
T <sub>3</sub> - Gliricidia density 2 (24 trees/coconut square)	91	76	86	26	34	44
T <sub>4</sub> - Gliricidia density 2 (prunings buried)	98	88	92	27	33	38
T <sub>5</sub> - Acacia density 1 (16 trees/coconut square)	92	69	81	22	26	39
T <sub>6</sub> - Acacia density 2 (24 trees/coconut square)	87	64	90	27	28	41
Significance	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
CV%	15	20	19	12	18	18

**Table 9.** Biomass yield (MT/per ha) of legume trees (2000)

Treatments	Potthukulama			Nilpanagoda		
	Wood	Foliage	Total	Wood	Foliage	Total
T <sub>2</sub>	21.2	6.4	27.6	14.5	8.5	23.0
T <sub>3</sub>	20.4	7.6	28.0	17.5	9.2	26.7
T <sub>4</sub>	21.5	7.3	28.8	18.1	9.8	27.9
T <sub>5</sub>	15.9	17.0	32.9	12.5	13.5	26.0
T <sub>6</sub>	18.7	17.5	36.2	16.2	15.4	31.6
Significance	*	**	*	*	**	*
CV%	15.2	23.5	22.1	20.3	28.1	23.0
LSD (P=0.05)	3.2	2.3	3.6	3.1	4.2	3.4

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**Experiment 4.4: Evaluation of leguminous ground cover species for green manuring at Bandirippuwa Estate, Lunuwila (IL1/S3) 1999**

Preliminary screening of 19 ground covers imported from CIAT was initiated in late 1999 at Bandirippuwa Estate. Plots of 1.5 m x 1.5 m replicated three times were evaluated dry matter productivity, leaf litter productivity, nitrogen yield and ground covering ability.

Cover crop species were *Mucuna pruriens* (CIAT 9349), *Desmodium rensonii* (ex Davao), *D. heterophyllum* (CIAT 349), *D. heterocarpon* (CIAT 13086 and CIAT 23665), *Pueraria phaseoloides* (CIAT 8042, CIAT 32118, CIAT 7182 and Local), *Calopogonium caeruleum* (CIAT 7304), *C. muconoides* (CIAT 17856, local), *Stylosanthes guianensis* (CIAT 184), *Arachis pintoi* (CIAT 17434, CIAT 18744), *Centrosema acutifolium* (CIAT 5277), *C. macrocarpum* (CIAT 25522), *C. pubescens* (CIAT 438, CIAT 15160, CV Cardilo and local), *Macroptilium atropurpureum* (local).

Initial assessments were done during the year.

The experiment is in progress.

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**Experiment 4.6: Optimising biomass productivity of *Gliricidia sepium* under Coconuts - Ratmalagara Estate (IL<sub>1</sub>/S4), Madampe; Andigama Series (Moderately Shallow Phase) - 1999**

This study was originally established to determine the effects of pruning frequency and type of planting material on the biomass yield of *Gliricidia* grown under coconuts with the aim of optimising the foliage biomass to be used as green manure. The trial was modified in Oct/Nov, 1999 by extending pruning intervals from 3, 4 and 6 months to 6, 12 and 18 months to optimise both foliage as well as wood biomasses.

Biomass data collected for an eighteen month period are given in Table 10. Harvesting

of *Gliricidia* at six months intervals produced substantially higher foliage and wood biomass than the other treatments. Further, harvesting of only matured branches at about monthly intervals (continuous harvesting) appeared to be as effective as 12 and 18 month harvestings.

The experiment is in progress.

**Table 10.** *Biomass yield (MT/ha- Fresh weight) of Gliricidia as affected by different pruning regimes*

Pruning frequency	Foliage biomass	Stem yield	Foliage/Wood ratio
06 months	17.1	45.3	0.38
12 months	4.6	20.0	0.08
18 months	11.1	27.8	0.41
Continuous harvesting	10.3	21.7	0.49
Significance	***	***	
LSD (P=0.05)	2.6	6.5	
CV%	25.6	22.0	

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**PROJECT 5: IMPROVEMENT OF ORGANIC MATTER STATUS AND WATER HOLDING CAPACITY OF COCONUT SOILS**

**Experiment 5.1.13: Management of leguminous ground covers to improve productivity of coconut - 2000**

**Locations:** Pallama Seed Garden, Pallama - DL<sub>1</sub> (Katukele Series)  
Melsiripura Farm, Melsiripura - IL<sub>1</sub> (Melsiripura Series)

Many benefits including soil quality improvement by cultivation of ground covers under annual-cropping systems is well established. However, these benefits may be off set due to improper management. Although, cover cropping has been practiced in coconut lands for sometime in Sri Lanka, systematic and long-term evaluations of effects of cover crops on coconut yield have not been done. The present study was to quantify the benefits of ground covers and their management in terms of coconut yields.

**Treatments:** 02 methods of cover management - Harrowing or slash- down  
02 fertilizer mixtures to coconuts - N, P, K, Mg or P, K, Mg only  
02 types of ground cover - *Pueraria* or natural cover

**Trial Design:** Split Plots with four blocks and nine effective palms/plot.  
Main plots - Cover management  
Sub plots - Fertilizer levels  
Sub-sub plots - Cover types

Trial at Pallama Seed Garden (PSG) commenced in May 2000 and *Pueraria* seeds were sown in June 2000. Growth of the cover was poor due to unexpected delay of the south-west monsoon. Trial at Melsiripura was established in October/November. Delayed rains slowed down the growth of *Pueraria* at this site too. Nut yields are being recorded at both locations.

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

**Experiment 5:2:1. Comparison of different management methods for effective control of illuk (*Imperata cylindrica*) in mature coconut plantations, Mangalaweli Estate, Mangalaeliya (IL1/S2) - 1996**

Treatments shown in Table 11 were laid as a RCBD with three replicates. Frequent samplings were done to understand the dynamics of weed biomass in response to different weed management methods. The treatments were repeated at six monthly intervals.

Nut yields of plots that received two levels of glyphosate to control Illuk were significantly higher than those in uncontrolled Illuk plots (Table 11). This trend has been noticed since 1999. Although the nut yields in harrowed and slashed plots were higher than in the control, the difference was not significant. Glyphosate was effective in controlling Illuk at both levels tested. Harrowing and slashing were also effective but not as good as glyphosate.

Illuk biomass in the glyphosate plots was significantly lower than that of all other treatments (Table 12). There was not much difference in Illuk biomass between the uncontrolled plots and slashed/harrowed plots. This further established the fact that Illuk cannot be controlled effectively by slashing or harrowing.

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**Table 11.** *Nut yield as affected by different weed control treatments controlling illuk (*Imperata cylindrica*) at Mangalaweli Estate, Mangalaeliya*

Treatments	Nuts/Palm/year			
	1997	1998	1999	2000
Harrowing	31	43	56	56
Glyphosate (8 l/ha)	27	45	88	72
Glyphosate (4 l/ha)	32	54	82	65
Circle weeding/slashing	33	35	56	56
Slashing	35	45	60	55
Uncontrolled (Illuk)	35	45	42	47
Significance	ns	*	*	*
LSD (P=0.05)	-	9	19	14
CV			16	13

**Table 12.** Weed biomass ( $g/m^2$ ) as affected by treatments for controlling Illuk (*Imperata cylindrica*) at Mangalaweli Estate, Mangala Eliya

Treatment	1997-1999	March 2000			June 2000			Sept 2000		
		Dicot	Illuk	Total	Dicot	Illuk	Total	Dicot	Illuk	Total
Harrowing (twice/year)	419	22	133	155	22	140	162	15	94	109
Glyphosate (8 l/ha)	244	120	20	140	76	3	79	51	2	53
Glyphosate (4 l/ha)	260	134	8	142	145	0.0	145	27	0.0	27
Circle weed/Slash	464	149	100	249	30	42	72	17	10	27
Slashing (twice/year)	424	5	251	256	0	204	204	0.0	125	125
Uncontrolled	636	9	155	164	2764	679	705	17	105	122
Significant	-	**	**	**	**	**	**	**	**	*
LSD (P=0.05)	-	45	107	100	100	304	100	39	84	69
CV %		13	24	22	8	12	17	21	19	23

Treatments were applied in June 97, May 1998, Feb 1999, Sep 1999, March 2000 and Oct 2000.

**Experiment 5.1: Comparison of different weed management systems and their effects on coconut yield. Isolated Seed Garden, Ambakelle (IL1/S2). 1996**

Different weed control treatments given in Table 13 were on a RCBD with three replicates. Each plot had six effective coconut palms. During the year, two rounds of slashing and chemical weeding were carried out. The majority of the weeds present in this location were Illuk (*Imperata cylindrica*), Atora (*Panicum repens*), Rilathana (*Pennisetum polystachyon*), Podisinghomaran (*Chromolaena odorata*), Getakola (*Hedyotis auricularia*) and Nidikumba (*Mimosa pudica*). The application of glyphosate and cover crop (*Pueraria*) reduced the total weed biomass significantly, compared with other treatments (Table 13). Slashing appeared less effective for the control of monocot weeds. Again, there was no difference between two levels of glyphosate on weed biomass.

Application of glyphosate at both rates significantly increased nut yield over the unweeded control, slashing and cover crop treatments (Table 14). *Pueraria* was capable of suppressing weed growth and the effect was shown in nut yield.

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**Table 13.** *Weed biomass (g/m<sup>2</sup>) at different sampling times as affected by the application of different weed control treatments (Adult palm) at I.S.G. (Ambakele)*

Treatments	1996-1999	Jan	April	June	Nov
		2000	2000	2000	2000
Slashing and mulching	386	215	142	194	70
Slash and removing the slash	382	246	156	282	84
Glyphosate 2.88 kg ai/ha	220	113	81	89	35
Glyphosate 1.44 kg ai/ha	191	99	73	115	82
Cover Cropping	204	51	51	53	31
Unweeded	469	249	184	318	202
Significance		***	***	**	**
LSD (P=0.05)		75	57	96	51
CV %		13	20	17	12

Treatments were applied in 96 Nov, 97 May, 98 Jan, 98 May, 99 Jan, 99 July, 2000 Feb and Aug 2000

**Table 14.** *Nuts yield (nuts/palm/year) of coconut as affected by the application of different weed control methods at Isolated Seed Garden (Ambakele)*

Treatments	Nuts/palm/year			
	96/97	98	99	2000
Slashing/Mulching	58	106	100	91
Slashing/Slash remove	61	93	107	87
Glyphosate 1.44 ai/kg/ha	73	103	135	110
Glyphosate 0.72 ai/kg/ha	72	106	128	116
Pueraria grand cover	68	105	105	92
Unweed control	62	90	109	81
Significance			*	*
LSD (P=0.05)			10	19
CV %			15	10.8

**Experiment 5.1.2: Comparison of different weed management systems and their effect on the growth of coconut seedlings**

**5.1.2.2: Isolated Seed Garden (I.S.G.), Ambakelle (IL<sub>1</sub>/S<sub>2</sub>) - 1996**

Different weed control treatments given in Table 15 were on RCBD with three replicates. Each plot had six effective coconut seedlings. Most dominant weeds were Illuk (*Imperata cylindrica*), Atoa (*Panicum repens*), Rilathana (*Pennisetum polystachyon*), Podisinghomaran (*Chromolaena odorata*), Getakola (*Hedyotis auricularia*) and Gandapana (*Anisomeles indica*). Two glyphosate treatments and cover cropping with *Pueraria* effectively reduced the weed biomass compared to slashing and uncontrolled treatments (Table 15).

The experiment is in progress.

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**Table 15.** *Weed biomass (g/m<sup>2</sup>) as affected by different weed control treatments (young palms) at I.S.G. (Ambakele)*

Treatment	1996-99	Feb 2000	April 2000	June 2000	Sept 2000	Nov 2000
Slashing and mulching the palm with slashed weeds	223	38	79	106	39	82
Slashing and slash removed	221	41	68	93	39	69
Glyphosate 1.44kg ai/ha	106	2	64	80	1	6
Glyphosate 2.88kg ai/ha	98	16	35	78	2	7
Cover Cropping	103	26	38	53	32	43
Unweeded	278	65	94	103	97	109
Significant		**	**	**	**	**
LSD (P=0.05)		11	24	40	26	37
CV%		22	13	26	12	18

Treatments were applied in 96 Nov, 97 May, 98 May, 99 Jan, 99 June, 99 Dec, 2000 July and December 2000.

### Experiment 5.1.3: Comparison of several recommended cultural practices for weed management in coconut lands

A large number of field experiments have been carried out from time to time on cover cropping, planting of *Gliricidia*, chemical weeding, grazing etc. The effects of these different cultural practices on nut yield have not been consistent.

Six different treatments were: T<sub>1</sub>- planting of *Gliricidia* (in double rows in an avenue at 1 m x 2 m spacing), T<sub>2</sub>- cover cropping with *Pueraria*, T<sub>3</sub>- grazing with cattle, T<sub>4</sub>- slashing, T<sub>5</sub>- application of glyphosate (1.5 l per ha and two rounds per year depending on weed growth) and T<sub>6</sub>- control treatment in which only the perennial shrubs are removed. These treatments were arranged in randomised block design with three replicates and nine effective palms per plot. Sites were selected as follows.

Halgahamulla Estate, Mirigama (Shallow Boralu, WL<sub>3</sub>/S<sub>4</sub>),  
Thennahena Estate, Hakmana (Shallow Boralu, IL<sub>1</sub>/S<sub>5</sub>),  
Pallama Seed Garden (Sandy Loam, IL<sub>1</sub>/S<sub>2</sub>) and  
Ussawa Division, Melsiripura Estate (IL<sub>1</sub>/S<sub>2</sub>).

Leaf and soil sampling, measurements of weed biomass and nut yield as well as cost/benefit analyses are planned.

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**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 of coconut in the wet and wet intermediate zones-1997**

The objective of these models is to collect agronomic and economic data on various intensive cropping systems with different crop/farm animals consequence in coconut based farming systems specially in land suitability classes S<sub>4</sub> and S<sub>5</sub>. Crops/animals vary with rainfall, soil, farm resources and status of the farmer. Recording of the agronomic and economic data from different existing models is being continued.

Nut yield improvement in different intensive cropping/farming models over monoculture coconut continued during this year too (Table 16). Yield improvement under intensive farming was attractive in the model at Gaspé. This might be due to additional benefits of fertilization and improved management.

Crop models with rambutan, pepper and tea produced attractive returns due to high market prices that prevailed during this year (Table 17). Pineapple, cashew, milk generated reasonable income to the growers. Coffee and banana prices were low hence returns were also marginal.

The experiment is in progress.

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**Table 16:** *Yields of coconuts (nuts/palm/year) under monoculture and different crop/farm models*

Locations	Agro-ecolo. Zone	Crop/farm model	1992-99		2000	
			Intercropped	Monoculture	Intercropped	Monoculture
Walpita-A	WL <sub>3</sub>	Coconut (m.p.) + Pepper + Banana	69	63	78	76
Udella	WL <sub>3</sub>	Coconut (r.p.) + Pepper + Coffee	38	34	42	36
Kahatawila-1	IL1	Coconut (m.p.) + Pepper + Coffee	57	50	59	51
Rathmalagara	IL <sub>1</sub>	Coconut (m.p.) + NFT's + Pasture + Goat	70	64	65	60
Deegalla	IL <sub>1</sub>	Coconut (m.p.) + Pasture + Fodder + Cattle	37	33	40	39
Gaspe	WL <sub>3</sub>	Coconut (m.p.) + Pasture + Fodder + Cattle	65	40	99	79
Galle	WL <sub>2</sub>	Coconut (m.p.) + Tea	-	-	64	48
Walpita-B	WL <sub>3</sub>	Coconut + Pepper + Pineapple	-	-	78	76

m.p. = Mature coconut plantation

r.p. = Coconut re-plantation

**Table 17:** *Performance of intercrops at on-farm crop/farm models in the Wet and Wet Intermediate Zones-2000*

Location	Agro-ecological zone	Model	Agronomic yield/ha	Cumulative expenditure Rs/ha	Income (Rs/ha)	Net profit (Rs/ha)
Walpita-A	WL <sub>3</sub>	Crop	Pepper- 575 kg	44546	234585	190039
Walpita-B	WL <sub>3</sub>	Crop	Pineapple-7 840 kg Pepper- 375 kg	67500	260150	192650
Kahatawila	IL <sub>1</sub>	Crop	Pepper- 384 kg Coffee- 144 kg	38720	215238	176608
Deegalla	IL <sub>1</sub>	Crop	Cashew- 290 kg	14259	44956	30697
Urapola	WL <sub>2</sub>	Crop	Rambutan- 32, 340 fruits	96777	344671	247694
Galle	WL <sub>2</sub>	Crop	Tea- 7, 320 kg (fresh leaf)	88520	171720	83200
Imaduwa	WL <sub>2</sub>	Crop	Tea- 8, 520 kg (fresh leaf)	111980	187440	75460
Gaspe	WL <sub>3</sub>	Farm	Milk- 3 482 L	88932	158928	69996

**PROJECT 19: SMALL HOLDER COCONUT FARMING SYSTEMS WITH ANNUAL/PERENNIAL CROPS IN THE INTERMEDIATE AND DRY ZONE**

**Experiment 19.1: Investigate the suitability of coconut/cashew mixed cropping in the dry zone, Kamandaluwa Estate, Andigama (IL<sub>3</sub>/S<sub>5</sub>) – 1991**

Coconut and cashew seedlings were both planted at the same time as a non-replicated block at spacing detailed in Table 18. The area of each plot is 0.5 ha.

In all three years so far, cashew yield in model 2 (coconut at 12 m x 6 m and 69 cashew trees/ha) was the highest.

Only about 30 - 40 per cent of the coconut trees in models 1 - 4 were in flower after 10 years from planting and this shows coconut take a long period to yield particularly in class 5 (S<sub>5</sub>) lands under normal management in the intermediate dry zone. Cashew yield in model 5 system indicate that cashew cannot be intercropped with new planting of coconut at normal planting density (8.5 m x 8.5 m; 156 palms/ha). While at the closest planting, none of the coconut palm has flowered. The yield of cashew has also been decreased in this treatment (Table 18).

During this year too, cashew was affected by *Helopeltis*.

The experiment was terminated.

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**Table 18.** *Cashew yield as affected by different densities and planting arrangements of coconut and cashew*

Model (coconut spacing)	Coconut density (palm/ha)	Cashew density (trees/ha)	Cashew yield (nuts/tree/year)		
			1998	1999	2000
12m x 6m	138	0	-		
12m x 6m	138	69	640	900	1010
10m x 5m	200	100	525	360	710
12m x 6m x 6m (double avenue)	180	90	492	341	545
8.5m x 8.5m	156	78	211	160	402

(Note: In all cases, the cashew was planted at the centre of the planting square, alternating in both directions and staggered).

**Experiment 19.3: Performance of grafted cashew under coconut at Ratmalagara Estate, Madampe (IL<sub>3</sub>/S<sub>4</sub>) – 1995**

The treatments given in Table 20 were tested on a RCBD with three replicates. Each plot consisted of nine effective coconut palms.

Seedling, grafted and air-layered cashew differ in their canopy form and possibly also

in their root distribution. Coconut yield was not affected by the plant types (Table 19a). Seedling cashew flowered after four years of planting. The bud-grafted and air layered cashew took only one and two years for the first flowering respectively.

During the year, bud-grafted cashew gave the highest yield (3.4 kg/tree/yr) while air-layered and seedling cashew produced 2.5 and 0.9 kg/tree/yr respectively (Table 19b). Generally, cashew yield during the year was low due to continuous rains that prevailed in January - March. Hence, Helopeltis attack increased while fruit set decreased.

The experiment is in progress.

**Table 19 (a).** *Coconut yield as affected by intercropping of different planting materials of cashew*

Treatments	Coconut Yield (nuts/palm/year)	
	1996 - 99	2000
Coconut monoculture	60	58
Bud-grafted cashew	57	52
Air layered cashew	58	56
Seedling cashew	62	54
Significance (p=0.05)	n.s.	n.s.

**Table 19 (b).** *Yield of cashew from three different plant types*

Treatment	Yield of cashew (kg/tree/year)			
	1997 (Year 2)	1998 (Year 3)	1999 (Year 4)	2000 (Year 5)
Grafted cashew	0.3	1.2	2.8	3.4
Air layered cashew	-	-	0.9	2.5
Seedling cashew	-	-	0.6	0.9

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

**Experiment 21.4.2: Buffalo grazing as a mean of weed control in coconut plantations, Makandura Seed Garden (WL<sub>3</sub>/S<sub>3</sub>) - 1998**

This experiment is on a Complete Randomized Block Design (RCBD) with three replicates and 16 effective palms/plot. The soil of the site is clay-loamy and three treatments were assigned to ground pasture and weed cover necessary and about management by (a) general slashing by rota-slasher attached to a four-wheel tractor as judged 3 rounds per year, (b) *Pueraria* cover cropping and (c) buffalo management (one animal for every 2.0 ha) with rotational grazing on an one month cycle.

Table 20 shows that nut yield of buffalo grazed plots were seem to be higher than that in cover crops. However, there was no difference between buffalo grazing and slashing of weeds. This indicates that *Pueraria* ground cover might be competitive for nut yield.

**Table 20.** *Effect of buffalo grazing, cover cropping and slashing on yield of coconut at Makandura*

Treatments	Coconut Yield (nuts/palm/year)		Soil Compaction (N/cm <sup>3</sup> )	Weeding Cost (Rs./ha/year)
	1999	2000		
Slashing	64	89	108.3	3100.00
Cover cropping	57	81	116.6	2000.00
Buffalo grazing	66	94	138.7	948.00
Significance	*	*	*	
LSD (P=0.05)	6	8	11.3	
CV%	8	11	2.5	

(Note: No value assigned for milk from the buffaloes).

It is interesting to note that soil compaction in grazed plots was significantly higher than those of other two treatments (Table 20). In future, harrowing once a year would be helpful to reduce soil compaction by buffaloes.

Average milk yield of a buffalo was 5.0 L/day during the year. Buffalo grazing was a profitable method of weed control.

The experiment is in progress.

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

### **Experiment 21.5.1: Development of smallholder dairy farming under coconut**

Much work has been done on strategies to overcome feed shortages and to improve poor quality feeds for livestock under coconut and different feeding systems have been recommended. The adoption of these recommendations by the farmers is poor. This may be due to technical, social and economic reasons.

Therefore a study was proposed to evaluate different recommended feeding systems (including performance of recommended pasture varieties, supplementation of Urea, Molasses, Mineral Block, Feeding *Gliricidia* etc.) in farmer fields, to assess the farmer perception on above technologies and to demonstrate how to use small coconut lands for sustainable feed supply for cattle.

Under this project, 12 farm models in three agro ecological zones (IL<sub>1</sub>, IL<sub>3</sub> & WL<sub>3</sub>) were proposed and during the year four farm models were established (Table 21).

Data on milk yield, coconut yield, biomass production of pasture/fodder, the quality parameters of pasture (Ex. Crude Protein content) and farmer perceptions of above technologies will be recorded.

**Table 21:** Details of selected farmer's sites

Farmer	Location	Agro-eco Zone	Crop-livestock model			Dairy cattle	
			Coconut (ac)	Pasture		Breed (s)	Number
				Variety	Extent (Ac)		
Mr. O. Jayaratna	Pannala	IL <sub>1</sub>	0.75	<i>B. brizantha</i> <i>B. mutica</i>	0.50 0.25	Jersey cross	04
Mr. M. Pantelin	Bingiriya	IL <sub>1</sub>	0.50	<i>B. miliiformis</i> <i>B. brizantha</i>	0.25 0.25	Jersey & Friesian crosses	02
Mr. E. M. P. Kumarasiri	Hettipola	IL <sub>3</sub>	0.50	<i>B. miliiformis</i> <i>B. brizantha</i>	0.25 0.25	Jersey cross	02
Mr. N. Jayasinghe	Hettipola	IL <sub>3</sub>	0.25	<i>B. ruziziensis</i> <i>B. miliiformis</i>	0.13 0.13	Jersey cross	01

This experiment is in progress.

*A D Samarajeewa, R Marasinghe and M D V Saparamadu*

#### 21.5.2: Demonstration on goat farming under coconut

Goats are widely adapted to a range of feeds and have higher feed conversion rate than other livestock species. Although much information on extensive systems of goat keeping is available, feasibility of intensive methods with *in-situ* grown fodder species under coconut has not been tested.

Therefore, a demonstration was established at Bandirippuwa estate with the objective of demonstrating the feasibility of an intensive method of goat keeping with *in-situ* grown fodder. Two acres of a *Panicum maximum* (var. Guinea B) and *Gliricidia sepium* mixed pastures was established for this trial.

Initially 8 animals (one male and seven females) were introduced. Guinea B and *Gliricidia* were provided daily at the rate of 10% of the body weight (on live weight basis). During the year, body weight gain of 730g/animal/month was recorded while dung production was 450g/day/animal in this system.

This demonstration trial continues.

*A D Samarajeewa, R Marasingha and M D V Saparamadu*

**PROJECT 24 : STUDY ON IMPACT OF TRADE AGREEMENTS ON  
COCONUT SECTOR**

**Study 24.1 : Import duty reduction for substitute oils and its implications  
for the coconut oil industry**

This study analysed the impact of import duty reduction for edible oils on the local coconut oil industry. More specifically, this study attempted to:

- i) identify the reasons for the closing down/irregular functioning of oil mills
- ii) determine the profitability of coconut oil manufacturing at prevailing prices of inputs and outputs
- iii) determine the effect of tariff changes on imported substitute oils and export earnings from D.C. on the foreign exchange balance
- iv) determine the import duty levels in order to protect the local coconut oil industry.

Primary data were collected by a field survey of: a) 40 coconut oil millers scattered in the coconut-growing area, selected using a stratified random sampling procedure, and b) 15 selected coconut oil/D.C. shippers in and around Colombo, and c) a few key policy makers. The survey was conducted from October 1999 to March 2000. A structured schedule was used and was supplemented with informal discussions. Secondary data were collected through published sources.

Results revealed that the lowering of import duty on substitute oils was the most significantly affected reason for closing down or irregular functioning of mills (Table 22).

**Table 22** *Reasons for the closing down/irregular functioning of mills*

Reason	Total score <sup>1</sup>
• Lowering of tariff on importation of substitute oils	56
• GST burden on CNO manufacture	43
• Copra scarcity	23
• Labour shortage	8
• Others	17
Sum of total score	147
Mean score	29

Source: Survey of coconut oil millers by the authors (1999/2000).

As Table 23 shows, manufacturing of coconut oil was not profitable to millers given the input and output prices that prevailed (29 March 2000).

<sup>1</sup> Millers were asked to rank the reasons for closing down/irregular functioning of their oil mills. The reasons ranked by millers as first were assigned a score of  $n$ , where  $n$  was the maximum number of reason millers reported. The reasons ranked from second to  $n$  th were assigned scores on a similar basis.

**Table 23** *Costs and returns of coconut oil manufacturing (Rs/MT of oil\*)*

Item	Unit Price	
OUTPUT		INCOME (Rs)
• 1 MT of oil	@ Rs 53 per kg	53 000
• 603 kg of poonac	@ Rs 7 per kg	4221
Gross Return		57 221
INPUTS		COST (Rs)
(A) Variable Costs		
• Materials		
- Copra (1675 kg of copra is required to extract 1MT of oil)	@ Rs 7000 per candy (254 kg) of copra	46 161
• Labour, electricity, fuel wood		3000
Total variable cost (Rs/MT of oil)		49 161
(B) GST		@ 12.5% 6145
• Cost including GST**		55 306
C) National Security Levy (NSL)		@ 5.5 % 3042
• Cost including GST + NSL		58 348
Total Cost (Rs/MT of oil)		58 348
Net Return (Rs/MT of oil)		- 1127

Note : \* As at 29 March 2000.

\*\*GST is levied if the turn over per three months exceeds Rs 500 000 (p 18 of Manual of GST Law, 1998).

Source: Survey of coconut oil millers by the authors (1999/2000).

The last column of Table 24 shows that the additional expenses of foreign exchange on importation of an increased volume of other oils outweighed the additional earnings of foreign exchange received from exporting an additional volume of D.C., thus making the country a net loser.

**Table 24** *Additional exports of D.C. and additional imports of other oils during post-policy period*

Year	Incremental exports of DC (IEX <sub>DC(t)</sub> ) in MT	Average export price of DC (AP <sub>DC</sub> ) in Rs/MT	Incremental foreign exchange earnings (IFE <sub>DC(t)</sub> )* in Rs million	Incremental imports of other oils (IIM <sub>o(t)</sub> ) in MT	Average price of other oils (O <sub>p</sub> )(Rs/MT)	Incremental foreign exchange expenditure (IFE <sub>o(t)</sub> )* in Rs million	Gain or loss (Rs million)
1997	12611	66 998	845	56619	32 812	1858	- 1013
1998	- 5893	65 771	- 388	43827	44 998	1972	- 2360
1999	11821	80 942	956	68448	36 931	2528	- 1572

Notes : ♣ IFE<sub>DC(t)</sub> = IEX<sub>DC(t)</sub> \* AP<sub>DC</sub>.

♣ IFE<sub>o(t)</sub> = IIM<sub>o(t)</sub> \* Op.

Table 26 shows the import duty levels need to be very high in order to protect the local coconut oil industry. For example in 1999, it should have been well over 100 per cent, and in some months even over 200 per cent. However, the scope for such a protection is practically limited by fluctuating palm oil prices.

**Table 25** *Import duty levels for substitute oils to protect the local CNO industry*

Year	Month	COP of CNO when income from poonac is accounted for (Rs/MT of CNO)	World market price of palm oil (Rs/MT)	Import duty ought to be (%)
1999	January	95571	42 498	89
	February	97900	37 686	119
	March	102757	33 754	156
	April	99765	35 517	137
	May	94157	31 585	151
	June	91487	26 231	194
	July	95146	21 757	268
	August	98400	23 994	246
	September	101930	27 647	211
	October	96710	27 304	198
	November	85745	26 492	173
	December	81326	31 984	114

The oil productivity per unit land area of oil palm is about 3.5 to 4 times greater than that of coconuts<sup>2</sup>. Further, coconut mills in Sri Lanka still use age-old oil extraction technologies, having low efficiencies. Although these considerations imply that the scope for coconut oil to compete with palm oil as a crop for edible oil is limited, the coconuts can take the advantage as a crop supplying feedstock for oleochemicals, used in the surfactant industry. The world demand for surfactants is projected to grow at an average of 4 per cent per annum. Downstream processing of CNO to produce oleochemicals therefore seems to be a strategy to make CNO competitive. In this area too, however, palm kernel oil (PKO) will compete as PKO has nearly identical properties as CNO.

(A collaborative study with the Biometry Division)

*M. T. N Fernando, T. S. G Peiris, S. R Samarajeewa,  
S. D. J. N Subasinghe, and K. V. N. N. Jayalath*

## **PROJECT 25 : STUDIES ON CURRENT ECONOMIC ISSUES**

### **Study 25.1 : An appraisal of economics of the growing *Gliricidia* under coconut as an energy source for dendro-thermal power plants**

Economics of growing *Gliricidia* under coconuts as an energy source for dendro-thermal power plants were investigated using input and output data collected from on-farm *Gliricidia* trials established by the fuel-wood project. This investment is economically feasible for farmers given the power plant delivered price of Rs. 1250 per MT of *Gliricidia* dry wood, but not lucrative as compared with mixed cropping alternatives such as coconut-based pineapple, banana and ginger etc. However, for S<sub>5</sub> and below land suitability classes where rehabilitation of lands by Nitrogen Fixing Trees is necessary, and other mixed cropping practices are not possible, this investment seems attractive. Moreover, for those

<sup>2</sup> One ha of oil palm cultivation consisting of 150 palms produces 2.7 MT of palm oil and 270 kg of palm-kernel oil in the tenth year from field planting (Varghese and Nampoothiri, 1998). Whereas a mature coconut cultivation of one ha, on average, produces about 7000 nuts, i.e. 1422 kg of copra on dry weight, which makes about 0.83 MT of coconut oil.

absent land lords who do not wish to grow other intercrops due to intense management demands of material inputs and labour, gliricidia seems to be ideally suited because of its lower labour and material inputs demand.

*M T N, Fernando, K B Dassanayake and P G Joseph*

### **3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES**

#### **3.1 Coconut based adaptive research programme**

Coconut based adaptive research programme (under the Second Perennial Crop Development Project funded by the Asian Development Bank)

General objectives of this programme are;

- i.) to increase the productivity and farm income of coconut lands by adopting an intercropping/farming systems approach by introducing appropriate crop/livestock components and cost effective management systems,
- ii) to make use of coconut growers as partners of the technology development process in technology testing, adoption and integration,
- iii) to increase sustainability of coconut cultivation,
- iv) demonstration/transfer of appropriate technology on intercropping/animal husbandry,
- v) to gather information on technical, managerial and social issues from the pilot project which facilitate further extension of the programme.

During the implementation, progressive farmers were selected on a regional basis with the assistance of the Coconut Cultivation Board (CCB).

At each site, farmer's practice at present was compared with the CRI recommended practice by an unreplicated paired design. The plots were generally above 0.5 ha.

The factors such as planting, varieties, fertilizer, husk burial, mulching, irrigation and a variety of perennial and seasonal intercrops (cocoa, coffee, pepper, cinnamon, rambutan, cashew, lime, orange, mango, passion fruit, pineapple, banana, papaya and yam etc.) are being compared.

81, out of the 125 intended sites have commenced operation. Initially, priority was given to establish sites in the Southern region initially and then to the other areas. Much attention was given for the development of cinnamon under coconut in Galle, Matara, Kalutara and Colombo districts while the same effort was taken to promote cashew under coconut in Kurunegala district. Besides traditional intercrops, rambutan was introduced to Moneragala and Akuressa areas. Similarly, bud-grafted orange was also introduced to Hambantota and Anuradhapura districts.

Agronomic and economic data are being gathered from each site.

*H A J Gunathilake, S Senaratne and N A K de Silva*

### 3.2 Fuel wood plantation project

Fuel wood plantation was further expanded to a total of 18 hectares during the year. This includes about 10,000 seedlings of *Acacia* and about 20,000 cuttings of *Gliricidia* planted during October-November season, 1999.

*K B Dassanayake, H A J Gunathilake and N Alagiyawanna*

## 4. MISCELLANEOUS STUDIES

### 4.1 Demonstration farm, Tabbowa, Nattandiya.

A total extent of 2.5 ha of farm is being managed on a self-financing basis to demonstrate improved cultural practices in coconut cultivation and to increased productivity of lands by intercropping selected crops such as cinnamon, pepper, cocoa etc. During the year 12,507 coconut seedlings were issued and income was Rs.340,350.00 (Table 26). The net profit of the farm was Rs.154,537.03.

Six groups of school students, large numbers of students from various agricultural training schools & coconut growers visited the farm.

*H A J Gunathilaka and R A Swarnathilaka.*

**Table 26.** *Income and Expenditure of the Demonstration Farm, Nattandiya*

Income			Expenditure	
Item	Quantity	Value (Rs)	Item	Value (Rs)
a) Sale of coconut	26,283	121,772.63	a) Labour	279,995.90
b) Sale of coconut Seedlings			b) Other materials	21,932.00
Poly bagged :			c) Electricity	8,299.00
T x T	956	40,152.00		
D x T	8	320.00		
RD	8	320.00		
Bare rooted :				
T x T	11,183	290,758.00		
D x T	118	2,950.00		
RD	62	1,550.00		
KC	172	4,300.00		
Sub total		340,350.00		
Sale of other crops		2,641.30		
Total income		464,763.93	Total expenditure	310,226.90
Profit		154,537.03		

### 4.2. Animal breeding programmes:

An animal breeding program at Ambakele, Makandura and PRS is being continued to provide improved breeds of buffalo and goats for coconut growers.

During the year 24 goats were sold among the farmers identified by the local veterinary officer.

It was planned to maintain a 40 female buffalo herd, hence females were not sold (Table 27).

**Table 27.** *Details of the animal herd*

Animal	Place	Breed	Herd			
			End of 1999		End of 2000	
			Female	Male	Female	Male
Buffalo	Makandura	Murrah	11	03	12	09
	Ambakele	Murrah	14	04	18	8
Goat	PRS	Sri Lankan Boer	11	32	40	44

*H A J Gunathilaka, S Senarathna (Agronomy)  
G B A Wijesekara, V M B A Weragoda (EMD)*

## 5. OTHER PARTICULARS

- Resource Person and Research Collaborator - European Union Assisted Multi-disciplinary Research and Development Project: Sustainable Supply of Fuelwood to Meet Sri Lankas Energy Needs: EC DGIB Contract: LKA/B7-6201/IB 970538(05): with Ministry of Science & Technology, Dept. of Forest and Forest Conservation of Sri Lanka and Natural Resources Institute, United Kingdom.
- Technical Evaluation Committees: on purchase of Capital Items: Laboratory Equipment

One-day training programmes/NIPM lectures/PEP Advisory visits

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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 of plant and soil samples.

**REPORT OF THE GENETICS AND PLANT BREEDING DIVISION**  
**Acting Head – J.M.D.T. Everard M.Sc.**

**1. GENERAL**

The highlight of the year was the production and distribution of CRISL98 (Tall x San Ramon), the new release, for adaptive trials. The response to CRI's call for growers' participation in evaluating CRISL98 on their fields was very encouraging. In the year 2000 alone, a total of 2848 seedlings was established in 10 districts representing a range of agro-ecological environments in the country. The production of CRISL98 seed by manually pollinating selected tall palms at the Isolated Seed Garden, Ambakelle (ISG) with San Ramon pollen was continued. The number of CRISL98 seeds produced during the year was 9169. These seeds are being raised at the ISG nursery for distribution among selected growers.

Establishment of the Pallama Seed Garden (PSG) for mass production of CRISL98 progressed steadily during the year despite heavy casualties through Black Beetle damage and water logging. During the year, 1442 tall palms and 107 San Ramon palms were planted, reaching the final tally to date of 4507 comprising 3004 tall and 1503 San Ramon. Production of the genetically superior Tall and San Ramon for raising seedlings for the expansion of PSG was continued at ISG and from a newly selected palm pool at the PSG.

Steady increases in nut yield were evident in all cultivars in the multi-locational cultivar comparison at the two sites at Bandirippuwa (Lunuwila) and Suriyapura (Gampaha). This trial is now in the 17<sup>th</sup> year after establishment and up to this stage in all the sites, the inter-varietal hybrids DGxT and DYxT outperformed pure tall cultivars, TallxTall, Moorock and Plus Palm selections. DGxT recorded significantly high yields at Bandirippuwa, 78 nuts/palm/year and Suriyapura, 61 nuts/palm/year (5 picks) compared to tall cultivars that averaged 60 and 38 nuts/palm/year respectively at the two sites.

This year however, the performance of all the five cultivars was poor at Thammenna, all recording yields less than 35 nuts/palm/year with no significant differences. Unevenly distributed rainfall and lack of proper field management to arrest soil moisture depletion would have probably caused the decrease at this site. The copra out turn per nut varied vastly between cultivars and sites showing a clear genotype x environment interaction with plus palms recording the highest of 298 g/nut at Suriyapura and DGxT recording the lowest of 188 g/nut at Thammenna. However, DGxT gave the highest copra yield per palm, 18.7 kg/palm/year at Bandirippuwa and Moorock Tall recorded the lowest, 5.43 kg/palm/year at Thammenna. The experiment is to be continued for another five years, as it is likely to unveil useful information to support the potential of hybrids for more extensive planting.

The trials established to assess the performance of F<sub>1</sub> progeny from crosses between selected tall palms at ISG, Dwarf Green and Sam Ramon, were maintained successfully at all locations for the 15<sup>th</sup> year. All the three crosses recorded yields above 54 nuts/palm at the two sites, Bandirippuwa and Rathmalagara. The best were 90 and 74 nuts/palm/year recorded by TxDG at respective sites, Rathmalagara and Bandirippuwa. The results also indicated the promise in the combining ability of TallxSan Ramon for the important trait, copra/nut. TxSR recorded a copra out turn of 336 and 329 g/nut at Bandirippuwa and Rathmalagara respectively both being significantly higher than that of TxDG (average, 246 g/nut) and TxT (average, 290

g/nut). These progeny trials too will be continued for another five years, as they have not stabilized in yield.

Collection and conservation of coconut germplasm continued at a rapid pace with the financial assistance of COGENT/ADB. The field gene banks at Bandirippuwa, Pottukulama, Lenawa, Raddegoda and Kohombana were maintained successfully while a new gene bank was established at the Pallama Seed Garden (12 accessions). Characterization of the conserved germplasm was undertaken in all the gene banks. The Coconut Genetic Resources Database (CGRD) of the COGENT was updated with the progress of rejuvenated germplasm accessions in field gene banks. Preparation of a catalogue of all conserved germplasm was commenced for inclusion in the world collection of coconut accessions to be compiled by COGENT in 2001. The trials established for evaluation of germplasm and crosses generated from germplasm accessions were maintained and early growth rates so far have not revealed any noteworthy findings.

DNA assay procedures were used for the first time to assess the genetic diversity of coconut germplasm in the country. The results revealed the population structure of coconut in Sri Lanka and how the genetic variation is distributed. The data revealed that the existing variation has been exploited to a great extent and stressed the need for germplasm enrichment by exotic introductions for further genetic improvement of the coconut. Deliberations were already commenced for importation of 23 germplasm accessions, nine from India, six from Ivory Coast and eight from Fiji and PNG.

A preliminary study was undertaken to map the coconut genome using molecular markers and a foundation was laid for a long term programme for generating a high density map of coconut for use in marker assisted breeding.  $F_2$  families were obtained by selfing  $F_1$  established at the Progeny Trial at Bandirippuwa, which arose from known tall and dwarf parents at ISG. These families have been screened for detection of DNA polymorphisms at heterozygous loci in  $F_1$  and their segregation in  $F_2$  constructs.

The successful completion of the IFAD assisted project collaborating with the Plant Physiology Division, continuation of the ADB Phase III Project collaborating with Plant Physiology and Tissue Culture Divisions, active participation in the ADB Science and Technology Project for manpower and infra-structure development and the CESS funded project for expansion of biotechnology research, are also noteworthy activities of the GPB Division during the year 2000. The Division also secured two NRC grants for molecular pathogen diagnosis and development of DNA markers during the year.

## **2. RESEARCH PROJECTS**

### **PROJECT: EVALUATION OF EXISTING CULTIVARS**

#### **Experiment 12.1. Evaluation of five improved cultivars (1983/86)**

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

## Treatments:

The five cultivars under evaluation are

- V1 Dwarf green x Tall (DG x T) (CRIC 65)
- V2 Dwarf yellow x Tall (DY x T) (CRIC 65)
- V3 Tall x Tall (TT) (CRIC 60)
- V4 Moorock Tall (MT)
- V5 Ordinary Tall (from plus palms) (PPT)

Experiment number	Location	Year of establishment	Soil type	Agro-ecological region
12.1.1	Bandirippuwa	1983	Loamy sand	Wet intermediate
12.1.2	Thammenna	1983	Latosol	Dry zone
12.1.3	Palugaswewa	1985	Sandy clay loam	Dry intermediate zone
12.1.4	Suriyapura	1986	Lateritic gravel/clayey	Wet zone

The yield data for the five-year period 1996-2000 and five-year averages of the five cultivars at the two sites, Bandirippuwa and Thammenna planted simultaneously in 1983 are given in Table 1. Despite the apparent yield reduction shown by hybrids in the year 2000 a slight increase in the yield was shown by all the three tall cultivars at Bandirippuwa. A prominent yield reduction was shown by all the cultivars at Thammenna, all recording less than 35 nuts/palm/year. It is interesting to note that the performance of hybrids has drastically reduced at this site compared to previous years. However, the five-year average yields still indicate hybrids, DGxT and DYxT as better performers than the three tall cultivars at both sites.

**Table 1.** Nuts /palm/yr. of the five cultivars in the evaluation of cultivars at Bandirippuwa (B) and Thammenna (T) Estates during 1996-2000.

Cultivar	1996		1997		1998		1999		2000		Mean		
	B	T	B	T	B	T	B	T	B	T	B	T	
DG x T	67	73	46	81	47	32	103	107	78 <sup>a</sup>	30 <sup>ab</sup>	590	68.2 <sup>a</sup>	64.6 <sup>a</sup>
DY x T	65	65	45	71	57	32	88	81	71 <sup>ab</sup>	35 <sup>a</sup>	627	65.2 <sup>a</sup>	56.8 <sup>a</sup>
T x T	48	51	32	46	32	20	63	45	64 <sup>bc</sup>	26 <sup>b</sup>	886	47.8 <sup>b</sup>	37.6 <sup>b</sup>
MT	42	36	32	36	30	17	51	39	55 <sup>c</sup>	25 <sup>b</sup>	672	42 <sup>b</sup>	30.6 <sup>b</sup>
PPT	44	49	34	49	34	22	56	46	60 <sup>c</sup>	30 <sup>ab</sup>	642	45.6 <sup>b</sup>	39.2 <sup>b</sup>

<sup>a</sup> <sup>b</sup> and <sup>c</sup> significantly different groups

The Rainfall data of the two sites were tabulated (Table 2) for the last six years with the intention of relating the yield patterns to either intensity or distribution of rainfall.

The relatively better rainfall, both intensity and distribution at Bandirippuwa was clearly reflected in superior yields shown by all cultivars on the five-year average. The yields at Thammenna varied drastically with the distribution of rainfall. The lower two years, 1998 and 2000 (both with just 34 wet days/year) recorded extremely low yields averaging less than 35 nuts/palm/year. The results suggest a genotype x environment interaction, which could well become clearer with data for a few more years. Thus this experiment needs to be continued for at least another five years to obtain more conclusive results.

**Table 2.** Rainfall distribution at Thammenna and Bandirippuwa during 1994-2000.

Year	Bandirippuwa		Thammenna	
	Total rainfall (mm)	No. of wet days	Total rainfall (mm)	No. of wet days
1994	1905.0	140	875	40
1995	1943.9	135	1163	44
1996	1738.7	128	823	42
1997	1902.4	140	916	62
1998	1997.9	130	1009	34
1999	2214.5	126	1086	48
2000	1686.6	110	976	34

The fruit components were analyzed from a nut each of each palm in every pick and Table 3 and 4 summarize the data of the two sites Bandirippuwa and Thammenna respectively.

**Table 3.** Fruit components of five cultivars established at Bandirippuwa as mean of six picks in 2000

Fruit Component of cultivar	DG x T		DY x T		T x T		MT		PPT	
	AVG	CV	AVG	CV	AVG	CV	AVG	CV	AVG	CV
Fresh nut weight (g)	1300 <sup>b</sup>	24	1333 <sup>b</sup>	25	1560 <sup>a</sup>	26	1785 <sup>a</sup>	22	1441 <sup>b</sup>	22
Husked nut weight (g)	749 <sup>b</sup>	25	782 <sup>b</sup>	28	886 <sup>a</sup>	24	920 <sup>a</sup>	25	763 <sup>b</sup>	25
Split nut weight (g)	554 <sup>c</sup>	22	598 <sup>b</sup>	29	664 <sup>a</sup>	21	681 <sup>a</sup>	20	579 <sup>bc</sup>	22
Kernel weight/ nut (g)	359 <sup>c</sup>	23	366 <sup>c</sup>	24	423 <sup>b</sup>	22	448 <sup>a</sup>	21	377 <sup>c</sup>	21
Estimated copra/nut (g)	240	-	250	-	284	-	294	-	244	-
Estimated copra/palm (kg)	18.7	-	17.8	-	18.2	-	16.2	-	14.6	-

AVG = Average CV = Coefficient of Variation <sup>a b and c</sup> significantly different groups

**Table 4.** Fruit components of five cultivars established at Thammenna as mean of six picks in 2000

Fruit Component of cultivar	DG x T		DY x T		T x T		MT		PPT	
	AVG	CV	AVG	CV	AVG	CV	AVG	CV	AVG	CV
Fresh nut weight (g)	1188 <sup>a</sup>	29	1316 <sup>b</sup>	30	1452 <sup>b</sup>	29	1503 <sup>b</sup>	27	1527 <sup>b</sup>	24
Husked nut weight (g)	590 <sup>c</sup>	33	627 <sup>bc</sup>	37	670 <sup>a</sup>	34	672 <sup>a</sup>	31	647 <sup>ab</sup>	30
Split nut weight (g)	458 <sup>b</sup>	28	468 <sup>b</sup>	28	520 <sup>a</sup>	27	523 <sup>a</sup>	25	514 <sup>a</sup>	26
Estimated copra/nut (g)	189	-	201	-	214	-	215	-	207	-
Estimated copra/palm (kg)	5.7	-	7.0	-	5.6	-	5.4	-	6.2	-

AVG = Average CV = Coefficient of Variation <sup>a b and c</sup> significantly different groups

The fruit weight varied inconsistently in the two sites as in the previous year with higher weights in the tall cultivars. Husked nut weight to fresh nut ratio is higher in the tall cultivars, CRIC60 and Moorock reflected in higher amounts of copra/nut at both sites. This result was consistent over the past two years. Moorock recorded a notable 294g of copra per nut, which is well above the average 200-225g of copra per nut in Sri Lanka tall coconuts. This recommends Moorock as a suitable candidate for inclusion in crosses designed for genetic improvement. The cross Moorock x Ambakelle tall is already under investigation in five different agro-climatic zones. However, owing to higher nut yields, hybrids competed evenly with tall cultivars in the weight of copra produced per palm during the year. It is noteworthy that among the tall cultivars CRIC60 yielded a higher weight of copra at Bandirippuwa, and lesser than plus palm, (the control) at Thammenna.

The yield data of the five cultivars at the other two sites, Suriyapura and Palugaswewa are given in Table 5. Although it is too early to assess the yield pattern of the five cultivars in these two experiments the slight increase in the yields of all cultivars and the relatively better performance of hybrid cultivars at both sites is notable.

**Table 5.** *Number of nuts/palm in five cultivars established at Palugaswewa Estate (P) and Suriyapura Estate (S) during 1998/2000.*

Cultivar	98 (5 picks)		1999		2000	
	P	S	P	S	P	S
DG x T	34	36	52	61	55	61
DY x T	36	35	51	51	63	52
T x T	20	27	42	29	46	36
MT	18	30	41	37	44	41
PPT	17	20	46	29	50	38

The fruit components of the five cultivars at Suriyapura are given in Table 6. It is interesting to note that apart from nut numbers, the copra yields per nut in the hybrids were also above average for tall coconuts in Sri Lanka at Suriyapura, which is the wettest of the four sites under investigation. The copra yields per nut in tall cultivars were also very high although a higher per palm copra yield was recorded by hybrids due to their higher nut numbers.

**Table 6.** *Fruit components of five cultivars established at Suriyapura Estate as mean of six picks in 2000*

Fruit Component of cultivar	DG x T		DY x T		T x T		MT		PPT	
	AVG	CV	AVG	CV	AVG	CV	AVG	CV	AVG	CV
Fresh nut weight (g)	1276	27.0	1401	19.2	1565	28.2	1510	28.4	1589	25.3
Husked nut weight (g)	802	22.4	904	21.4	883	22.7	878	23.3	932	21.2
Split nut weight (g)	596	18.0	657	15.1	687	19.5	655	18.8	691	17.5
Kernel weight (g)	414	18.7	447	15.1	454	17.0	425	9.9	452	17.9
Estimated copra/nut (g)	257	-	289	-	283	-	281	-	298	-
Estimated copra/palm (g)	15.7	-	15.0	-	10.2	-	11.5	-	11.3	-

AVG = Average CV = Coefficient of Variation

The overall results of the evaluation of cultivars at the four sites clearly illustrates the high yield as well as the high copra outturn potential of hybrids DGxT and DYxT compared to tall cultivars under favourable soil moisture conditions. Accumulation of more data over another five consecutive years would provide information for more definitive recommendations on coconut planting material.

*S A C N Perera, J.M.D.T. Everard, W.M.U. Fernando,  
W B S Fernando, and M H L Padmasiri*

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

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

Four hundred and forty five individuals arising from 151 progeny families obtained by crossing palms selected for sustained high nut weights during adverse climatic conditions in 1991 were planted in field 14/ISG in 1993 in order to assess the progeny performance under low moisture and stress conditions. Another 95 progeny families arising from the above crosses were established at the Maduru Oya Seed Garden in 1995. These families will be maintained in observational trials until they reach yield stability to commence analysis of fruit components and assessment of water-use-related physiological parameters.

*J M D T Everard, W M U Fernando, M H L Padmasiri  
and R Jayatillke*

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

A pool of 100 elite palms comprising of 60 palms from field 4/ISG and 40 palms from field 9/ISG selected on the basis of long term nut yield and fruit component data, have been used in a crossing programme since May 1998 to produce Tall x San Ramon seed nuts. The selected palms (female parents) were crossed with San Ramon pollen obtained from palms at Bandirippuwa Estate (palm numbers 4, 14 and 15 of field 16 and palm numbers 64, 65, 66 and 67 of field 09) during 1999. In order to expedite the programme a further 100 elite palms were selected from Field 5 of the Pallama Seed Garden for production of 'tall' seed. The pollination programme was implemented successfully and an average fruit setting success of over 35% was recorded.

*L. Perera, S.A.C.N. Perera, W M U Fernando, S A C N Perera  
S A S Chandrasiri and 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  
**Agro-climatic zone/soil type :** Dry intermediate zone;

This assessment of full sib families was established to evaluate the performance of the progeny of palms selected from fields 1 and 2 of the ISG based on consistency in giving high yields for over 18 consecutive years. This experiment however, suffered a severe set back at early stages of development due to high casualties through water logging. The yields of the families are being recorded and the average yields of half-sib families have reached satisfactory levels and show signs of stabilizing.

*W M U Fernando, S A C N Perera and M H L Padmasiri*

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

Progeny arising from crosses between Ambakelle tall and four germplasm accessions are being evaluated at five locations to test the inheritance of drought tolerance and other commercially useful traits in the resulting progenies.

**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 Anne's tall  
 Ambakelle tall x Kasagala tall  
 Ambakelle tall x Debarayaya tall  
 Ambakelle special

Experiment Number	Location	Year of establishment	Soil type	Agro-ecological region
11.3a	Girtland	1995	Gravel	Wet intermediate
11.2a	Melsiripura	1995	Reddish brown latasol	Wet intermediate
11.2b	Siringapatha	1995	Sandy Loam	Wet zone
12.3b	Bataata	1996	Reddish brown earth	Dry zone
12.3c	Kivulakelle	1997	Red yellow latosol	Dry zone

The rate of leaf production was measured for each cross at all the sites and the results of the three locations established simultaneously, Girtland, Melsiripura and Siringapatha are given in Table 7.

**Table 7.** Mean number of new leaves produced in progeny of the 5 crosses planted at Siringapatha, Melsiripura and Girtland Estates during 1995 (LSD = Least significant difference at 0.05 level)

Cross	Siringapatha			Melsiripura			Girtland		
	'98	'99	2000	1998	'99	2000	'98	'99	2000
Tall x Moorock	5.7	7.1	9.02	7.08 <sup>ab</sup>	7.2	8.77 <sup>ab</sup>	6.0	6.2	7.47
Tall x St. Anne's	5.4	6.4	8.61	6.76 <sup>b</sup>	6.5	8.11 <sup>b</sup>	5.9	6.6	8.02
Tall x Debarayaya	5.2	6.9	9.63	7.36 <sup>a</sup>	6.9	8.98 <sup>a</sup>	6.1	6.3	7.56
Tall x Kasagala	5.3	6.9	9.33	7.21 <sup>a</sup>	6.9	8.96 <sup>a</sup>	6.3	6.4	7.5
Ambakelle Special	6.9	7.2	9.29	6.59 <sup>b</sup>	6.5	8.21 <sup>b</sup>	5.8	6.2	7.38
LSD at 5%	ns	ns	ns	0.346	ns	0.601	ns	ns	ns

<sup>a</sup> and <sup>b</sup> significantly different groups

The rate of leaf production appears to steadily increase in all the progenies. At Melsiripura Tall x Debarayaya and Tall x Kasagala crosses exhibited significantly higher rates of leaf production in 2000. Flowering has begun at all three sites by December 2000. Rates of leaf production in the progeny at the two sites established two years later, Bataata and Kivulakelle are given in Table 8.

**Table 8.** *Mean number of new leaves produced in progeny of the 5 crosses planted at Batatta and Kivulakelle during the year 2000.*

Cross	Batatta	Kivulakelle*
T x Moorock	5.73 <sup>bc</sup>	5.38
T x Sr. Anne's	6.19 <sup>bc</sup>	4.93
T x Debarayaya	6.60 <sup>ab</sup>	5.35
T x Kasagala	5.66 <sup>c</sup>	5.15
Ambakelle Special	7.16 <sup>a</sup>	5.16

<sup>a</sup> <sup>b</sup> and <sup>c</sup> significantly different groups

\* not significant

At Bataata leaf production by Ambakelle special, the putative drought tolerant cultivar was significantly better than all the other crosses. Generally all cultivars performed better at Batatta compared to Kivulakelle. This could be due to poor management at the latter site.

*S A C N Perera, W M U Fernando, M H L Padmasiri,  
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#### **Experiment 12.4: Selfing of F<sub>2</sub> palms at Bandirippuwa Estate and evaluation of F<sub>3</sub> progenies at Ratmalagara (1994)**

The experiment was planned with the objective of comparing the selfed F<sub>2</sub> progenies arising from eight Dwarf x Tall F<sub>1</sub> hybrid palms in order to study the segregation of traits in subsequent generations. From the 18 F<sub>2</sub> palms resulting, thirty-six F<sub>3</sub> families were obtained by selfing and open pollination. The F<sub>3</sub> families have been planted at Ratmalagara Estate in November 1995.

Average leaf production rate at 54 months from planting is summarized in Table 9.

**Table 9.** Family means of leaf production rate at 54 months from planting in self-pollinated and open pollinated  $F_3$  families of  $F_2$  of Dwarf x Tall ( $F_2$ ) (The number of palms in each family is given in parenthesis).

$F_1$ self	$F_2$ palm number	Self pollinated/Open pollinated	Average annual rate of leaf production of $F_3$ families
222	4563	SP (2)	7.50
		OP (9)	8.67
125	4837	SP (7)	10.71
		OP (8)	8.66
125	4911	SP (2)	9.00
		OP (5)	9.40
125	4973	SP (6)	10.66
		OP (5)	9.20
144	4868	SP (3)	8.00
		OP (3)	9.66
144	4935	SP (2)	8.50
144	4944	SP (1)	10.00
144	4945	OP (5)	9.80
		SP (4)	10.50
144	4865	OP (5)	8.20
		SP (4)	7.50
148	4914	OP (5)	10.40
		SP (1)	11.00
148	4832	SP (1)	11.00
148	4833	SP (8)	9.66
		OP (2)	10.50
226	4580	SP (2)	6.50
		OP (4)	8.75
226	4635	SP (1)	11.00
		OP (2)	8.00
226	4579	SP (1)	12.00
		OP (1)	7.00
132	4923	SP (9)	9.55
		OP (6)	8.67
157	4917	SP (4)	10.00
		OP (2)	10.00
158	4677	OP (2)	8.00

Family size is given in parenthesis

*W M U Fernando and G K Ekanayake*

**PROJECT : EVALUATION OF PROGENIES OF SELECTED DAMBAKELLE 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.**

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

**No. of palms/plot:** 10 palms

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

**Treatments:**

All nine combinations.

Location	Year of establishment	Soil type	Agro ecological zone
Bandirippuwa	1986	Loamy sand	Wet intermediate zone
Rathmalagara	1986	Lateritic	Dry intermediate zone
Andigama Mudalihamy	1986	Sandy Loam	Dry intermediate zone
Mangala Eliya <sup>1</sup>	1987	Loamy sands	Dry zone
Daisy Valley <sup>2</sup>	1987	Clay loam	Wet intermediate zone

<sup>1</sup> with Open pollinated tall as an additional variety

<sup>2</sup> with DG x T and DG x SR as additional varieties

**Table 10.** Nut yield (nuts/palm/yr.) of the 3 types of progenies and three fertilizer levels of the progeny trials at Bandirippuwa and Rathmalagara during 1998-2000. (within year values with the same letter are not significantly different;  $P > 0.05$ ).

Treatment	Bandirippuwa			Rathmalagara		
	1998	1999 <sup>1</sup>	2000	1998	1999	2000
Variety						
T x DG	41 <sup>a</sup>	97 <sup>a</sup>	74 <sup>a</sup>	50 <sup>a</sup>	110 <sup>a</sup>	89 <sup>a</sup>
T x T	40 <sup>a</sup>	54 <sup>b</sup>	61 <sup>b</sup>	30 <sup>b</sup>	60 <sup>b</sup>	66 <sup>b</sup>
T x SR	34 <sup>a</sup>	40 <sup>b</sup>	54 <sup>b</sup>	33 <sup>b</sup>	57 <sup>b</sup>	68 <sup>b</sup>
Fertilizer level						
T1 recommended	41 <sup>a</sup>	62 <sup>a</sup>	67 <sup>a</sup>	35 <sup>a</sup>	76 <sup>a</sup>	69 <sup>b</sup>
T2 half	35 <sup>a</sup>	57 <sup>a</sup>	58 <sup>b</sup>	35 <sup>a</sup>	78 <sup>a</sup>	75 <sup>ab</sup>
T3 one and a half recommended	39 <sup>a</sup>	63 <sup>a</sup>	64 <sup>a</sup>	39 <sup>a</sup>	74 <sup>a</sup>	78 <sup>a</sup>
Interaction	ns	ns	ns	ns	ns	

<sup>1</sup> 10% of palms subjected for controlled pollination, <sup>a</sup> and <sup>b</sup> within year values with the same letter are not significant at  $P > 0.05$ , ns - not significant at  $P > 0.05$  and \* significant at  $P > 0.05$ .

Differential fertilizer application was commenced at Rathmalagara and Bandirippuwa after 75% of the palms attained flowering (since 1993). The rest of the sites were used purely

for testing progenies under different agro-climatic areas and soil types with average management. The nut yield during 1998-2000 at the two sites are given in Table 12.

T x DG maintained a significant superiority in the production of nuts over the other two crosses. Response to differential application of fertilizer became evident for the first time after six years of imposing the treatment. The current yields of all the three progenies are very encouraging for their age, 15 years.

The fruit component analyses of T x DG, T x T and T x SR during the year at the two sites are presented in Table 11.

**Table 11.** *Fruit components of the crosses Tall x Dwarf, Tall x Tall and Tall x San Ramon at the sites Bandirippuwa and Ratmalagara*

Fruit component (g)	Bandirippuwa			Ratmalagara		
	T x DG	T x T	T x SR	T x DG	T x T	T x SR
Fruit weight (g)	1243	1554	1852	1373	1587	1942
Husked nut weight (g)	750	887	1019	742	870	996
Split nut weight (g)	551	652	731	544	645	838
Kernel weight (g)	399	433	494	371	419	472
Estimated copra/nut (g)	240	284	326	237	278	319
Estimated copra/palm (kg)	17.8	17.3	17.6	21.1	18.4	21.7

The striking feature is the very high copra production of all the three progenies exceeding 17.3 and 18.4 kg of copra/palm at Bandirippuwa and Ratmalagara respectively in 2000. The copra/nut is well above the average of Sri Lankan Tall coconuts, which is known to be around 200 – 225 g/nut. The outstanding performance of T x SR cross justifies the release of this as a new cultivar in 1998.

The yield performance of progenies at Andigama, Mangala Eliya and Daisy Valley are given in Table 12. Once again in all the three sites the performance of Tall x Dwarf hybrid progenies was better than Tall x Tall and Tall x SR progenies at all the sites in spite of poor yields observed at Andigama and Mangala Eliya. The management practices adopted at these estates are extremely substandard. In contrast at Daisy Valley a very high standard of management is maintained. This is reflected in the results, in spite of the heavy water logging that takes place in about 1/3<sup>rd</sup> of the site during rainy periods. The extremely good performance of hybrids at Daisy Valley is also due to the higher rainfall at this site.

Two observation trials established at Sirikandura (1989; T x DG, T x T, T x SR and T x DY) and at Rathmalagara (1989; DG x T, DY x T, DG x SR, DG x SR and DT x SR) to assess their performance under average estate management also progressed well during the year. These trials are being maintained satisfactorily and to date almost all the palms are in flower. (Table 13). The trial at Rathmalagara once had a set back due to elephant attack while the palms at Sirikandura suffer badly by non-removal of the old stand.

**Table 12.** *Nut yield (number of nuts/palm/yr.) of the progeny trials at Mangala Eliya, Andigama and Daisy Valley Estates.*

Cross	Nuts/palm/yr.					
	Mangala Eliya*		Andigama**		Daisy Valley	
	1999	2000	1999	2000	1999	2000
T x DG	31	35	17	59	42	82
T x T	23	27	17	39	24	46
T x SR	23	33	13	48	48	48
T (OP)	21	28	--	--	--	--
DG x SR	--	--	--	--	34	78
DG x T	--	--	--	--	36	88

DG, dwarf green; T, tall; SR, San Ramon; T (OP), Tall (open pollinated)  
\* 5 picks only, \*\* 4 picks only

**Table 13.** *Number of palms in flower and percent (\*) in different progenies observed at Sirikandura and Rathmalagara Estates.*

Cross	Sirikandura	Cross	Rathmalagara
T x DG	70 (97)	DG x T	18 (100)
T x T	69 (95)	DY x T	15 (94)
T x SR	69 (95)	DY x SR	15 (100)
T x DY	71 (99)	DG x SR	16 (100)

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

*S A C N Perera, J.M.D.T. Everard, W M U Fernando, W B S Fernando, M H L Padmasiri, and R Jayatilleke*

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

**Design:** Complete Randomized Block design with 8 blocks; 8 palms/plot Each plot surrounded by a guard row of Ambakelle special.

**Crosses:** DG x Tall from first generation dwarf selected at ISG  
DG x Tall from second generation dwarf at ISG  
DG x T (CRIC65)  
Ambakelle special

**Year of Planting:** December 1993

**Location:** Andigama Farm, Giriulla

This trial suffered an early set back due to water logging and subsequently by rat damage. This has poorly reflected on the growth and maturation of seedlings. The casualties were as high as 40%. The flowering data of the experiment are as follows.

**Table 14.** *Number of palms in flower and percent (\*) in two progenies and Ambakelle special at Andigama Farm Giriulla.*

Year Cross	2000
1 <sup>st</sup> generation DG x T	21 (61%)
2 <sup>nd</sup> generation DG x T	11 (44%)
CRIC65 DG x T	17 (71%)
Ambakelle special	4 (11%)

*J M D T Everard, C K Bandaranayake and R Jayatilleke.*

**PROJECT : COLLECTION CONSERVATION AND EVALUATION OF COCONUT GERMPLASM**

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

Pre-prospection and collecting of germplasm continued during the year and new locations identified were Deegawapi, Amparai and Damana in the Amparai district, Rambukkana in the Kegalle district, Gannoruwa in the Kandy district and Nittambuwa, Kalagedihena, Bogamuwa and Yakkala in the Gampaha district. Seeds were collected from these sites and laid in the nursery while fruit components were analyzed from a sample of each collection (Table 15). Passport data for all the accessions were submitted to the COGENT Coconut Genetic Resources Database at Montpellier, France.

**Table 15.** *Fruit component analysis of coconut accessions collected during 2000.*

Accession	Fresh nut wt. (g)	Husked nut wt. (g)	Husk wt. (g)	Shell wt (g)	Kernel wt. (g)	Copra wt. (g/nut) (Calculated)
1. Rambukkana	1589	596	993	184	302	191
2. Nittambuwa	1526	703	823	197	356	225
3. Kalagedihena	1695	782	913	224	373	250
4. Gannoruwa	2090	817	1273	248	386	261
5. Bogamuwa	1381	638	736	173	338	204
6. Yakkala	1231	582	649	161	311	186
7. Damana	1891	882	1009	229	412	282
8. Amparai	1904	899	1004	239	407	288
9. Deegawapi	1938	900	1039	242	425	288

Among collections made in the previous year (1999) 12 were planted as accessions in the Pallama Gene Bank for *ex-situ* conservation. The accessions and details of planting are given in Table 16.

*J M D T Everard, C K Bandaranayake, S A C N Perera,  
G K Ekanayake, R B Attanayake and S Mallawaarachchi*

**Table 16.** *Details of accessions planted at Pallama Field Gene Bank during 2000.*

Accession Name	Abbreviation	No. of Plants
Thelidiriya	TLD	53
Kalawewa	KL	60
Ambakelle Special	AS	60
Galadivulwewa	GDW	60
Sidurupitiya	SO	28
Wanathavillu	WV	60
Ihalakagama	IK	60
Vijithapura	VJ	61
Mahawalatenna	MWT	54
Hangiliyagama	HNG	60
Blackstone	BT	57
Lanlib	LL	60

**Experiment 12.7.2: Conservation Blocks at Potthukulama Research Station (PRS) and Bandirippuwa (1988/89) Lenawa (1997), Raddegoda (1998/1999), Pallama (2000) and Kohombana.**

Yield recording was initiated at Potthukulama (PRS) conservation block for 10 accessions in which more than 90% of the individuals are in bearing. Mean annual nut yield of the accessions in year 2000 is given in Table 17.

**Table 17.** *Yield data of 10 germplasm accessions at the Potthukulama Gene bank. (Sample size = 30 palms)*

Accession	Age (Yr.)	Mean no. of nuts/palm/yr.	Std. Error
Moorock	11	42	4.7
Palugaswewa	11	55	5.0
Pitiyakande	11	60	5.1
Clovis	10	43	4.1
Margaret	10	63	4.3
Kundasale dwarf	09	52	5.1
Namalwatta	08	63	4.9
St. Anne's	08	59	4.7
Cameroon Red Dwarf	07	13	3.5
Dwarf Brown	06	26	5.3

The census of all the germplasm conservation blocks was updated. Morphological characters of 30 palms per accession were recorded and COGENT's Coconut Genetic Resources Database (CGRD) was duly updated. The census of all gene banks giving annual an update of each on number of bearing palms, young palms, and vacancies as reported in previous years is available at the GPB Division.

### Experiment 12.7.3: Evaluation of Dwarf green x Debarayaya tall

Selected palms from the highly drought prone area of Debarayaya were used as pollen parents for crossing with dwarf green. Forty eight seedlings of this cross were planted in a randomized design with 48 CRIC 65 (Dwarf green x Ambakelle tall) seedlings for comparison at Raddegoda estate, Delwita in 1995. Flowering data for the two cultivars are given in Table 18.

**Table 18.** *Percentage flowering in the two cultivars at Raddegoda.*

Cross	Percentage of palms that have flowered %	
	1999	2000
D x Debarayaya	66.7%	83.3%
D x T	64.4%	91.7%

*S A C N Perera, W M U Fernando and G K Ekanayake*

### PROJECT B-8: CONSERVATION AND EVALUATION OF COCONUT GERMPLASM

#### Experiment B-8.1 New variety block (crop museum) Bandirippuwa Estate, (1983)

The varietal collection of coconut forms at BE has been successfully maintained.

*W M U Fernando and 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 19.

**Table 19.** *The status of the local germplasm collection at Bandirippuwa as at 31 December 2000.*

Status of Collection	Bodiri	Gon thembili	Pora pol	Ran thembili	Navasi	Kamandala	Dikiri
Bearing	44	52	31	24	24	05	01
Young palms	01	01	01	06	07	--	--
Total	45	53	32	30	31	05	01

*S A C N Perera, W M U Fernando and G K Ekanayake*

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

The status of the palms are as reported in the previous year. Collection of pollen from 6 selected palms to produce seednuts for planting at Pallama is continued in this year too.

*S A C N Perera, W M U Fernando, S Mallawarachchi  
and M H L Padmasiri*

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

The current status of the dwarf palm block established at Bandirippuwa is as same in the previous year as shown in Table 20.

**Table 20.** *The status of the dwarf palm block at Bandirippuwa Estate (DR Dwarf red; DY Dwarf yellow; DG Dwarf green; MHD Mirishena Dwarf; BGD Brazillian green dwarf.*

Status	Dwarf forms				
	DR	DY	DG	MHD	BGD
Total number established	73	44	99	41	77
Vacancies	29	33	71	13	37
Young palms/seedlings	0	0	0	16	16
Palms in flower	0	0	0	8	9
Palms in bearing	44	10	28	4	16

*S A C N Perera, R Jayatilleke and G K Ekanayake*

### Experiment B-8.5: Evaluation of nine promising germplasm accessions - Nariyampotta division, Andigama farm, Giriulla (1994).

The experiment was initiated to carry out a systematic evaluation of the between and within population variability of a representative set of germplasm accessions conserved within the gene banks. For this purpose 9 germplasm accessions, which were diverse in their origins were selected and 15 half sib families of 5 each were planted per accession in a fully randomized design in January 1995 at Andigama Farm Giriulla. The experiment is progressing satisfactorily. Flowering commenced in six of the ecotypes, namely Maliboda (12%), St Anne's (10%), Ambakelle Special (7%), Margaret (14%), Moorock (4%) and Debarayaya (3%).

*L Perera, W M U Fernando and G K Ekanayake*

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

Progeny of three hybrid crosses were planted along with Ambakelle special as a control at Loling Estate Halkandawila, Payagala in May 1997 in order to evaluate the progenies for sap production potential. The growth characters measured after two years from planting are summarized in Table 21. As an extension to the trial, 25 Navasi, 14 Kamandala,

25 Andigama Tall, 39 St. Anne's tall and 33 Tall x Debarayaya along with 77 Tall x Tall (guard rows) seedlings were also planted.

**Table 21.** *Rate of leaf production 2 years after planting at Loling Estate, Payagala. (D, Dwarf; T, Tall; CRD, Cameroon Red Dwarf).*

Cross	No. of seedlings	Annual rate of leaf production
D x T	156	9.23
CRD x Ambakelle Tall	111	8.95
Dwarf green x Debarayaya tall	109	10.79
Ambakelle special	49	8.27

*S A C N Perera and N Herath*

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

King coconut seedlings raised from self pollination of selected parent palms at Marandawila, Walpita, Walahapitiya and Madampe were planted in two trial blocks at Raddegoda Estate, Delwita and Margaret Estate, Pallama in May and June 1999 respectively. In each population, palms which are regular in bearing and produce nuts with desirable palatability characters were selected as parents and the objective of the experiment was to test the potential of fixing these characters in the progeny through selfing. Forty individuals each from Marandawila, Walpita and Walahapitiya along with the open pollinated control from Marandawila (40 seedlings) were planted at Raddegoda Estate in a randomized block design with 10 seedlings /plot. At Margaret Estate 54 seedlings from Marandawila, 25 from Walpita, 45 from Walahapitiya, 25 from Madampe and 48 open pollinated control seedlings from Marandawila were planted in a fully randomized design. The trials are progressing satisfactorily.

Under the IFAD project, 5000 open pollinated King coconut seed nuts from Marandawila and Walahapitiya populations were raised in Coconut Cultivation Board nurseries at Kandetiya and Ibbagamuwa. These seedlings, to be maintained as observation trials were issued free enthusiastic growers.

*W M U Fernando, C K Bandaranayake, M H L Padmasiri,  
R B Attanayake and N Herath*

**Experiment B-10.2: Characterization of Coconut germplasm using molecular markers for enhancement of the coconut breeding and conservation strategies (1996).**

A self-pollination programme was commenced in July 1998 for establishment of F<sub>2</sub> families of the F<sub>1</sub> crosses of Tall x Tall, Tall x San Ramon and Tall x Dwarf. As a result 426 Tall x Tall, 334 T x San Ramon and 817 Tall x Dwarf, F<sub>2</sub> seed nuts have been produced and were laid in the research nursery up to 31<sup>st</sup> December 1999. The seedlings belong to F<sub>2</sub> families of the F<sub>1</sub> crosses, Tall x San Ramon and Tall x Dwarf were established at Pallama Seed Garden (Ginigathhena).

The self-pollination programme is now being continued with 3 individuals per cross to obtain 9 families of at least 100 individuals per family. These families are expected to serve as base families for mapping the coconut genome.

*J.M.D.T. Everard, C. K. Bandaranayake and S.A.C.N. Perera*

### **3. RESEARCH PROJECTS FUNDED BY OTHER AGENCIES**

#### **3.1 ADB PHASE II (COGENT) PROJECT**

##### **RAPD-BASED CHARACTERIZATION OF CONSERVED COCONUT BIO-DIVERSITY IN SRI LANKA WITH EMPHASIS ON DETECTION OF MARKERS LINKED TO DROUGHT TOLERANCE.**

This study attempted at developing DNA based polymorphisms among coconut germplasm accessions with different degrees of tolerance to moisture stress with the long term objective of tagging physiological and *in-vitro* indicators of drought tolerance to molecular markers. RAPDs were detected as molecular markers while physiological parameters, Net Assimilation Rate, Stomatal Diffusive Resistance, Leaf Water Potential and Abscisic Acid Content in the xylem sap and tolerance of *in vitro* cultures for different levels of Polyethylene Glycol were investigated as phenotypic markers. In addition the coconut germplasm conservation programme was continued on the guidelines of COGENT. A further 40 accessions of coconut germplasm were screened for RAPDs for assessment of genetic similarity. The results clearly revealed the population structure of coconut in Sri Lanka and how the genetic variation is organized. The data suggested that the existing variation has been exploited to a great extent and stressed the need for germplasm enrichment by exotic introductions for further genetic improvement of the coconut. Deliberations have already commenced for importation of 23 germplasm accessions, nine from India, and six from Ivory Coast and eight from Fiji and PNG. Under this project a catalogue of coconut germplasm in Sri Lanka has been prepared for the international coconut database to ease exchange of coconut germplasm.

*J.M.D.T. Everard, S.A.C.N. Perera, W.M.U. Fernando*

#### **3.2 IFAD FUNDED PROJECT**

An IFAD funded project for sustainable use of coconut genetic resources to enhance incomes and nutrition of coconut smallholders in the Asia-Pacific region with emphasis on enhancing the income and employment opportunities in the coconut sector, through conservation and sustainable use of special coconut ecotypes was carried out.

The project comprised three components; a farmer participatory survey to identify multipurpose uses of the coconut, suitable varieties and production constraints, identification, multiplication, collection and *in-situ* conservation of Thembili (king coconut) germplasm showing uniform bearing and favourable biochemical constituents for industrial utilization and development of technology to improve the shelf-life of Thembili (king coconut) to cater to the overseas market. This

project has been successfully completed and the final report of the project is available at the GPB Division. The main outcome of the project was the identification of king coconut germplasm for immediate use in promotion as a natural beverage, multiplication of better quality king coconut and distribution among small-scale farmers for immediate utilization, development of technology for increasing shelf life, preparation of catalogues on farmers' varieties of coconut, coconut based food recipes and value added products of coconut.

*W.M.U. Fernando, C.S. Ranasinghe, C. Bandaranayake,  
and S.A.C.N Perera*

### **3.3 NRC PROJECT FOR DNA BASED SCREENING OF PALMS EXHIBITING RAPID DECLINE SYNDROME (RDS), PREMATURE DECLINE SYNDROME (PDS) AND LEAF SCORCH DECLINE SYNDROME (LDS) FOR IDENTIFICATION OF CAUSATIVE FACTORS**

Isolation of DNA from palms exhibiting RDS, PDS and LDS and initial screening with standard primers in the polymerase chain reaction has been commenced.

*J M D T Everard*

### **3.4 NRC PROJECT FOR DEVELOPMENT OF DNA MARKERS FOR IDENTIFICATION OF COCONUT HYBRIDS**

This study is to be commenced shortly.

*A A F L K Perera*

#### **4. Laboratory and Miscellaneous Studies**

The studies come under this category has been covered under research projects and outside funded projects.

#### **5. Training and Extension**

Dr. W M U Fernando, Mr. J M D T Everard, Ms. S A C N Perera and the technical and field staff of the Genetics & Plant Breeding Division participated as resource persons in the one day training programme on coconut under planting and replanting organized by the CRI (April 2000).

A student from the Colombo University underwent attachment training under Mr. J.M.D.T. Everard in the Genetics and Plant Breeding Division.

Two scientists from IFS underwent training on molecular assay procedures under Mr. J.M.D.T. Everard in the Genetics and Plant Breeding Division.

## 6. Other activities

The following activities of the GPB Division has been successfully carried out during the year and the information on each activity as reported in previous annual reports of the division are archived in the division and available in printed form for record and reference.

*Seed gardens:* Maintenance and seed production at the Isolated Seed Garden (Ambakelle), establishment of the Pallama Seed Garden (Pallama), collection and issue of pollen, seedling production at the research nursery continued as Divisional functions.

*Overseas training:* Mrs. C K Bandaranayake, Geneticist and Plant Breeder, continued her Postgraduate studies towards a Ph.D. degree at the University of Birmingham, UK up to July 2000 and returned to the Island in August for the local component of her study.

### *Academic and Professional Achievements:*

- (a) Mr. A.A.F.L.K. Perera, Geneticist and Plant Breeder was awarded the Ph.D. degree by the University of Dundee, Scotland, UK.

## 7. Acknowledgements

The cooperation and assistance of the research, technical and field staff of the Genetics and Plant Breeding Division is of very high standard during the year and they all deserve a note of appreciation. The excellent contribution of Mrs. I.N. Jayawardane, Clerk/Typist and Mr. H. Nandasena, Office Attendent of the division in maintaining office procedures during the year is also noteworthy. Miss S.A.C.N. Perera and all technical officers of the division have worked immensely for completion of this very comprehensive report which, cover data collation and analysis of a large number of field experiments.

**REPORT OF THE SOILS AND PLANT NUTRITION DIVISION**  
**Head - L.L.W. Somasiri, Ph D**

**1. GENERAL**

The research programme of the Division was aimed at refining technology on soil moisture conservation, nutrient management, particularly with locally available organic materials and inorganic fertilizers, evaluating micronutrient requirement for coconut and developing irrigation techniques for coconut. During the year, the Division maintained nineteen on-going field experiments consisting of fifteen trials on coconut nutrition and four on irrigation and soil moisture studies. The on-going deep ground water survey in the Kurunegala District was also continued using Cess funds.

The field experiment on comparison of Eppawela Rock Phosphate (ERP) with Imported Rock Phosphate (IRP) and Triple Super Phosphate (TSP) showed that leaf phosphorus concentrations of all treatment palms this year were in the sufficiency range (> 0.11%) irrespective of the phosphate source. There was no significant difference in bearing percentage between phosphate sources or level of application. Data of this experiment showed that ERP is a promising source of phosphate for young palms in the Wet-Intermediate zone.

The experiment on substitution of sodium chloride (common salt) for muriate of potash as a coconut fertilizer showed that there was a decreasing trend in nut yield of sodium chloride treated palms compared to muriate of potash treated palms this year.

The experiment on the effect of fertilizer, ethrel application and irrigation on toddy yield showed that the yield increased by 80% due to application of NPK fertilizer.

The yield of king coconut showed an increasing trend in response to NPK treatments irrespective of combinations, compared to the control (no fertilizer).

The experiment on seasoning poultry manure on performance of the coconut palm showed that fresh poultry manure was harmful to coconut roots upto a depth of 30 cm and this effect could be mitigated by seasoning for 3 months in open air.

Under the nutrient mapping project, 1000 soil samples collected from Kurunegala catena showed that soil chemical parameters were highly variable even with a soil series. It further showed that there was a trend of Zn and Cu depletion from the soils in the manure circle. It indicated that application of Zn and Cu fertilizer might be needed in future. Majority of coconut palms in the Boralu catena was deficient in magnesium.

## 2. RESEARCH PROJECTS

### PROJECT 5.0 DEVELOPMENT OF AN IMPROVED PACKAGE OF SOIL MOISTURE CONSERVATION PRACTICES FOR LAND SUITABILITY CLASSES 3, 4 AND 5 TO INCREASE YIELD BY 25%

#### Experiment 5.0.2: Use of polythene for soil moisture conservation under rainfed conditions

The objective of the experiment was to evaluate (a) the effect of husk burial on soil moisture status near the effective root zone of coconut, (b) the suitability of polythene for soil moisture conservation instead of husk burial and (c) the effect of these practices on coconut production. This experiment, in a randomized block design with 4 replicates and 6 palms (40 years old) per plot, was established in 1996 at Madampe and in 1999 at Ratmalagara.

Expt. No	Location	Agro-ecological region	Soil type	Land suitability class
5.0.2.1	Madampe	IL <sub>1</sub>	Sand (Sudu series)	S <sub>4</sub>
5.0.2.2	Ratmalagara	IL <sub>1</sub>	Sandy clay loam (Andigama series)	S <sub>4</sub>

All the treatments were applied in a 60 cm wide and 60 cm deep 1/3 circle trench at 1.75m distance from the palm. The treatments are given below.

T <sub>1</sub>	-	Trench filled with soil only
T <sub>2</sub>	-	Trench filled with husks
T <sub>3</sub>	-	Outer perimeter lined with polythene and trench filled with soil
T <sub>4</sub>	-	Trench lined with polythene as in T <sub>3</sub> but filled with husks
T <sub>5</sub>	-	No trench (control)

The cumulative nut yield upto 1999 and the nut yield of 2000 in the experimental site at Kajugahalanda Estate, Madampe and the nut yield in 1999 and 2000 in Ratmalagara Estate are given in Table 1.

**Table 1.** *The nut yield of Kajugahalanda Estate, Madampe and Ratmalagara Estate, Madampe*

Treatment	Nut yield (nuts/ha/y)			
	Kajugahalanda Estate, Madampe		Ratmalagara Estate, Madampe	
	Cumulative upto 1999	2000	1999	2000
T <sub>1</sub>	19079	7873	7663	8828
T <sub>2</sub>	23023	8970	10684	9065
T <sub>3</sub>	20252	8364	7327	8749
T <sub>4</sub>	22455	8795	8751	8354
T <sub>5</sub>	21635	9332	10338	7663
CV	21%	22%	21%	18%
Significance (P ≤ 0.05)	ns	ns	ns	ns

There was no difference in yield between the control and the other treatments at both sites.

Since there was no any trend of response to treatments, it was decided to terminate the experiment at both sites with effect from 2001.

*L P Vidhana Arachchi, MTR D Perera and K R E M Fernando*

**Experiment 5.0.3: Evaluation of the effect of husk pits on soil moisture conservation and yield increase of coconut.**

This experiment was carried out as an observation trial to test the effect of different methods of husk burying on coconut yield. The experiment, in a randomized block design with 3 replicates and 6 palms (45 years old) per plot, was established in 1998 at the following locations.

Expt. No	Location	Agro-ecological region	Soil type	Land suitability class
5.0.3.1	Caran Estate, Bingiriya	IL <sub>1</sub>	Andigama series	S <sub>4</sub>
5.0.3.2	Muthugala Estate, Dambadeniya	IL <sub>1</sub>	Kuliyapitiya series	S <sub>4</sub>

The treatments were as follows.

- T<sub>1</sub> - Control - mulch only
- T<sub>2</sub> - Husks, buried in 1/3 circular trench
- T<sub>3</sub> - 1/3 circular trench without husks but refilled with soil
- T<sub>4</sub> - Husk buried in 8' x 4' x 2' pit
- T<sub>5</sub> - Husks buried in 1/3 circular trench + mulch

The treatments were imposed in 1998. Application of 3 kg of APM and 1 kg of dolomite was carried out annually. The nut yield of both sites was recorded during the year. The yield data of both sites are given in Table 2.

**Table 2.** *The nut yield in the experimental site at Caran Estate, Bingiriya and Muthugala Estate, Dambadeniya*

Treatment	Nut Yield (nuts/ha)			
	Caran Estate, Bingiriya		Muthugala Estate, Dambadeniya	
	1999	2000	1999	2000
T <sub>1</sub>	10169	8990	6553	7595
T <sub>2</sub>	9756	6355	8963	9300
T <sub>3</sub>	10289	6045	7366	10230
T <sub>4</sub>	11133	7130	7688	9455
T <sub>5</sub>	10763	7130	8032	11625
CV	16.7%	20%	25%	25%
Significance (P ≤ 0.05)	ns	ns	ns	ns

There was an overall decrease of yield in all treatments from 1999 to 2000. Nevertheless, there was no significant difference in yield between treatments.

*L P Vidhana Arachchi and K R E M Fernando*

**PROJECT 6.0: SUBSTITUTION OF LOW COST PHOSPHATE (ERP) IN PLACE OF SAPHOS PHOSPHATE FERTILIZER FOR YOUNG COCONUT PALMS IN DIFFERENT AGROCLIMATIC ZONES**

**Experiment 6.0.1: Effect of different phosphate sources on the performance of coconut seedlings (1991)**

This experiment, on a randomized block design with 3 replicates and 6 palms per plot, was established in 1991 on Andigama series soils at Ratmalagara Estate in IL<sub>1</sub> agro ecological region. The site falls into land suitability class S<sub>4</sub>. The seedlings belonged to T x T variety.

The treatments of this experiment for the year 2000 consisted of three phosphate sources viz. triple super phosphate (TSP), saphos phosphate (SP) and Eppawela rock phosphate (ERP) applied in terms of P<sub>2</sub>O<sub>5</sub> equivalents of 150 g, 300 g and 600 g (recommended done is 180 g) per year respectively. Basal treatments of urea, muriate of potash and kieserite were also applied at the rate of 343 g, 343 g and 500 g respectively per palm per year. The treatments were applied at 6 monthly intervals. Different P sources and levels of treatments are given in Table 3.

**Table 3.** *The sources of P, and the levels of treatments with the control*

Treatment	Level (rate) of application g/palm/y		
	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>
TSP (46% P <sub>2</sub> O <sub>5</sub> )	326	652	1300
SP (27.5% P <sub>2</sub> O <sub>5</sub> )	545	1090	2180
ERP (30% P <sub>2</sub> O <sub>5</sub> )	500	1000	2000
(P <sub>2</sub> O <sub>5</sub> equivalent)	(150)	(300)	(600)
Control	0	0	0

<b>Basal application</b>	Urea	700 g/palm/y
	Muriate of potash	700 g/palm/y
	Kieserite	500 g/palm/y

During the period 1992-1999, the cumulative number of fronds in all the treatments was 59-67. There was no significant difference in number of fronds.

The changes in bearing percentage from 1999 to 2000 are given in Table 4.

**Table 4.** *The bearing percentage of palms in 1999 and 2000*

Treatment	Bearing percentage	
	1999	2000
Control	44	61
TSP - Level 1	66	83
TSP - Level 2	33	81
TSP - Level 3	64	89
SP - Level 1	77	83
SP - Level 2	72	94
SP - Level 3	61	83
ERP - Level 1	61	74
ERP - Level 2	60	78
ERP - Level 3	55	66
Level of Significance	ns	ns
CV	42	30

Although the data in Table 4 shows that the bearing percentages of phosphate treated plots were higher than the control, the differences were not significant. The high variation in bearing percentage among palms would have masked the treatment effect.

The phosphorus concentrations in the 14<sup>th</sup> leaf in 1999 and 2000 and available P of soils are given in Table 5.

**Table 5.** *Phosphorus concentration of the 14th leaf (percentage of dry matter) of treated palms and available phosphorus of soils in 1999 and 2000*

Source	Treatment Level	1999	2000	2.5% Acetic acid extractable P mg/kg in soil (0-20 cm)
		Leaf P	Leaf P	
TSP	1	0.144	0.126	35
	2	0.138	0.126	108
	3	0.137	0.132	143
SP	1	0.136	0.124	108
	2	0.147	0.133	253
	3	0.146	0.119	644
ERP	1	0.140	0.135	222
	2	0.142	0.132	333
	3	0.143	0.128	471
Control		0.131	0.121	5.2

The P concentration of the 14<sup>th</sup> leaf fell within the sufficiency range (0.11-0.13%) for all the phosphorus sources and the control in both years. However, there was a decreasing trend in leaf concentration from 1999 to 2000.

The 2.5% acetic acid extractable phosphorus fraction in the soil has increased with treatments, from 108-644 mg with saphos phosphate, 222-471 mg/kg due to ERP application and from 35-143 mg with TSP. The low values for TSP treatment would indicate movement of P out of the sampled zone or fixation of P in the soil. Although the control plots contained only 5.2 mg/kg of acetic acid extractable P, the phosphorus concentration of the 14<sup>th</sup> frond of palm in those plots was within the sufficiency range (Table 5).

Neither phosphorus nutrition nor the bearing percentage of palms indicated a significant difference among phosphorus sources or between treatments and the control. The experiment will be continued to determine the effect of different phosphorus sources on nut yield.

*L L W Somasiri, C P A Kurundukumbura and W Gunasena*

**PROJECT 6.1: COMMON SALT AS A PARTIAL SUBSTITUTE FOR MURIATE OF POTASH FOR ADULT COCONUT PALMS**

**Experiment 6.1.1 : Effect of sodium and chloride on yield of coconut (1996- 2001)**

This experiment, on a randomized block design with 3 replicates and 6 palms per plot, was established in 1997 at the following sites.

Expt. No	Location	Year of establishment	Soil type	Agro-ecological region
6.1.1.1	Wayagolla (Gravelly loam)	1996	Boralu series	WL <sub>3</sub>
6.1.1.2	Ganewatta (Sandy loam)	1996	Wariyapola series	IL <sub>3</sub>

Palms at both sites are about 40 years old.

The treatments of this experiment are muriate of potash (1.6 kg/palm/y), potassium sulphate (1.8 kg/palm/y), sodium chloride (1.2 kg/palm/y), sodium sulphate (1.45 kg/palm/y) and a control (no potassium, sodium or chloride treatment). Each treatment plot was given a basal dose of ammonium sulphate (1.2 kg/palm/y) and saphos phosphate (0.6 kg/palm/y). At both sites, leaf and soil sampling and the treatment applications were completed in May 2000. The nut yields of both sites are given in Table 6.

At Wayagolla estate, both nut yield and copra yield of NaCl treatment were lower than that of the muriate of potash treatment in year 2000. However, sodium sulphate treatment did not show a yield decrease. However, at both sites, there was no statistical difference in nut yield or copra yield between treatments.

**Table 6.** *Nut yield of the experimental sites at Wayagolla and Ganewatta upto 1999 and in 2000*

Treatment	Wayagolla				Ganewatta			
	Nut yield		Copra yield (kg/palm)		Nut yield		Copra yield (kg/palm)	
	Cumulative yield 1997-1999	2000	Cumulative yield 1997-1999	2000	Cumulative yield 1997-1999	2000	Cumulative yield 1997-1999	2000
Control	166	51	40.4	13.6	151	62	31.0	11.7
Muriate of potash	185	67	42.9	16.6	120	63	34.2	12.1
Potassium sulphate	170	65	39.2	15.1	163	60	33.3	10.2
Sodium chloride	163	54	37.9	13.9	160	65	31.0	12.3
Sodium sulphate	187	67	43.3	16.7	162	68	30.8	12.4
Significance of difference	ns	ns	ns	ns	ns	ns	ns	ns

The concentrations of K, Na and Mg of the 14<sup>th</sup> leaf of the palms at both sites are given in Table 7.

**Table 7.** *The K, Na and Mg concentrations of the 14<sup>th</sup> leaf of each treatment at both sites in 2000 (as percentage of dry matter)*

Treatment	Experimental site					
	Wayagolla			Ganewatta		
	%K	%Na	%Mg	%K	%Na	%Mg
Control	1.09	0.19	0.15	1.40	0.18	0.20
Muriate of potash	1.34	0.14	0.14	1.36	0.16	0.22
Potassium sulphate	1.33	0.15	0.13	1.34	0.14	0.21
Sodium chloride	0.82	0.39	0.17	1.33	0.18	0.23
Sodium sulphate	1.04	0.30	0.14	1.35	0.16	0.17
LSD						

At Wayagolla sites, leaf K concentrations of potassium treated plots were higher than that of sodium treated plots. Similarly Na concentrations of the 14<sup>th</sup> leaf of sodium treated plots were higher than that of potassium treated plots. However, at Ganewatta site, there was no difference in leaf K, Na and Mg concentration of 14<sup>th</sup> leaf between treatments.

At both sites, leaf Mg concentration was below the sufficiency range (0.25% - 0.35%). This could inhibit the treatment effect of the experiment.

The potassium, magnesium and sodium status of soils sampled in December 1999 of both sites are given in Table 8.

**Table 8.** *Potassium, magnesium and sodium status of soils of Wayagolla site and Ganewatta site in December 1999*

Treatment	Wayagolla Site						Ganewatta Site					
	Exch. K mg/kg		Exch. Mg mg/kg		Exch. Na mg/kg		Exch. K mg/kg		Exch. Mg mg/kg		Exch. Na mg/kg	
	←----- Soil sampling depth ----->											
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-25 cm	25-50 cm	0-25 cm	25-50 cm	0-25 cm	25-50 cm
Control	39.0	23.4	81.6	37.2	13.8	16.1	99.4	143.9	183.6	132.0	23.7	34.5
Muriate of potash	97.5	78.0	69.6	32.4	16.1	9.2	369.7	355.7	121.2	109.4	23.4	26.2
Potassium sulphate	70.2	46.8	78.0	32.4	18.4	18.4	452.0	363.9	160.8	144.4	29.7	32.2
Sodium chloride	54.6	23.4	73.2	30.0	43.7	23.0	76.0	74.4	104.5	74.2	52.7	67.6
Sodium sulphate	46.8	23.4	61.2	21.6	27.6	23.0	81.5	62.0	107.9	101.5	49.4	45.3
Centre of square							62.5	64.3	63.0	99.0	14.9	25.3
LSD	30.1	25.1	10.1	9.2	18.5	9.2	82.5	78.5	55.1	50.1	20.2	18.1

The values given in Table 8 reflect the nutrient status of soils of the experiment at Wayagolla estate six months after the third treatment application. Exchangeable potassium in soils receiving potassium was high in both the top layer (0-20 cm) and the sub layer (20-40 cm) compared to the rest of the treatments. Exchangeable sodium in soils receiving sodium treatments also had increased. Although exchangeable Mg in all treatments were higher than exchangeable N and K, the leaf Mg concentrations were below the sufficiency range (< 0.17%). Kieserite application may alter this situation.

At Ganewatta site too, the exchangeable potassium concentrations in soils of potassium treatments at both top layer and sub layer are higher than that in other treatments and the control. Exchangeable K in control and sodium treatments were slightly higher than that of the centre of the square indicating that residual K from previous treatments were still remaining.

The exchangeable sodium concentrations were also higher in sodium treatments compared to potassium treatments and the control treatment. Although the leaf Mg concentration of palms receiving potassium treatments were below the sufficiency range (< 0.23%), the exchangeable Mg concentrations in all treatments were greater than 100 mg/kg except the sub soils of the NaCl treatments.

The behaviour of coconut palms in the two sites appeared to be different. At Wayagolla where soils were gravelly, the leaf K concentrations dropped in three years with cut down of potassium fertilizer but at Ganewatte it did not happen. The leaf sodium concentration of sodium treatments increased only at Wayagolla sites. These observations indicate that behaviour of coconut palms in gravelly soils is quite different from that in sandy soils.

*L L W Somasiri, U S S Perera, N M D Chandrasoma and K L Ranasinghe*

**PROJECT 7.0: DEVELOPMENT OF A SUITABLE FERTILIZER MIXTURE FOR YOUNG PALMS, TAPPING PALMS AND KING COCONUT PALMS**

**Experiment 7.0.1: Effect of N, K and Mg on the performance of coconut seedlings**

The experiment was established in 1991 with T x T seedlings planted on Andigama series soil at Ratmalagara Estate. As treatments, three levels of N (300 g, 600 g, 1200 g) as urea, K, (322 g, 644 g, 1288 g) as muriate of potash and Mg (44 g, 88 g, 176 g) as kieserite were combined factorially in 3<sup>3</sup> design with 3 replicates. A basal application 500 g TSP/palm/year was given. The treatments tested are much higher than the recommended dosages (amounts of N, K and Mg applied correspond to each treatment are given in parenthesis).

The total number of fronds produced by palms upto 1999 and the bearing percentages in 1999 and 2000 are given Table 9.

**Table 9.** *The main treatment effects on the number of fronds and bearing percentage*

Treatment	Cumulative No. of fronds per palm		Bearing percentage	
	1991-1999		1999	2000
N <sub>1</sub> (300 g/y)	81 (± 4)		70 (± 12)	94 (± 8)
N <sub>2</sub> (600 g/y)	81 (± 3)		68 (± 14)	97 (± 7)
N <sub>3</sub> (1200 g/y)	80 (± 4)		69 (± 16)	89 (± 9)
K <sub>1</sub> (322 g/y)	81 (± 4)		65 (± 12)	91 (± 11)
K <sub>2</sub> (644 g/y)	80 (± 3)		68 (± 10)	93 (± 8)
K <sub>3</sub> (1288 g/y)	81 (± 3)		74 (± 18)	96 (± 7)
Mg <sub>1</sub> (44 g/y)	79 (± 3)		66 (± 17)	92 (± 10)
Mg <sub>2</sub> (88 g/y)	80 (± 3)		72 (± 13)	92 (± 6)
Mg <sub>3</sub> (176 g/y)	82 (± 4)		70 (± 12)	95 (± 10)
Level of significance	ns		ns	ns

The data showed that the differential treatments of this experiment have not been effective on production of fronds or bearing percentage of young palms. However, bearing percentage at the end of year 2000 ranged from 89 to 97 and it showed an increasing trend with increasing K treatment.

Table 10 shows that the mean values of both N and K concentrations in the 14<sup>th</sup> leaf correspond to all main treatment effects were in the sufficiency ranges.

**Table 10.** *The main treatment effects of leaf N, K and Mg concentration of the 14<sup>th</sup> frond (as % of dry matter) in 2000*

Treatment	%N	%K	%Mg
N <sub>1</sub> (300 g/y)	2.12 (± 0.16)	1.53 (± 0.16)	0.19 (± 0.03)
N <sub>2</sub> (600 g/y)	2.32 (± 0.28)	1.42 (± 0.09)	0.19 (± 0.03)
N <sub>3</sub> (1200 g/y)	2.18 (± 0.24)	1.35 (± 0.13)	0.21 (± 0.04)
K <sub>1</sub> (322 g/y)	2.34 (± 0.27)	1.34 (± 0.17)	0.20 (± 0.02)
K <sub>2</sub> (644 g/y)	2.10 (± 0.14)	1.41 (± 0.10)	0.21 (± 0.04)
K <sub>3</sub> (1288 g/y)	2.18 (± 0.25)	1.54 (± 0.09)	0.18 (± 0.03)
Mg <sub>1</sub> (44 g/y)	2.25 (± 0.31)	1.49 (± 0.14)	0.18 (± 0.02)
Mg <sub>2</sub> (88 g/y)	2.25 (± 0.22)	1.43 (± 0.15)	0.18 (± 0.02)
Mg <sub>3</sub> (176 g/y)	2.13 (± 0.18)	1.37 (± 0.13)	0.23 (± 0.03)
Significance of difference	ns	ns	ns

However Mg concentration was below the sufficiency range for all treatments including Mg treatments. But Mg concentration of Mg<sub>3</sub> treatment was significantly higher than that of Mg<sub>1</sub> and Mg<sub>2</sub>. Table 11 shows the effect of N and Mg treatments on leaf K concentration and effect of N and K treatments on leaf Mg concentration.

**Table 11.** *Leaf K and leaf Mg concentrations of NxK, K x Mg, N x Mg combinations*

Treatment combination	Leaf K%	Treatment combination	Leaf K%
N <sub>1</sub> K <sub>1</sub>	1.47 ± 0.20	K <sub>1</sub> Mg <sub>1</sub>	1.42 ± 0.20
N <sub>1</sub> K <sub>2</sub>	1.48 ± 0.11	K <sub>2</sub> Mg <sub>1</sub>	1.48 ± 0.04
N <sub>1</sub> K <sub>3</sub>	1.68 ± 0.02	K <sub>3</sub> Mg <sub>1</sub>	1.56 ± 0.08
N <sub>2</sub> K <sub>1</sub>	1.36 ± 0.02	K <sub>1</sub> Mg <sub>2</sub>	1.33 ± 0.15
N <sub>2</sub> K <sub>2</sub>	1.37 ± 0.06	K <sub>2</sub> Mg <sub>2</sub>	1.43 ± 0.10
N <sub>2</sub> K <sub>3</sub>	1.51 ± 0.08	K <sub>3</sub> Mg <sub>2</sub>	1.54 ± 0.09
N <sub>3</sub> K <sub>1</sub>	1.21 ± 0.06	K <sub>1</sub> Mg <sub>3</sub>	1.28 ± 0.06
N <sub>3</sub> K <sub>2</sub>	1.35 ± 0.06	K <sub>2</sub> Mg <sub>3</sub>	1.32 ± 0.03
N <sub>3</sub> K <sub>3</sub>	1.48 ± 0.02	K <sub>3</sub> Mg <sub>3</sub>	1.52 ± 0.10
Treatment combination	Leaf Mg%	Treatment combination	Leaf Mg%
N <sub>1</sub> Mg <sub>1</sub>	0.18 ± 0.02	K <sub>1</sub> Mg <sub>1</sub>	0.19 ± 0.02
N <sub>2</sub> Mg <sub>1</sub>	0.18 ± 0.01	K <sub>2</sub> Mg <sub>1</sub>	0.18 ± 0.02
N <sub>3</sub> Mg <sub>1</sub>	0.19 ± 0.03	K <sub>3</sub> Mg <sub>1</sub>	0.17 ± 0.01
N <sub>1</sub> Mg <sub>2</sub>	0.18 ± 0.02	K <sub>1</sub> Mg <sub>2</sub>	0.19 ± 0.02
N <sub>2</sub> Mg <sub>2</sub>	0.18 ± 0.01	K <sub>2</sub> Mg <sub>2</sub>	0.19 ± 0.02
N <sub>3</sub> Mg <sub>2</sub>	0.19 ± 0.02	K <sub>3</sub> Mg <sub>2</sub>	0.16 ± 0.01
N <sub>1</sub> Mg <sub>3</sub>	0.21 ± 0.02	K <sub>1</sub> Mg <sub>3</sub>	0.22 ± 0.01
N <sub>2</sub> Mg <sub>3</sub>	0.22 ± 0.02	K <sub>2</sub> Mg <sub>3</sub>	0.26 ± 0.03
N <sub>3</sub> Mg <sub>3</sub>	0.25 ± 0.03	K <sub>3</sub> Mg <sub>3</sub>	0.25 ± 0.03

The data indicated that the leaf K concentration decreased with increasing N level at all three levels of K treatments. However Mg treatments showed decreasing effect on leaf K percentage only at K<sub>1</sub> and K<sub>2</sub> treatment levels. The leaf K percentage of K<sub>3</sub> treatment was not affected by Mg treatments.

The leaf Mg was slightly increased by N<sub>3</sub> treatment level compared to N<sub>1</sub> and N<sub>2</sub> treatments. But leaf Mg was slightly decreased by K<sub>3</sub> treatment level. Data also showed that treatment levels of Mg<sub>1</sub> and Mg<sub>2</sub> were not sufficient for maintaining leaf Mg at the sufficiency range (> 0.25%). The leaf Mg concentration of N<sub>3</sub>Mg<sub>3</sub> and K<sub>3</sub>Mg<sub>3</sub> combinations were significantly higher ( $p < 0.05$ ) than that of other combinations. Nutrient status of the soils is shown in Table 12.

It is clearly seen from Table 12 that total N, exchangeable K and Mg of soils increased with increasing N, K and Mg treatment levels respectively. It is also seen that the exchangeable K and Mg decreased with increasing N treatment levels and exchangeable Mg decreased with increasing K treatment levels. However, the differences were not significant.

**Table 12.** Total N, exchangeable K and exchangeable Mg concentration in the soils in the manure circles of treatment palms

Treatments	Soil Depth 0-25 cm		
	Total N (mg/kg)	Exch. K (mg/kg)	Exch. Mg (mg/kg)
N <sub>1</sub> (300 g/y)	1304 ± 207	226 ± 51	42 ± 14
N <sub>2</sub> (600 g/y)	1500 ± 370	214 ± 50	46 ± 19
N <sub>3</sub> (1200 g/y)	1690 ± 415	206 ± 66	31 ± 11
K <sub>1</sub> (322 g/y)	1323 ± 244	129 ± 39	47 ± 18
K <sub>2</sub> (644 g/y)	1582 ± 344	179 ± 31	35 ± 17
K <sub>3</sub> (1288 g/y)	1602 ± 463	339 ± 58	37 ± 11
Mg <sub>1</sub> (44 g/y)	1397 ± 263	230 ± 78	29 ± 11
Mg <sub>2</sub> (88 g/y)	1474 ± 368	203 ± 70	38 ± 6
Mg <sub>3</sub> (176 g/y)	1615 ± 434	211 ± 50	53 ± 18
Significance of difference	ns	ns	ns

The results showed that the differential N, K and Mg treatments applied to young palms did not affect the bearing percentage by the year 2000; i.e. after 9 years of experimentation. Also N and K status of all palms were in the sufficiency range while Mg was in the deficiency range except in Mg<sub>3</sub> treatments. The leaf Mg concentration of Mg<sub>3</sub> treatment was close to the lower level of the sufficiency range.

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**Experiment 7.0.2: Formulation of a suitable fertilizer mixture, irrigation and ethrel levels for palms in tapping continuously or seasonally**

This experiment was established in November 1998 at Bandirippuwa Estate (IL<sub>1</sub>, Sandy loam, S<sub>2</sub>) in a factorial design with 3 replicates and with three fertilizer treatments, two irrigation treatments and two ethrel treatments. There are four effective palms per plot. The treatments are as follows.

No Fertilizer	(FL0) -	No Fertilizer
Fertilizer 1	(FL1) -	Equal to nutrient removal by toddy & other parts (N = 460 g, P <sub>2</sub> O <sub>5</sub> = 248 g, K <sub>2</sub> O = 1890 g and MgO = 100 g)
Fertilizer 2	(FL2) -	1 1/2 times of FL1 treatment
No irrigation	(IL0) -	No water
Irrigation	(IL1) -	Watering to 80% of field capacity
No ethrel	(EL0) -	No ethrel
Ethrel	(EL1) -	Application of 2.5% ethrel solution

Yields were obtained as sweet toddy that was measured daily upto December 1999. With effect from January 2000, yield was measured daily as fermented toddy.

The 2<sup>nd</sup> fertilizer application was carried out in June 2000. Irrigation treatments were applied when soil water status dropped to 50% of the field capacity using tensiometer readings. As frequent rains occurred throughout the year, the water table remained constant at 1.5-2.0 m depth. Moisture status of topsoil dropped to 50% of the field capacity only for a few weeks in July, August and September. The irrigation treatment was applied during the above period. Ethrel application was done on every emerging flower.

From the 2<sup>nd</sup> fertilizer application, the toddy yields were measured for each flower separately.

There were no noteworthy trends but the data collected will be fully analyzed in due course.

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**Experiment 7.0.3: Formulation of a suitable fertilizer recommendation for king coconut (1997-2002)**

This experiment, on a randomized block design with 4 replicates and 4 palms per plot and six treatments was established on adult palms at the following two locations.

Expt. No.	Location	Agro ecological region	Soil type	Land suitability class
7.0.3.1	Marandawila	IL <sub>3</sub>	Imperfectly drained, deep loamy sand (Palugaswewa series)	S <sub>2</sub>
7.0.3.2	Walpita	WL <sub>3</sub>	Well drained, moderately deep gravelly loam (Boralu series)	S <sub>4</sub>

The age of palms at Marandawila was 17 years while that of Walpita was 21 years.

The fertilizer treatments are given in Table 13.

**Table 13.** *N, P, K and Mg treatment combinations of the experiment*

Treatment	Rate of application g/palm/6 month			
	Urea (g)	SP (g)	MOP (g)	Dolomite (g)
T <sub>1</sub>	-	-	-	-
T <sub>2</sub>	400	250	650	400
T <sub>3</sub>	600	375	1000	600
T <sub>4</sub>	800	500	1350	800
T <sub>5</sub>	400	300	800	500

The mean nut yields of Marandawila and Walpita sites are given in Table 14.

**Table 14.** *The nut yields at Marandawila and Walpita*

Treatment	Marandawila nuts/palm		Walpita nuts/palm	
	Cumulative yield from 1998-1999	2000	Cumulative yield from 1997-1999	2000
T <sub>1</sub>	237	102	138	66
T <sub>2</sub>	219	105	165	79
T <sub>3</sub>	224	94	183	76
T <sub>4</sub>	215	102	171	68
T <sub>5</sub>	191	99	157	83
Level of Significance	NS	NS	P < 0.05	NS
LSD			44	

T<sub>1</sub> - Control - no fertilizer; T<sub>2</sub> - NPK removal/6 months; T<sub>3</sub> - 1.5 times NPK removal/6 months; T<sub>4</sub> - 2 times NPK removal/6 months; T<sub>5</sub> - APM

In contrast to Marandawila site, the Walpita site showed significant difference in nut yield between the control and treatment T<sub>3</sub> (treatment equivalent to NPK removal). The mean of other treatments were also higher than the control. The same trend was observed in the yield of 2000 also but the differences were not significant.

The yield data at Marandawila site did not show a significant difference between treatments upto 2000. The leaf nutrient status of treatment palms in year 2000 is given in Table 15.

**Table 15.** *The leaf nutrient concentration of 14<sup>th</sup> frond of the treatment palms (percentage of dry matter) at Marandawila and Walpita in year 2000*

Treatment	Marandawila				Walpita			
	N	P	K	Mg	N	P	K	Mg
T <sub>1</sub>	1.97	0.13	1.06	0.21	1.87	0.12	1.02	0.19
T <sub>2</sub>	1.72	0.12	1.02	0.20	1.95	0.13	1.13	0.19
T <sub>3</sub>	1.85	0.12	1.01	0.22	1.95	0.13	1.09	0.17
T <sub>4</sub>	1.90	0.12	1.01	0.21	1.94	0.12	1.05	0.19
T <sub>5</sub>	1.85	0.13	0.88	0.19	1.99	0.12	0.99	0.19
LSD	ns	ns	ns	ns	ns	ns	ns	ns

T<sub>1</sub> - Control - no fertilizer; T<sub>2</sub> - NPK removal/6 months; T<sub>3</sub> - 1.5 times NPK removal/6 months; T<sub>4</sub> - 2 times NPK removal/6 months; T<sub>5</sub> - APM

There was no significant difference between treatments in terms of leaf nutrient concentrations during the year (Table 15). At the Marandawila site, the N concentrations remained below 1.90% and K concentrations remained below 1.02% for all treatment palms despite two years treatment applications. Nitrogen and K concentration in the leaf were slightly higher in the control than in the treatments. The N concentration in the 14<sup>th</sup> leaf at Walpita site was below the sufficiency range for the control (< 1.9%) but in the sufficiency range for other treatments. Also at Walpita, leaf P concentration was within the sufficiency range for all treatments (> 0.12%) but both K and Mg concentrations were below the sufficiency range for all treatments.

As seen in Table 16, at the Marandawila site, only exchangeable K of T<sub>3</sub> and T<sub>5</sub> treatments showed significantly higher values than the control. But total N contents were not

significantly different between treatments. The values of total N were also very low despite continuous urea treatment for two years. Despite dolomite treatment, soil Mg level also had not significantly increased by year 2000. Soil data showed that the retention of nutrients in the soil was very poor in soils at Marandawila. This may be due to the sandy texture of these soils.

At the Walpita site, exchangeable K of soils increased significantly ( $P < 0.05$ ) over the control due to treatment application. However exchangeable magnesium was not significantly different between treatments despite different levels of dolomite application (Table 16).

The overall results showed that magnesium deficiency existed in king coconut palms at both sites, Marandawila and Walpita. Potassium status of palms also has not increased to the sufficiency range by the year 2000 despite 3 years treatment application.

**Table 16.** *Nutrient concentration of soils at 0-20 cm depth in the manure circle of treatment palms at Marandawila and Walpita*

Treatment	Marandawila			Walpita	
	Total N mg/kg	Exch. K mg/kg	Exch. Mg mg/kg	Exch. K mg/kg	Exch. Mg mg/kg
T <sub>1</sub>	449	58.5	44.4	152.1	108.0
T <sub>2</sub>	425	78.0	43.2	179.4	88.8
T <sub>3</sub>	436	93.6	60.0	206.7	100.8
T <sub>4</sub>	449	62.4	45.6	288.6	103.2
T <sub>5</sub>	435	89.7	50.4	206.7	84.0
Level of Significance	ns	P<0.05	ns	P < 0.05	ns
LSD		30.0		53.1	

T<sub>1</sub> - Control - no fertilizer; T<sub>2</sub> - NPK removal/6 months; T<sub>3</sub> - 1.5 times NPK removal/6 months; T<sub>4</sub> - 2 times NPK removal/6 months; T<sub>5</sub> - APM

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**PROJECT 7.1: IMPROVEMENT OF DIFFERENTIAL FERTILIZER RECOMMENDATION (DFR) BASED ON NUTRIENT STATUS OF LEAF & SOIL**

**Experiment 7.1.1: Evaluation of the effect of DFR based on leaf nutrient status on the productivity of coconut (1995)**

This demonstration trial comprising four blocks of 16 palms was established in 1995 at Pottukulama Research Station (IL<sub>3</sub>, Welipellessa series, S<sub>2</sub>). Treatments for the current year are given in Table 17. Treatment application for the 5<sup>th</sup> year was completed in August 2000. The treatment -3 (T<sub>3</sub>), the DFR treatment, was determined based on nutrient concentration of 14<sup>th</sup> frond in 2000. The nut yield of the 5<sup>th</sup> year was not significantly different between treatments. The cumulative nut yields for 1995 - 1999 and the yield for 1999 - 2000 of the experiment and copra yield during year 2000 are given in Table 18.

**Table 17.** *The fertilizer treatments for the year 2000*

Treatments	Urea g/palm/y	IRP/ERP g/palm/y	MOP g/palm/y	Dolomite g/palm/y
T <sub>1</sub> (Control)	-	-	-	-
T <sub>2</sub> (3 kg APM)	800	600	1600	1000
T <sub>3</sub> (DFR)	800	600(ERP)	1600	2000
T <sub>4</sub> (4.5 kg APM)	1200	900	2400	1500

IRP - Imported rock phosphate, ERP - Eppawela rock phosphate, MOP - Muriate of potash

**Table 18.** *Crop yield*

Treatments	Nuts (palm/year)		Copra (kg/palm/year)
	Cumulative 1995- 1999	1999/2000	1999/2000
T <sub>1</sub>	246	101	22.7
T <sub>2</sub>	292	103	23.3
T <sub>3</sub>	319	91	21.5
T <sub>4</sub>	295	86	18.1
Level of significance	p ≤ 0.05	ns	ns
LSD	70		

T<sub>1</sub> - Control; T<sub>2</sub> - 3 kg APM; T<sub>3</sub> - DFR; T<sub>4</sub> - 4.5 kg APM

This experiment failed to show any difference in nut yield between DFR and the general recommendation of APM over the control. The experiment was terminated at the end of year 2000.

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**Experiment 7.1.2: Evaluation of the productivity of coconut palms in response to high dose of chemical fertilizer and development of criteria for Differential Fertilizer Recommendation (DFR)**

This experiment, on a randomized block design with 3 replicates and six palms per plot, was commenced at the following locations.

Expt. No.	Location	Agro ecological region	Soil series	Year of commencement	Land suitability class
7.1.2.1	Madampe	IL <sub>1</sub>	Madampe series	1999	S <sub>1</sub>
7.1.2.2	Mawathagama	IL <sub>1</sub>	Kurunegala series	2000	S <sub>2</sub>
7.1.2.3	Mangala-eliya	DL <sub>1</sub>	Borupan series	2000	S <sub>2</sub>
7.1.2.4	Ganewatta	IL <sub>3</sub>	Wariyapola series	2000	S <sub>3</sub>
7.1.2.5	Udugama	IL <sub>3</sub>	Andigama series	2000	S <sub>4</sub>

The treatments are given in Table 19.

**Table 19.** *Treatment combinations in the experiment (g/palm/y)*

Treatments	Urea	SP/ERP	MOP	Dolomite
T <sub>1</sub>	800	600	1600	1000
T <sub>2</sub>	1000	750	2000	1250
T <sub>3</sub>	1200	900	2400	1500
T <sub>4</sub>	1400	1050	2800	1750
T <sub>5</sub>	1600	1200	3200	2000

**Experiment 7.1.2.1 - Madampe**

The yield data for Madampe site is given in Table 20.

**Table 20.** *The nut yield and the copra weight in the year 2000 at Madampe site*

Treatment	Nuts/ha/y	Copra wt. (kg/ha/y)
T <sub>1</sub>	10268	2160
T <sub>2</sub>	12223	2393
T <sub>3</sub>	8751	2111
T <sub>4</sub>	9058	1984
T <sub>5</sub>	10332	2334
Level of Significance	ns	ns

As seen from Table 20, in the year after 1<sup>st</sup> treatment application, there was no significant difference in yield and copra weight between treatments. The variation of soil nitrogen status in the soil during the year is seen from Table 21.

**Table 21.** *Total N in the soils of manure circle in treatment plots at different times after treatment application (mg/kg). Soil depth: 0- 25 cm at Madampe site*

Treatment (Urea level)	Pre-manorial*	4 months after	8 months after	12 months after
T <sub>1</sub>	536	697	500	375
T <sub>2</sub>	429	804	643	429
T <sub>3</sub>	429	911	697	456
T <sub>4</sub>	429	1340	590	509
T <sub>5</sub>	402	1394	804	536

An increase in total N in the soil was seen in all treatments 4 months after the application. The total N was highly correlated ( $r = 0.959$ ) with the application dose of urea. However, N in all treatment plots showed a decreasing trend during the period 4 months to 12 months after treatment application. It implies that soil N in the loamy soils of this site would increase after initial application of high urea doses but would decline rapidly within a year.

### 7.1.2.2 Mangala-eliya

Preliminary yield recording was continued at the above site before treatment application.

### 7.1.2.3 Udugama

### 7.1.2.4 Mawathagama

### 7.1.2.5 Ganewatte

Locations previously selected were abandoned due to various difficulties in the management of the experiment. Selection of new locations for the above soil series are in progress.

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## PROJECT 7.2: STUDIES ON THE ROLE OF MICRONUTRIENTS IN THE PRODUCTIVITY OF THE COCONUT PALM

### Experiment 7.2.1: Determination of critical levels for Zn and Cu (1997 - 2002)

This experiment, in a randomized block design with 3 replicates and 6 palms (40 years old) per plot, was established in 1997 at the following two locations. The age of the palms was about 40 years at both sites.

Expt. No	Location	Agro-ecological region	Soil type	Land suitability class
7.2.1.1	Pottukulama Research Station	IL <sub>3</sub>	Deep sandy loam (Welipelessa series)	S <sub>2</sub>
7.2.1.2	Ratmalagara Research Station	IL <sub>1</sub>	Sandy clay loam with gravel in the sub soil (Andigama series)	S <sub>4</sub>

The treatment combinations of ZnSO<sub>4</sub>.7H<sub>2</sub>O and CuSO<sub>4</sub>.5H<sub>2</sub>O and the cumulative yields of both sites are presented in Table 22. The basal doses for all treatment palms were 3 kg of APM and 1 kg of dolomite per palm.

There was no significant yield difference in the cumulative yield of 1998 and 1999 or the yield in year 2000 at both Pottukulama and Ratmalagara sites.

The Cu and Zn concentrations of the manure circle soils taken from different treatment combinations before 3<sup>rd</sup> treatment application are given in Table 23.

At the Pottukulama site, the available Cu of soil that was extracted by DTPA did not show a significant difference between treatments although values were high at higher levels of application. However, at Ratmalagara site, available Cu of top soils treatments T5 and T6 was significantly higher ( $p < 0.05$ ) than the control. The available Zn concentration of

soils at both sites showed a significant increase with higher level of Zn treatments. The increase was shown in both top soils (0-20 cm) and sub soils (20-40 cm). (Table 23).

The concentrations of Cu and Zn in the 14<sup>th</sup> leaf of treatment palms in PRS and RE before 3<sup>rd</sup> treatment application are given in Table 24.

In the leaf Zn concentration, there was an increase in treatments compared to the control but the rate of increase did not show a correlation with treatments. Leaf Cu concentration did not show a difference between treatments and the control.

**Table 22.** *The treatment combinations and the average nut yield*

	Treatments		Pottukulama site		Ratmalagara site	
	ZnSO <sub>4</sub> g/palm	CuSO <sub>4</sub> g/palm	Cumulative yield from 1998 to 1999	2000 (9 picks)	Cumulative yield from 1998 to 1999	2000 (9 picks)
T <sub>1</sub>	-	-	188	99.7	155	103.2
T <sub>2</sub>	50	100	190	99.1	143	93.5
T <sub>3</sub>	50	200	182	83.5	157	87.2
T <sub>4</sub>	100	100	186	90.2	144	89.4
T <sub>5</sub>	100	200	174	88.6	151	87.3
T <sub>6</sub>	200	400	200	88.8	150	87.8
Level of Significance			ns	ns	ns	ns
CV			20%	21%	13%	18%

**Table 23.** *The Cu and Zn concentrations of the manure circle soils of each treatment before 3<sup>rd</sup> treatment application*

No.	Pottukulama site				Ratmalagara site			
	Cu mg/kg		Zn mg/kg		Cu mg/kg		Zn mg/kg	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
T <sub>1</sub>	0.56	0.94	0.52	0.29	1.41	2.19	0.96	0.45
T <sub>2</sub>	1.53	0.74	4.81	1.31	1.66	1.61	1.55	0.99
T <sub>3</sub>	2.10	0.83	8.99	2.93	1.95	1.46	2.85	0.92
T <sub>4</sub>	2.02	0.88	3.59	0.97	1.95	2.16	1.53	0.76
T <sub>5</sub>	1.95	0.70	6.84	1.42	13.43	3.61	10.19	4.12
T <sub>6</sub>	2.24	1.29	12.40	4.83	7.52	2.09	13.26	3.47
Significance of difference	ns	ns	*	*	*	ns	**	*
LSD			5.11	2.81	5.51		4.31	2.30

T<sub>1</sub> - No ZnSO<sub>4</sub> and CuSO<sub>4</sub> application (Control); T<sub>2</sub> - 50 g CuSO<sub>4</sub> and 100 g ZnSO<sub>4</sub> palm/y; T<sub>3</sub> - 50 g CuSO<sub>4</sub> and 200 g ZnSO<sub>4</sub> palm/y; T<sub>4</sub> - 100 g CuSO<sub>4</sub> and 100 g ZnSO<sub>4</sub> palm/y; T<sub>5</sub> - 100 g CuSO<sub>4</sub> and 200 g ZnSO<sub>4</sub> palm/y and T<sub>6</sub> - 200 g CuSO<sub>4</sub> and 400 g ZnSO<sub>4</sub> palm/y

**Table 24.** *Zn and Cu concentration in the 14<sup>th</sup> leaf of treatment plots before 3<sup>rd</sup> treatment application*

No.	Pottukulama site		Ratmalagara site	
	Cu mg/kg	Zn mg/kg	Cu mg/kg	Zn mg/kg
T <sub>1</sub>	4.83	18.4	4.91	31.9
T <sub>2</sub>	4.51	34.1	4.81	29.6
T <sub>3</sub>	4.73	21.3	4.75	27.4
T <sub>4</sub>	4.49	25.8	4.71	26.7
T <sub>5</sub>	4.49	35.1	4.54	26.0
T <sub>6</sub>	4.69	20.9	4.83	24.7

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**Experiment 7.2.2: Quantification of the removal of some nutrients by the coconut palm**

This experiment aims to quantify the removal of some nutrients from coconut palms growing in moderately suitable (S<sub>4</sub>) and highly suitable (S<sub>1</sub>) land classes.

The experiment, on the S<sub>1</sub> land suitability class (Madampe series soils) was commenced in September 1998 at the Bandirippuwa Estate. Palms were randomly selected from the field. Ten replicate palms were initially selected.

All the plant components removed from the palm, in each month, from September 1998 to September 1999 were collected and dry weights were determined (Table 25). All the components were prepared for chemical analysis for N, P, K, Ca, Mg, Na, Fe, Cu, Mn, Zn & B.

**Table 25.** *The dry weight of different components removed per coconut palm per year - Madampe series soils (Bandirippuwa Estate)*

Month	No. of nuts/palm	Nuts (kg/palm)	Fallen fronds (kg/palm)	Inflorescence, button nuts and immature nuts (kg/palm)	Total (kg/palm)
September 98	10	12.9	2.6	2.7	18.2
October	8	5.6	2.9	3.5	12.0
November	5	4.0	2.1	1.8	7.9
December	2	2.0	3.5	1.6	7.1
January 99	4	5.0	6.6	3.9	15.5
February	8	9.3	4.9	2.0	16.2
March-April	22	25.7	8.3	2.9	36.9
May	10	13.0	8.1	1.6	22.7
June	16	19.2	0.9	1.7	21.8
July	15	12.1	1.6	1.9	15.6
August	11	7.9	2.6	1.9	12.4
<b>Total</b>	<b>111</b>	<b>116.7</b>	<b>44.1</b>	<b>25.5</b>	<b>186.3</b>

It shows that the total dry weight of components removed per year by a palm in Madampe series was 187 kg of which 62.5% is shared by the weight of nuts and 23.5% by fronds. It is seen that 50% of the total nuts for the year were produced during the period

March - July. Also, 63% of the total dry weight of fallen fronds were recorded during January to May.

The amount of macronutrients removed by nuts and fallen fronds of a palm during the year is given in Table 26.

**Table 26.** *The major nutrients removed by nuts and fallen fronds of the palm (g/palm/year)*

Components of the nuts	N	P	K	Na	Ca	Mg
Nut water	4.7	1.9	48.8	1.7	2.5	1.8
Shell	27.2	1.8	46.3	2.8	3.6	3.0
Kernel	285.0	39.5	150.0	2.0	6.3	22.7
Husk	182.0	19.8	1088.0	81.9	31.9	42.5
<b>Total</b>	<b>498.9</b>	<b>63.0</b>	<b>1333.1</b>	<b>88.4</b>	<b>44.3</b>	<b>69.3</b>
Components of the frond						
Blade	120.0	6.6	73.9	32.8	57.5	26.0
Pith	48.9	6.5	161.8	195.0	95.2	77.4
Ekel	15.7	1.2	20.2	14.7	25.6	17.1
<b>Total</b>	<b>184.6</b>	<b>14.3</b>	<b>255.9</b>	<b>245.5</b>	<b>178.3</b>	<b>120.5</b>

As seen from Table 26, potassium removal in nuts was the highest compared to other elements. Except for phosphorus, the other elements removed by fallen fronds are in the range of 120-250 g per palm annually.

Micronutrient removals by nuts are given in Table 27.

**Table 27.** *Micro nutrient removals by nuts (mg/palm/year)*

Components of the nuts	Fe	Mn	Cu	Zn	B
Nut water	24.5	51.9	4.1	11.7	31.1
Shell	176.0	13.7	125.0	89.2	103.0
Kernel	597.0	274.0	230.0	428.0	46.2
Husk	2357.0	395.0	327.0	578.0	826.0
<b>Total (mg/palm/y)</b>	<b>3154.5</b>	<b>734.6</b>	<b>686.1</b>	<b>1106.9</b>	<b>1006.3</b>

As seen from the Table 27, the highest removal of micro nutrient per palm was of Fe followed by Zn and B respectively. However the quantities were less than 4 g per year for Fe and almost 1 g per year for Zn and B.

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**Experiment 7.2.3: Determination of micronutrient status of the soils and coconut palms in major soil series under different fertilizer practices**

This experiment was initiated with the following objectives;

- i To study the micronutrient availability in major coconut growing soils and in coconut palms, and to identify any deficiencies in the palms.
- ii. To establish relationships between the level of micronutrients of soils and in palms.

- iii. To establish relationships between the yield and the level of micronutrients in palms and soil.
- iv. To identify the micronutrient levels in coconut palms under different fertilizer practices (long term organic & inorganic manure applied soils).

Experimental locations were selected from those shown in Table 28. Ten palms were selected and marked for data collection at each site over a five-year period.

Soils at the Kalpitiya sites showed differences in pH. The results are therefore, presented in two categories based on soil reaction.

**Table 28.** *Sampling locations for studies of micronutrient*

Soil Series	Location	Fertilizer practices		
		Organic	Inorganic	Neglected
Kalpitiya	Talawila, Palakuda, Kadayamatte, Daluwa	Organic	Inorganic	Neglected
Weliketiya	Thoduwawa, Talawila, Kottantivu, Setapola	Organic	Inorganic	Neglected
Madampe	Madampe, Galmuruwa, Ma rawila, Koswadiya	Organic	Inorganic	Neglected
Andigama	Kachchakaduwa, Panirendawa, Welipannagahamula, Ratmalagara	Organic	Inorganic	-
Wariyapola	Hettipola, Ibbagamuwa, Nikadalupota, Kanaththagama	Organic	Inorganic	-
Dummalasuriya	Dummalasuriya	Organic	-	-

The nutrient concentrations of Fe, Mn, Cu and Zn of different soil series with different soil depths are given in Tables 29 (a, b, c and d).

The analytical data of Table 29 (a) showed that available Fe in sandy soils (Kalpitiya series, Weliketiya series and Dummalasuriya series) as well as loamy soils (Andigama series, Wariyapola series and Madampe series) were quite high in both top and sub layers. However it was observed that Fe concentration of soils was not much dependent on management practices.

The analytical data of Table 29(b) showed that the available Mn in coastal sandy soils such as Kalpitiya series and Weliketiya series were lower than that in the soils of the interior part of the country such as Wariyapola series and Andigama series. In general values for

centre of square were of the same order as for manure circles indicating that the coconut cultivation has not effectively decreased available Mn in the soils.

The available Cu concentration (Table 29 (c)) in most soils ranged from 0.4-1.2 mg/kg but Cu concentration in Wariyapola series was of a higher order (0.96 - 1.5 mg/kg) compared to other soils. The results did not show any variation of Cu availability according to management practices. Also, there was no clear difference between values for the manure circle and the centre of square. It appears that coconut plantation has not effectively decreased available Cu in the soils. However it is possible that Cu fixed in the soil also may be converted to available form as the palm takes up Cu.

In contrast to other micro nutrients, available Zn values for the centre of squares were generally lower than that for manure circle (Table 29 (d)) particularly in the top layer (10-20 cm) of all the soils except at neglected sites of Madampe series. Generally availability of Zn is also quite low ranging from 0.3 mg/kg to 4 mg/kg. The data show that there may be a decreasing trend of available Zn in soil due to coconut cultivation.

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**Table 29 (a).** Available Fe concentration (mg/kg) in the manure circle (MC) and the centre of square (CS) of different soil series and pH's under different fertilizer practices

Soil series	Available Fe											
	Organic Manure Application				Inorganic Manure Application				Neglected			
	MC		CS		MC		CS		MC		CS	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
Kalpitiya * (pH 7.5-8.5) (pH 5.5-6.5)	11.4	7.0	7.6	6.4	11.9	16.2	8.6	5.7	14.1	8.9	11.9	12.3
Weliketiya * (pH 7.5-8.5) (pH 5.5-6.5)	15.1	12.1	15.2	16.3	41.8	24.1	36.1	28.8	28.8	19.2	16.6	13.5
Andigama (pH 5.5-6.5)	15.5	17.0	21.3	17.5	18.6	17.6	19.2	21.9	nd	nd	nd	nd
Wariyapola (pH 5.5-6.5)	44.9	30.5	36.2	34.3	17.1	74.2	56.4	24.3	nd	nd	nd	nd
Madampe (pH 5.5-6.5)	19.1	25.7	22.4	21.3	34.5	42.9	22.1	15.2	86.2	59.3	21.8	32.1
Dummalasuriya (pH 5.5-6.5)	9.0	6.7	10.6	11.1	nd	nd	nd	nd	nd	nd	nd	nd

nd - not determined

\* Data separately presented based on soil reaction.

**Table 29 (b).** Available Mn concentration (mg/kg) in the manure circle (MC) and the centre of square (CS) of different soil series and pH's under different fertilizer practices

Soil series	Available Mn											
	Organic Manure Application				Inorganic Manure Application				Neglected			
	MC		CS		MC		CS		MC		CS	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
Kalpitiya * (pH 7.5-8.5) (pH 5.5-6.5)	3.00	2.10	0.90	0.80	6.1	16.2	8.6	5.7	4.0	3.1	3.1	3.2
	7.20	4.10	1.00	0.70	2.3	26.7	16.5	12.4	4.0	3.1	3.1	3.2
Weliketiya * (pH 7.5-8.5) (pH 5.5-6.5)	4.40	3.50	1.50	1.20	2.9	5.8	5.8	4.1	3.8	1.7	2.5	1.5
	1.60	1.00	2.80	3.00	4.7	4.4	6.2	7.6	3.8	1.7	2.5	1.5
Andigama (pH 5.5-6.5)	14.70	11.9	7.5	10.3	7.5	7.2	7.5	7.8	nd	nd	nd	nd
Wariyapola (pH 5.5-6.5)	34.10	36.5	34.10	34.10	34.8	29.8	37.1	27.6	nd	nd	nd	nd
Madampe (pH 5.5-6.5)	4.11	3.04	1.48	1.32	6.2	6.5	8.7	10.7	14.0	8.6	19.5	8.6
Dummalasuriya (pH 5.5-6.5)	9.01	6.71	10.61	11.11	nd	nd	nd	nd	nd	nd	nd	nd

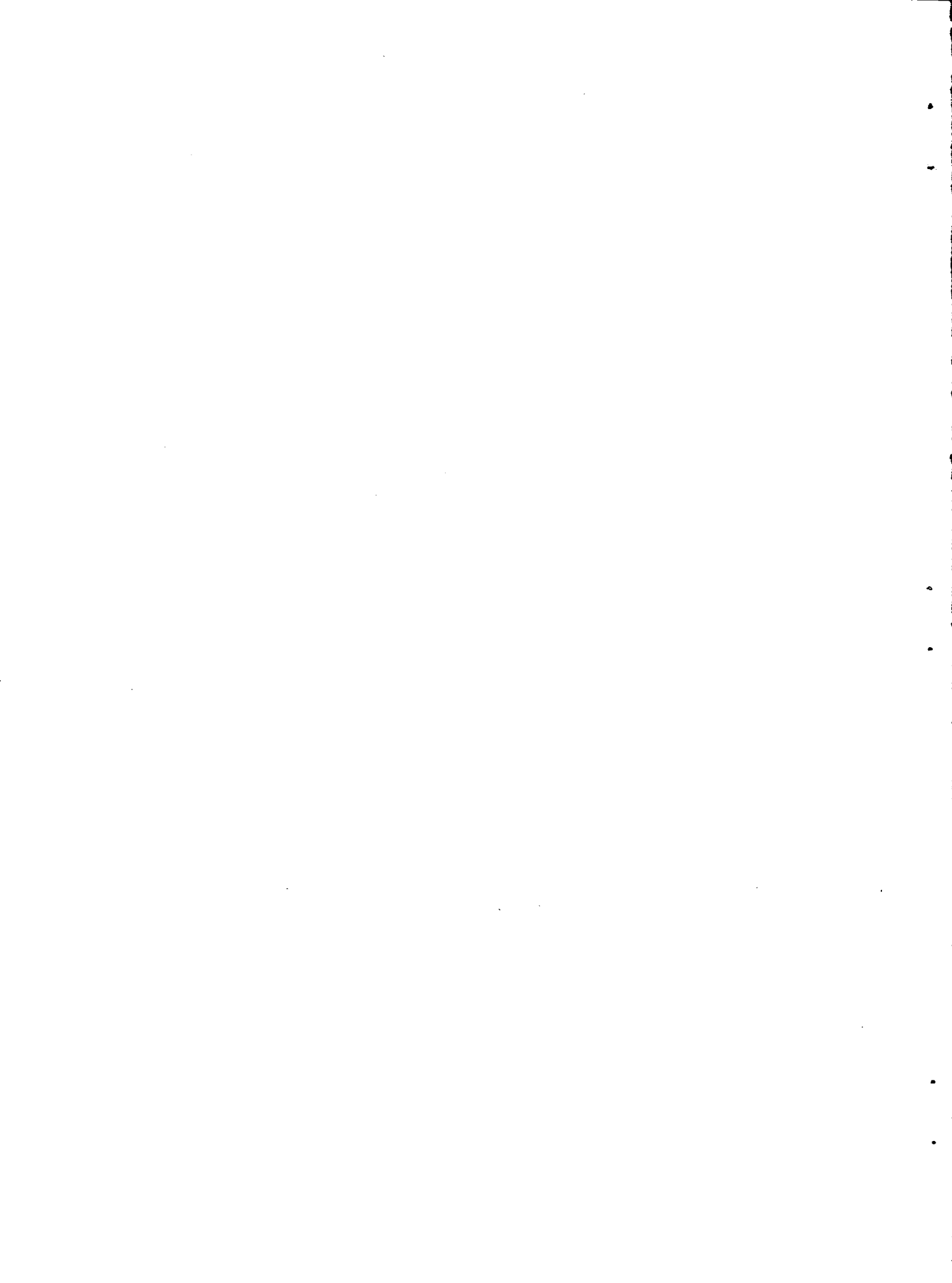
nd - not determined \* Data separately presented based on soil reaction.

**Table 29 (c).** Available Cu concentration (mg/kg) in the manure circle (MC) and the centre of square (CS) of different soil series and pH's under different fertilizer practices

Soil series	Available Cu											
	Organic Manure Application				Inorganic Manure Application				Neglected			
	MC		CS		MC		CS		MC		CS	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
Kalpitiya *												
(pH 7.5-8.5)	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4				
(pH5.5-6.5)	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	4.0	0.5	0.5	0.5
Weliketiya *												
(pH7.5-8.5)	0.4	0.3	0.2	0.3	0.4	0.5	0.5	0.5				
(pH5.5-6.5)	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.4	1.3	1.0	0.3	1.0
Andigama												
(pH5.5-6.5)	1.0	0.7	0.7	0.8	0.5	0.6	0.5	0.5	nd	nd	nd	nd
Wariyapola												
(pH5.5-6.5)	0.9	1.1	1.3	1.2	1.4	1.5	1.5	1.2	nd	nd	nd	nd
Madampe												
(pH5.5-6.5)	0.5	0.4	0.3	0.4	0.5	0.6	0.5	0.5	0.6	1.2	0.1	0.5
Dummalasuriya												
(pH 5.5-6.5)	0.5	0.4	0.4	0.4	nd	nd	nd	nd	nd	nd	nd	nd

nd - not determined

\* Data separately presented based on soil reaction.





**Table 30.** *Nut and copra yield at Pottukulama and Badalgama experimental sites*

Treatments	Pottukulama site				Badalgama site			
	Mean annual yield from May 1996 to April 1999		Nut yield from May 1999 to April 2000		Mean annual yield from Aug.1996 to July 1999		Nut yield from Aug. 1999 to July 2000	
	Nuts/ palm/y	copra wt. kg/palm/y	Nuts/ palm/y	copra wt. kg/palm/y	Nuts/ palm/y	copra wt. kg/palm/y	Nuts/ palm/y	copra wt. kg/palm/y
T <sub>1</sub> - Control (no manure) - surface	61	14.0	79	18.0	31	5.3	26	6
Control (no manure) - trench	63	13.3	80	17.7	33	5.3	22	4
T <sub>2</sub> - Fresh layer - surface	92	17.3	104	23.2	34	6.7	32	7
Fresh layer - trench	73	19.3	99	21.3	39	8.3	31	7
T <sub>3</sub> - Fresh broiler - surface	68	16.7	93	20.0	37	7.3	30	5
Fresh broiler - trench	73	18.3	88	19.4	36	7.0	25	3
T <sub>4</sub> - Layer stored for 1 m - surface	73	19.3	87	19.3	38	7.6	30	5
Layer stored for 1 m - trench	67	15.7	87	17.5	40	8.0	33	8
T <sub>5</sub> - Broiler stored for 1 m- surface	68	17.7	87	16.3	43	8.3	38	7
Broiler stored for 1m- trench	67	16.0	89	16.7	42	9.0	36	9
T <sub>6</sub> - Layer stored for 3 m - surface	75	18.7	96	22.5	40	8.3	33	6
Layer stored for 3 m - trench	71	20.3	98	20.9	45	8.6	33	7
T <sub>7</sub> - Broiler stored for 3m - surface	75	17.7	88	19.7	41	8.7	33	7
Broiler stored for 3m - trench	76	16.7	100	21.5	41	9.0	44	10

At the end of year 2000, it was decided to terminate the experiment at Badalgama due to lack of cooperation of the landowner.

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**PROJECT 9: DEVELOPMENT OF IMPROVED FERTILIZER APPLICATION TECHNIQUES FOR COCONUT TO IMPROVE EFFICIENCY OF NUTRIENT UPTAKE AND TO MINIMIZE COST**

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

This experiment, on a randomized complete block design with 3 replicates and 6 palms per plot, was established in 1995 at the following two locations. The age of the palms was 40 years.

Expt. No	Locations	Agro-ecological region	Soil type	Land suitability class
9.0.1.1	Thammanna Estate, Puttalam	DL <sub>1</sub>	Sandy loam (Borupan series)	S <sub>2</sub>
9.0.1.2	Wayagolla Estate, Attanagalla	WL <sub>3</sub>	Sandy clay loam (Boralu series)	S <sub>4</sub>

The treatments are as follows.

- T<sub>1</sub> - Control (no fertilizer but turning soils)
- T<sub>2</sub> - APM (Adult Palm Mixture) broadcast/turn/no mulch
- T<sub>3</sub> - APM broadcast/turn/mulch with coconut fronds
- T<sub>4</sub> - ACM (Adult Coconut Mixture) broadcast in dry period, urea (N) broadcast in rainy period/mulch
- T<sub>5</sub> - Band application (APM broadcast in a 30 cm wide, circular band, 60 cm away from the palm/turn/mulch)
- T<sub>6</sub> - Localized application (3 kg of APM is equally distributed in 10 Alavangu holes (depth and diameter: 15 cm) dug at 60 cm distance from the palm and mulch)

Leaf samples of the 14<sup>th</sup> frond obtained in April 2000 were analyzed for major nutrients. The 5<sup>th</sup> fertilizer application was completed in May 2000. This experiment has not shown any significant yield response to treatments in terms of nuts and copra yield continuously for 5 years at both sites (Table 31). Therefore it was decided to terminate this experiment at both sites at the end of year 2000.

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**Table 31.** *Yield data of the experimental sites at Puttalam and Attanagalla*

Treatments	Puttalam				Attanagalla			
	Cumulative yield from May 1996 to April 1999		Nut yield from May 1999 to April 2000		Cumulative yield from June 1996 to May 1998		Nut yield from June 1998 to May 1999	
	palm/y	copra wt. kg/palm/y	palm/y	copra wt. kg/palm/y	palm/y	copra wt. kg/palm/y	palm/y	copra wt. kg/palm/y
T <sub>1</sub>	172	36	55	10	200	34	68	17
T <sub>2</sub>	171	38	51	11	226	49	85	21
T <sub>3</sub>	179	41	56	12	209	45	72	18
T <sub>4</sub>	178	40	49	11	203	44	77	19
T <sub>5</sub>	180	40	52	12	218	37	76	18
T <sub>6</sub>	179	36	53	12	215	46	69	17
Level of Significance	ns	ns	ns	ns	ns	ns	ns	ns

T<sub>1</sub> - Control - no fertilizer; T<sub>2</sub> - APM broadcast, turn; T<sub>3</sub> - APM broadcast, turn, mulch; T<sub>4</sub> - ACM + urea  
T<sub>5</sub> - APM in band, turn, mulch; T<sub>6</sub> - APM in 10 holes

**Experiment 9.0.2: Studies on different methods of kieserite application with NPK mixtures to coconut palms for minimizing K and Mg interaction**

The objective of this experiment was to find the best method of kieserite application with NPK mixtures for correcting Mg deficiency of coconut palms efficiently whilst minimizing K and Mg interaction. The experiment, on a randomized block design with 3 replicates and five treatment plots, was established in 1999 at three locations as follows.

Expt. No	Locations	Agro-ecological region	Soil type	Land suitability class
9.0.2.1	Pottukulama Estate	IL <sub>3</sub>	Sandy loam (Welopelessa series)	S <sub>2</sub>
9.0.2.2	Bandirippuwa Estate	IL <sub>1</sub>	Deep sandy loam (Madampe series)	S <sub>1</sub>
9.0.2.3	Bandirippuwa Estate	IL <sub>1</sub>	Sandy clay loam with iron stone gravel in the sub layer (Boralu series)	S <sub>4</sub>

The treatments (per palm per year) are as follows.

- T<sub>1</sub> - APM (3 kg) in the entire manure circle (1.75 m) - Control
- T<sub>2</sub> - APM (3 kg) + kieserite (1 kg) in the entire manure circle (1.75 m)
- T<sub>3</sub> - APM (3 kg) in one half of the manure circle and kieserite (1 kg) in the other half of the manure circle
- T<sub>4</sub> - APM (3 kg) in the entire manure circle and kieserite (1 kg) in the entire manure circle 6 months later
- T<sub>5</sub> - The manure circle is divided into two portions; 0.8 m radius circle round the palm (Portion 1) and a 0.8 m wide strip, adjoining the portion 1, round the palms (Portion 2)  
Kieserite (1 kg) in portion 1 and APM (3 kg) in portion 2

The experiment was continued in year 2000. Soil sampling continued and samples were analyzed for exchangeable K and Mg. Statistical analysis showed fluctuation of K and Mg in soils between 3 months intervals for each treatment (Table 32). The experiment clearly indicated that treatments that received only potassium maintained relatively higher values for soil exchangeable K for a period of 6 months. Application of K to the manure circle raised the exchangeable K while the soil exchangeable Mg decreased, thus confirming the interaction between the two elements.

Data shows that at the end of the April 2000, none of the treatment was effective in increasing magnesium concentration in the 14<sup>th</sup> leaf. However Mg concentrations have increased in all the treatments except T<sub>1</sub> in season 2. There was a decline in Mg concentration from season 2 to season 3 which was rather severe for T<sub>1</sub> and less severe for other treatments (Table 33).

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**Table 32.** Levels of soil exchangeable K with different treatments. (Top soil 0-25 cm)

	Soil exchangeable Potassium ( meq / 100g soil )						Soil exchangeable Magnesium ( meq / 100g soil )					
	July 99	Oct. 99	Jan. 00	April 00	July 00	Significance	July 99	Oct. 99	Jan. 00	April 00	July 00	Significance
T <sub>1</sub>	0.16	0.36	0.28	0.15	0.06	***	1.1	0.76	0.86	0.59	0.65	**
T <sub>2</sub>	0.15	0.36	0.12	0.07	0.08	***	1.05	0.83	0.88	0.61	0.67	**
T <sub>3a</sub>	0.14	0.16	0.06	0.07	0.05	**	0.87	1.12	1.01	0.66	0.71	***
T <sub>3b</sub>	0.14	1.05	0.2	0.14	0.10	**	0.87	0.70	0.87	0.51	0.65	***
T <sub>4</sub>	0.22	0.78	0.2	0.12	0.08	***	0.96	0.85	0.72	0.77	0.73	ns
T <sub>5a</sub>	0.18	0.19	0.09	0.09	0.08	*	0.91	1.45	1.04	0.74	0.87	***
T <sub>5b</sub>	0.18	0.95	0.21	0.12	0.09	***	0.91	0.73	0.73	0.51	0.54	*
Significance	NS	***	***	ns	ns		ns	***	ns	*	ns	
LSD	-	0.2958	0.0523	-	-		-	0.2581	-	0.1741	-	

T<sub>1</sub>-NPK; T<sub>2</sub>-NPK&Mg; T<sub>3a</sub>-NP&Mg; T<sub>3b</sub>-NP&K; T<sub>4</sub>-NPK, later Mg; T<sub>5a</sub>-NP&Mg; T<sub>5b</sub>-NP&K

ns - Non significant  
 \* - Significant at 5%  
 \*\* - Significant at 1%  
 \*\*\* - Significant at 0.1%

**Table 33:** *Fluctuation of Potassium in the 14<sup>th</sup> leaf of the adult coconut palms*

	Concentration of Potassium (% dry weight)			Concentration of Magnesium (% dry weight)		
	July to October 1999	October 1999 to January 2000	January to April 2000	July to October 1999	October 1999 to January 2000	January to April 2000
T <sub>1</sub>	1.436	1.490	1.409	0.181	0.181	0.139
T <sub>2</sub>	1.461	1.492	1.414	0.177	0.198	0.165
T <sub>3</sub>	1.572	1.654	1.498	0.177	0.194	0.152
T <sub>4</sub>	1.344	1.501	1.370	0.183	0.189	0.166
T <sub>5</sub>	1.456	1.498	1.485	0.196	0.193	0.152
Significance	ns	ns	ns	ns	ns	ns

T<sub>1</sub> -NPK; T<sub>2</sub> -NPK and Mg; T<sub>3</sub> -1/2 circle K -1/2 circle Mg; T<sub>4</sub> -NPK, later Mg; T<sub>5</sub> -Inner Mg - outer K

**PROJECT 10: DEVELOPMENT OF DRIP IRRIGATION SYSTEM FOR LAND SUITABILITY CLASSES 3, 4 AND 5**

**Experiment 10.0.1: Designing a suitable drip irrigation system for coconut plantations in Andigama series soils.**

This experiment, on a randomized block design with 3 replicates and 6 palms (15 years old) per plot, was established in 1996 at Ratmalagara (IL<sub>1</sub>). It was located on a shallow sandy clay loam soil (Andigama series) falling to land suitability class S<sub>5</sub>. A sub-surface tubing system with screw drippers was established to provide water to coconut palms at different irrigation intervals.

Following are the treatments of the experiment.

- T<sub>1</sub> - Control - No irrigation
- T<sub>2</sub> - Husk buried round the palm (1/3 of the manure circle)
- T<sub>3</sub> - Irrigation at 5 days intervals at 600 l per palm (10-30 kPa depletion range)
- T<sub>4</sub> - Irrigation at 10 days intervals at 720 l per palm (10-100 kPa depletion range)
- T<sub>5</sub> - Irrigation at 25 days intervals at 1080 l per palm (10-300 kPa depletion range)
- T<sub>6</sub> - Irrigation at 40 days intervals at 1200 l per palm (10-1500 kPa depletion range)

Basal dosage: 3 kg Adult Palm Mixture and 1 kg of dolomite per palm annually

The nut yield of this experiment is given in Table 34.

The irrigation treatments were meant to maintain different degrees of water stress in the palms by controlled irrigation and to determine the optimum irrigation rate that would nullify water stress.

**Table 34.** *Nut yield for each treatment*

Treatment	Yield (nuts/ha)	
	Cumulative yield in 1998 and 1999	2000
T <sub>1</sub>	16396	7928
T <sub>2</sub>	19772	10298
T <sub>3</sub>	17488	7712
T <sub>4</sub>	16987	6739
T <sub>5</sub>	20756	10042
T <sub>6</sub>	19594	6901
% CV	33	30
Significance of difference	ns	ns

From 1998 upto 2000, the yields of the husk pit treatments and irrigation treatment of 10 - 300 K Pa was higher than the other treatments and the control. The well-distributed rainfall that prevailed during 1999 and 2000 often disturbed the irrigation treatments.

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**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)**

The objective of this experiment was to determine available nutrients in all major soils in the coconut growing areas and to attempt to establish threshold levels for each nutrient in the soil for coconut. During the period 1996-1999, soil samples were collected to represent the top layer (0-25 cm depth) and the sub layer (25-50 cm) of four major soil series, namely, Kurunegala series, Kuliypitiya series, Boralu series and Pallama series. The total extent covered by these soils was 80970 ha. Samples were obtained at the frequency of one sampling location per every 100 ha. Soil samples were taken from each location to represent the manure circle of the coconut palm as well as the centre of the square. Leaf samples (14<sup>th</sup> frond) from coconut palms were also taken from the same location.

Table 35 shows the average nutrient concentration in the manure circle soils and the centre of square soils of both Kurunegala series and Kuliypitiya series.

**Table 35.** *Average nutrient concentration in the manure circle soils and the centre of square soils of Kurunegala series and Kuliypitiya series (Figures in brackets are number of samples)*

Nutrient	Kuliypitiya series		Kurunegala series	
	Manure circle	Centre of square	Manure circle	Centre of square
Total N (mg/kg)	1163 ± 165 (21)	1126 ± 133 (22)	1354 ± 101 (18)	1332 ± 110 (18)
Available P (mg/kg)	10.5 ± 2.6 (44)	9.76 ± 3.1 (43)	16.2 ± 2.8 (51)	7.78 ± 0.88 (56)
Exch. K (meq/100 g)	0.15 ± 0.01 (103)	0.15 ± 0.01 (123)	0.22 ± 0.02 (103)	0.16 ± 0.02 (103)
Exch. Ca (meq/100 g)	1.8 ± 0.1 (102)	2.3 ± 0.17 (121)	1.36 ± 0.10 (102)	1.83 ± 0.19 (99)
Exch. Mg (meq/100 g)	0.78 ± 0.05 (111)	0.98 ± 0.08 (123)	0.77 ± 0.06 (103)	1.87 ± 0.09 (102)
Exch. Na (meq/100 g)	0.10 ± 0.01 (108)	0.09 ± 0.01 (122)	0.13 ± 0.01 (104)	0.12 ± 0.01 (103)
Av. Fe (mg/kg)	40.3 ± 1.2 (28)	36.4 ± 2.6 (28)	41.7 ± 3.8 (40)	42.4 ± 3.5 (39)
Av. Mn (mg/kg)	45.2 ± 5.8 (19)	51.1 ± 6.2 (21)	28.0 ± 2.9 (38)	25.4 ± 3.2 (38)
Av. Cu (mg/kg)	0.55 ± 0.06 (23)	0.55 ± 0.06 (16)	0.35 ± 0.04 (35)	0.40 ± 0.03 (34)
Av. Zn (mg/kg)	0.86 ± 0.17 (18)	0.27 ± 0.057 (15)	0.39 ± 0.05 (24)	0.38 ± 0.08 (23)

There was no significant difference between nutrient concentrations in the manure circle soils with that of centre of the square soils except available Zn of Kuliypitiya series. It follows that there was no effective decrease of available nutrients in the manure circle of the coconut

palms in both soils except for Zn in Kuliypitiya series. Probably, the respective non-available nutrient pools in the soil would regularly replenish the available nutrient pools.

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**PROJECT 30: STUDIES ON THE DECOMPOSITION PATTERN OF DIFFERENT ORGANIC MANURES**

**Experiment 30.0.1: Estimation of the decomposition rate of different sources of organic manure and nutrient availability to the coconut palm (1995)**

This experiment, on a randomized complete block design with 3 replicates and 4 palms (45 years old) per plot, was established in 1996 at the following locations.

Expt. No	Location	Agro-ecological region	Soil type	Land suitability class
30.0.1.1	Mangala-eliya	DL <sub>3</sub>	Deep loamy sand (Borupan series)	S <sub>2</sub>
30.0.1.2	Horombawa	IL <sub>1</sub>	Sandy clay loam with gravel in sub soil (Kuliypitiya series)	S <sub>4</sub>

The treatments are annually applied as follows.

T <sub>1</sub>	-	Control (no fertilizer)
T <sub>2</sub>	-	Cattle manure (35 kg/palm/y)
T <sub>3</sub>	-	Goat manure (25 kg/palm/y)
T <sub>4</sub>	-	Layer poultry manure (30 kg/palm/y)
T <sub>5</sub>	-	Broiler poultry manure (30 kg/palm/y)
T <sub>6</sub>	-	Gliricidia (30 kg/palm/y)

The quantity of each organic manure is equivalent to 368 g of N.

The 14<sup>th</sup> leaf of the plot palms was sampled from both sites in April 2000. Leaf nutrient levels of 2000 did not show a significant difference between treatments. The leaf nutrient concentrations (N, P, K and Mg) of palms at the Horombawa site were within the sufficiency range of respective elements. But at the Mangala-eliya site, N and K concentrations were just below the sufficiency range for all the treatments. The yield records of nuts and copra in both experimental sites are given in Table 36. The yield differences between treatments were not significant during the whole period of the experiment. However yield of control plots (no fertilizer) was slightly lower than that of organic manure treatments.

**Table 36.** *Nuts and copra yield of experimental sites at Mangala-eliya and Horombawa*

	Mangala-eliya site				Horombawa site			
	Mean annual yield May 1996 to April 1999		Yield May 1999 to April 2000		Mean annual yield May 1996 to April 1999		Yield from May 1999 to April 2000	
	Nuts/palm/y	Copra kg/palm/y	Nuts/palm/y	Copra kg/palm	Nuts/palm/y	Copra kg/palm/y	Nuts/palm/y	Copra kg/palm/y
T <sub>1</sub>	48	8.0	56	11	43.0	7.7	44	10.2
T <sub>2</sub>	56	10.0	71	15	50.3	9.7	48	10.0
T <sub>3</sub>	56	9.3	66	13	50.3	9.3	48	10.2
T <sub>4</sub>	55	9.7	62	13	53.6	9.3	48	11.1
T <sub>5</sub>	58	9.7	60	13	52.0	10.0	46	9.8
T <sub>6</sub>	59	10.0	74	16	51.3	10.0	48	10.7

T<sub>1</sub> - Control; T<sub>2</sub> - Cow dung; T<sub>3</sub> - Goat dung; T<sub>4</sub> - Layers; T<sub>5</sub> - Broilers; T<sub>6</sub> - Gliricidia

Microbiological parameters of soils at Mangala-eliya site were also studied. The following observations were made during this study.

The bacterial and fungal incidence at Mangala-eliya and Horombawa experimental sites, 5<sup>th</sup> year after treatment application, are given in Tables 37,38,39 and 40 respectively. The summary of observations is given below. Bacteria and fungi were identified by morphological and biochemical characteristics.

- In poultry broiler & poultry layer manure treated soils, more species of fungi were present than in other treatments.
- *Gliricidia* showed a high fungal population only in the 1<sup>st</sup> sampling. It could be due to rapid decomposition of *Gliricidia*.
- Most isolated species are common soil fungi.
- In general, during the first and the second sampling times, fungal species variation was high.
- *Bacillus* species are common at both sites in all sampling times.
- Some new species of fungi and bacteria appeared during the later stages of decomposition.

The site at Horombawa had to be abandoned due to sale of the land in July 2000.

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**Table 37.** Bacteria isolated from different organic manure treated soils at different sampling times (Mangala-eliya)

Code No.	Fungi Species	Control				Cow dung				Goat dung				Poultry (layer)				Poultry (broiler)				<i>Gliricidia</i>			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A	<i>Bacillus brevis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B	<i>Bacillus cereus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
C	<i>Bacillus circulans</i>	+	+	-	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
D	<i>Bacillus coagulans</i>	+	+	-	-	+	+	-	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+
E	<i>Bacillus megaterium</i>	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-
F	<i>Bacillus mycoides</i>	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	-
G	<i>Bacillus polymyxa</i>	-	-	-	-	-	+	+	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	-	-
H	<i>Bacillus pumilus</i>	+	-	+	-	+	+	-	+	+	+	-	+	+	+	+	-	-	+	+	-	+	+	+	-
I	<i>Bacillus subtilis</i>	+	-	-	-	+	+	-	-	+	+	-	-	+	+	+	-	+	+	+	+	+	+	+	-
K	<i>Bacillus species</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
P	<i>Staphylococcus epidermidis</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-
Q	<i>Micrococcus varians</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	-	-	-	-
R	<i>Micrococcus luteus</i>	-	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	-	-	-
S	<i>Serratia liquefaciens</i>	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	-	+	+	+	-	-	-	-	-

1 - July 1999

2 - November 1999

3 - March 2000

4 - July 2000

Manure applied on 28<sup>th</sup> March 1999

**Table 38.** *Fungi isolated from different organic manure treated soils at different sampling times (Mangala-eliya)*

Code No.	Fungi Species	Control				Cow dung				Goat dung				Poultry (layer)				Poultry (broiler)				<i>Gliricidia</i>			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
a	<i>Mucor species</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
b	<i>Sacharomyces species</i>	-	-	-	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
c	<i>Aspergillus niger</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
d	<i>Aspergillus japonicus</i>	-	-	-	-	-	+	-	-	+	-	-	+	+	+	-	+	+	+	-	+	+	+	-	+
e	<i>Aspergillus ochraceus</i>	-	-	-	-	+	-	-	+	+	-	+	+	-	+	+	+	-	+	+	+	-	-	-	-
f	<i>Aspergillus flavipes</i>	-	-	+	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	-
h	<i>Penicillium citrinum</i>	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-
i	<i>Penicillium oxalicum</i>	+	+	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
j	<i>Penicillium citreonigrum</i>	-	-	-	-	-	-	-	-	+	+	-	-	+	+	+	+	+	+	+	+	+	-	-	-
k	<i>Penicillium restrictum</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-
l	<i>Curvularia species</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-
m	<i>Fusarium oxysporum</i>	+	-	-	-	+	+	-	-	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	-
n	<i>Fusarium moniliforme</i>	-	-	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-
p	<i>Syncephalastrum racemosum</i>	-	-	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-

1 - July 1999      2 - November 1999      3 - March 2000      4 - July 2000

Manure applied on 28<sup>th</sup> March 1999

**Table 39.** *Bacteria isolated from different organic manure treated soils at different sampling times (Horombawa)*

Code No.	Fungi Species	Control				Cow dung				Goat dung				Poultry (layer)				Poultry (broiler)				<i>Gliricidia</i>			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A	<i>Bacillus brevis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B	<i>Bacillus cereus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
C	<i>Bacillus circulans</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D	<i>Bacillus coagulans</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
E	<i>Bacillus megaterium</i>	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	-
F	<i>Bacillus mycoides</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	-	-	+	-
G	<i>Bacillus polymyxa</i>	-	-	-	-	-	-	+	-	+	-	+	-	+	+	+	+	+	+	+	+	-	-	+	+
H	<i>Bacillus pumilus</i>	+	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
I	<i>Bacillus subtilis</i>	+	-	-	-	+	+	-	-	+	+	+	+	+	+	+	-	+	+	+	+	+	-	-	-
J	<i>Bacillus thuringiensis</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
K	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
L	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
M	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-
N	<i>Bacillus species</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-
P	<i>Staphylococcus epidermidis</i>	-	-	-	-	-	-	-	-	+	+	-	-	+	-	-	-	-	+	+	-	-	+	-	-

1 - July 1999

2 - November 1999

3 - March 2000

4 - July 2000

Manures applied on 28<sup>th</sup> March 1999

*contd....*

Contd.

Code No.	Fungi Species	Control				Cow dung				Goat dung				Poultry (layer)				Poultry (broiler)				<i>Gliricidia</i>			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Q	<i>Micrococcus varians</i>	-	-	-	-	+	-	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
R	<i>Micrococcus lutueus</i>	-	-	-	-	+	-	-	-	+	+	+	-	+	+	+	+	+	+	+	-	+	-	-	-
S	<i>Serratia liquefaciens</i>	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	-	+	+	+	-	+	-	-	-
T	<i>Pseudomonas aeruginosa</i>	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	+	+	-	-	-	-	-	-
U	<i>Enterobacter cloacae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
X	<i>Flavo bacterium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-

1 - July 1999

2 - November 1999

3 - March 2000

4 - July 2000

Manure applied on 28<sup>th</sup> March 1999

**Table 40.** *Fungi isolated from different organic manure treated soils at different sampling times (Horombawa)*

Code No.	Fungi Species	Control				Cow dung				Goat dung				Poultry (layer)				Poultry (broiler)				<i>Gliricidia</i>			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
a	<i>Mucor</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
b	<i>Sacharomyces</i>	+	+	-	-	+	+	-	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+
c	<i>Aspergillus niger</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
d	<i>Aspergillus japonicus</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-
e	<i>Aspergillus ochraceus</i>	-	-	-	-	+	-	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+
f	<i>Aspergillus flavipes</i>	-	-	+	-	+	+	+	-	+	+	+	-	+	+	+	-	+	+	+	-	+	+	+	-
g	<i>Aspergillus terreus</i>	-	-	-	-	-	-	-	-	+	+	+	-	+	+	+	-	+	+	+	-	+	+	+	+
h	<i>Penicillium citrinum</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	-	+	-
i	<i>Penicillium oxalicum</i>	+	+	-	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-
j	<i>Penicillium citreonigrum</i>	-	-	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-	+	-	-	-
k	<i>Penicillium restrictum</i>	-	-	-	-	+	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	+	-	-	-
l	<i>Curvularia species</i>	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	+	-	-	-
m	<i>Fusarium oxysporum</i>	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
n	<i>Fusarium moniliforme</i>	-	-	-	-	+	+	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+
o	<i>Absedia species</i>	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	+	+	-	-	+	-	-	-
p	<i>Syncephalastrum racemosum</i>	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+	+	+	+	+	-	-	-	-

1 - July 1999

2 - November 1999

3 - March 2000

4 - July 2000

Manure applied on 28<sup>th</sup> March 1999

**PROJECT 30.1: STUDIES ON LONG TERM EFFECT OF ORGANIC MANURE APPLICATION TO COCONUT**

**Experiment 30.1.1: Comparison of the efficiency of three organic manures and a green manure (*Gliricidia*) against Adult Palm Mixture (APM)**

The experiment, on a randomized block design with 3 replicates and 6 (45 years old) palms per plot, was established in 1997 at the following locations.

Expt. No	Location	Agro-ecological region	Soil type	Land suitability class
30.1.1.1	Ratmalagara Estate	IL <sub>1</sub>	Andigama series (moderately deep phase)	S <sub>4</sub>
30.1.1.2	Pottukulama Estate	IL <sub>1</sub>	Welipelessa series	S <sub>2</sub>

The treatments were as a single application per year as follows.

T <sub>1</sub>	-	Control (no fertilizer)
T <sub>2</sub>	-	3 kg APM (Adult Palm Mixture) + 1 kg dolomite per palm
T <sub>3</sub>	-	35 kg cattle manure + 1200 g MOP per palm
T <sub>4</sub>	-	25 kg goat dung + 800 g MOP per palm
T <sub>5</sub>	-	30 kg poultry manure + 250 g MOP per palm
T <sub>6</sub>	-	30 kg gliricidia + 750 g SP + 1500 g MOP + 1000 g dolomite per palm

The annual leaf sampling was done in April 2000 (one year after the 3<sup>rd</sup> manure application) and the 4<sup>th</sup> manure application was completed in May 2000.

The nutrient concentrations in the 14<sup>th</sup> leaf of the plot palms of experimental site at Ratmalagara were in the sufficiency range with respect to N, P, K, Ca and Mg. In the experiment at Pottukulama, N concentration in the 14<sup>th</sup> frond ranges from 1.8 - 2.1% and Mg concentration ranged from 0.21 - 0.29%. It follows that some treatment plots were below the sufficiency range for N (< 1.9%) and/or Mg (< 0.25%) respectively. The P and K concentrations of the 14<sup>th</sup> frond of palms at Pottukulama were also in the sufficiency range.

Yield data of the experimental sites at Ratmalagara and Pottukulama are given in Tables 41 and 42 respectively.

**Table 41.** *Yield data of the experimental site at Ratmalagara Estate*

Treatment	April 97 to March 99 nuts/palm/y	April 97 to March 99 copra (kg/palm/y)	April 99 to March 2000 nuts/palm/y	April 99 to March 00 copra (kg/palm/y)
T <sub>1</sub> - Control	64	14.2	55	4.2
T <sub>2</sub> - APM + dolomite	79	16.9	56	4.9
T <sub>3</sub> - CD + MOP	89	18.0	59	5.4
T <sub>4</sub> - GD + MOP	89	18.6	63	5.6
T <sub>5</sub> - PM + MOP	88	18.1	74	5.4
T <sub>6</sub> - Gliricidia + SP + MOP + Dol	83	17.5	59	5.2
Level of Significance	ns	ns	ns	ns

**Table 42.** *Yield data of the experimental site at Pottukulama Estate*

Treatment	April 97 to March 99 nuts/palm/y	April 97 to March 99 Copra (kg/palm/y)	April 99 to March 00 nuts/palm/y	April 99 to March 00 Copra (kg/palm/y)
T <sub>1</sub>	99	34.4	62	13.1
T <sub>2</sub>	131	36.5	70	13.4
T <sub>3</sub>	143	39.6	72	15.0
T <sub>4</sub>	133	38.8	67	15.8
T <sub>5</sub>	131	38.2	66	14.8
T <sub>6</sub>	126	37.0	71	14.4
Level of Significance	ns	ns	ns	ns

T<sub>1</sub> - Control; T<sub>2</sub> - APM + dolomite; T<sub>3</sub> - CD + MOP; T<sub>4</sub> - GD + MOP; T<sub>5</sub> - PM + MOP; T<sub>6</sub> - Gliricidia + SP + MOP + Dol

The mean nut yield for animal manure was 25% higher than that of *Gliricidia* treatments at Rathmalagara experimental site.

*N A Tennakoon, M A Wasanthi Mala, B C E Perera and W Gunasena*

### 3. LABORATORY/MISCELLANEOUS STUDIES

#### (1). Determination of leaf nutrient status of young coconut palms having unsplit fronds

Coconut palms having unsplit fronds are often seen in coconut estates. This experiment was carried out to find out whether there was any nutrient disorder in those palms. Leaf samples from the 6<sup>th</sup>, 9<sup>th</sup> and 14<sup>th</sup> fronds of coconut palms, having unsplit fronds and healthy young coconut palms at Old Hotel Estate, Mundel were analyzed. Soil samples were also taken from the manure circles and centre of squares at the depth of 0-25 and 25-50 cm to determine the pH and electrical conductivity.

Leaf analysis showed that the N, Mg and Ca concentrations of 14<sup>th</sup> frond of affected palms were below the respective sufficiency ranges while that of healthy palms were within

the sufficiency range. Concentrations of Cu and Zn were also below the sufficiency range (Table 43).

N, P, Mg, Ca, Fe, Mn, Cu and Zn concentrations in 6<sup>th</sup> and 9<sup>th</sup> leaves of affected palms were lower than that of the healthy palms while K and Na concentration were higher than in healthy palms (Table 43). The pH and electrical conductivity of the soil are given in Table 44. The pH of the topsoil of the manure circle of affected palms was higher by one unit compared to that of healthy palms. This could have affected the availability of nutrients such as Fe, Mn, Cu, Zn and P. However, further experiments are needed to test any relationship between the occurrence of unsplit leaves and nutrient deficiency.

**Table 43.** *Macro and micro nutrient levels of coconut palms having unsplit leaves and healthy palms*

Number of frond	Kind of leaves	N%	P%	K%	Mg%	Ca%	Na%	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
6 <sup>th</sup>	Unsplit	1.53	0.11	2.34	0.24	0.31	0.14	279	142	5.78	23.8
6 <sup>th</sup>	Healthy	2.33	0.15	1.81	0.26	0.35	0.06	368	271	8.78	34.3
9 <sup>th</sup>	Unsplit	1.62	0.10	1.73	0.23	0.22	0.14	450	178	5.08	16.6
9 <sup>th</sup>	Healthy	1.95	0.16	1.67	0.24	0.25	0.08	473	318	6.94	32.7
14 <sup>th</sup>	Unsplit	1.27	0.12	1.47	0.16	0.29	0.14	131	142	3.99	15.3
14 <sup>th</sup>	Healthy	1.90	0.14	2.08	0.38	0.35	0.08	907	381	5.22	23.8

**Table 44.** *pH and Electrical conductivity of the soils*

Soil samples	Position	Depth (cm)	pH (1:5 w/w)	EC me.eq/cm
Unsplit	Manure circle	0-25	7.00	28.5
	Manure circle	25-50	6.09	19.5
	Centre square	0-25	5.97	19.5
	Centre square	25-50	5.71	18.0
Healthy	Manure circle	0-25	5.74	31.5
	Manure circle	25-50	5.79	27.0
	Centre square	0-25	5.99	27.0
	Centre square	25-50	6.02	22.5

*W A M Prabhashini and N A Tennakoon*

## (2). **Distribution of nutrients in coconut plantations as affected by soil series**

Leaf analysis data collected for differential fertilizer recommendations (DFR) from 1991 to 1998 were used for this study. These data were divided as from the Dry zone, the Intermediate zone and the Wet zone and again according to the soil series.

The selected soil series and the percentage of palms deficient in each soil with respect to N, P, K and Mg respectively are given in Table 45.

Data for 564 samples from the Wet, 1071 from the Intermediate and 145 from the Dry Zone were used. N deficiency was highest in the Dry Zone followed by the Intermediate Zone and the Wet Zone respectively. Occurrence of P deficiency was highest in the Intermediate Zone followed by the Dry Zone and Wet Zone.

Potassium deficiency was the highest in the Intermediate Zone followed by the Dry Zone and the Wet Zone respectively.

Occurrence of magnesium deficiency was the highest in the Wet Zone followed by the Intermediate Zone and the Dry Zone. Nitrogen deficiency was as high as 72.9% in the Dry Zone followed by the Intermediate Zone where it was 60%.

**Table 45.** *Nutrient deficient soil series in different agro-climatic zones*

Agro-climatic zone	Nutrient	Soil series	% of samples showing deficiency
Dry zone	N	Kalpitiya	72.9
	P	Kalpitiya	18.9
	K	Kalpitiya	73.7
	Mg	Kalpitiya	32.4
Intermediate zone	N	Kuliyapitiya	60.0
	P	Kuliyapitiya	46.7
	K	Kuliyapitiya	93.3
	Mg	Kuliyapitiya	53.3
Wet zone	N	Pallama	33.6
	P	Boralu	17.6
	K	Pallama	62.6
	Mg	Boralu	70.4

*R Vithya, D Giritharan and N A Tennakoon*

### (3). Loss of N after urea and dolomite application to soil

A laboratory experiment and a field experiment were established for the determination of loss of N after urea and dolomite application to a sandy soil.

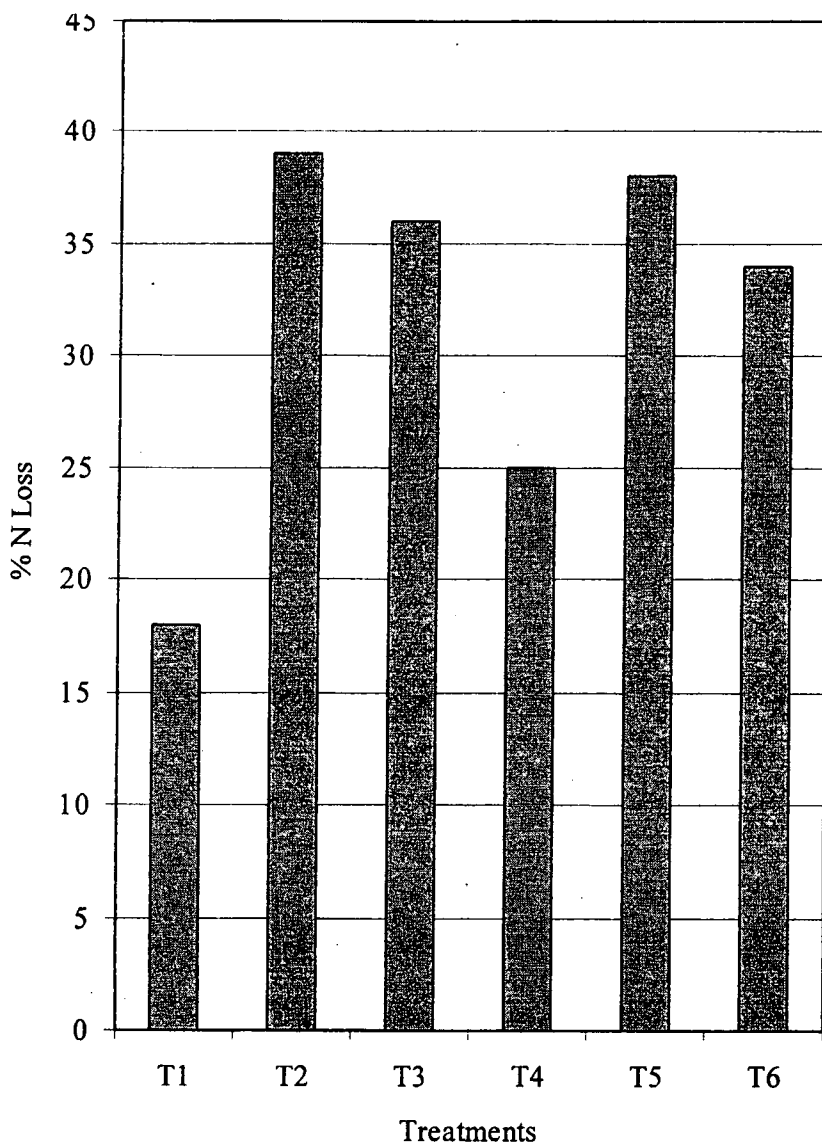
Treatments of the laboratory experiment were as follows.

- T<sub>1</sub> - Control
- T<sub>2</sub> - Urea 0.5 g/1 kg soil
- T<sub>3</sub> - Urea + dolomite mixture
- T<sub>4</sub> - Urea + dolomite mixture with mulch
- T<sub>5</sub> - Dolomite applied 3 days after urea application with no mulch
- T<sub>6</sub> - Dolomite applied 3 days after urea application with mulch

These treatments were replicated 3 times.

To determine volatilization losses, one kg of soil was placed in a large glass container and different manure combinations were applied as above. A beaker containing 5 ml of 0.05 N H<sub>2</sub>SO<sub>4</sub> mixed with indicator was placed on the soil and the lid of the container was tightly sealed. Residual H<sub>2</sub>SO<sub>4</sub> was titillated against 0.1 N NaOH after one month of storage and the absorbed ammonia calculated.

The results are shown in the Figure 1.



**Figure 1.** *Nitrogen loss in different treatments*

High rates of N volatilization were observed for treatment 2 (39%), treatment 3 (36%) and treatment 5 (38%). The volatilization was less than 24% in treatment 4, which included application of mulch after application of urea plus dolomite. Treatment 6 also showed considerable N loss (30%) during this period. This laboratory experiment clearly showed that N volatilization percentage could be reduced by the application of mulch.

A field experiment was also carried out to estimate N loss. Twenty four coconut palms were selected at Bandirippuwa Estate and the following treatments were applied in a Complete Randomized Block Design with three replicates. Treatments were as follows.

- T<sub>1</sub> - Control (no fertilizer)
- T<sub>2</sub> - Urea only (800 g /palm)
- T<sub>3</sub> - Urea (800g/palm) + dolomite (1000 g/palm) applied at the same time
- T<sub>4</sub> - Urea (800 g/palm) + dolomite (1000 g/palm) applied at the same time and mulched with coconut fronds

- T<sub>5</sub> - Dolomite (1000 g/palm) applied 3 days after urea (800g/palm) application  
T<sub>6</sub> - Dolomite (1000 g/palm) applied 3 days after urea (800g/palm) application and mulched with coconut fronds

Soil samples (0-20 cm depth) were taken every week for five weeks. Total N was determined by the Kjeldhal method.

Treatment 6 showed significantly high levels of total N (0.42%) 7 days after treatment and showed very low reduction after 4 weeks. Treatment 4 also showed high retention of N in the soil because of mulching. The others showed significantly ( $P \leq 0.05$ ) low total N values.

This study clearly shows that the application of mulch reduces N volatilization and maintains a favourable N content in the soil.

The results are shown in the Figure 2.

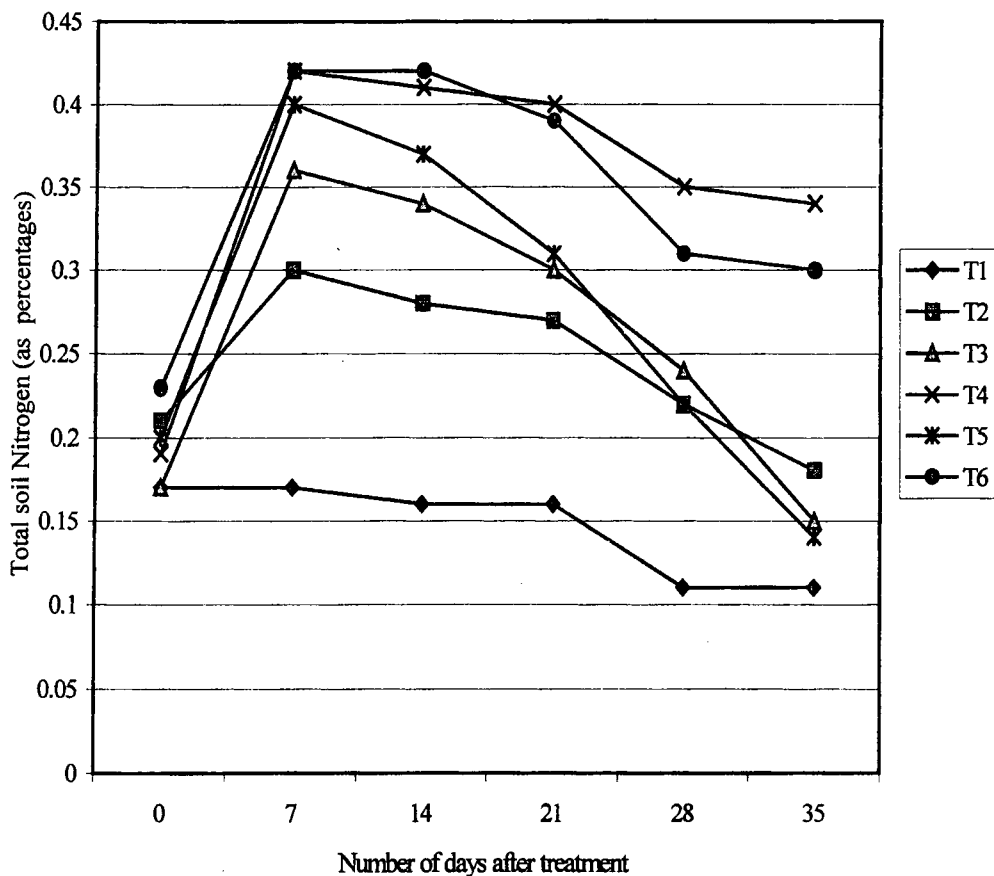
*Chalani Hettiarachchi and N A Tennakoon*

#### **(4). Extraction of available nutrients in husks by leaching**

The sequential leaching of fresh husks was done and the leachate was analyzed for available N and K. The fresh husks were cut into 2 cm x 2 cm cubes and 2 g of husk pieces were shaken with 100 ml of water for 1 h and filtered. The residues were again shaken with 100 ml of water and filtered. The procedure was continued until no nutrients were found in the filtrate. The total nutrient content in a husk was also determined for comparison.

The investigations have shown that the total plant nutrient content in a husk is about 2.6% of its dry weight. Potassium and nitrogen are the dominant nutrients in the husk, the concentrations of which are approximately 2% and 0.3% respectively. The carbon/nitrogen ratio was 151: 1. An interesting character of the husk is that 35% of total potassium can be leached with water. Thus, a heap of husks from 1000 coconuts contain about 3.4 kg of leachable potassium. These are equivalent to 6.2 kg of muriate of potash. By burying husks in coconut lands soon after dehusking, the readily leachable quantity of potassium can be conserved as fertilizer. To meet the annual potassium requirement of a coconut palm, husks of 223 nuts would be sufficient.

*D M D I Wijebandara and L L W Somasiri*



**Figure 2.** Total soil nitrogen with different treatments

**(5). Estimation of removable N, P, K and Mg in coconut growing soils**

A pot experiment was carried out in three different soil series (Boralu series, Wariyapola series and Kurunegala series) with *Panicum maximum* to estimate the removable N, P, K and Mg in major coconut growing soils.

Soils in pots were treated with the following treatments with 4 replicates in a Completely Randomized Block Design.

T <sub>1</sub>	-	Control (no fertilizer)
T <sub>2</sub>	-	(-N) 1 g TSP, 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O
T <sub>3</sub>	-	(-P) 0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O
T <sub>4</sub>	-	(-K) 0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O
T <sub>5</sub>	-	(-Mg) 0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.2 g KCl
T <sub>6</sub>	-	(+NPKMg) 0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O

The grass was cut at soil level at one month intervals and fresh and dry weights were recorded. Monthly harvesting will continue until the grass ceases its vegetative growth.

Chemical analysis of samples is in progress.

**4. Acknowledgments**

I sincerely thank the Head, and the staff of the Biometry Division for the assistance in designing field experiments, data recording and statistical analysis.

# REPORT OF THE CROP PROTECTION DIVISION

Head - L.C.P Fernando, PhD

## 1. SUMMARY

An outbreak of a leaf rot disease caused by a complex of fungi was reported from Matara and part of Galle districts. Preliminary field studies with different fungicides indicated that drenching of Tebuconazole (Folicur) and Tridemorph (Calixin) were effective in controlling the disease. These chemicals were recommended and long-term studies were initiated.

The distribution pattern of coconut mite, *Aceria guerreronis* and its predator, *Neoseiulus paspalivorus* in infested palms were studied in two sites. Out of the infested nuts of 3-7 months old, 46% and 24% did not show symptoms of damage in Kalpitiya and Madurankuliya respectively. The highest mean number of pest and predator was present in 5 to 6 months old nuts. A significantly high variability in the mean number of *A. guerreronis* and *N. paspalivorus* was observed among nuts which will have implications in interpreting experimental data. The study of the seasonal population pattern of *A. guerreronis* and *N. paspalivorus* populations was continued in 3 sites. In all sites populations of the pest and the predator fluctuated over time. The peak population of the pest was between July - August, June - September and August - September in Kalpitiya, Madurankuliya and Wanathavillu respectively. The predators also followed a similar trend except in Wanathavillu. The neem based product, "Nomite plus" sprayed on to the infested bunches reduced the mite population by about 64% in 3 weeks. The field trials in determination of the optimum frequency of application of Neem oil and garlic mixture and NeemAzal are in progress. During a survey conducted in Gampaha District a entomopathogenic fungus of *A. guerreronis*, *Hirsutella thompsonii* was isolated. The local strain and the imported Ivory Coast strain of *H. thompsonii* gave over 60% mortality of *A. guerreronis* in the laboratory and their pathogenicity was proved in preliminary field tests.

An experiment was initiated using trap densities of 6, 4 and 3 per hectare to determine the optimum density for mass trapping of red weevil, *Rhynchophorus ferrugineus*. Field testing of the electronic device to detect palms infested by red weevil, revealed that it needs to be further improved to be effective in field conditions, hence modified.

The effect of placing pheromone traps in a field containing breeding grounds of black beetle, *Oryctes rhinoceros* was tested. The traps placed at a rate of 2 traps per ac. reduced the fresh bud damage of young palms from 27% to 3% in a 3-month period and continued at the same level. Removal of traps after 9 months increased the damage again. The trail started to evaluate the efficacy of different chemicals against black beetle was not successful due to high incidence of *Baculovirus* and *Metarrhizium* infections of breeding larvae and absence of damage on seedlings.

The effect of releasing *Eriborus trochanteratus* and *Brachymeria nephantidis* separately and in combination in controlling coconut caterpillar, *Opisina arenosella* was determined. Both species reduced the pest population by more than 90% within 4-5 months after release, while the reduction in the population occurred in 2 - 4 months when both species were released together. However, the parasitism did not increased considerably over time due to the lack of suitable hosts between pest generations.

Studies on the infectivity of fungus, *Ganoderma boninense* were continued. The seedlings planted in vacancies created due to death of *Ganoderma* infected palms at different durations prior to transplanting were not infected up to 2 years. No infection was detected in seedlings raised in nurseries of disease affected estates up to the end of nursery period.

The study to determine whether nesting sites are a limitation for the existence of honeybees in coconut lands was continued. The occupancy rates of pots at the end of the year were 53.3%, 20% and 6.6% in Walpita, Nalla and Bandirippuwa respectively.

The staff of the Division continued to assist the growers and the Coconut Cultivation Board in managing the pests and diseases.

### **Outbreak of leaf rot disease**

An outbreak of a leaf rot disease was reported from Matara and parts of Galle districts. Nearly, 25000 palms, have been affected by the disease. The identification of the causal agents of the disease revealed that complex of fungi is involved. Most common fungi are *Fusarium*, *Gleosporium*, *Geocladium*, *Exserohilum*, *Pestalotiopsis*, *Rhizoctonia* and *Curvularia* species.

The fungi infect the unopened tender fronds and cause a wet rot, which starts from the tips of spindle leaves as brown water-soaked lesions. The lesions gradually enlarge, turn black and rot. Later these lesions coalesce and the rot extends to the whole leaf. When the disease progresses, and affected leaves mature the rotten parts break away giving the palm an appearance similar to black beetle damage. Mostly the rotten leaflets stick together and the leaf appear as a fish bone when it fully open. Sometimes lesions could be seen on midribs of palms too. Preliminary field studies with different fungicides indicated that drenching 1l of Tebuconazole ("Folicur" 4ml/ L), Tridemorph ("Calixin" 5ml/L) at 2 monthly intervals or spraying of 1% Copper fungicide solution, 0.5% Dithiocarbamate solution at 3-5 week intervals on to the crown after pruning the affected spindles were effective in controlling the disease. These chemicals were recommended as interim measures and long-term studies were initiated.

## **2. RESEARCH PROJECTS**

### **PROJECT 15.1: STUDIES ON ACTIVITY PATTERNS OF LARVAL AND PUPAL PARASITOID SPECIES OF COCONUT CATERPILLAR (1995)**

#### **Experiment 15.1.18: Effect of host deprivation on fecundity and longevity of *Brachymeria nephantidis* (2000)**

In the field, the parasitoids have to survive without suitable hosts for varying lengths of time due to the discrete generation pattern of coconut caterpillar. A laboratory study was conducted to determine how host deprivation would affect *B. nephantidis*. Each of 6 female *Brachymeria* were withheld from hosts for durations of 5, 10, 15 and 20 days and were provided with hosts thereafter until their death. Another 6 females were provided hosts throughout their lives and all insects were fed with honey during the experimental period. The number of ovipositions and the longevity of each female were recorded.

The results showed that host deprivation significantly affect the fecundity of females (Mann-Whitney test; significant at 0.03), but there was no significant difference in ovipositions (Kruskal Wallis test;  $P < 0.05$ ) among females deprived of hosts for different durations. The mean fecundity of undeprived females was 65.3 while females deprived for 5, 10, 15 and 20 days laid mean numbers of 38.0, 36.0, 28.3 and 22.8 eggs respectively. However, the longevity of females was not significantly affected by host deprivation (Mann-Whitney test; significant at 0.13). The mean longevity of undeprived females was 17 days while it was 15.6, 20.8, 25.8 and 30.8 days in females deprived for 5, 10, 15 and 20 days respectively. Even the longevity of females increased when deprived of hosts their fecundity was drastically affected if hosts were not available for 5 days which is always the case in the field.

L C P Fernando, K A S Chandrasiri and K F G Perera

**Experiment 15.1.19: Determination of the effectiveness of a single release of *Eriborus trochanteratus* and *Brachymeria nephantidis* in controlling coconut caterpillar in the field (2000)**

*E. trochanterartus* and *B. nephantidis* were released once, singly and in combination to determine the effectiveness of a single augmentative release in controlling coconut caterpillar in the field. Release of *E. trochanterartus* was made in Kumarasena estate at Embilipitiya and *B. nephantidis* was released in Moraketiya estate, Embilipitiya and Weehena estate, Ganewatte. Similarly a combination of both species were released in Katunayake and in Ratnawathie estate, Moraketiya. The ratios of the parasitoids released to numbers of suitable stage of the pest are given in Table 1.

The pest populations were reduced to about half in the subsequent generation after the release of parasitoids (Table 1). However it took varying intervals to reduce the pest population to a very low level at each site. At both sites in which a combination of parasitoid species were released, >90% of the pest present at the time of parasitoid release was controlled in 2 - 4 months after release (2 - 3 generations after release) while it occurred only at one of the *Brachymeria* release sites and *Eriborus* release site at the same interval.

Reduction in coconut caterpillar populations in the field could be due to the parasitoids released, parasitoids present in the field or micro-climatic factors. Micro-climatic factors would directly influence the coconut caterpillar population and affect the survival of parasitoids. In Ratnawathie and Kumarasena estates, parasitization by parasitoids that existed in the field were higher than in other sites and may have too contributed to the reduction in the pest (Table 2).

**Table 1.** Percentages of the pest populations at each generation with respect to population level prior to release of parasitoids

Pest generation after release	Percentage pest and release ratio (pest: parasitoid)				
	Eriborus	Brachymeria		Eriborus + Brachymeria	
	Kumarasena estate	Weehena estate	Moraketiya estate	Katunayake Eri.- 300:1 Brac.- 300:1	Ratnawathie estate Eri.-300:1 Brac.-100:1
1	12.7	47.9	64.2	41.5	45.8
2	27.9	53.4	8.4	9.2	32.3
3	10.9	50.5	3.8	6.9	5.2

The parasitism rates of the parasitoids released were very high in the pest generation following the release compared to the pre-release rates confirming that release of *Eriborus* and *Brachymeria* were responsible for the drastic reduction in the pest populations (Table 2). Both parasitoid species either released singly or in combination gave over 25% parasitism of the total pest and even much higher rates of the suitable pest stages (either larvae or pupae) (Table 3) in the first generation after release except at Moraketiya where pest: parasitoid ratio was highest. However, the parasitism rates of the subsequent generations varied from site to site (Table 2). This suggests that the unavailability of suitable pest stages continuously and change in micro-climatic conditions influence the survival of the parasitoids and hence their effectiveness.

The results also showed that the parasitism rates varied with the number of parasitoids released in relation to the number of suitable pest stages present at the time of release. The highest parasitism rate of *Brachymeria* was recorded at Ratnawathie estate where pest: parasitoid ratio was lowest (100:1) while it was lowest at Moraketiya estate where the ratio was highest (1000:1) (Table 3). In *Eriborus* release sites too, the same trend existed. However, this trend was not same in subsequent generations.

**Table 2.** Percentages of parasitism of the total pest population (larvae and pupae) by the parasitoids released and that present in the field at each generation of the pest in five sites

Gener- -ation	Estate and parasitoid species											
	Kumarasena estate		Weehena estate		Moraketiya estate		Katunayake			Ratnawathie estate		
	Eri.	Other	Brac.	Other	Brac.	Other	Eri.	Brac.	Other	Eri.	Brac.	Other
0	0.5	1.5	7.7	10.3	0.6	1.1	6.0	2.1	0.0	0.0	2.1	1.0
1	39.2	22.3	39.3	14.6	17.0	3.0	27.3	10.1	0.0	8.4	16.8	25.0
2	10.1	10.9	22.5	7.7	47.9	13.0	45.8	16.4	0.0	3.8	20.6	34.7
3	38.2	17.6	29.2	10.0	48.2	24.5	31.5	11.9	0.0	8.6	41.9	25.9

**Table 3.** Percentage parasitism of pest larvae by *Eriborus* and pest pupae by *Brachymeria* in each pest generation at different sites

Generat- -ion	Percentage parasitism and release ratio (pest: parasitoid)									
	Kumarasena estate		Weehena estate		Moraketiya estate		Katunayake		Ratnawathie estate	
	Eri. 100:1	Brac. 300:1	Brac. 300:1	Other 1000:1	Eri. 300:1	Brac. 300:1	Eri. 300:1	Brac. 100:1		
0	0.5	14.0	3.9	7.7	9.6	0.0	10.7			
1	54.8	63.5	32.2	29.9	68.9	14.9	78.7			
2	18.6	39.7	52.7	64.0	84.5	9.7	60.3			
3	48.7	76.2	63.1	65.3	100.0	36.8	82.9			

The percentages of parasitism of *Brachymeria* at the same release ratio was nearly equal but that of *Eriborus* was not the same (Table 3) indicating that *Eriborus* is more sensitive to micro-climatic conditions.

It could be concluded that releasing sufficient numbers of lab-bred *E. trochanteratus* and *B. nephantidis* could control high populations of coconut caterpillar. The results suggests that release of *Brachymeria* and *Eriborus* at ratios of 100:1 - 300:1 and less than 300:1 (pest: parasitoid) respectively would be sufficient, but further studies are required for confirmation. Since micro-climatic conditions could affect the effectiveness of the parasitoids considerably

release of both *E. trochanteratus* and *B. nephantidis* in combination is desirable to obtain early control of the pest.

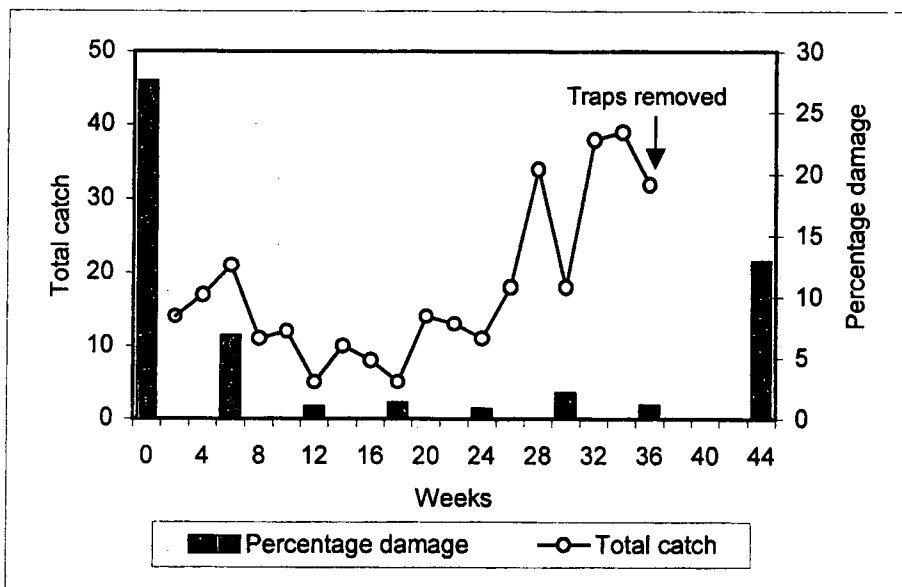
*L C P Fernando and K A S Chandrasiri*

### PROJECT 16.4: DEVELOPMENT OF A PHEROMONE TRAP FOR THE CONTROL OF BLACK BEETLE IN COCONUT PLANTATIONS (1996)

#### Experiment 16.4.6: Effect of placing pheromone-baited traps in reducing damage of black beetle (2000)

In the previous studies it has been shown that pheromone-baited traps are effective in trapping black beetle in the field. Therefore, the effect of placing traps in the field in reducing the damage of black beetle was commenced in a 5 ac. block in Katunayake where the breeding grounds are inside the experimental site. The traps were placed at a rate of 2 traps/ac and bi-weekly beetle catches and monthly fresh bud damage assessments were made.

The damage reduced from 27.5% to 1.5% in 3 months and continued until the traps were removed at 9 months (Fig. 1). The increase in the damage after removal of traps suggested that removal of traps when the beetle catches are still high could increase the damage again. The study is being continued with reinstallation of the traps.



**Fig. 1.** Captures of *O. rhinoceros* and percentage bud damage in the palms during trapping and after removal of traps

*L C P Fernando, D C L Hapuarachchi and N G Premasiri*

**PROJECT 17: STUDIES ON THE CONTROL OF BOLE AND ROOT ROT DISEASE OF COCONUT (1993)**

**Experiment: 17.1.3: Studies on infection of coconut seedlings by *Ganoderma boninense* when filling vacancies in *Ganoderma* affected lands (1998)**

At Sitrakala estate, Ambalantota fifty vacancies that occurred due to the death of infected palms 1, 2, 3, 4 and 5 years before were filled with 10 months old T x T coconut seedlings. Ten seedlings were planted for each category. Root samples from five randomly selected seedlings from each category were plated on *Ganoderma* Semi-selective medium (GSM) aseptically. No infection was detected two and a half years after planting. The experiment is in progress.

*H T R Wijesekara, I R Wickramananda, L C P Fernando, S P Manoj and N G Premasiri*

**Experiment 17.1.4 : Studies on infection of coconut seedlings by *G. boninense* in nurseries of disease affected estates (1998)**

Three nursery beds established in Dehigahalanda and Sitrakala estates, which are affected by *Ganoderma* and unaffected nursery at Embilipitiya from nuts of a affected *Ganoderma* estate were tested for infection of *Ganoderma*. No infection was detected from samples of roots, collar tissues and husks until end of the nursery period.

*H T R Wijesekara, L C P Fernando, S P Manoj and N G Premasiri*

**PROJECT 18.1: INVESTIGATION OF BEEHONEY PRODUCTION IN DIFFERENT COCONUT BASED CROPPING SYSTEMS**

**Experiment 18.3: Assessment of the performance of honeybee colonies (1998)**

The experiment commenced to determine whether nesting sites are a limitation for the existence of honeybees in coconut lands was continued. Thirty pots each at Bandirippuwa and Walpita and ten pots at Nalla were maintained. Eighteen colonies at Walpita were attacked by a predator bird, during March and April and therefore, those colonies have been absconded during this period. Later, the attack was prevented by covering the pots using a wire mesh.

It was observed that in Walpita where many intercrops were available, the pots had a higher occupancy rate than in Nalla where only few intercrops are available (Fig. 2).

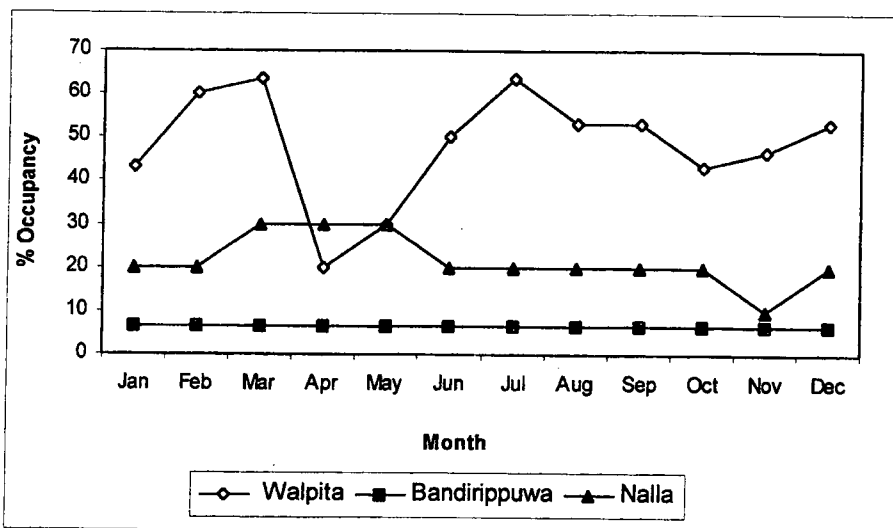


Fig. 2. The occupancy rate of pots by honey bees at Walpita, Nalla and Bandirippuwa during 2000

Pots at Bandirippuwa were very weakly occupied by the bees during the year. The results revealed that although nesting sites are available, bees do not tend to occupy them and survive well in any area, which could be due to insufficient food or unsuitable climatic conditions or both. In Walpita availability of food sources such as cocoa, pepper, passion fruit, pineapple, banana etc. and also the cooled microenvironment under the intercrops where pots have been kept might have favoured the occupancy and survival of bees.

*N S Aratchige, L C P Fernando and W W F N Fernando*

## PROJECT 24.1: ASSESSMENT OF YIELD LOSSES OF COCONUT DUE TO PEST INFESTATIONS

### Experiment 24.1.1: Effect of coconut scale infestations on the yield of coconut (1998)

The experiment initiated at Andigama Farm to assess the copra loss due to coconut scale infestations was completed. Each of twenty palms was selected from healthy palms and palms having over 60% leaves damaged and treated to check further infestation. The number and husked weight of nuts of each palm were recorded at each pick for three years.

There was no significant difference in the mean yield per year between healthy and affected palms in each year (Table 4). Similarly no significant difference in mean copra yield between healthy and affected palms was observed (Table 4). However, mean yield and copra content of affected palms was lower than that of unaffected palms.

**Table 4.** Mean yield per year and copra weight per palm per pick in each year

Damage category	Number of nuts and copra weight (kg)					
	1998		1999		2000	
	No. nuts	Copra wt.	No. nuts	Copra wt.	No. nuts	Copra wt.
Healthy	78.4	0.29	77.2	0.24	52.5	0.23
>60%	66.8	0.27	69.0	0.22	46.9	0.23
Sig.	ns	ns	ns	ns	ns	ns

**PROJECT 25: CONTROL OF VERTEBRATE PESTS IN COCONUT PLANTATIONS (1997)**

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

The two year experiment conducted to evaluate different mechanical barriers viz. barbed wire, wire mesh, tiles and polythene in protecting seedlings from rat damage at Pitiyakanda estate, Mawathagama was completed. The materials were fixed around the collar regions of seedlings to protect them from rodents. The treatments were arranged in Randomized Block Design with 36 replicates.

The percentages seedlings dead at the end of the experimental period were 31.1%, 19.4%, 16.7%, 19.4% and 33.3% in seedlings protected by barbed wire, wire mesh, tiles, polythene and unprotected respectively.

The results confirmed the findings of the previous experiment conducted at Yatawatte estate and therefore it could be recommended that covering the collar region of seedlings with roof tiles and wire mesh are effective in preventing damage to seedlings. Wire mesh is more preferred because it would not cause building up of heat around the collar region as in the case of tiles and polythene barriers.

*L C P Fernando, I R Wickramananda, D M Jayakody and N G Pemsiri*

**PROJECT 26: IMPROVEMENT OF INTEGRATED PEST MANAGEMENT PROGRAMME FOR RED WEEVIL (1998)**

**Experiment 26.1: Development of an electronic device for the detection of red weevil infested palms (1998)**

Limited preliminary testing in the field showed that the device to detect the presence of red weevil larvae in the palms is highly effective in amplifying the crunching sound while filtering out environmental and other noises. The major limitation of the device was that it could detect larvae that are present up to about 2' distance either way from the sensor. Therefore the sensor of the detector had to be placed at 4' distances of the trunk, which is time consuming and impractical. Later it was improved to detect larvae of up to a 4' distance.

*L C P Fernando, N Nanayakkara (University of Moratuwa), K F G Perera and W W F N Fernando*

**Experiment 26.2: Determination of optimum trap density for mass trapping of red weevil**

The present recommendation for mass trapping of red weevil using pheromone-baited trap is highly accepted by the growers due to its effectiveness. Presently it is recommended to install the traps at a density of 6 traps per hectare. In large plantations, a large number of traps are required to cover the whole area. This is costly and therefore it is

important to consider the possibilities of reducing the density of traps while effectively trapping the weevils.

The objective of this study was to determine the optimum trap density for mass trapping of red weevil. Six hectares of about 7 years old plantations were selected at Badalgama and Dunkannawa for the experiment. At both sites traps were installed at three densities i.e. 6, 4 and 2 traps per ha. Each treatment was replicated in two hectares in each location. The infested palms were counted before the traps were installed and weevils captured are sexed and counted weekly. Damage assessment is done at two-month intervals. The experiment is in progress.

*I R Wickramananda, K F G Perera, W W N Fernando and R Wijetunga*

#### **PROJECT 27: CONTROL OF COCONUT MITE, *ACERIA GUERRERONIS* (1999)**

##### **Experiment 27.11: Studies on population fluctuations of coconut mite, *A. guerreronis* and the predatory mite, *Neoseiulus paspalivorus* (1999)**

The populations of *A. guerreronis* and *N. paspalivorus* were monitored in 6, 7 and 4 estates in Kalpitiya, Madurankuliya and Wanathavillu respectively. One young nut from each of five palms was sampled in each estate at monthly intervals. The number of coconut mites and predatory mites in each nut were recorded.

In all sites populations of both species of mites fluctuated over time. In general, the peak population of the coconut mite was observed between June and September. The peak populations in Kalpitiya, Madurankuliya and Wanathavillu were recorded between July-August, June-September and August-September respectively (Fig. 3). However very high populations of coconut mite were also recorded in January at Madurankuliya and in April at Wanathavillu, which was due to a very large numbers present in a few nuts.

The results indicated that in Kalpitiya and Madurankuliya the predatory mite populations followed a similar trend as the coconut mite population, but in Wanathavillu such was not observed (Fig. 3).

The study is in progress.

*N S Aratchige, L C P Fernando, K A S Chandrasiri, P Manoj and M Gunawardena*

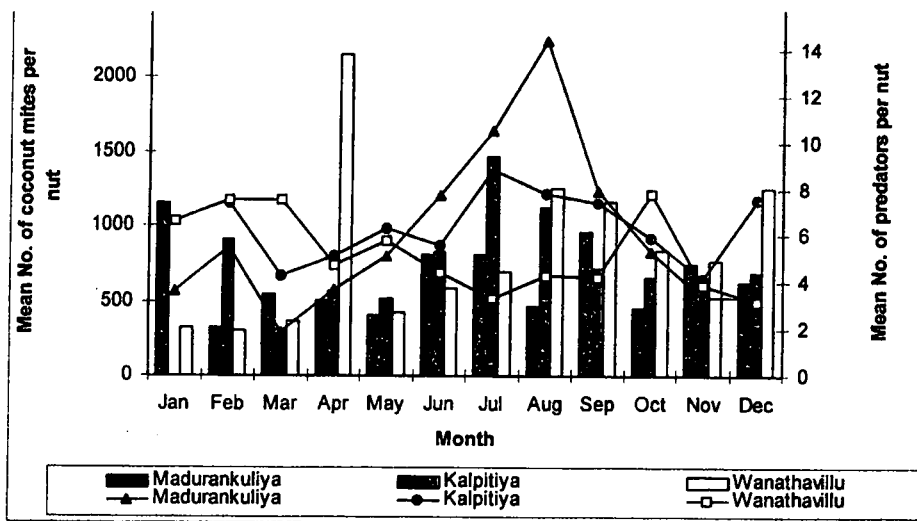


Fig. 3. Mean populations of coconut mite (columns) and predatory mite (lines) at Kalpitiya, Madurankuliya and Wanathavillu in 2000

#### Experiment 27.12: Development of a rearing technique for *N. paspalivorus* (1999)

The arena used for rearing of *N. paspalivorus* was modified. The new arena consisted of a black paper dipped in paraffin wax and was kept on 0.5cm foam with the edge lined with moist tissue papers to prevent mites escaping. Eight such arenas can be kept in a plastic container of 45cm x 30cm x 6cm. Pieces of tender tissues of coconut containing coconut mite were provided as the food sources and the arenas were kept in dark. The predators oviposited and developed to the adult stage successfully. However provision of coconut mite is not always possible in rearing of the predatory mite, hence alternative hosts mites have to be identified.

Leaf samples of weeds in the understory of infested coconut palms were collected from 4 estates in Kalpitiya and observed for alternative hosts. No suitable hosts were found. The study is in progress.

*N S Aratchige, L C P Fernando M Gunawardena and K F G Perera*

#### Experiment 27.13: Distribution patterns of *A. guerreronis* and *Neoseuilus paspalivorus* in coconut palms (2000)

The distribution patterns of *A. guerreronis* and the predator *N. paspalivorus* in 3-7 months old bunches of 30 infested palms at Kalpitiya and Madurankuliya were studied.

In Kalpitiya and Madurankuliya coconut mite were present in average of 88% and 75% of the nuts respectively. Out of these nuts 46% and 24% of the nuts respectively did not show symptoms of damage. The mean number of coconut mites per nut varied significantly ( $P < 0.0001$ ) among palms, bunches of the same palm and bunches of the same age in each site. In both sites the mean number of coconut mites increased up to bunch 5 and declined thereafter (Table 4). The coefficient of variation (CV) for each bunch was very high indicating that there was a high variability in the number of coconut mites among nuts of the same age (Table 4).

The mean number of predatory mites per coconut mite infested nut varied significantly among palms and bunches of different ages at Kalpitiya ( $P < 0.05$ ) and Madurankuliya ( $P < 0.01$ ). The mean number of predatory mites were higher in older bunches than in younger ones (Table 5) probably due to the less tightness of the perianth in older nuts which makes easy access to them. However the CV for bunches of the same age was very high (Table 5).

**Table 4.** Distribution of mites per nut among bunches of different ages at Kalpitiya and Madurankuliya

Bunch no.	Kalpitiya				Madurankuliya			
	Mean	Median	Max.	CV	Mean	Median	Max.	CV
3	254.9 <sup>c</sup>	180	1170	85	174.9 <sup>d</sup>	90	1140	125
4	520.0 <sup>b</sup>	390	4770	111	514.3 <sup>ab</sup>	300	2220	103
5	692.6 <sup>a</sup>	555	4410	96	574.8 <sup>b</sup>	330	3540	128
6	497.8 <sup>b</sup>	420	2220	72	450.8 <sup>b</sup>	285	2580	120
7	314.3 <sup>b</sup>	270	780	61	325.6 <sup>c</sup>	180	2670	136

Mean numbers with the same letter are not significantly different (Duncan grouping)

**Table 5.** Distribution of *N. paspalivorus* in bunches of different ages at Kalpitiya and Madurankuliya

Bunch number	Kalpitiya			Madurankuliya		
	Mean	Range	CV	Mean	Range	CV
3	0.05 <sup>b</sup>	0 - 06	1072	0.46 <sup>b</sup>	0 - 04	204
4	0.70 <sup>b</sup>	0 - 12	271	2.63 <sup>a</sup>	0 - 26	171
5	2.80 <sup>a</sup>	0 - 34	202	2.52 <sup>a</sup>	0 - 13	126
6	3.40 <sup>a</sup>	0 - 49	203	3.58 <sup>a</sup>	0 - 22	124
7	2.70 <sup>a</sup>	0 - 20	147	3.00 <sup>a</sup>	0 - 33	182

Mean numbers with the same letter are not significantly different (Duncan grouping)

The variations in the numbers of coconut mites even in the bunches of the same age is due to their colonization pattern and this fact need to be considered in sampling of infested nuts for research studies and reliable interpretation of the experimental data.

*H G Buddhika, C N Gammathige (NAITA), L C P Fernando, N S Aratchige and  
D C L Hapuarachchi*

#### **Experiment 27.14: Pathogenicity of local and Ivory Coast strains of *Hirsutella thompsonii* on *A. guerreronis* (2000)**

During a survey conducted in six Divisional Secretariat regions in the Gampaha District, a local strain of the fungus *Hirsutella*, which is a prospective bio-control agent of coconut mite was isolated from dead *Colomerus novaehbridensis*. *C. novaehbridensis* mites live underneath the perianth of coconuts and causes minor damage. This fungus was identified as *Hirsutella thompsonii* by the CABI Bioscience, UK.

Pathogenicities of the two strains on *A. guerreronis* were tested in the laboratory. Agar discs of 0.5cm diameter and containing the mycellium and spores of the fungi were inserted into similar size holes cut out on perianths of 3 - 4 months old infested nuts. Agar discs without fungus were placed in nuts used as control treatment and each treatment consisted of 7 replicates. The dead mites were collected from the nuts few days after

inoculation, kept in a high humidity chamber and presence of *Hirsutella* mycellium on dead mites was recorded.

The highest mortality of 86.6% mites due to fungus and other reasons was obtained in the imported strain. Mortality of the local strain was 77.5% in the local strain and the mites in the untreated nuts had a mortality of 7.9% due to reasons other than the fungus. However there was no significant difference between local and imported strain of *Hirsutella*.

The same test was carried out using tender coconut leaf pieces, which is a suitable substrate to rear coconut mites and overcome the difficulty in counting live mites on nut pieces. Eighteen tender leaf pieces of 2.5cm length were placed on petri-plates containing black paper and cotton wool at the edge. Leaf pieces were artificially contaminated with local and imported strains of *Hirsutella* and twenty-five adult mites were introduced. The numbers of dead and live mites in different stages were counted.

The results indicated that local strain is as nearly effective as the imported strain (Fig. 4). Only few mites of the local strain had escaped infection. It also showed that mites could breed among the folded parts of the tender leaflets of coconut seedlings.

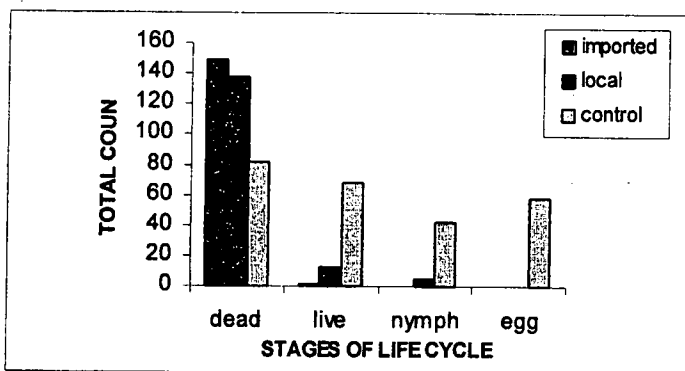


Fig. 4. Number of dead and live mites and their different stages on leaf tissues treated with imported and local strains of *Hirsutella* ( $n = 6$ )

Preliminary field studies revealed that the local strain was pathogenic to coconut mites in field conditions.

*D J Herath (University of Peradeniya), H T R Wijesekara, L C P Fernando  
W W F N Fernando and J M R S Bandara (University of  
Peradeniya)*

#### Experiment 27.15: Determination of the frequency of application of NeemAzal and Neem oil-garlic mixture for effective control of *A. guerreronis*

From preliminary studies it was found that both NeemAzal and Neem oil-garlic mixture are effective in reducing the populations of coconut mite by about 60%. However, effective period of a single application and the consequences of repeated applications are yet to be determined. Therefore, this experiment was designed to study the pattern of population reduction of both pest and predatory mites in the palms treated at different frequencies and to prepare a schedule for long-term chemical application, based on the results.

Infested palms were selected in two sites, Anawasal and Pallivasalthurai at Kalpitiya. Palms were treated with neem oil (20ml) and garlic (20 g) per litre water and 4 ml NeemAzal in one litre of water. One litre was sufficient to spray all bunches of four palms using a hand sprayer after climbing the tree. Both treatments were repeated at three different intervals viz. monthly, one and half monthly and two-monthly. Each treatment consisted of seven palms. The total number of nuts in bunches were recorded at monthly intervals. One nut was collected from each palm at monthly intervals and the populations of coconut mites were estimated.

The results showed that in both sites there was a clear reduction (with respect to the initial population) in the number of coconut mites in most treatments at 1 week after the treatment (Figs. 5 and 6). Thereafter the populations fluctuated largely in both sites without having consistent trends. However, in Anawasal the populations in all treatments, except in the palms treated with neem oil and garlic at 1½ -month intervals were lower than that of the control. The palms treated with neem oil and garlic at 2-month intervals always had the populations lower than that of the initial population, hence the most effective treatment (Fig. 5). But in Pallivasalthurai the palms treated with NeemAzal at monthly intervals had the populations lower than that of the initial population (Fig. 6). The experiment is being continued.

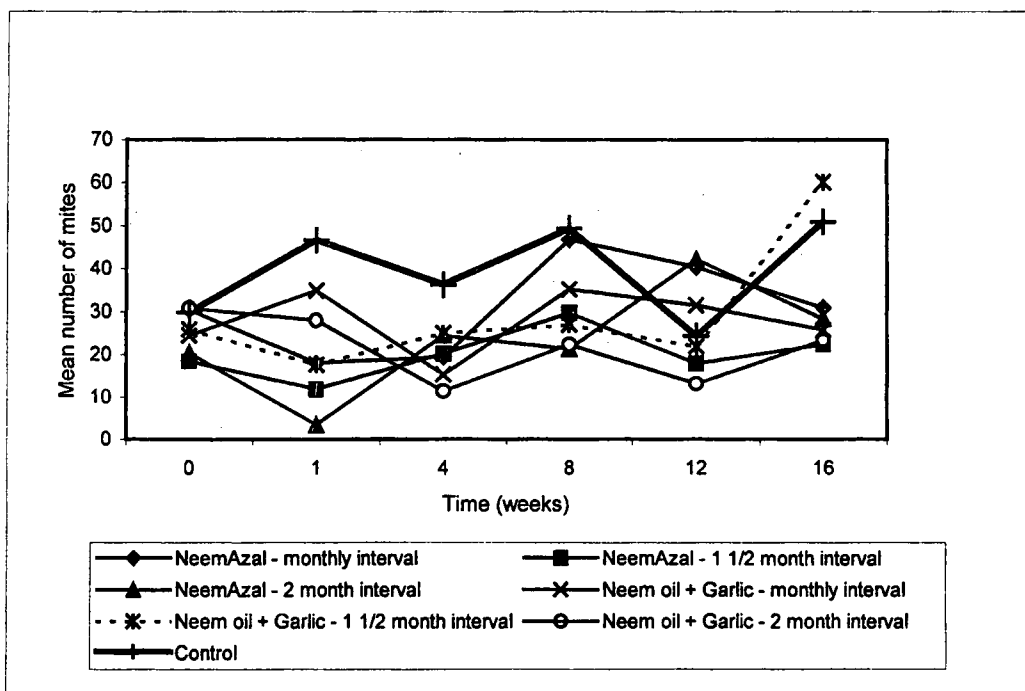


Fig. 5. Population levels of *A. guerreronis* in different treatments with time at Anawasal

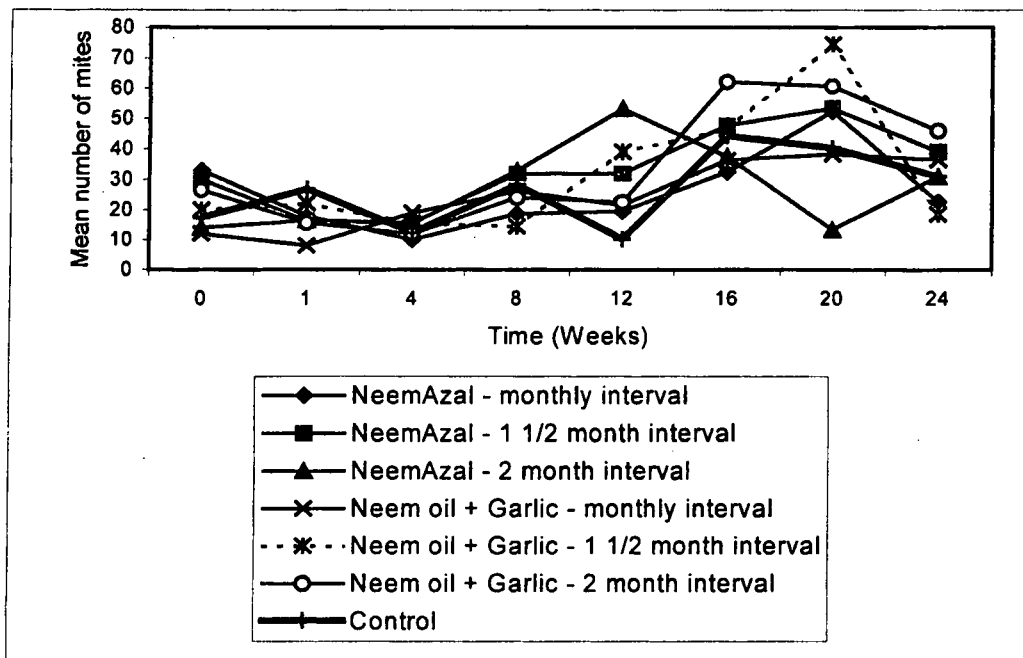


Fig. 6. Population levels of *A. guerreronis* in different treatments with time at Pallivasalthurai

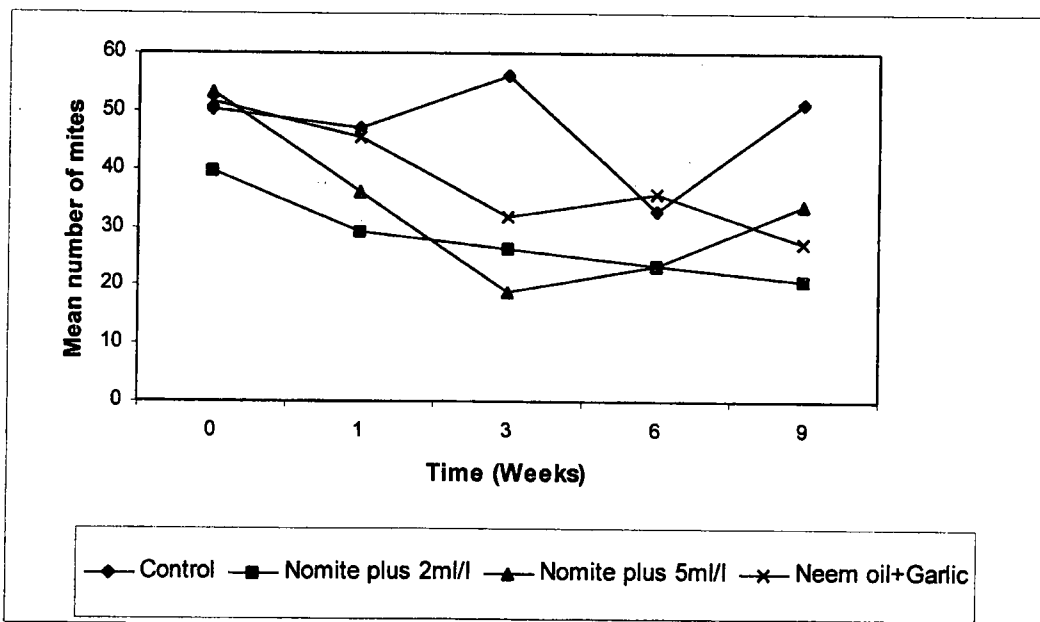
I R Wickramananda, K F G Perera and D M Jayakody

#### Experiment 27.16: Evaluation of Nomite plus for the control of *A. guerreronis*

Nomite plus is a commercial product which contains neem and garlic extracts. It has been tested in India and proved to be effective against *A. guerreronis*. Therefore, the product was tested at Madurankuliya to assess its efficacy in our conditions.

Nomite plus was diluted at the rates of 2 and 5 ml per litre and were sprayed to the infested bunches using a hand sprayer. About 250 ml was required to spray all bunches in the crown. Nut samples were collected from 3 –5 month old bunches at different time intervals. The number of total mites and the percentage of live mites in the colonies were assessed.

The application of Nomite plus at the rates of 2 and 5 ml/l, reduced the number of mites in the nuts (Fig. 7). The maximum reduction of 64% with respect to the initial population level was achieved at three weeks after treatment in the dose of 5 ml/l. All treatments have yielded a reduction in the population of mites in the nuts when compared with the control. The gradual reduction in the population with time in the Nomite plus treatment at the rate of 2 ml/l is noteworthy. It could be suggested that this treatment is better than the others in reducing the population in the nuts.



**Fig. 7.** Effect of two concentrations of Nomite plus (2ml and 5 ml per litre) in comparison with neem oil and garlic mixture (N+G). Eight palms were used for each treatment

*I.R. Wickramananda, K.A.N.M. Kasthuriarachchi (Aquinas College) and C. Hapuarachchi*

**Experiment B 26.4 : Evaluation of different chemicals as repellents for black beetle (2000)**

An experiment was initiated at Ratmalagara estate to evaluate new chemicals as repellents for black beetle. Four artificial breeding places consisted of coir dust and cow dung mixture were formed and black beetle larvae were introduced monthly to maintain the black beetle population continuously. Five hundred coconut seedlings were planted around the breeding grounds to be used for the experiment once they are subjected to attack by black beetle. Although larvae were introduced regularly no significant damage was observed in the seedlings and high percentage of larva was dead due to infections of *Baculovirus* and *Metarrhizium*. Therefore, the experiment was abandoned.

*H T R Wijesekara, S P Manoj and N G Premasiri*

**Experiment B 26.5.1: Screening of fungicides against leaf rot disease of coconut (2000)**

A preliminary trial was conducted to evaluate different fungicides for the control of leaf rot disease in Pinnagoda estate and Kotawila estate at Kamburugamuwa.

At Pinnagoda estate 0.5% solutions of the contact fungicides, Copper hydroxide (Champion) and Mancozeb (Dithane M 45/Manzate) were sprayed onto the bud region while the systemic fungicide Tridemorph (Calixin) was drenched into the crown at the rate of 5 ml/l of water. Trunk injection of 10 ml of Calixin was also made. Spraying and drenching were repeated 2 weeks after the first application. At Kotawila estate different concentrations of the systemic fungicides, Tebuconazole (Folicur) and Benomyl (Benlate) were applied as a crown drench and trunk injection (refer Table 6) once. Spraying and drenching of fungicides were

done after pruning the affected portions of spindle leaves. The presence of new lesions was recorded 2 months after treatment.

The results revealed that drenching of Folicur (4ml/l per palm) into the crown was the most effective treatment followed by Calixin (5ml/l per palm) (Table 6). Although, Champion and Mancozeb was effective 2 weeks after first application their effect diminished with time.

**Table 6.** *Percentage of palms with no fresh symptoms at two months after application of different fungicides for the control of leaf rot disease*

Treatment	Dose	Percent palms with no fresh lesions	
		One week after application	Two months after application
<b>Pinnagoda estate</b>			
Champion	0.5%	50.0	37.5
Mancozeb	0.5%	75.0	25.0
Calixin, drench	5ml/l	0.0	62.5
Calixin, trunk injection	10 ml	0.0	37.5
Control		37.5	37.5
<b>Kotawila estate</b>			
Folicur, drench	2ml/l	-	25.0
Folicur, drench	4ml/l	-	75.0
Benlate, drench	3g/l	-	37.5
Folicur, trunk injection	5ml	-	50.0
Benlate, trunk injection	4g/10 ml	-	37.5
Control		-	25.0

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**Experiment B 26.5.2: Effect of drenching fungicides for the control of leaf rot disease (2000)**

Drenching fungicide solutions on to the crown of coconut palms is more convenient than spraying. Therefore a preliminary trial was conducted at Polathumodera to investigate whether spraying of 0.5% Champion, 0.5% Mancozeb contact fungicides could be replaced by drenching and as effective as drenching of Folicur (4 ml/l) and pruning of spindle leaves alone. The treatments were applied twice at 2-monthly intervals and appearance of fresh symptoms were recorded one month after the second application. The continuous rain prevailed in the area interfered with the experiment, hence palms in all treatments except the control showed 60% fresh symptoms while it was 80% in the control.

This experiment is in progress.

*H T R Wijesekara, N S Aratchige, S P Manoj, K F G Perera, D M Jayakody and N G Premasiri*

### 3. CROP PROTECTION SERVICES

#### Incidence of pest and diseases

Two hundred and sixty two pest incidence were reported during the year. The highest number of incidence was on red weevil followed by coconut scale (Table 7). Appropriate control measures were recommended for the reported incidence.

**Table 7.** *Reported pest and disease incidence in different provinces in 2000*

Pest/ Disease	Western	North-western	North-central	Southern	Eastern	Total
Red weevil	25	110	1	1	0	137
Black beetle	3	17	0	0	0	20
Coconut caterpillar	3	12	0	6	0	21
Coconut scale	3	34	1	1	0	39
Coconut mite	0	4	0	0	0	4
Mammalian pests	0	3	0	0	0	3
Minor pests	1	5	0	0	0	6
Diseases	3	23	1	2	0	29

#### Biological control

##### a. Coconut caterpillar

Coconut caterpillar infestations were successfully controlled by timely surveillance, continuous monitoring and release of parasitoids. The number of parasitoids released is given in Table 8.

##### b. Weeds

The biological control agent *Pareuchates pseudoinsulata* of the 'Podisingho maran' (*Chromalaena odorata*) was issued to the growers.

##### c. Synthesis and sale of red weevil pheromone

Pheromone synthesis in the CRI laboratory was continued during the year and 4265 pheromone vials were sold to growers and CCB regional offices.

**Table 8.** *Release of parasitoids in different provinces for the control of coconut caterpillar*

Province	P1	P2	P3	P4	P5	Total
Eastern	17,000	30250	7750	5950	-	60950
North western	38300	38000	16405	47,050	25000	164,755
Southern	-	-	-	800	12,500	13,300
Uva	7250	2500	15,960	35,150	-	60,800
Western	-	-	200	800	-	1000
Total	62,550	70,750	40,915	89,750	37,500	301,465

P1 - *Goniozus nephantidis*

P2 - *Bracon hebetor*

P3 - *Eriborus trochanteratus*

P4 - *Brachimeria nephantidis*

P5 - *Trichospilus pupivora*

## **Chemical control**

Trunk injection of Monocrotophos 60% was carried out in severe pest outbreaks. A total of 6791 palms were treated against coconut caterpillar (300), coconut scale (4891) and nettle grub (600). A total of 135.3 l of Monocrotophos was sold to growers to control red weevil and other infestations.

## **4. TRAINING AND EXTENSION ACTIVITIES**

### **Extension activities**

The staff continued to assist the growers and the Coconut Cultivation Board in managing pests and diseases.

Divisional staff participated as resource personnel in various training programmes arranged by the CRI and other institutes.

Students from universities, technical colleges, schools and growers visited the Crop Protection Division during the year.

### **Training activities**

Two Students from Aquinas College underwent in-plant training from 23 June – 23 October 2000.

Two undergraduate students from University of Peradeniya, University of Ruhuna and student from Aquinas College completed research projects in the Division.

## **5. ACKNOWLEDGEMENTS**

I thank the staff of Crop Protection Division for their cooperation and assistance in research and other activities during the year. Sincere thanks are due to Head and staff of the Biometry Division for the assistance given in analysis of experimental data.

**REPORT OF THE BIOMETRY DIVISION**  
**HEAD – D T Mathes, FIS**

**1. GENERAL**

The division continued to assist the staff in statistical consultancy and computer related activities. The experiments on different frequencies of harvesting of coconuts, under different agroclimatic zones showed promising results. The work on 'Analysis of rainfall in coconut growing areas in Sri Lanka' funded by the National Science Foundation was continued during the year. The yield forecast made for the year 2000 was 2896 mln. nuts and the actual realized was 3050 mln. Nuts. The meteorological stations at Bandirippuwa, Ratmalagara, Ambakelle, and Bogaswewa were maintained satisfactorily.

**2. Assistance in the use of Computers and Computing**

- I. Computerization of experimental data was continued throughout the year.

*D T Mathes, T S G Peiris and W E C Fernando.*

- II. Continuous assistance was provided to all divisions on the use of application packages and System software.

*H P de Zoysa, J D J S Kularatna and S S Rajapakse*

- III. Co-ordinated the work in maintaining the Personal Management System in the Establishment Division.

*H P De Zoysa*

- IV. Assistance was provided for the installation of hardware and software. Coordinated activities of computers in the Institute.

*H P De Zoysa*

- V. Development of Research Monitoring Programme (RMP) was designed and works coordinated.

*H P De Zoysa and T S G Peiris*

- VI. Computerization of all the weather variables recorded at different meteorological stations continued throughout the year. The computerized data were sent to the Meteorology Department, Colombo, every month.

*T S G Peiris, J D J S Kularatna, Kingsly Herath, P Fernando, B Perera*

- VII. Computerizing & processing of information of the Medical Aid Scheme was continued.

*T S G Peiris*

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

*T S G Peiris*

### **3. BIOMETRICAL ASSISTANCE**

Assistance to the research staff was provided by way of statistical consultancy, selection of lands, layout of experimental designs, design of field surveys and questionnaires, analysis and interpretation of data. Undergraduate and postgraduate students from various universities were provided with special assistance in respect to their projects.

### **4. RESEARCH PROJECTS**

#### **RESEARCH THRUST 20 : APPLICATION OF BIOMETRY IN COCONUT RESEARCH**

##### **Experiment 20.0.3: Calibration trial at Walpita Estate (Wet Zone) – (1984)**

(a) The bimonthly recording of vegetative and yield characters were carried-out during the year. Variations in yield parameters and general status of yield pattern in the area between the six picks for the year 2000 are given in Table 1. The total number of bunches for the year showed an increase of 3.4% over 1999, while number of nuts per palm, showed a slight decrease. The recorded yield was 13710 nuts/ha compared to 13835 in 1999. The copra yield per hectare was 3014 Kg/ha as against 2975 Kg/ha received in 1999. In general the year 2000 could be considered as a good crop year and similar to that of year 1999.

(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 copra yield per hectare for the two groups are shown in Table 2.

Over the nine year period reported, monthly harvesting increased average yield by 23.9%. For the year 2000, monthly harvesting recorded a 25 % increase in nut number and a 32 % increase in husked nut weight as against two monthly harvesting. The data also showed 3.2% fallen nuts for harvesting at monthly intervals as against 8.3% for harvesting at two monthly intervals.

**Table 1.** *Yield components of palms at Walpita Estate in 2000 and 1999*  
*(Figures are average from 100 palms)*

Pick No.	Number of Bunches/Palm		Number of nuts/palm		Number of nuts/ha		Number of nuts/bunch		Weight of husked nut(g)		* Copra (Kg/ha)	
	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999
1	2.0	1.9	10.9	6.7	1719	1054	5.4	3.6	728	683	400	230
2	1.8	2.1	14.6	17.5	2301	2762	8.0	8.4	707	727	520	643
3	1.8	1.9	18.5	18.9	2928	2985	10.3	10.1	642	695	601	664
4	2.4	1.9	17.9	17.1	2835	2708	7.6	9.1	668	622	606	539
5	2.1	2.2	12.6	17.0	1985	2684	6.0	7.7	711	623	452	535
6	2.2	1.9	12.3	10.4	1942	1642	5.7	5.5	698	693	434	364
<b>Total</b>	<b>12.3</b>	<b>11.9</b>	<b>86.8</b>	<b>87.6</b>	<b>13710</b>	<b>13835</b>			<b>692</b>	<b>674</b>	<b>3013</b>	<b>2975</b>

\*

**Copra Yield = husked nut weight x 0.32**

**Table 2. Number of nuts and copra yield at Walpita Estate**

Frequency of harvesting	Number of nuts per ha/year		Copra yield kg/ha/yr	
	1991 - 1999 Ave	2000	1993 - 1999 Ave	2000
Monthly (T <sub>1</sub> )	14669	15280	3056	3447
Two monthly (T <sub>2</sub> )	11836	12210	2231	2606
Difference	2833	3070	825	841
% increase	23.9	25.1	37.0	32.3

D T Mathes, Ranjith Fernando, W M L G Fernando, Kingsly Herath and P Fernando

### PROJECT 13 : INFLUENCE OF HARVESTING PRACTICE ON NUT PRODUCTION (1997)

#### Experiment No. 13.0.1 Frequency of harvesting

- Treatments: (a) Harvesting at 30 day intervals - T<sub>1</sub>  
 (b) Harvesting at 60 day intervals - T<sub>2</sub>  
 (c) Harvesting at 120 day intervals - T<sub>3</sub>  
 (d) No harvesting, but collecting fallen nuts - T<sub>4</sub>

Experimental Design: Randomized complete block design with 4 blocks and 6 palms per plot.

The experiment (20.0.3) at Walpita showed good promise for harvesting nuts at monthly intervals. As a result, further trials were established during the year 1997, two at Ratmalagara Estate (for high and medium yielding palms) and one at Poththukulama Research Station (for high yielding palms). The results obtained for the year 2000 are shown in Tables 3, 4 and 5.

**Table 3. Yield components for medium yielding palms (2000)**  
(Ratmalagara Estate)

Frequency of harvesting (Intervals)	Bunches produced/6 palms		Nuts/6 palms Including fallen nuts		Fallen nuts/ 6 palms		% Fallen Nuts	
	1999	2000	1999	2000	1999	2000	1999	2000
30 days	79	74	392	412	17	12	4.3	2.9
60 days	74	64	374	352	57	42	15.4	11.9
120 days	62	49	334	307	151	100	45.3	32.6
No harvesting but collecting fallen nuts	65	53	313	303	313	303	100.0	100.0
Significance (P =)			0.001				0.01	
CV (%)			5.1				9.3	
LSD			5.0				51.0	

Statistical analysis of data showed significant differences between the treatments for bunches ( $p=0.001$ ) and number of nuts ( $p=0.01$ ). Harvesting at 30 day intervals recorded higher numbers of bunches and nuts as compared to harvesting at 60 day intervals. The respective percentages being 15.6 and 17.0. There were no significant differences shown between 'harvesting at 120 day intervals' and for 'no harvesting but collecting fallen nuts'. The percentage fallen nuts for harvesting at 30 day intervals was a mere 2.9%.

**Table 4.** *Yield components for High Yielding palms (2000) (Ratmalagara Estate)*

Frequency of harvesting (Intervals)	Bunches produced /6 palms		Nuts/ 6 palms Including fallen nuts		Fallen nuts 6 palms		%	
	1999	2000	1999	2000	1999	2000	Fallen nuts	
							1999	2000
30 days	79	78	591	516	26	14	4.4	2.8
60 days	77	69	516	393	89	63	17.2	16.0
120 days	72	64	495	363	281	130	56.7	35.8
No harvesting but collecting fallen nuts	71	63	440	387	440	387	100.0	100.0
Significance (P=)				0.01				0.01
CV (%)				7.3				10.2
LSD				8				68

Statistical analysis showed significantly higher number of bunches ( $p=0.01$ ) and nuts ( $p=0.01$ ) for harvesting at 30 day intervals as compared to harvesting at 60 day intervals. The respective percentages are 13.1 and 31.3. Harvesting at, 120 day' intervals and 'No harvesting but collecting fallen nuts' showed no difference between the treatments in respect of number of bunches and nuts.

**Table 5.** *Yield components for High Yielding Palms (2000) (Poththukulama Research Station)*

Frequency of harvesting (Intervals)	Bunches produced/6 palms		Nuts/6 palms Including fallen nuts		Fallen nuts/6 palms		%	
	1999	2000	1999	2000	1999	2000	Fallen nuts	
							1999	2000
30 days	84	78	676	580	9	6	1.3	1.1
60 days	82	73	620	482	70	47	11.3	9.9
120 days	80	49	600	351	237	107	39.5	30.6
No harvesting but collecting fallen nuts	73	57	536	388	536	388	100.0	100.0
Significance (P=)				0.001		0.001		
CV (%)				7.6		8.4		
LSD				8.0		61.0		

The treatments showed similar results for number of nuts, as that was observed for the trials at Ratmalagara estate for high and medium yielding palms. The percentage fallen nuts for monthly harvesting was as low as 1.1%.

*D T Mathes, Ranjith Fernando, W M L G Fernando, Kingsly Herath and P Fernando*

#### **Experiment No: 20.0.4 National demand for coconuts National Coconut Production and utilization of nuts**

The national coconut production from 1994 to 2000 (actual) and the predicted production from 2000 to 2005 are shown in Table 6. The prediction was based on the formula developed (CRI, 1999). The actual production realized was 3050 million nuts with a prediction error of 5%. The number of nuts remaining after culinary use, prior to and after 1999, clearly indicates that it will not be necessary to import nuts in future for culinary purposes.

**Table 6.** *National coconut production and culinary requirements (in million nuts)*

Year	Annual production		Nuts for culinary	Balance nuts after culinary use
	Actual	Predicted		
1994	2622		1603	1019
1995	2755		1619	1136
1996	2546		1635	911
1997	2630		1652	978
1998	2540		1668	872
1999	2830		1685	1145
2000	3050	2896	1702	1194
2001		2705	1719	986
2002		2765	1736	1029
2003		2875	1753	1122
2004		2815	1771	1044
2005		2757	1788	969

(The nut requirement for culinary purpose was estimated based on the annual population increase of 1%.)

The balance nuts not observed for culinary purposes enter the market to produce-desiccated coconut, coconut oil, copra, coconut cream/milk and milk powder and for export, as whole nuts. Table 7 shows the number of nuts utilized for various purposes.

**Table 7.** *The number of nuts used (in million nuts) for various purposes*

Year	For culinary	DC production	Fresh nut export	Copra export	CCMP export	Coconut oil export	Total used	Balance nuts available for coconut oil for local use
94	1603	380	25.4	31.9	11.1	36.2	2088	534 (20.4%)
95	1619	465	26.5	50.3	10.2	71.6	2243	512 (18.6%)
96	1635	425	17.5	38.6	14.2	22.5	2153	393 (15.4%)
97	1652	446	18.7	42.1	13.6	29.6	2198	428 (16.3%)
98	1668	306	17.5	44.3	16.7	21.3	2074	466 (18.4%)
99	1685	460	23.0	55.2	30.8	26.7	2182	548 (19.4%)

(1MT DC = 6800; 1MT Oil = 8000 nuts; 1 MT Copra = 4925 nuts); CMMP = coconut cream/milk and milk power; ( ) represent percentage balance nuts with respect to the total production).

(These figures are based on CDA statistics)

The data indicates that, if coconut oil is not produced for local consumption, around 450 million nuts (i.e. 20% of the production) would be available. Coconut oil exports have been decreasing. Nut exports are almost stagnant. The exports of coconut cream/milk/milk powder have been increasing slowly.

In addition to the culinary requirement, 20 nuts per person/year are required to be used as coconut oil, soap etc. Accordingly, the annual requirement of coconut oil in MT is shown in the column 4 of Table 8.

**Table 8.** *Local use of nuts in million nuts (coconut oil, soap etc.)*

Year	Balance nuts available for coconut oil	Local oil requirement in million nut equivalent	Oil produced for local market	Actual surplus Nuts
1994	534	356	444	90
1995	512	360	444	68
1996	393	363	306	87
1997	428	367	260	168
1998	466	371	283	183
1999	548	375	252	217

The calculations indicate that the present national coconut production is more than sufficient to cater to all the needs of the coconut industry and there still remains a surplus of nuts. According to these statistics, oil production for the local market is much less than the national requirement after 1995. This may be linked to the increased import of non-coconut based oil. Even if the national requirement of oil is totally met from coconut oil (column 3), there will still be surplus nuts.

*T S G Peiris and M T N Fernando*

**Experiment No: 20.05 Re-investigation of long-term field experimental data in coconut.**

Long-term field experiments showed non-significance between fertilizer treatments and the control. The usual covariance analysis using pre-experimental data did not change the results either. Most of the experimental designs are randomized complete block designs with a single guard row between two adjoining plots. The blocking is usually done by visual observation of the land. Due to practical problems in finding large extents of land for experimentation, single guard rows between plots are employed instead of the desirable guard row around each plot.

Yield records have not been kept for these guard row palms. The statistical analyses were done separately for different years as well as using repeated measure design techniques taking all years together. This present study was undertaken to use the effect on neighboring palms as a measure for reducing experimental error. Data were obtained from concluded long-term field experiments of Agronomy division.

This technique showed no impact on the final conclusions. However, analysis of residuals for unadjusted data showed the presence of some inherent fertility in some plots. It was also found that the relative efficiency index did not suggest that RCBD was superior to CRD. In addition to the above studies, the status of most of the field experiments conducted by the division of Agronomy, Soils and Plant Nutrition and Genetic and Plant Breeding were investigated in detail during the latter part of the year in view of the poor response shown for various treatments. Based on the results the following are suggested.

- \* To take into account the residual effect of each palm with respect to position, prior to blocking, in conducting long term experiments in a place where an experiment had already been sited.
- \* To consider soil depth or some other soil fertility character when blocking the experimental land for treatments.

- \* To keep individual yield records of the guard row palms and other palms in the experimental field, in addition to the effective palms
- \* To minimize local variation within and between plots as far as possible during the experimental period.

T S G Peiris

**EXPERIMENT THRUST:** 20.1 Application of Climatology in Coconut Research

**Experiment No:** 20.1.1 Analysis of rainfall in coconut growing areas in Sri Lanka

Daily rainfall data for 36 years from 18 locations representing four agro-ecological regions in the coconut growing areas were analyzed. The basic analysis showing a decline in rainfall on a location basis was reported in Annual Report of CRI (1999). The decline in annual rainfall and number of rainy days for different periods in the selected agro-ecological regions are given in Tables 9 and 10 (Ratnapura was excluded from this study).

**Table 9.** *The mean annual rainfall (mm) for 12-year periods from 1962 - 1997 and their percentage drops over time with respect to the period 1962 - 1973 in the selected agro-ecological regions.*

Agro-ecological region	1962 - 1973	1974 -1985	1986 -1997
LCWIR	1880	1678 (10.7)	1636 (12.9)
LCDIR	1466	1198 (18.2)	1319 (10.0)
LCDR	1167	1120 (4.0)	1102 (5.6)
LCWR	2781	2683 (3.5)	2435 (12.4)

(Values in parentheses represent the percentage drop with respect to 1962 - 1973)

**Table 10.** *Mean number of rainy days per year in 12-year periods during 1962 - 1997 and its percentage drops when compared to 1962 - 1973 period in the selected agro-ecological regions*

Agro-ecological region	1962-1973	1974-1985	1986 -1997
LCWIR	118	106 (10.1)	95 (19.5)
LCDIR	86	69 (19.9)	72 (11.1)
LCDR	85	78 (8.4)	69 (23.2)
LCWR	147	136 (7.5)	134 (9.9)

(Values in parentheses represent the percentage drop with respect to 1962 - 1973)

The drop in mean annual rainfall over different periods was the highest in intermediate regions (LCWIR and LCDIR) and lowest in LCDR. With respect to the number of rainy days, the percentage drop was higher in LCWIR and LCDIR than that in LCWR or LCDR.

The analysis of weekly moving totals for each location showed, that the rainfall pattern has changed from the conventional classification reported by Domro (1974). Thus rainy seasons within a year were reclassified and renamed as:

- Rainfall from March to June as extended southwest monsoon (ESWM).
- Rainfall from September to November as second inter monsoon (SIM).
- Rainfall during December as Northeast monsoon (NEM).

As the probabilities of longer dry spells in January, February, July and August are progressively higher and there is less rain, these months were not considered as rainy months. The total annual contribution of the eight remaining months varied from 85-90%. Among these rainy periods, the contribution of SIM is about 50%. The corresponding contributions from ESWM and NEM rains were about 42% and 8%, respectively.

Gamma distribution adequately fits ( $p > 0.05$ ) to the date of onset and the length of extended southwest monsoonal rains for all the locations. Further, it was found that a common distribution could be used only for LCWR. Thus except in LCWR, locational specific recommendations are required for other regions. Based on this gamma model, the intervals that provide the highest probability values for 15-day and 21-day periods are presented in Table 11.

**Table 11.** *Probability values of the onset of south-west rains for 15 days and 21 day periods*

Location	15 days		21 days	
	period	Probability	Period	Probability
Horakelle	April 5 - April 19	0.2322	April 3 - April 23	0.3269
Kurunegala	March 25 - April 8	0.3083	March 23 - April 12	0.4290
Bandirippuwa	March 28 - April 11	0.2784	March 25 - April 14	0.3892
Rajakadalawa	April 4 - April 18	0.2439	April 1 - April 21	0.3427
Ratmalagara	April 4 - April 18	0.2648	April 1 - April 21	0.3710
Kirama	March 18 - April 1	0.2518	March 15 - April 4	0.3534
Mediyawa	March 27 - April 10	0.3384	March 24 - April 13	0.4679
Nikaweratiya	April 4 - April 18	0.3304	March 29 - April 18	0.4629
Polonthalawa	March 30 - April 13	0.3317	March 27 - April 16	0.4594
Ridibendiwela	April 2 - April 16	0.3632	March 30 - April 19	0.4990
In LCWR	March 20 - April 3	0.3090	March 17 - April 6	0.4297

The results in Table 11 indicate that there is a 46 - 50% probability that, extended southwest monsoon rains start during the first week to third week of April in Nikaweratiya, Polonthalawa and Ridibendiela in LCDIR. The probability that the extended southwest monsoon rains in Mediyawa area would start during the last week of March to second week of April is 46%. Similar recommendations can be derived for other locations as well. Thus, it can be suggested that implementation of agronomic practices in relation to the onset of southwest monsoon rains can be performed according to Table 11.

Based on modeling more recommendations on rainy periods during March to June and September to November were derived for planning agronomic practices. The study suggested that the number of locations and durations were not adequate to confirm the change of rainy seasons, as there is very distinctive spatial and temporal variation of rainfall within each agro-ecological region. Thus this study needs to be extended to more locations and more years. The distribution of rain during December and the reasons for the change of rainy seasons are yet to be investigated.

This project was funded by the National Science Foundation (NSF).

*T S G Peiris and D T Mathes*

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The Annual Report of Coconut Research Institute (1999).

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## 5. YIELD RECORDING

The recording of yield components of 28 experiments, (conducted by the Research Divisions) was continued in the following estates up to end of April. Thereafter this activity was transferred to the respective Divisions.

1. Bandirippuwa
2. Poththukulama
3. Ratmalagara
4. Saddhatissa Estate
5. Wayagola Estate, Attanagalla
6. Walpita Estate
7. Thambapanni Estate, Puttalam
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
15. Daisy valley Est. Mawathagama
16. Siriwasa Est. Mangalaeliya
17. Welipennaghamulla, Udugama Est.

All recordings were computerized for each harvest and a computer printout of the raw data and summary data were sent to the office-in-charge of each experiment.

## 6. EXTENSION ACTIVITIES

- Lectures were conducted for trainees attending courses organized by the Coconut Research Institute and National Institute of Plantation Management.
- Trainees from different Institutions were assigned to this division from time to time.
- Visitors and students from Universities were briefed on the work of the Division.

## 7. AGRO-METEOROLOGY

The four 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 1530 hrs), evaporation, relative humidity (morning and afternoon), sunshine hours and soil temperature (at six different depths.)

Computerization of the meteorological data at Bandirippuwa Estate, Ratmalagara Estate, Isolated Seed Garden and Maduru Oya seed garden and providing information to Department of Meteorology and other Institutions were continued throughout the year. The following data are maintained and a summary is given below.

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### **8.1 Bandirippuwa Estate**

- (a) **Rainfall (Table 12)** All months of the year experienced rainfall. The total rainfall for the year was 1686.6 mm. This rainfall is lower than the average recorded for the period 90-99. Though the total rainfall was the lowest, it was uniformly distributed over the year.

The total rainfall for the first 6 months was higher than that for the second 6 months period. Percentages being 59 and 41 respectively. This is unusual when compared to distribution patterns in rainfall over past years.

- (b) **Temperature (Table 12)** The monthly maximum temperature ranged from 31.7 (November) to 30.1<sup>0</sup>C (June/July) while monthly minimum temperature ranged from 22.0(December) to 24.5 (May). The average over the year was 27.0. Uniform temperature was maintained during the year.
- (c) **Sunshine (Table 12)** Sunshine hours ranged from 4.8 (November) to 8.6 hrs./day (July) The average for the year was 7.1 h./day The year showed increased sunshine hours compared to 1999. This is perhaps due to reduced number of rainy days observed during the year.
- (d) **Evaporation (Table 12)** The lowest and highest evaporation was recorded in October and March and the values were 3.1 to 4.3 mm respectively.
- (e) **Relative Humidity (Table 12)** The average relative humidity in the morning fluctuated around 84% during the year. In the afternoon it varied around 77%. This was similar to that experienced for 1999.
- (f) **Wind velocity (Table 12)** The wind velocity varied from 3.1 km/hr in October to 5.5 km/hr in January with a mean of 4.3 km/hr. In general there was high wind velocity over the year.

**Table 12: Meteorological Data (Bandirippuwa Estate)**

	Rainfall (mm)			Temperature (C <sup>o</sup> )		Evaporation (mm)	Relative Humidity (%)		Sunshine (Hrs)	Wind Velocity (Km/h)
	1999	90-99 Ave.	2000	Max.	Min.		a.m.	p.m.		
January	49.4	59.8	220.6	30.6	22.1	4.2	84	70	6.4	5.2
February	113.8	52.0	127.2	30.9	22.6	3.7	85	71	7.3	3.3
March	20.6	54.9	164.2	31.7	22.5	4.3	84	76	7.8	2.9
April	363.6	185.7	181.5	31.6	23.3	3.9	85	79	8.1	3.1
May	305.4	292.5	175.0	31.3	24.5	4.0	85	81	8.2	4.1
June	92.1	134.9	126.7	30.1	24.4	3.6	83	81	6.4	5.3
July	90.2	101.6	20.7	30.1	24.4	4.2	82	77	8.6	5.5
August	50.2	65.6	180.6	30.3	23.4	3.9	86	81	7.0	5.4
September	90.3	163.3	207.6	30.2	23.5	3.4	84	78	5.6	3.6
October	747.2	366.7	102.2	30.6	23.2	3.1	84	79	7.4	3.2
November	261.4	347.8	76.6	31.7	22.3	3.2	82	75	4.8	3.7
December	30.3	90.0	103.7	31.0	22.0	4.0	80	73	7.3	5.7
<b>Total</b>	<b>2214.5</b>	<b>1914.8</b>	<b>1686.6</b>	<b>30.8</b>	<b>23.2</b>	<b>3.8</b>	<b>84</b>	<b>77</b>	<b>7.1</b>	<b>4.3</b>

## 8.2 Ratmalagara Estate (Table 13)

All months during the year experienced rainfall. The total rainfall was 1699.7 mm and the last six months experienced a rainfall of only 44.6% of the total. This pattern is rather unusual to the normal pattern of rainfall experienced over the past many years where the last six months period showing higher rainfall than the first six months period.

## 8.3 Isolated Seed Garden (Table 13)

All the months recorded rainfall, with July experiencing a mere trace. The total rainfall for the year was 1498.6 mm., as against 1636.9 mm., recorded in 1999. Unusually the first half of the year experienced 57.3% of the total rainfall, deviating from the pattern observed over the past many years.

## 8.4 Maduru Oya (Table 13)

All the months during the year experienced rainfall. The total rainfall recorded for the year was 1506.4 mm., which is lower than the recorded rainfall of 1662.1 in 1999. Heavy rainfall amounting to 506.5 mm was experienced for the month of November. This accounts for 1/3 of the total rainfall observed for the year 2000.

*Table 13 : Rainfall (mm) at Ratmalagara, Isolated Seed Garden and Maduru oya*

	Ratmalagara Estate			Isolated Seed Garden			Maduru Oya	
	1999	90-99 Ave.	2000	1999	90-99 Ave.	2000	1999	2000
Jan.	79.1	50.6	89.7	35.0	64.1	102.5	391.8	205.3
Feb.	42.9	31.9	231.5	196.4	41.6	79.5	234.4	235.3
Mar.	3.1	46.5	111.6	0.0	46.4	183.8	0.5	36.7
Apr.	185.9	171.6	243.1	131.0	148.5	255.8	19.1	34.1
May	291.7	224.4	157.5	205.4	184.5	164.6	0.0	19.6
Jun.	83.8	102.0	108.2	32.9	92.6	72.7	13.8	22.1
Jul.	47.1	60.5	10.3	22.1	53.1	1.4	0.0	27.9
Aug.	18.4	32.4	177.3	18.5	19.7	157.6	31.5	79.7
Sep.	99.8	125.9	157.1	129.3	97.7	164.8	128.3	57.6
Oct.	769.2	370.2	107.7	540.2	296.6	64.9	300.4	24.0
Nov.	367.8	384.9	120.0	251.7	315.3	65.8	294.7	506.5
Dec.	56.9	95.4	185.7	74.4	132.1	185.2	247.6	257.6
<b>Total</b>	<b>2045.7</b>	<b>1696.3</b>	<b>1699.7</b>	<b>1636.9</b>	<b>1492.2</b>	<b>1498.6</b>	<b>1662.1</b>	<b>1506.4</b>

# REPORT OF THE TISSUE CULTURE DIVISION

Head - L K Weerakoon, Ph D

## 1. GENERAL

During the year, major focus was given to plant regeneration in immature embryo, plumule and immature inflorescence explants.

Twelve tissue-cultured plants were planted at Bandirippuwa Estate to evaluate their performance in the field. The growth of the four tissue-cultured plants, which were planted at Bandirippuwa Estate in the previous year, was found to be satisfactory. Fifteen more tissue-cultured plants were fully acclimatized and ready for field planting.

The ploidy level of a few clonal plants derived from plumule explants was tested using flow cytometry and no variations in the ploidy level were detected.

The effect of palm maturity on callogenesis in immature inflorescence explants and the feasibility of using morphological characters of the palm as an index to select suitable inflorescences to obtain explants were investigated. The results revealed that there was no significant effect of palm maturity on callusing frequency. Furthermore, there was no significant correlation between the callus production and morphological characteristics of the palm indicating that use of such characters as an index to select suitable immature inflorescences for culture is not feasible.

The DFID-funded project on "Increasing the efficiency of embryo culture technology to promote coconut germplasm collection and exchange" was completed. Some of the important findings of the study include the development of a better growth medium for embryo culture, the positive effect of gibberellic acid (GA<sub>3</sub>) on embryo germination and possible use of abscisic acid (ABA) for embryo maturation. These findings made a significant contribution towards the improvement of the current embryo culture protocol.

In vitro screening of 9 germplasm accessions (Sri Lanka Green Dwarf, Sri Lanka Yellow Dwarf, Sri Lanka Green Dwarf X Sri Lanka Tall, Sri Lanka Yellow Dwarf X Sri Lanka Tall, Sri Lanka Tall (Ambakelle), Sri Lanka Tall (Ambakelle special), Sri Lanka Tall [Moorock), Sri Lanka Tall (St. Anne's), Sri Lanka Tall X San Ramon ) for drought-tolerance was completed. Based on the level of drought-tolerance, the above accessions could be grouped into three categories.

The propagation of dikiri coconut through embryo culture was continued and 26 embryo-cultured dikiri plants were distributed among farmers in Weligama.

The feasibility of using a charcoal-free culture medium for induction of callus in plumule explants was tested. Even though it was possible to produce callus in charcoal-free media, the callusing frequency was relatively low when compared to charcoal-containing media.

Biochemical analysis of zygotic embryos (at different stages of maturity), plumule callus, embryogenic and non-embryogenic structures derived from plumule callus was initiated and the contents of total sugar, starch and proline in the above tissues were

determined. The preliminary results revealed that the proline content in zygotic embryos decreased with maturity. The proline level in callus was much higher than that of embryogenic and non-embryogenic structures.

## 2. RESEARCH PROJECTS

### Project 18: STUDIES ON THE VEGETATIVE PROPAGATION OF COCONUT

#### 18.1: *In vitro* culture of coconut embryos

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

Rescue of *dikiri* embryos through the embryo culture technique was continued and 26 *dikiri* plants were distributed among farmers in Weligama. The experiments on the effect of GA<sub>3</sub> on germination of *dikiri* embryos were continued. The modified Eeuwens Y3 liquid medium (Y3CRI medium) was used as the basal medium. Three levels of GA<sub>3</sub> (0.046, 0.23, 0.35 µM) were tested against the control (without GA<sub>3</sub>).

As shown in Table 1, germination of *dikiri* embryos in all treatments was relatively low when compared to the rates observed in previous experiments (Annual Report 1999). The exact reasons for the poor germination of *dikiri* embryos in this experiment are not known. However, a seasonal variation in *dikiri* embryo germination has been observed in the past and it might be one of the reasons for low germination rate observed here. The germination of embryos treated with 0.23 and 0.35 µM GA<sub>3</sub> was observed to be higher than that of the control, indicating the positive effect of GA<sub>3</sub> on embryo germination (Table 1). Out of the two concentrations of GA<sub>3</sub> tested, 0.35 µM was shown to be more effective in promoting germination. Further experiments should be carried out to determine the optimum concentration of GA<sub>3</sub> for enhancing embryo germination.

**Table 1.** *Percentage germination of dikiri embryos treated with different concentrations of GA<sub>3</sub>.*

Concentration of GA <sub>3</sub> (µM)	Germination (%)
0.0	27.3
0.23	47.6
0.35	50.0

As the objective of the above experiment was to study the effect of GA<sub>3</sub> on embryo germination, it was not incorporated in the culture medium after the germination of embryos. Further experiments could be conducted to study the effect of GA<sub>3</sub> on subsequent shoot and root growth in germinated embryos. GA<sub>3</sub> is known to promote cell elongation and the culture of embryos in the presence of GA<sub>3</sub> for a prolonged period might cause excessive elongation of shoot. Thus, the most effective concentration and duration of GA<sub>3</sub> treatment for enhancing germination and subsequent shoot and root growth of embryos need to be determined.

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

### **Experiment 18.1.2: Screening coconut germplasm for drought-tolerance using *in vitro* techniques (1986)**

The ADB-funded project (done in collaboration with the Genetics & Plant Breeding and Plant Physiology Divisions) on screening 20 accessions of coconut germplasm for drought tolerance was continued.

Mature nuts were collected from selected palms of 13 coconut accessions namely Sri Lanka Green Dwarf, Sri Lanka Yellow Dwarf, Cameroon Red Dwarf, Sri Lanka Green Dwarf X Sri Lanka Tall, Sri Lanka Yellow Dwarf X Sri Lanka Tall, Sri Lanka Tall (Ambakelle), Sri Lanka Tall (Ambakelle special), Sri Lanka Tall (Moorock), Sri Lanka Tall (St.Anne's), Sri Lanka Tall (Gon thembili), Sri Lanka Tall (Margaret), Sri Lanka Tall X San Ramon, and King coconut. The embryos were excised and cultured in Y3CRI liquid medium. Once the embryos germinated and produced the first photosynthetic leaf, water stress conditions were induced by incorporating polyethylene glycol (PEG) in to the culture medium. The concentration of PEG was progressively increased until the plants showed symptoms of water stress. The maximum level of PEG that was tolerated by each plant was recorded.

*In vitro* screening of 9 coconut accessions (Sri Lanka Green Dwarf, Sri Lanka Yellow Dwarf, Sri Lanka Green Dwarf X Sri Lanka Tall, Sri Lanka Yellow Dwarf X Sri Lanka Tall, Sri Lanka Tall (Ambakelle), Sri Lanka Tall (Ambakelle special), Sri Lanka Tall [Moorock), Sri Lanka Tall (St.Anne's), Sri Lanka Tall X San Ramon ) for drought tolerance was completed. The level of drought tolerance of the different accessions was evaluated, based on their level of tolerance to PEG. The accessions, which showed a low level of tolerance to PEG, were regarded as drought-sensitive whereas the accessions, which showed a high level of tolerance to PEG, were regarded as drought-tolerant.

The results clearly showed that the two dwarf types (Sri Lanka Green Dwarf and Sri Lanka Yellow Dwarf) had the lowest level of tolerance to PEG indicating that they are highly susceptible to water stress (Table 2).

The two hybrids, Sri Lanka Green Dwarf X Sri Lanka Tall and Sri Lanka Yellow Dwarf X Sri Lanka Tall showed a slightly higher level of drought-tolerance when compared to the two dwarf types. However, the degree of drought tolerance of Sri Lanka Green Dwarf X Sri Lanka Tall and Sri Lanka Yellow Dwarf X Sri Lanka Tall was lower than that of the tall types. Out of the four tall types, the level of drought tolerance of Sri Lanka Tall (Moorock) was much lower than the other 3 accessions. As shown in Table 2, the two accessions, Sri Lanka Tall (Ambakelle) and Sri Lanka Tall (St.Anne's) had the highest level of drought tolerance. The hybrid, Sri Lanka Tall X San Ramon also showed a high level of drought tolerance (Table 2).

**Table 2.** *Tolerance levels of 9 coconut accessions to water stress induced under in vitro conditions*

Germplasm accession	Highest level of Tolerance to PEG (%)
Sri Lanka Green Dwarf	3.10
Sri Lanka Yellow Dwarf	3.11
Sri Lanka Green Dwarf X Sri Lanka Tall	3.76
Sri Lanka Yellow Dwarf X Sri Lanka Tall	4.19
Sri Lanka Tall (Moorock)	5.06
Sri Lanka Tall (Ambakelle special)	7.00
Sri Lanka Tall X San Ramon	7.11
Sri Lanka Tall (St. Anne's)	7.32
Sri Lanka Tall (Ambakelle)	7.50
Significance	p = 0.001
LSD	0.37
CV%	8.92

Induction of water stress has already been initiated with three more accessions namely, Sri Lanka Tall (Gon thembili), Sri Lanka Tall (Margaret) and King coconut and the *in vitro* assay will be completed in a few months. Due to poor germination of embryos, it was not possible to initiate *in vitro* drought simulation for the accession Cameroon Red Dwarf.

Since the project is still ongoing and data is not available for all 20 accessions, comparison of individual palms within each accession was not done. Upon completion of the *in vitro* assay for all the accessions, the different accessions/individuals will be classified accordingly.

*L K Weerakoon, E S Santha and K P I E Ambagala*

### **Experiment 18. 1. 3. Studies on the improvement of embryo culture technology (1994)**

The experiments on the effect of ABA on maturation of *in vitro*-cultured embryos were continued. Immature nuts (9 and 10 month-old) of the cultivar Sri Lanka Tall were used as experimental material and 3 levels of ABA (5, 10, 20  $\mu$ M) were tested against the control (without any ABA). ABA (filter sterilized) was incorporated into Y3CRI medium (both solid and liquid) and immature embryos were cultured into different treatments.

In previous experiments, substantial numbers of embryos in some treatments were lost due to contamination and thus it was difficult to interpret the results and elucidate the effect of different concentrations of ABA on embryo maturation (Annual report 1999). However, when the experiment was repeated, the results obtained revealed that ABA promoted maturation and subsequent germination of embryos (Table 3).

**Table 3.** Germination percentage of embryos (obtained from 9 & 10 month old nuts) treated with different concentrations of ABA.

Concentration of ABA ( $\mu\text{M}$ )	State of the Medium	Maturity of nut	
		9 months	10 months
0	Liquid	3.3	13.3
	Solid	40.0	43.3
5	Liquid	3.3	6.6
	Solid	53.3	56.7
10	Liquid	6.6	6.6
	Solid	76.7	70.0
20	Liquid	16.6	13.3
	Solid	56.7	80.0

The results clearly indicated that incorporation of ABA in liquid medium was not effective in promoting embryo maturation, and the percentage of embryo germination in liquid medium, which contained ABA, was very low (Table 3). As shown in Table 3, when incorporated in solid medium, ABA enhanced germination of embryos and the positive effect was more pronounced with higher concentrations of ABA (10 and 20  $\mu\text{M}$ ). The highest percentage of germination for 9 month-old embryos was achieved with 10  $\mu\text{M}$  ABA, whereas 20  $\mu\text{M}$  ABA gave rise to the highest percentage of germination (80%) with 10 month-old embryos (Table 3).

The results also indicated that retrieval of immature embryos cultured on solid medium was higher than in liquid medium even in the control, which did not contain any ABA (Table 3).

Another factor, which could affect embryo maturation, is the duration of ABA treatment. In the present study, the embryos were kept in ABA-containing media only for a short period of time (3 days to 2 weeks). Further experiments are necessary to determine the optimum concentration as well as the duration of ABA treatment.

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## 18.2. Studies on clonal propagation of coconut

### Experiment 18. 2. 1. *In vitro* culture of immature zygotic embryos of coconut

The effect of two novel plant growth regulators, namely Thiadiazuron (TDZ) and Jasmonic acid on induction of somatic embryogenesis in immature embryo-derived callus was tested. Two levels of TDZ and jasmonic acid (1 and 5  $\mu\text{M}$ ) were tested using medium 72 as the basal medium. No positive effect of the two growth regulators on somatic embryogenesis was observed at the levels tested. Higher concentrations of the two growth regulators are being tested.

The polyamines putrescine, spermidine and spermine have been considered as plant growth regulators due to their effect on cell growth, cell division, and differentiation at low concentrations. The role of polyamines as regulators of embryo development has been studied in several crops. Thus the effect of spermine and spermidine on induction of somatic

embryos in immature embryo-derived callus is being investigated. The medium 72 was selected as the basal medium and 3 levels of spermine (0.5, 1.0, 5.0  $\mu\text{M}$ ) and spermidine (0.01, 0.1, 1.0  $\mu\text{M}$ ) in combination with ABA (5  $\mu\text{M}$ ) are being tested.

Studies done on several crops have shown that ethylene accumulation in culture vessels can inhibit various stages of somatic embryogenesis. Silver nitrate ( $\text{AgNO}_3$ ) is known to block the biological action of ethylene. Thus an experiment was undertaken to study the effect of ethylene accumulation in the culture vessel on somatic embryogenesis through the effect of different levels of  $\text{AgNO}_3$ .  $\text{AgNO}_3$  was incorporated into embryo induction medium and regeneration medium at 3 levels (1, 5, 10  $\mu\text{M}$ ). The preliminary results indicated that  $\text{AgNO}_3$  had a positive effect on somatic embryo formation and shoot regeneration at the level of 5  $\mu\text{M}$ . The effect of another ethylene inhibitor, AVG on somatic embryogenesis is also being tested.

Several of the clonal plants derived from immature embryo callus were fully acclimatized and four of them were planted in the field in April. The performance of the two clonal plants, which were planted in the field in 1999, was found to be satisfactory.

During the transfer to *ex vitro* conditions, physiological status of *in vitro*-grown plants is an important factor, which determines the success rate during acclimatization. Thus anatomical studies (stomatal density, percentage of open and close stomata, epicuticular wax thickness, epidermal cell length and width) of clonal plants at different stages of acclimatization are being done to assess their physiological status. The information gathered from the study will be used to improve the acclimatization procedure of clonal plants.

The use of hydroponic technique for acclimatization of clonal plants is being attempted as a measure to improve their *ex vitro* growth.

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#### **Experiment 18. 2. 4. Culture of floral meristem explants (1995)**

The effect of palm maturity on callogenesis was studied. A series of Inflorescences (-1 to -9 stages, taking youngest open inflorescence as 0) were collected from palms belonging to 3 age groups (7-9, 12-15 and 20-25 years). The morphological characters such as number of leaves, length of trunk and length of the most mature, unopened inflorescence (-1 stage,) in each palm were also recorded to test the feasibility of using these characters as an index to select suitable inflorescences to obtain explants.

Even within the same age group, there was a very high variation in the maturity status of inflorescences between individual palms. Culturing of tissues obtained from several inflorescences of each palm within a duration of 1-2 days was difficult. Thus for initial studies, only the inflorescences having an external spathe length of 8-12 cm were selected for culturing (this varied from -5 to -9 stages in different palms indicating the very high variation with regard to maturity status of inflorescences between individual palms).

**Table 4.** *Callus production in immature inflorescence explants obtained from palms belonging to 3 different age groups.*

Age group of palm (years)	Mean percentage of callus production
7-9	21.52
12-15	31.35
20-25	32.51
Sig	ns
CV%	65.46

As shown in table 4, there was no significant effect of palm maturity on callusing frequency. Furthermore, there was no significant correlation between the callus production and morphological characteristics such as number of leaves and length of -1 inflorescence indicating that use of such characters as an index to select suitable immature inflorescences for culture is not feasible.

For histological analysis, a portion of each inflorescence used for culturing was fixed in FAA (50 % ethanol-90 ml: 10 % formaldehyde-5 ml: glacial acetic acid- 5 ml), which was followed by a dehydration series. The samples were embedded in resin for ultra-thin sectioning. Attempts will be made to find out any correlation between the anatomy and morphogenetic potential of explants.

Samples of inflorescences of different developmental stages were dried at 70° C for 72 hrs and stored at room temperature. These samples will be used for analysis of starch, sugars and proline. Once the above analysis is completed, attempts will be made to find any correlation between the anatomy / biochemistry and morphogenetic potential of the explants.

Previous studies have shown that explants from very tender inflorescences are not suitable for callus induction. However, if such tissues can be matured under in vitro conditions and if callus can be obtained from such tissues, the difficulty in collecting the most suitable developmental stage for in vitro culture could be minimized. As a preliminary experiment, several of very tender inflorescences (external spathe lengths ranging from 4.5 - 7.5 cm) were pre-cultured on a maturation medium (modified Eeuwens's Y3 solid medium) for 7-10 days prior to culture in callus induction medium. The preliminary results indicated the possibility of obtaining callus from in vitro-matured explants (mean percentage of callusing was 20.1%).

Different maturation media in combination with different durations of pre-culture are being tested to improve callus production.

Two plants derived from immature inflorescence callus were transferred to soil and only one was able to survive.

*L K Weerakoon and M A Lokuge*

#### **Experiment 18. 2. 5. Culture of plumule explants (1997)**

Production of embryogenic callus from plumule explants was continued. The medium 72 supplemented with 24 µM 2,4-D and 0.25 % activated charcoal (Pharmacos brand) was

used for callogenesis and the average frequency of callusing was 50-55 %. The type of activated charcoal present in the medium was a critical factor that determined the callusing frequency in vitro-cultured coconut tissues. Due to the depletion of the stock of Pharmacos charcoal (which has been used since the inception of the experiments on plumule culture), it was necessary to find another suitable type of charcoal or develop a charcoal-free medium for callogenesis. Thus, the feasibility of using acid washed charcoal (BDH brand) in the culture medium was tested. Plumule explants were cultured in medium 72 supplemented with 50-500  $\mu\text{M}$  2,4-D and 0.05- 0.25 % BDH acid washed charcoal.

The Results revealed that an increase in the concentration of 2,4-D up to 100 and 500  $\mu\text{M}$  (with 0.1 and 0.25 % BDH acid washed charcoal respectively) was required to obtain callus at a frequency observed with 24  $\mu\text{M}$  2,4-D and 0.25 % Pharmacos charcoal (Table 5). These results indicated that the adsorption capacity of BDH acid washed charcoal was much higher than that of Pharmacos charcoal.

**Table 5:** *Callogenesis in plumule explants in media containing different concentrations of 2,4-D and charcoal.*

Concentration of 2,4-D and charcoal	Callogenesis (%)
50 $\mu\text{M}$ 2,4-D + 0.05 % AC	30.9
100 $\mu\text{M}$ 2,4-D + 0.1 % AC	49.2
250 $\mu\text{M}$ 2,4-D + 0.25 % AC	37.8
500 $\mu\text{M}$ 2,4-D + 0.25 % AC	47.4
CV (%)	21.4
Significance	P=0.05
LSD	12.2

AC = Activated charcoal (BDH acid washed)

A quantitative analysis of 2,4-D adsorption by Pharmacos charcoal and BDH acid washed charcoal in solid medium (carried out at the Institut de Recherche pour le Development (IRD), Montpellier, France) confirmed that the adsorption capacity of BDH acid washed charcoal was much higher than that of Pharmacos charcoal (Table 6).

**Table 6:** *Adsorption of 2,4-D by different brands of charcoal.*

Type of charcoal	Level of 2,4-D applied (mg/l)	Level of freely- available 2,4-D (mg/l)
Pharmacos	5.31	0.05 $\pm$ 0.002
	53.1	5.16 $\pm$ 0.19
BDH acid washed	5.31	0.0
	53.1	$\pm$ 0.002

Charcoal was added to the medium at a concentration of 0.25 %.

Experiments on the development of a charcoal-free culture medium for callogenesis in plumule explants were continued. Previous studies showed that callus could be produced in plumule explants when cultured in charcoal-free media containing antioxidants such as citric acid (5 mg/l ) and PVP (10 g/l) in combination with 0.3-0.5  $\mu$ M 2,4-D. However, the callusing frequency (20-30 %) was much lower when compared to charcoal-containing media.

**Table 7:** *Change in the pH of the culture medium with different antioxidants.*

Concentration of Antioxidant	Concentration of 2,4-D ( $\mu$ M)	pH of the medium 7 days after autoclaving
Control (without any antioxidant)	0.5	5.77 $\pm$ 0.002
5 mg/l citric acid	0.5	5.93 $\pm$ 0.01
10 mg/l citric acid	0.5	5.80 $\pm$ 0.03
20 g/l PVP	0.5	5.89 $\pm$ 0.01
1100 $\mu$ M ascorbic acid	0.5	4.78 $\pm$ 0.04
0.25 % Pharmacos charcoal	24	5.27 $\pm$ 0.003

Prior to autoclaving, the pH of the medium was adjusted to 6.0.

Another interesting observation made during the study was that the addition of various antioxidants to the medium could lower its pH after autoclaving (Table 7). Usually the antioxidants are added to the medium prior to adjusting the pH (except for charcoal which is added after the adjustment of pH), which is followed by autoclaving. The change in pH was comparatively higher in the media containing Pharmacos charcoal and ascorbic acid (Table 7).

Based on the observation that Pharmacos charcoal caused a lowering in the pH of the culture medium but gave rise to high callusing frequency, it was assumed that lowering the pH in charcoal-free media could result in improved callusing. However, the results of a preliminary study indicated that reducing the pH of the medium from 6.0 to 5.5 did not improve callusing frequency (Table 8). A further reduction in the pH resulted in a decrease in callusing frequency (Table 8).

**Table 8:** *The effect of pH of the culture medium on callogenesis.*

pH of medium prior to autoclaving	Callogenesis (%)
5.0	20.0
5.5	30.9
6.0	28.1

The average callusing frequency under the present culture conditions is 50 %. However, a higher callusing frequency (about 90 %) has been achieved in some laboratories by culturing intact plumules excised from freshly harvested embryos. Thus attempts were made to initiate callus from plumules excised from fresh embryos and instead of separating from the embryo, the plumule was excised along with the top portion (about 1/3) of the embryo. The tissue was either crushed or sliced before culturing. However, application of this method did not give rise to increased callus production.

Histological analysis of the somatic embryos produced under the present culture conditions revealed that many of them were incomplete and possess only the root pole.

It is well documented that application of cytokinin promotes the shoot apex development in somatic embryos. Therefore, an experiment was carried out to determine the effect of four cytokinins namely, BAP, 2iP, kinetin and TDZ (at the level of 5-15  $\mu\text{M}$ ) on the formation of complete (bipolar) somatic embryos. Plant regeneration was observed in about 2-5 % of callus cultured in the regeneration media. The results (Table 9) revealed that although plant regeneration was observed in the presence of different cytokinins, there was no significant improvement in the plant regeneration when compared to the control (medium containing only ABA). Furthermore, the application of cytokinin resulted in the formation of shoot-like structures that did not develop into normal shoots. It has been reported that 2iP and TDZ have the potential to improve coconut plant regeneration through somatic embryogenesis. However, prolonged application of cytokinin (5 weeks) might have an adverse effect on somatic embryo formation. Therefore, experiments were undertaken to study the effect of the duration of cytokinin application on somatic embryogenesis.

Experiments were undertaken to study the effect of  $\text{AgNO}_3$  (0-10  $\mu\text{M}$ ), as an ethylene inhibitor on somatic embryogenesis and plant regeneration. The combined effect of two osmotic agents, ABA (5  $\mu\text{M}$ ) and PEG (0-3 %) on somatic embryogenesis and plant regeneration is also been studied.

**Table 9:** *Effect of cytokinin in combination with ABA on plant regeneration.*

Type of cytokinin	Concentration ( $\mu\text{M}$ )		
	5	10	15
BAP	+	-	-
2iP	+	+	-
Kinetin	+	-	-
TDZ	+	-	+

+ = Plant regeneration was observed in 2-5 % of the callus cultured in the media.

During the year, 16 plants regenerated from plumule-derived callus were transplanted in soil. Thirteen of them were able to survive and are at different stages of development. Out

of the plants, which were established in soil in the previous year, one plant was planted in the field and three more are ready to be planted in the field.

Genetic fidelity of plumule derived callus and clonal plants was tested using flow cytometric analysis. According to the results, all the material analyzed was diploids and there is no variation in the ploidy level.

The analysis of proline, total sugar and starch in zygotic embryos at different stages of maturity (11-16 months after pollination), plumule-derived callus and embryogenic/non-embryogenic structures derived from plumule callus were undertaken with the objective of identifying possible biochemical markers for somatic embryogenesis. The preliminary results revealed that the proline content in zygotic embryos decreased with maturity. The proline level in callus was much higher than that of embryogenic and non-embryogenic structures. The analysis needs to be repeated in order to make conclusions.

Extraction and separation of proteins (by SDS-PAGE) from plumule-derived callus, embryogenic and non-embryogenic structures were initiated with the objective of developing protein markers to predict the embryogenic capacity of callus .

*S C Fernando and L K Weerakoon*

#### **Experiment 18.2.6. Studies on cell suspension culture of coconut (1997)**

Friable callus is the most suitable starting material for cell suspension initiation. As the coconut tissues generally produce highly compact callus, attempts to obtain friable callus were continued.

Culturing of crushed callus in a solid medium for about 30 days followed by the transfer to a liquid medium resulted in the production of small callus clumps (Treatment c; Table 5), which could be easily separated from the mother tissues. However, proliferation of these clumps was slow. Occasionally, callus derived from a few individual embryos showed better proliferation indicating a possible genotypic effect on callus morphology. Microscopic observation of cell suspension-conditioned medium revealed that it contained only cell debris.

Based on the observations made previously, an experiment was initiated to study the effect of picloram (50-100  $\mu$ M) on the rate of cell proliferation in small cell clumps obtained in treatment c.

Attempts were made to regenerate plants from cell clumps that were maintained in a liquid medium. The cell clumps were transferred to a solid medium containing ABA. All the callus tissues initially showed a reduced growth in the presence of ABA. Transferring of callus to a hormone-free medium resulted in the production of haustorial type tissues. Similar observations were made when the experiment was repeated. The effect of liquid medium (containing ABA) on plant regeneration in cell clumps is also under study.

**Table 10:** *Effect of different treatments on friable callus initiation*

Treatment	Observation
3. Culture of plumule explants in liquid medium	Sporadic callusing and compact callus
4. Culture of compact callus in liquid media containing increased Ca <sup>++</sup> and sucrose concentrations	No callus multiplication
5. Subculture of crushed, compact callus on to a solid medium for 0-30 days followed by transfer to a liquid medium. The cultures were maintained in the liquid medium (with shaking) for 4 months and the medium was replenished at 6 weekly intervals.	Small callus clumps were observed in cultures, which were initially maintained in a solid medium for more than 25 days and then transferred to liquid medium.
6. Subculture of callus on different basal media (AA, B5 and N6) supplemented with 100 µM 2,4-D and 0.1 % BDH acid washed charcoal.	No difference in callus morphology was observed over a period of 6 months.

The ploidy level of cell clumps maintained in suspension for about two years was tested using flow cytometry. All the tested clumps were diploid and no variation in ploidy level was detected.

*S C Fernando*

### **Experiment 18. 2. 9. Culture of shoot meristems (1982)**

A few shoots were obtained from callus derived from seedling shoot tips. Five of the clonal plants derived from shoot tip callus were planted in the field. The performance of the two clonal plants, which were planted in the field in 1999, was found to be satisfactory.

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### **3. ACKNOWLEDGMENTS**

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# COCONUT PROCESSING RESEARCH DIVISION

Officer-in-charge - C Jayasekara, Ph D

## 1. GENERAL

The study on chemical composition of developing kernel at different stages of maturity is continued. Analysis of total sugars in nut water and the kernel at different stages of maturity revealed that total sugar content in nut water decreases with the increase in kernel weight.

Experiments conducted to improve nutritional value of coconut oil showed that blending coconut oil with vegetable oils such as sesame oil at the ratio of 9:1 or 3:1 increased essential fatty acids content to 6% and 11% respectively. Use of Soya oil is not suitable as it gives unacceptable odour.

Experiments were carried out to increase alcohol percentage in fermenting coconut sap. Pure cultures of yeast isolated from fermenting toddy were inoculated into unfermented sap. Results indicated that a few strains of wild yeast are capable of producing 9.3 % alcohol.

Value added products such as yoghurt and ice cream were prepared with a mixture of non-fat milk and coconut milk at the ratio of 50:50. Ice cream was prepared by blending dikiri kernel with non-fat milk at the ratio of 1:1. Coconut flavour remained with the use of vanilla and almond essence.

## 2. RESEARCH PROJECTS

### PROJECT 40.0: Kernel formation and constituents

#### Experiment 40.0.1: Biosynthesis of coconut kernel (DGxT)

The analysis continued for the variety DGxT for the determination of chemical changes of the kernel and nut water during maturation. The pH, sugar, and volume of nut water were measured in maturing nut water, and fresh weight, moisture, sugars, free fatty acids, iodine value and total nitrogen in the developing kernel. Analyses of total nitrogen and fatty acid composition could not be completed due to non-availability of facilities. The results for maturity stages 6-12 are given in Table 1 and Table 2 (Each value is the mean of 8 replicates).

**Table 1.** *Variation of composition of nut water during maturation*

Maturity stage (months)	Volume of nut water(ml)	pH	Total Sugars %
6	389	5.0	2.97
7	432	5.0	4.10
8	377	5.5	4.01
9	377	5.5	4.15
10	262	5.5	3.29
11	274	5.1	3.04
12	253	5.6	2.07

**Table 2.** *Variation of composition of kernel during maturation*

Maturity stage (Months)	Kernel fresh weight(g)	Moisture %	FFA %	Iodine value	Total Sugars %
7	85	89.97	0.15	15.4	3.19
8	226	78.53	0.11	14.3	3.42
9	305	62.65	0.01	11.0	2.86
10	373	55.55	0.02	8.5	na
11	345	46.55	na	na	na
12	340	48.50	na	na	na

NA-Not Analysed      FFA-Free Fatty Acids

The results are in accordance with expectations. As the nut matures between 6 and 12 months, water decreases in volume and kernel fresh weight increases. Sugar in both water and kernel reaches a maximum at 7-9 months. As the kernel matures, saturated fats increase although free fatty acids remain low.

The results suggest a considerable import of sugars into the nut at the earlier stages of development and warrant a more comprehensive study of nutrient balance within the nut through all of the development stages.

*C.Yalegama, A.Dharmasena and W.P.K.K.Fernando.*

#### **PROJECT 40.1: Fatty acid composition preservation and value addition to Coconut oil**

##### **Experiment 40.1.4: Fatty acid composition, its quality when blended with sources rich in essential fatty acids**

##### **(1) Blending of coconut oil with soya oil**

Coconut oil is deficient in linoleic and linolenic acids, which are essential fatty acids, the content being less than 2%. Soya oil is very rich in these essential fatty acids (45-65%). Therefore coconut oil and Soya oil were mixed to increase the linoleic and linolenic acid contents.

The fatty acid composition of the blends prepared by vigorous stirring, was calculated using a computer programme based on values reported in the literature. Methyl esters of each blend were analysed for fatty acids using Gas Chromatography and compared with calculated values. The results are given in Table 3.

**Table 3.** *Comparison of calculated and analysed values of Fatty acids*

Blend	Calculated			Analysed		
	Saturated	Mono unsaturated	Poly unsaturated	Saturated	Mono unsaturated	Poly unsaturated
Soya	15.0	40.0	45.0	15.0	42.0	46.0
10% Soya	79.8	9.4	6.3	73.0	11.0	9.0
20% Soya	71.6	12.8	10.6	65.0	15.0	17.0
25% Soya	75.0	14.5	12.8	70.0	15.0	17.0
50% Soya	51.0	14.5	30.0	44.0	17.0	32.0
Coconut	85.0	6.6	1.7	85.0	5.9	2.4

Stability of the blends were tested for a 6 month period by determination of Free Fatty Acids, Iodine Value, and peroxide value. Table 4 gives the initial condition of the oil blend and table 5 gives the condition after 6 months. Analyses were carried out at 30 day intervals.

The results (Table 3) indicate that there is no significant difference among the fatty acid composition of calculated and analysed values. According to the results there is no loss of fatty acids during mixing of oils. Mixing coconut oil with other vegetable oils can increase essential fatty acids content in coconut oil we consume.

**Table 4.** *Initial Characteristics of the blend*

Sample	Smell	FFA%	Volatile matter %	IV	SV	PV
Soya	Soya	0.0611	0.0111	130	230	10
10% Soya	CNO	0.0477	0.1667	19	227	5
20% Soya	CNO	0.0390	0.2198	31	230	8
25% Soya	CNO	0.0477	0.1332	38	210	9
50% Soya	Slight CNO	0.0398	0.0477	62	212	17
Coconut	CNO	0.0722	0.0413	8	230	4

IV- Iodine value      SV- Saponification Value      PV- Peroxide value CNO - Coconut

**Table 5.** *Characteristics of the blends after 6 months*

Sample	Smell	FFA %	IV	PV
Soya	Soya	0.0722	120	15
10% Soya	CNO	0.0761	16	7
20% Soya	CNO	0.0650	20	8
25% Soya	CNO	0.0290	29	12
50% Soya	Slight CNO	0.0290	28	21
Coconut	CNO	0.0911	8	5

The results show that there are no marked changes in FFA, Iodine value(IV), Peroxide value(PV) and smell even after 6 months storage. Decrease in iodine value in 50% Soya blend shows instability of unsaturated fatty acids.

According to the FFA values the blends 10%, 20%, and 25% Soya can be stored up to 6 months without affecting their initial qualities. Frying qualities were tested for the blends. Papadam and potatoes were deep fried using the blends. Results are given in Table 6.

**Table 6.** *Frying qualities of blends*

Blend	Potatoes				Papadam			
	Frothing	Smell	Crispiness	Taste	Frothing	Smell	Crispiness	Taste
Coconut	Not observed	Good	Good	Good	Not observed	Good	Good	Good
Soya	Observed	Strong, bad	less	bad	Observed	strong	less	bad
10%	much less frothing	Good	Better than soya	Good	Less frothing	Good	Better than soya	Good
20%	Observed	Not bad	Better than soya	Not bad	Observed	Not bad	Better than soya	Not bad
25%	Observed	Not bad	Better than soya	Not bad	Observed	Not bad	Better than soya	Not bad
50%	Observed	strong	Less	bad	Observed	strong	Less	bad

According to the results Coconut Soya blend cannot be used as a good frying oil as it froths and gives a strong and disagreeable smell during frying. It can be used in shallow frying despite the very strong smell.

*C. Yalegama and A. Dharmasena*

## 2. Blending of coconut oil with Sesame (Gingelly) oil

Sesame (Gingelly) oil contains 45% of essential fatty acids. It is easily grown in Sri Lanka. Four oil blends were prepared with 10%, 25%, 50%, and 70% of Sesame oil. Both coconut and Sesame were not purified. Stability of the blended oils was assessed by determination of Free Fatty Acids (FFA), Peroxide value (PV), Iodine Value (IV) for three months. The results are given in Tables 7 and 8.

**Table 7.** *Initial characteristics of the oil blends*

Blend	FFA%	PV Meq/kg	SV	IV
Coconut oil	0.545	3.0	255.2	7.3
Sesame oil	2.464	1.7	186.4	103.3
10% Sesame	0.683	3.9	240.2	15.5
25% Sesame	1.141	4.1	227.0	21.4
50% sesame	1.920	4.0	218.0	43.4
70% sesame	2.049	3.2	202.5	70.7

**Table 8.** *Characteristics of oil blends after 3 months*

Blend	FFA%	PV Meq/kg	IV
Coconut oil	0.930	8.0	7.7
Sesame oil	3.698	3.8	104.9
10% Sesame	1.247	12.0	17.3
25% Sesame	1.678	12.3	31.8
50% sesame	2.825	13.5	50.8
70% sesame	3.031	14.3	75.3

Free fatty acid (FFA) contents of oil blends during storage increase with increasing sesame oil. Sesame oil has a high FFA content. This is due to the instability of unsaturated oils. To decrease the initial FFA of sesame oil purification should be done prior to blending. The results show that coconut oil and blends with 10% sesame and 25% sesame can be stored without the FFA exceeding 2%. Iodine value has not increased greatly during storage. Peroxide value has also not increased markedly. According to the results blends with 10% sesame, 25% sesame and coconut oil can be satisfactorily stored more than 3 months but storage time can probably be increased with the use of purified oils.

*C. Yalegama and U. Perera,*

### 3. Sensory evaluation of oil blends

#### Sensory evaluation for the acceptability of oils

Six types of blends of oil mentioned above were tested by 21 panelists. The panelists were asked to score with an ordinal value 1,2,3,4,or 5 for colour and smell of the oil separately, depending on their preference (1=dislike very much, 2=dislike slightly, 3=neither like nor dislike, 4=like slightly, 5=like very much). The Friedman non-parametric test showed that the medians of treatments are significantly different ( $p < 0.0001$ ). Results show that panelists strongly preferred 90% coconut and 10% sesame blend for colour and 100% coconut oil for smell.

The preference for blends was further tested using three types of foods fried fish, noodles and kavum. Friedman test was significant only for taste ( $p < 0.0001$ ) of fried fish.

This indicates that there was no difference in preference for noodles and kavum prepared using different blends of coconut and sesame oil .

However for fried fish, 100% coconut oil, 90% coconut and 10% sesame blend are preferred.

*C.Yalegama and U.Perera,*

**PROJECT 41.0:                   Development research on Kernel Products**

**Experiment 41.1.1:           Preparation of yoghurt using coconut milk as the  
  main substrate**

Experiments were conducted to prepare yoghurt of desired texture, taste and colour from a mixture of coconut milk and non fat milk powder at the ratio of 50 % : 50 % (Sachez, C.P.,1988) using different setting media and cultures. Results are shown in Tables 9, 10 and 11.

Experiments are underway to get rid of layer separation.

*M.Jayasundera, C.Yalegama, and A.N.Kumara*

**Table 9.** *Physical characteristics of yoghurt with Highland culture*

Type of culture	Colour	Taste	Texture	Appearance
Highland	White	Oily	Not smooth	i Less oozing out of liquid ii Layer separation was observed

**Table 10.** *Physical characteristics of yoghurt with different percentages of gelatine*

Percentage of gelatine	Type of culture	Colour	Taste	Texture	Appearance
0.1	Highland	White	Oily	Not smooth	i Less oozing out of liquid ii Layer separation was observed
0.5	Highland	White	Oily	Not smooth	i Less oozing out of liquid ii Layer separation was observed

**Table 11.** *Physical characteristics of yoghurt with different culture media*

Origin of culture	Colour	Taste	Texture	Appearance
Highland	White	Oily	Not smooth	i Oozing out of liquid ii Layer separation was observed
Kotmale	White	Oily	Not smooth	i Oozing out of liquid ii Layer separation was observed
Newdale	White	Good	Not smooth	i Less oozing out of liquid ii Layer separation was observed

### Experiment 41.1.1: Preparation of ice cream from dikiri nuts

Ice cream was prepared with dikiri kernel and non fat milk powder in the ratio of 1:1 according to cottage manufacturing practice. The quality was determined in respect of the taste with different flavouring agents as given in the Table 12.

**Table 12.** *Taste of ice cream with different added flavours*

Type of Flavour	Taste
Vanilla	Coconut
Almond	Coconut
Chocolate	Good

Chocolate flavour was capable of masking coconut flavour.

*M. Jayasundera and C. Yalegama*

### Experiment 41.1.1: Preparation and storage of coconut milk/cream

Preliminary experiments were carried out to study the keeping quality of coconut cream extracted by a hydraulic pressing machine. It was observed that cream could be stored in a refrigerator or deep freezer for 3 days without significant increase of FFA.

H hundred packets of coconut cream were distributed among the CRI staff to study acceptability. Responses suggested that cream was suitable for preparing a wide variety of foods including desserts. It could be stored at room temperature for 3 hours and three days under refrigeration.

*C. Rodrigo, Pradeepa and R. Kulathunga*

### PROJECT 43.0: Development research on sap products

#### Experiment 43.1.2: Isolation of high alcohol producing yeast strains

Samples of field collected sweet toddy were treated with sodium metabisulphite to a final strength of 189-263 mg/L. This treatment suppresses bacterial activity while permitting vigorous yeast strains to multiply. After 12 hours, 1ml each was poured or streaked on sweet toddy or potato dextrose agar. Twenty two cultures were obtained from the colonies and their alcohol production at 3 and 5 days is presented in Table 13.

**Table 13.** *Alcohol production on the third and fifth days by pure cultures of yeast isolated from fermenting sap and inoculated into unfermented sterile sap (percentage in volume by volume)*

Yeast isolate (Y)	% Alcohol at third day	%Alcohol at fifth day
1	8.7	8.5
2	9.1	8.9
3	8.9	9.0
4	9.2	8.7
5	8.7	8.6
6	7.6	9.1
7	6.6	8.7
8	7.6	8.6
9	8.2	8.1
10	9.1	8.9
11	0.0	0.2
12	2.3	4.0
13	0.0	0.0
14	8.8	9.0
15	8.9	9.3
16	8.8	9.3
17	8.4	7.8
18	0.0	0.0
19	8.6	9.1
20	8.0	8.3
21	8.4	8.2
22	0.0	0.0

The yeast strains Y<sub>3</sub>, Y<sub>6</sub>, Y<sub>14</sub>, Y<sub>15</sub>, Y<sub>16</sub> and Y<sub>19</sub> reached an alcohol production greater than 9.0 % (v/v) by the 5<sup>th</sup> day of fermentation under laboratory conditions.

*M.C.P. Rodrigo and S.A.K.D. Hemantha*

### 3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES

#### PROJECT 42.0: Development research on nut water

##### Experiment 42.0.1: Development of beverages from seasoned nut water available from DC and Copra manufacture.

#### Improving the quality of the Coconut water drink by adding fruit pulp

The research continued with the addition of 3% of natural belli (*Aegle marmalos*) pulp. The shelf life of the product was studied by keeping it at 4°C and at room temperature. It was tested by visual observation and tasting done by 7 individuals.

**Table 14.** *Physical and chemical parameters of the beverage before storage*

Brix	Colour	Taste	%Acidity as citric acid	Other observation
12.5	Orange	Fresh belli taste	1.2	Separation of oil and water was not observed. Solid sediment was observed. On shaking its dispersed.

**Table 15.** *Physical and chemical changes of the beverage after 3 months*

Storage conditions	Brix	Colour	Taste	Acidity % as citric acid	Other observations
Room temperature	13	Yellow	Stale belli taste	3.04	Very thin oil layer was visible. On shaking solids and oil dispersed throughout the beverage
4°C (Refrigerated)	13.5	Orange	Fresh belli taste	1.14	Separation of oil was not observed. On shaking, solids dispersed throughout the beverage.

Addition of fruit pulp was tested as a masking agent for oil separation. Several percentages of different fruit pulps were tried for achieving good masking effect. Pineapple was not successful but belli fruit with 3% concentration gave a better taste.

Table 14 gives the physical and chemical parameters of the beverage prepared with belli pulp before storage. The initial quality of the beverage with 3% belli fruit pulp was quite acceptable with good taste. Table 15 gives the physical and chemical parameters of the beverage after storage for 3 months. Colour, taste and acidity changed with storage at room temperature. A very thin oil layer was also observed. When stored at 4°C, colour taste and acidity remained unchanged during storage. Oil separation was not observed.

*M.C.P Rodrigo and N.Jayasingha,*  
NSF funded project

#### 4. LABORATORY AND MISCELLANEOUS STUDIES

##### 4.1. Comparison of palm and coconut oil for frying quality

Coconut oil and palm oil were compared for their frying qualities with deep fried fish. Coconut oil was prepared in the Division and RBD grade palm oil was purchased from the market. Time taken for frying was measured. Keeping quality was studied by keeping the samples at room temperature until crispness is lost, and taste was determined by 7 people.

The time taken for frying was higher for palm oil (12 minutes and 10 minutes for coconut). Keeping quality was the same in both the cases. Panelists preferred the fish fried in coconut oil.

*C. Yalgame and M.Jayasundera*

#### **4.2. Detection of adulteration of coconut oil with palm oil**

$\beta$  -carotene was extracted with furfuraldehyde and diethylether from pure palm oil, mixed palm and coconut oil and pure coconut oil. When Antimony trichloride is added,  $\beta$ -carotene present in palm oil gives a blue colour and this test can be used to detect adulteration of coconut oil with palm oil.

*C.Yalegama*

#### **5. ACKNOWLEDGEMENT**

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# REPORT OF THE PLANT PHYSIOLOGY DIVISION

Head – C S Ranasinghe, Ph D

## 1. GENERAL

The division continued to emphasize research activities on shelf-life improvement of tender nuts, tapping coconut palms for toddy, water relations of the coconut palm and disorders of unknown etiology.

Experiments on the quality preservation of tender bodiri nuts were continued under laboratory conditions. When the whole nut was disinfected with Benlate (0.6g/L), completely covered with cling film and stored at 14-15 °C and 70% RH, the sugars, minerals and taste of nut water and the external appearance of the nut were maintained for a period of 3 weeks.

Application of 3.0 ml of 2.5% ethrel at the axil of every tapping spathe increased the daily toddy yield consistently for a period of four years. The increase was 35% during the first two years, 20% in the third year and 11% in the fourth year compared to untreated palms. The sugar content in the sap of ethrel treated palms was also higher than that of untreated palms.

The biological feasibility of using the coconut palm for the dual production of nut and toddy and the single production of nut or toddy was investigated. The annual removal of water and major nutrients per palm as nut components and toddy was calculated. In the single purpose, a sap-producing palm removed nine times more water than a nut-producing palm. In the dual purpose, the annual removal of water from a nut and sap producing palm varied according to production schemes and was still higher than by a nut-producing palm. A sap-producing palm removed the lowest quantities of N, P, K and Mg and a nut-producing palm the highest. To determine the economic viability of tapping dwarf coconut palms for production of treacle in home gardens, a new experiment was started with green and red dwarf palms at Bandirippuwa Estate. A new experiment also examines whether the 'tapping stimulation' alters the differentiation of female flowers and, hence the ratio of female/male flowers in tapped palms.

Following a 25-30 day rain free period, Brown Dwarf, Ambakelle Special and Debarayaya tall palms maintained a higher rate of transpiration and low stomatal resistance enabling a higher rate of photosynthesis compared to other accessions. Cameroon Red Dwarf and Moorock Tall showed a lower rate of transpiration and higher stomatal resistance indicating a higher water deficit within the palm compared to other accessions. Furthermore, it seems that abscisic acid is not the only biochemical agent for controlling stomatal opening and closure in coconut. A plant house study was started to evaluate the genotypic variation in the sensitivity of coconut seedlings to soil drying and pattern of abscisic acid production.

Mulching only the manure circle (1.75 m radius from the base of the coconut palm) with black polythene in Andigama series soil indicated a high water deficit in the palms during the dry period. The soil temperature under the polythene mulch (15 cm and 30 cm depth) was 1°C higher than that of an un-mulched palm and 2°C higher than that of a coir dust -mulched palm during a moderately dry period.

In leaf scorch decline (LSD) affected palms, the leaf Zn content was lower than in apparently healthy palms. Therefore, some of the affected palms at Bandirippuwa, Walpita

and Poththukulama estates were root fed with 100 ml of 1% ZnSO<sub>4</sub> solution to determine the effect of Zn on the expression of LSD symptoms. Rapid decline (RD) affected palms at Makandura seed Garden were supplied with micronutrients, common salt, nematicide, fungicide and tetracycline treatments to assess the progress of 'syndrome' following treatment.

In collaboration with Genetics and Plant Breeding Division two catalogues on coconut food recipes and value added coconut products in Sri Lanka were prepared.

## **2. RESEARCH PROJECTS**

### **PROJECT 13: TODDY TAPPING**

#### **Experiment 13.3: Sequential toddy and nut production in coconut. Bandirippuwa Estate (1996).**

To obtain maximum income from the coconut palm, the possibility of using it for the dual production of nuts and toddy was investigated. The experiment was a completely randomized design with 16 single palm replicates per treatment. The age of the palms was 40 years.

Following production schemes were tested:

- T<sub>1</sub> - Sap production only (tod)
- T<sub>2</sub> - Nut production only (nut)
- T<sub>3</sub> - Sequential sap and nut production from the same spathe (distal portion for toddy and proximal portion for nuts- 1/2to + 1/2n)
- T<sub>4</sub> - Sequential sap and nut production from the same palm (periodic tapping and nut production at three spathe intervals- 3to + 3n)

The cost and return analysis showed that the production schemes T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> gave a net income of Rs 80,000.00, 26,000.00, 45,000.00 and 63,000.00, respectively, per acre per annum (Annual Report 1999).

The annual removal of carbon per palm from the two products was calculated. The annual removal of carbon (C) from a nut and sap-producing palm (T<sub>3</sub> and T<sub>4</sub>) was similar to that of nut producing (T<sub>2</sub>) palm. A sap-producing palm (T<sub>1</sub>) removed the lowest amount of C (Table 1).

The annual removal of water per palm from two products was also calculated (excluding evapotranspiration). A sap-producing palm (T<sub>1</sub>) removed nine times more water than a nut-producing palm (T<sub>2</sub>). The annual removal of water from a nut- and sap-producing palm (T<sub>3</sub> and T<sub>4</sub>) varied according to production scheme and was still higher than a nut-producing palm (Table 1).

The annual removal of major nutrients per palm from two products (from nut components and toddy) was calculated based on the published rates (Annual Report of Soils and Plant Nutrition Division, CRI, 1997). A sap-producing palm (T<sub>1</sub>) removed the lowest amount of N, P, K and Mg and a nut-producing palm (T<sub>2</sub>) removed the highest amount.

**Table 1. Removal of carbon and water from single product (only nuts or sap) and dual product coconut palm**

Treat.	Annual yield per palm		Removal of Carbon (kg per palm / year)			Removal of water (L per palm / year)		
	Nuts	Sap (L)	Nuts	Sap	Total	Nuts	Sap	Total
Tod	-	234	-	14.74	14.74	-	187	187
Nuts	73	-	22.48	-	22.48	20	-	20
(1/2to+ 1/2n)	54	89	16.63	5.61	22.23	15	71	86
(3to + 3n)	40	143	12.32	9.01	21.33	11	114	125.4

**Table 2a. Nutrient removal from single product (only nuts or sap) and dual product coconut palm**

Treat.	Annual yield / palm		Removal of Nutrients (g /palm / year)							
	Nuts	Sap (L)	Nuts				Sap			
			N	P	K	Mg	N	P	K	Mg
Tod	-	234	-	-	-	-	124.02	24.8	545.69	0.99
Nuts	73	-	467.2	97.33	895.47	126.53	-	-	-	-
(1/2 to + 1/2n)	54	89	345.6	71.99	662.40	93.59	47.17	9.43	207.55	0.377
(3 to + 3n)	40	143	256.0	53.32	490.67	69.33	75.79	4.24	93.28	0.169

**Table 2b. Total nutrient removal from single product and dual product coconut palm**

Treat.	Annual yield per palm		Total Removal of Nutrients (g /palm / year)				
	Nuts	Sap (L)	N	P	K	Mg	
Tod	-	234	124.02	24.8	545.69	0.99	
Nuts	73	-	467.20	97.33	895.47	126.53	
(1/2 to + 1/2n)	54	89	392.77	81.42	869.95	93.967	
(3 to + 3n)	40	143	331.79	57.56	583.95	69.49	

The nutrient removal from a ½to + ½n palm (T3) was higher than 3to + 3n (T4) palm (Tables 2a, b).

In conclusion, a toddy-producing palm removed lower amounts of C, N, P, K, and Mg than a nut-producing palm, annually. In the use of coconut palm for the dual production of nut and toddy, periodic tapping and nut production at three spathe intervals gave the highest income per acre. However, if the coconut palms are used continuously for toddy, a continuous supply of water or high water table in the soil is required to prevent palms from dehydration. The experiment was terminated.

*C S Ranasinghe, W S Madurapperuma and A Jayatillake*

**Experiment 13.4: Chemical stimulation of toddy. Bandirippuwa Estate, Lunuwila (1996).**

The aim of this experiment was to identify suitable yield stimulants to improve toddy yield without reducing the sugar content of the sap. The experiment was a completely randomized design with 12 replicates per treatment. The volume of toddy per palm was measured daily and sugar content of toddy was measured monthly.

A small piece of cotton wool soaked in a 3 ml solution of Ethrel (Ethephon), at a concentration of 2.5%, was placed at the axis of the tapping spadix (inside the outer bract). The application was done once per spadix and on the first day of slicing. Untreated palms were used as control. Application of ethrel increased the daily toddy yield consistently for a period of four years. The increase was about 35% during the first two years, 20% in the third year and 11% in the fourth year compared to control palms (Table 3a). The sucrose and total sugar contents in the sap of ethrel treated palms were also higher than that of untreated palms consistently over four years (Table 3b).

**Table 3a.** *Effect of application of 2.5% Ethrel (axis) on toddy yield*

Treatment	Mean toddy volume (ml/day)			
	1997	1998	1999	2000
Control	830	682	715	608
2.5% Ethrel	1116	926	856	679
yield stimulation	35%	36%	20%	11%

**Table 3b.** *Effect of application of 2.5% Ethrel (axis) on sugar content of toddy*

Treatment	Sugar content (g/100 ml)							
	1997		1998		1999		2000	
	Suc	Total	Suc	Total	Suc	Total	Suc	Total
Control	12.40	13.96	12.39	14.20	12.45	14.06	na	12.64
2.5% Ethrel	14.30	16.90	13.65	16.24	14.31	16.82	na	17.82

na – not analysed

If the sap (fresh toddy) is used to produce treacle, an ethrel treated and untreated (control) palm would yield 50 and 40 L of treacle per palm per annum, respectively.

**Table 4:** *Diurnal sap flow pattern of 2.5% Ethrel treated and control palms*

Time of the day	Slicing (morning)							Slicing (evening)				Slicing (morning)		
	6.30	7.30	8.30	9.30	10.30	11.30	12.30	13.30	14.30	16.00	17.00	18.00	19.00	7.00
Control		56.20	36.80	41.81	36.80	30.20	18.20	28.40	24.00	21.20	50.60	39.60	47.30	43.50
2.5% Ethrel		73.50	43.30	45.30	41.30	39.30	19.20	20.40	28.00	25.15	79.00	53.67	44.60	65.20
Stimulation		31%	18%	8%	12.2%	30.1%	6%	-	17%	19%	56%	36%	-	50%

If it is used to produce jaggery (sugar), an ethrel treated and untreated palms would yield 42 and 34 kg of jaggery per palm per annum, respectively.

Diurnal sap flow studies also showed that the rate of flow (ml / h) was higher in 2.5% Ethrel treated coconut palms compared to untreated palms (Table 4). Therefore, studies were commenced to determine the role of ethrel in stimulation of toddy yield and sugar contents.

*C S Ranasinghe, W P K K Fernando, P S A de Saram and A Jayatillake*

**Experiment 13.5: Tapping dwarf coconut palms for production of treacle : a feasibility study. Bandirippuwa Estate, Lunuwila (2000).**

To determine the economic viability and biological feasibility of tapping dwarf coconut palms for production of treacle in home gardens, a new experiment was started with 12 palms each of green and red dwarf at Bandirippuwa Estate. The volume of toddy per palm was measured daily. Both volume of fresh toddy per spadix and per day for red dwarf palms were higher than that for green dwarf palms. The palms were tapped for a period of 6 months. Number of toddy yielding palms and the 'tappable duration' of each spadix decreased with time (Table 5). Hence the experiment was abandoned. Based on the volume of treacle produced and the cost of production, the net return will be calculated.

**Table 5.** *Volume of toddy and the mean number of days each spadix can be tapped in dwarf red and dwarf green palms*

Cultivar	Spadix no.	L / Spadix	ml / day	Tappable duration (days)
Dwarf red	S-1	12.98	664	20
	S-2	7.48	548	14
	S-3	11.07	666	17
	S-4	5.88	510	11
	S-5	5.55	604	09
Dwarf green	S-1	7.79	336	23
	S-2	4.46	315	14
	S-3	8.28	562	15
	S-4	2.54	230	11
	S-5	-	-	-

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**PROJECT 22: POST-HARVEST HANDLING OF TENDER KING COCONUTS AND BODIRI FOR QUALITY PRESERVATION.**

**Experiment 22.3: Development of a post-harvest technology to improve shelf-life of tender bodiri (1999).**

Bodiri nuts have less commercial value as mature nuts, copra or desiccated coconut. The low weight and the small size of bodiri nut, and the low volume of nut water should make it attractive for the export market as tender nuts. The taste of nut water of tender bodiri was also comparable with that of thembili (Annual Report 1999). Therefore, the technology package identified for quality preservation of tender king coconut was tested on 7-8 months old bodiri nuts, under laboratory conditions. Nut water samples were diluted 100 times,

purified using a sep-pak cartridge and analysed for sugars (Glucose, Fructose and Sucrose) using a high performance liquid chromatography (HPLC) system. Triangle test was conducted to find out whether the taste of nut water has been changed after storage. Twenty independent panelists participated in the taste test.

The sugar content, pH and taste of nut water were not affected and the external appearance of the nut was not changed after 4 weeks of storage at 13-15 °C and 70% RH (Table 6).

**Table 6.** *Sugar contents, total soluble solids (% Brix) and pH of nut water in brown bodiri (BB) and green bodiri (GB) at initial stage (fresh) and after four weeks of storage (4w) at 13-15 °C and 70% RH*

Type	Sugar type	Sugar content (g/100ml)		% Brix		pH	
		fresh	4w	fresh	4w	fresh	3w
BB	Glucose	1.83	1.46	4.3	4.14	4.8	5.0
	Fructose	1.62	1.75				
	Sucrose	nd	nd				
	Total	3.45	3.48				
GB	Glucose	2.50	2.31	4.88	4.81	4.7	4.9
	Fructose	2.40	2.31				
	Sucrose	0.10	nd				
	Total	5.00	4.62				

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## **PROJECT B-17: WATER RELATIONS OF THE COCONUT PALM**

### **Experiment B-17.1: Studies on water-use efficiency of different accessions of coconut in relation to the stable carbon isotope discrimination ratio (1992).**

The objective of this study was to determine actual and instantaneous water use efficiency (IWUE) of palms and correlate it with water-use efficiency assessed by stable carbon isotope discrimination ratio.

To determine the heritability of carbon isotope discrimination character from drought tolerant Ambakelle Special parents to their F2 progeny, leaf samples were collected from parents and their controlled pollinated progeny and  $^{13}\text{C}/^{12}\text{C}$  analysis was done by the Australian National University, Canberra, Australia.

A pot experiment with seedlings of four different crosses was completed. The crosses were;

- (a). Ambakelle Tall x Kasagala (AT x Ka)
- (b). Ambakelle Tall x St. Annes (AT x St. A)
- (c). Ambakelle Tall x Moorock (AT x Mo)
- (d). Tall x Tall (CRIC60).

The IWUE and actual water use efficiency of the seedlings were calculated (Annual Report 1999). Leaf samples were collected for determination of  $^{13}\text{C}/^{12}\text{C}$  and correlation with

actual and instantaneous water use efficiency of seedlings. The leaf samples will be sent to Australian National University, Canberra, Australia for  $^{13}\text{C}/^{12}\text{C}$  analysis.

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**Experiment B-17.2 : Importance of root to shoot communication in drying soil: role of abscisic acid in drought tolerance in coconut (1997).**

Physiological performance of 15 month-old Tall x Tall (CRIC60), Tall x San Ramon (CRISL98) and Dwarf Green x Tall (CRIC65) seedlings grown under plant house conditions at three soil moisture regimes was evaluated. The experiment was a Completely Randomized Block Design and for each treatment there were 8 seedlings of each variety. The moisture levels were obtained by changing the watering frequency as follows.

- T1 – Field capacity - FC
- T2 – Watering at 15 day intervals (moderate stress) - MS
- T3 - Watering at 20 day intervals (severe stress) – SS

After 12 weeks of growth in the plant house and 8 weeks under different watering treatments, rate of photosynthesis, transpiration, stomatal diffusive resistance, water potential and relative water content of leaves were measured. Xylem sap was collected for Abscisic acid analysis and leaf samples were collected for microscopical observation of thickness of the epicuticular wax layer.

The statistical analysis showed that there was no significant interaction between varieties and treatments indicating that they are independent of each other. However, except for leaf water potential, there was no significant difference among the varieties for photosynthesis, transpiration, stomatal diffusive resistance and relative water content of leaves. Irrespective of the treatments, the lowest water potential was shown by Tall x Tall and it was significantly lower than Tall x San Ramon and Dwarf Green x Tall (Table 7).

**Table 7.** *Mean rates of photosynthesis (PHOTO,  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ), leaf water potential (LWP, MPa), transpiration (TRANS,  $\mu\text{g cm}^{-2} \text{s}^{-1}$ ), stomatal diffusive resistance (SDR,  $\text{s cm}^{-1}$ ) and relative water content (RWC, %) of three different varieties of coconut seedlings*

VAR	PHOTO	LWP	TRANS	SDR	RWC
CRIC60	2.368	-1.5 <sup>a</sup>	0.682	43.915	88.75
CRISL98	1.939	-1.3 <sup>b</sup>	0.547	56.626	88.13
CRIC65	2.361	-1.4 <sup>ab</sup>	0.563	59.344	88.58
% CV	94.4	16.03	57.02	89.820	6.78
Sig.	ns	*	ns	ns	ns
LSD	1.21	1.26	0.196	27.62	3.46

There was a significant difference in photosynthesis, water potential, transpiration, stomatal diffusive resistance and relative water content of leaves between stressed and non-stressed seedlings, irrespective of the severity of stress level. In all three varieties the water-stressed seedlings (MS and SS) showed lower rates of photosynthesis, transpiration and leaf water potential and higher stomatal resistance compared to the seedlings grown at field capacity (FC) (Table 8). It indicated that none of the varieties could maintain satisfactory physiological functions even at moderate water stress (watering at 15 day intervals) under

plant house conditions. All the seedlings were equally sensitive to soil water stress and sensed water deficit by increasing stomatal resistance.

**Table 8.** Mean rates of photosynthesis (PHOTO,  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ), leaf water potential (LWP, MPa), transpiration (TRANS,  $\mu\text{g cm}^{-2} \text{s}^{-1}$ ), stomatal diffusive resistance (SDR,  $\text{s cm}^{-1}$ ) and relative water content (RWC, %) of coconut seedlings grown under three soil moisture regimes; field capacity (FC), moderate stress (MS), severe stress (SS)

VAR	PHOTO	LWP	TRANS	SDR	RWC
FC	4.590 <sup>a</sup>	-1.0 <sup>a</sup>	0.927 <sup>a</sup>	24.03 <sup>a</sup>	93.58 <sup>a</sup>
MS	0.963 <sup>b</sup>	-1.5 <sup>b</sup>	0.432 <sup>b</sup>	56.37 <sup>b</sup>	87.13 <sup>b</sup>
SS	1.115 <sup>b</sup>	-1.5 <sup>b</sup>	0.433 <sup>b</sup>	79.49 <sup>b</sup>	84.75 <sup>b</sup>
% CV	94.4	16.03	57.02	89.82	6.78
Sig.	***	***	***	***	***
LSD	1.21	1.26	0.196	27.62	3.46

\*  $p < 0.05$ , \*\*\*  $p < 0.001$

The same parameters of adult palms will be measured in the field during a rainy, moderately dry and a severe dry period.

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**Experiment B-17.3: RAPD-based characterization of conserved coconut biodiversity in Sri Lanka with emphasis on detection of markers linked to drought tolerance (1998).**

The main objective of the experiment was to correlate physiological parameters and abscisic acid (ABA) content of 20 coconut genotypes (talls, dwarfs and hybrids) during the dry period with detected molecular markers for drought tolerance. The stomatal diffusive resistance, rate of transpiration and xylem sap abscisic acid (ABA) content of twenty palms each of accessions Dwarf Green, Dwarf Yellow, Cameroon Red Dwarf, Dwarf green x Tall, Tall x Clovis, Moorock tall, Ambakelle tall, Ambakelle Special, Kasagala, Debarayaya and Goyambokka during the dry periods (following exposure to 25-30 days of rain free period) were measured. The xylem sap ABA content of twenty palms each of Gonthebili, St. Annes, Magaret and Dwarf yellow x Tall was analysed. Prevailing gloomy weather conditions prevented the physiological measurements on these palms.

It was possible to separate the accessions into three groups according to the measured parameters. Following exposure to 25-30 days of rain free period, Cameroon Red Dwarf and Moorock tall showed a higher stomatal resistance and, consequently, a lower rate of transpiration indicating a high water deficit condition in those palms compared to other accessions. Ambakelle Special and Debarayaya accessions showed a higher rate of transpiration indicating an improved water status of the palms and a lower stomatal resistance enabling a higher rate of photosynthesis that would result in a better growth and yield of the palms compared to others. The two accessions, Moorock tall and Kasagala had the highest ABA content in the xylem sap. The stomatal resistance was not always correlated with the abscisic acid content in the xylem sap of those palms (Table 9).

Furthermore, it seems that abscisic acid is not the only biochemical agent for controlling stomatal opening / closure in coconut. Therefore, it is worthwhile to evaluate the genotypic variation in the sensitivity of coconut seedlings to soil drying and pattern of abscisic acid production and the ratio of ABA/cytokinin in the xylem sap. The physiological performance of individual palms will be used to determine the relationship between RAPDs, *in-vitro* indicators and physiological parameters.

**Table 9.** *Grouping of accessions according to high, medium and low stomatal diffusive resistance (SDR,  $s\ cm^{-1}$ ), rate of transpiration (Trans,  $\mu g\ cm^{-2}\ s^{-1}$ ) and xylem sap abscisic acid content (ABA,  $ng\ ml^{-1}$ ).*

Accession	SDR	Trans	ABA content
Camer. Red Dwarf	82.76	0.79	5.97
Moorock Tall	61.89	0.94	18.80
Goyambokka	33.55	1.94	9.30
Kasagala	18.51	2.64	17.38
Tall x Clovis	12.04	3.47	12.29
Ambakelle Tall	10.61	3.38	13.76
Dwarf Green x Tall	9.54	2.89	13.67
Dwarf Green	7.15	2.97	13.50
Dwarf Yellow	5.61	3.36	12.07
Ambakelle Special	5.09	4.05	10.12
Debarayaya	4.06	4.56	5.50
Magaret	nm	nm	12.60
St. Annes	nm	nm	8.06
DY x Tall	nm	nm	7.62
Gon thembili	nm	nm	4.88

nm: not measured

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**Experiment B-17.4: Determination of the effect of different mulching material on plant water status in drought prone coconut lands. Ratmalagara Estate (1997).**

The aim of the study was to determine the effect of different mulching material on plant water status during the dry periods. The manure circle (1.75 m radius from the bole) of palms was covered with following mulching material.

- T<sub>1</sub> - Control (no mulch)
- T<sub>2</sub> - Husk mulch (250 husks)
- T<sub>3</sub> - Coir dust mulch (10 cm thick)
- T<sub>4</sub> - Straw mulch (5 cm thick)
- T<sub>5</sub> - Black polythene mulch (400 gauge black polythene cover)
- T<sub>6</sub> - Dried coconut frond mulch (12-14 fronds per annum)

Mulching the manure circle with coconut husks, coir dust, straw, black polythene or dried coconut fronds was not effective in improving the palm water status during the dry period of 60 days in Andigama soil series. All the palms were equally sensitive to soil water depletion and responded to water deficit by increasing the stomatal resistance (Annual Report

1999). The highest stomatal diffusive resistance and the lowest leaf and soil water potentials in black polythene mulched palms indicated a high water deficit condition in those palms during the dry period. Diurnal measurements of soil temperature under the black polythene mulch (15 cm and 30 cm depth) showed that it was 1°C higher than that of an un-mulched palm and 2°C higher than that of a coir dust -mulched palm during a moderately dry period (severe drought conditions were not experienced during the year).

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**Experiment B-17.5: Effect of different ground cover management systems on the growth of coconut palms in Andigama soil series at Rathmalagara Estate (1997).**

The effect of different ground cover management systems on the water status of coconut palms grown in shallow soils was studied. The following treatments were imposed:

- T<sub>1</sub> - Dead mulch in the manure circle; rest of the land bare (MCDM/CSB)
- T<sub>2</sub> - Dead mulch in the manure circle; rest of the land grass cover (*B. brizantha*) slashed every 6 months (MCDM/CSGC)
- T<sub>3</sub> - Dead mulch in the manure circle; rest of the land uncontrolled grass cover (*B. brizantha*) (MCDM/CSGU)
- T<sub>4</sub> - Dead mulch in the manure circle; rest of the land *Pueraria* cover (MCDM/CSP)
- T<sub>5</sub> - Dead mulch in the manure circle; rest of the land 6" thick coir dust cover (MCDM/CSCD)
- T<sub>6</sub> - Manure circle is left open; rest of the land bare (MCB/CSB)
- T<sub>7</sub> - Coir dust mulch (6" thick) covering the ground including manure circle (MCCD/CSCD)

Dead mulch (DM): 12 coconut fronds without petioles / yr

Plant water relations were measured throughout the year at monthly intervals. Since there was a well-distributed rainfall, a prolonged dry period was not experienced this year. During the wet period, transpiration rate, stomatal diffusive resistance and leaf water potential of leaves were not affected by the ground cover (Table 10).

**Table 10.** *Effect of different ground cover treatments on rate of transpiration and stomatal diffusive resistance of coconut palms during wet period of the year*

	Rate of Transpiration ( $\mu\text{g cm}^{-2} \text{ s}^{-1}$ )	Stomatal diffusive resistance ( $\text{s cm}^{-1}$ )	Leaf water potential (MPa)
MCDM/CSB	3.83	5.90	-1.2
MCDM/CSGC	4.89	4.60	-1.4
MCDM/CSGU	5.60	3.69	-1.4
MCDM/CSP	4.06	5.86	-1.3
MCDM/CSCD	5.20	3.97	-1.4
MCB/CSB	5.96	3.10	-1.2
MCCD/CSCD	5.93	3.37	-1.3

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**PROJECT 24: LEAF SCORCH DECLINE OF COCONUT PALM**

**Experiment 24.4: Studies on yield and biochemical nature of the inflorescence sap of LSD-affected palms (Bandirippuwa Estate, 1996).**

Ten palms of mild- and moderate-LSD affected palms were selected for the study and apparently healthy palms were used as control. The variation in yield, osmolality and sugar content of the sap was studied for a period of one year.

The total yield of toddy produced by the LSD-affected palms during the year (May 99 – June 00) was lower than that of healthy palms. The reduction was 24% and 49% in mild- and moderate-LSD palms, respectively. Detailed studies on the variation in toddy volume over inflorescences revealed that the mild-LSD palms yielded the same volume as healthy palms except for I-6, I-7, I-8 and I-11 whilst the moderate-LSD affected palms always yielded significantly lower volumes of toddy compared to healthy palms (table 11). This indicates an internal disability of LSD-affected palms in the sap production. However, the percentage contribution to the total yield by individual inflorescences (I-1 to I-14) seems to be similar irrespective of the stage of palms (Table 12). Except for the two inflorescences, the osmolality and sugar content of the sap did not vary over inflorescences (Tables 13 and 14).

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**Experiment 24.5: Investigations on leaf micronutrients of Leaf Scorch Decline affected palms**

In leaf scorch decline (LSD) affected palms the leaf Zn content was lower than that of apparently healthy palms (Annual report 1999). Therefore, to determine the effect of Zn application on expression of LSD symptoms, eight palms each of mild, moderate-LSD and healthy palms at Bandirippuwa and Walpita estates were root fed with 100 ml of 1%  $\text{ZnSO}_4$  solution at bimonthly intervals. The damage assessment and Zn and chlorophyll content of leaves are analysed at bimonthly intervals.

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**Table 11:** *Variation in sap yield (L / inflorescence) of healthy, mild-LSD and moderate-LSD affected palms over inflorescence and total yield during the year (99 May – June 2000).*

Stage of palm	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14	Total
Healthy	102.9 <sup>a</sup>	76.9 <sup>a</sup>	56.2 <sup>a</sup>	54.3 <sup>a</sup>	41.5 <sup>a</sup>	50.0 <sup>a</sup>	53.0 <sup>a</sup>	53.4 <sup>a</sup>	52.5 <sup>a</sup>	49.9 <sup>a</sup>	53.8 <sup>a</sup>	45.6 <sup>a</sup>	41.3 <sup>a</sup>	40.2 <sup>a</sup>	771.4 <sup>a</sup>
Mil – LSD	81.2 <sup>a</sup>	64.8 <sup>a</sup>	46.0 <sup>a</sup>	46.3 <sup>ab</sup>	34.8 <sup>ab</sup>	28.5 <sup>b</sup>	40.1 <sup>b</sup>	31.6 <sup>b</sup>	39.4 <sup>ab</sup>	37.9 <sup>ab</sup>	33.3 <sup>b</sup>	36.2 <sup>ab</sup>	34.2 <sup>a</sup>	34.2 <sup>a</sup>	588.4 <sup>b</sup>
Mod- LSD	47.3 <sup>b</sup>	42.1 <sup>b</sup>	29.6 <sup>b</sup>	29.9 <sup>b</sup>	23.7 <sup>b</sup>	22.4 <sup>b</sup>	27.0 <sup>c</sup>	25.8 <sup>b</sup>	27.2 <sup>b</sup>	26.6 <sup>b</sup>	27.4 <sup>b</sup>	28.6 <sup>b</sup>	21.0 <sup>b</sup>	18.4 <sup>b</sup>	396.9 <sup>c</sup>
CV	35.1%	35.2%	36.8%	45.7%	49%	37.1%	32%	31.5%	37.3%	38.6%	34.0%	44.5%	36.9%	41.7%	24.4%
Sig	***	***	***	*	ns	***	***	***	**	**	***	ns	**	**	***
LSD	24.8	19.8	14.8	18.2	15.0	11.4	11.8	10.7	13.6	13.5	11.9	15.0	10.9	11.8	131.2

**Table 12:** *Percentage contribution of the sap of each inflorescences to the total yield (% of total yield)*

Stage of palm	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14
Healthy	13.34%	9.97%	7.28%	7.04%	5.38%	6.48%	6.87%	6.92%	6.80%	6.47%	6.97%	5.91%	5.35%	5.21%
Mil-LSD	13.8%	11.02%	7.82%	7.87%	5.91%	4.84%	6.81%	5.37%	6.70%	6.44%	5.66%	6.15%	5.81%	5.81%
Mod-LSD	11.91%	10.6%	7.455	7.53%	5.96%	5.64%	6.80%	6.49%	6.85%	6.70%	6.90%	7.20%	5.28%	4.63%

**Table 13:** *Variation in osmolality (mmol / kg) of the sap of healthy, mild-LSD and moderate-LSD affected palms over inflorescence.*

Stage of palm	I - 1	I - 2	I - 3	I - 4	I - 5	I - 6	I - 7	I - 8	I - 9	I - 10	I - 11	I - 12	I - 13	I - 14
Healthy	868	828	833	850	801	675	687	717 <sup>a</sup>	705	879	1036	1067 <sup>a</sup>	844	997
Mil-LSD	1000	867	833	863	806	679	758	820 <sup>ab</sup>	796	928	923	868 <sup>b</sup>	911	930
Mod-LSD	894	808	863	876	718	680	772	880 <sup>b</sup>	769	844	947	1001 <sup>ab</sup>	941	1005
CV	15.7%	14.6%	18.8%	13.7%	17.6%	11.4%	20.0%	15.6%	12.1%	15.5%	16.6%	17.9%	19.1%	19.3%
Sig	ns	ns	ns	ns	ns	ns	ns	*	ns	ns	ns	*	ns	ns
LSD								115.2				160.7		

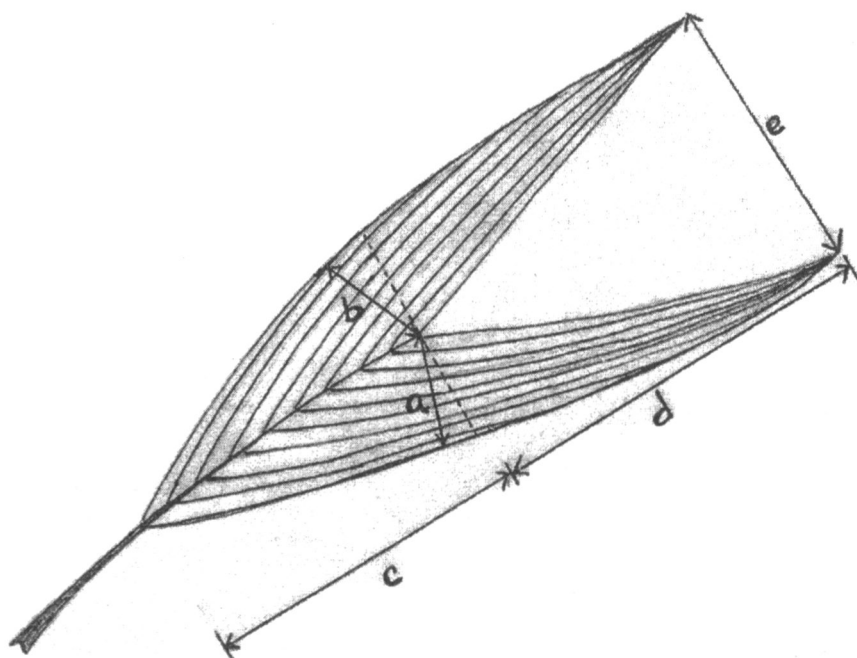
**Table 14:** *Variation in sugar content (g / 100 ml) of the sap of healthy, mild-LSD and moderate-LSD affected palms over inflorescence.*

Stage of palm	I - 1	I - 2	I - 3	I - 4	I - 5	I - 6	I - 7	I - 8	I - 9	I - 10	I - 11	I - 12	I - 13	I - 14
Healthy	16.51	16.32	15.68 <sup>ab</sup>	17.93	16.62	17.83	15.13	17.49 <sup>ab</sup>	16.08	16.62	16.70	16.66	14.78	15.51
Mil-LSD	17.55	17.59	14.19 <sup>a</sup>	16.53	15.82	16.60	14.79	19.78 <sup>a</sup>	17.58	16.77	16.05	15.42	17.00	16.33
Mod-LSD	17.88	18.11	17.18 <sup>b</sup>	17.12	16.37	16.61	14.13	16.45 <sup>b</sup>	16.02	16.36	16.98	17.83	18.19	17.35
CV	7.7%	9.4%	11.1%	15.3%	7.6%	12.3%	7.9%	14.5%	11.7%	14.4%	8.5%	16.6%	24.7%	10.3%
Sig	ns	ns	**	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	ns
LSD			1.59					2.38						

#### 4. MICELLANEOUS STUDIES

##### Experiment 1: A non-destructive method for determining leaf area of pinnate (unsplit) leaves of coconut seedlings

Young coconut seedlings in which the leaflets are not separated are often used in pot experiments under plant house conditions, tissue or embryo culture trials on plant acclimatization as well as in nursery experiments. A non-destructive method for determining the area of these leaves is not available but there are many situations where destructive sampling is not possible. Therefore, the aim of this study was to develop a regression equation to determine the area of an unsplit leaf using easily measurable leaf parameters (Fig. 1).



**Fig. 1:** A diagram of unsplit leaf showing the measured parameters *a*, *b*, *c*, *d* and *e*.

Seventeen each of tall x tall (CRIC60) and Dwarf Green x tall (CRIC65) coconut seedlings were used for the study. The age of seedlings was nine months. *A*, *b*, *c*, *d* and *e* of each leaf were measured non-destructively (Fig. 1) and actual area of each leaf was measured destructively using a leaf area meter. Separate regression equations developed for the varieties CRIC60 and CRIC65 are as described below.

$$\begin{aligned} \text{CRIC 60 : } Y &= 25.85 + 0.99 X, & r^2 &= 99.3\% \\ \text{CRIC 65 : } Y &= 38.36 + 1.04 X, & r^2 &= 96.9\% \end{aligned}$$

Where *Y* = actual leaf area

$$X = (a + b) \left\{ (c + \sqrt{(d^2 + e^2 / 4)}) / 2 \right\}$$

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## 5. TRAINING AND EXTENSION ACTIVITIES

Mr H T M K C Peiris, a final year student of Aquinas College, Colombo, completed a 6 month research project on 'A preliminary investigation on the use of lithium chloride as a non-radioactive tracer in studies on water absorption of rapid decline affected coconut palms' under the supervision of Dr C S Ranasinghe.

Research and technical staff participated as resource personnel in many training programmes for Agricultural teachers and students, Agricultural extension officers and Coconut Development Officers.

## 7. STAFF PUBLICATIONS AND COMMUNICATIONS

### a. Theses

Mr Nainanayake N P A D - Effect of soil type, soil compaction and water stress on establishment of coconut (*Cocos nucifera* L.) seedlings. M.Phil thesis, University of Peradeniya, Sri Lanka.

### b. Journals, presentations at seminars / workshops and scientific sessions

Nainanayake N P A D, Bandara D C, Nissanka N A A S P (2000) Root shoot relationships: an effective indicator of soil compaction and water stress for coconut (*Cocos nucifera* L.) seedlings. *Tropical Agricultural Research* 12, 151-62.

Ranasinghe C S, Wimalasekara R, Jayasekara C. (1998-1999) Effect of storage temperature and wrapping treatments on the keeping quality of tender king coconut. *Cocos* 13, 1-7.

Ranasinghe C S, Wimalasekara R, Nainanayake N P A D (2000) Simulated sea shipment of tender king coconut: effect of storage conditions on the keeping quality. PLACROSYM XIV, 12-15 Hyderabad, India, p. 69.

## 8. ACKNOWLEDGEMENT

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**MULTI-DISCIPLINARY PROJECTS**  
**Project Coordinator – C S Ranasinghe, Ph D**

**PROJECT 17 : RAPID DECLINE SYNDROME (RDS) OF COCONUT PALMS**

**Divisions that participated:**

Plant Physiology Division  
Crop Protection Division  
Soils and Plant Nutrition Division  
Biometry Division  
Genetics and Plant Nutrition Division  
Survey group (Plant Physiology Division, Crop Protection Division)

**General**

A multidisciplinary research programme was started to determine possible causes, effect of different treatments, soil physical properties, physiology, anatomy and the pattern of seed germination of RDS affected palms. The main experiments were started at Makandura Seed Garden (MSG) and a general survey was conducted at Bandirippuwa Estate (BE) and MSG. The affected palms in Field Nos. 1 and 2 of MSG were mapped to observe the distribution and progress of the condition.

**Experiment 1: Investigations to identify probable causes of rapid decline syndrome (RDS) of coconut (MSG, 2000).**

**Selection of palms**

A block of land (Field No. 2) at Makandura Seed Garden (MSG) carrying palms showing symptoms of varying severity was selected for the trial. Since it is necessary to test the presence of any interaction between symptom severity and applied treatments, affected palms were grouped into three categories based on the average number of drooping fronds, as follows.

Severity 1 (S1) – Approximately 7 fronds (33 % of the total fronds)  
Severity 2 (S2) – Approximately 4 fronds (22 % of the total fronds)  
Severity 3 (S3) – 0 fronds (0 % of the total fronds)

Within the available number of affected palms, two replicates were employed, with two palms per replicate. The grouping of palms into two replicates was done according to the average girth of trunk at the top. There were thus 12 palms per treatment, and the treatments were started in August 2000. Apparently healthy palms were also given the same treatments for comparison.

**Application of treatments:**

T1- micronutrients (0.46 g CuSO<sub>4</sub> and 0.76 ZnSO<sub>4</sub> / palm, root feeding at bimonthly intervals)  
T2 - common salt (1 kg / palm / year, surface application in the manure circle)

- T3 - fungicide (Topsin 0.2% solution, 20 L / palm, drenching the manure circle at four monthly intervals)
- T4 - nematicide (Nemacur 5% Granules, 50 g / palm, surface application in the manure circle at four monthly intervals)
- T5 - fungicide + nematicide (T3 + T4)
- T6 - oxytetracycline (5g / 5ml / palm, trunk injection at four monthly intervals)
- T7 - control (affected palms without treatment)

### **Post-treatment data collection:**

To assess the progress of symptoms the following data was collected.

1. Number of drooped and broken fronds in the canopy - at three monthly intervals
2. Nut numbers and weight, length and circumference of nuts - at two monthly intervals
3. Trunk circumference at canopy level - at six monthly intervals
4. Length and circumference of unopened spadix - at six monthly intervals
5. Leaf nutrient levels - at six monthly intervals
6. Chlorophyll content, stomatal resistance and transpiration of leaves - at three monthly intervals
7. Nematode and fungal populations in roots and adjacent soils - at three monthly intervals
8. Photographs of affected palms - at three monthly intervals

Three months after the initial treatment applications, significant changes in the above parameters were not observed and the treatment application and data collection are in progress. It seems that it is too early to see any treatment effect on the symptom expression in RDS-affected palms.

### **Nutrients**

Pre-treatment analysis of the leaf samples collected from affected palms revealed that they were deficient in only the two micro-nutrients Cu and Zn. Analysis of macro-nutrients showed deficiency of leaf Mg. Post-treatment analysis of leaf nutrients is yet to be carried out. A bottleneck for root feeding of micro-nutrients was finding healthy roots in affected palms.

### **Nematode population in soil and roots and *Fusarium* colonies in the roots**

Before- and after- imposing treatments, numbers of parasitic nematodes in soil and roots of RDS-affected palms were recorded. Parasitic nematodes were found only in the soil, both in pre-treatment and post-treatment observations (Table 1). From each treatment, 120 root pieces (3-5 mm) were plated on PDA, the number of *Fusarium* colonies after 5-6 days of incubation were counted and the numbers were taken as % of total (120 nos.). It seems that there is a reduction in the *Fusarium* colonies in all the palms after treatment application and the reduction was more prominent in nematicide treated palms compared to others. It seems that it is too early to see any effect of treatment on the population of nematodes and fungi in the RDS-affected palms.

**Table 1.** *Number of parasitic nematodes and Fusarium colony counts in the roots and soil of Topsin- (T) treated, Nemacur- (N) treated and T+N- treated and untreated (control) RDS affected palms and apparently healthy palms.*

Treat.	Pre-treatment			Post-treatment		
	No. of parasitic nematodes in		<i>Fusarium</i> colony counts %	No. of parasitic nematodes in		<i>Fusarium</i> colony counts %
	250 cm <sup>3</sup> of soil	25 g of root	root	250 cm <sup>3</sup> of soil	25 g of root	Roots sampled
T	16.25	nd	34	38.4	nd	30
N	77.9	nd	70	46.8	nd	29
T + N	37.9	nd	52	105.0	nd	34
Control	27.4	nd	37	22.75	nd	20
Healthy	149.25	nd	86	58.0	nd	60

nd – not detected

*C S Ranasinghe (PPD), R Wijesekara (CPD), D T Mathes (BiomD), N Aratchige (CPD), D Giritharan (SPND), D M D I Wijebandara (SPND), R D N Premasiri (PPD), L R S Silva (PPD), S P Manoj (CPD), C Hapuarachchi (CPD), P H A P Siriwardane (CPD), H L A Padmini (SPND), M A Wasanthimala (SPND), R Jayatillake (GPBD), S S Rajapakse (BiomD), N G Pemasiri (CPD), W W F N Fernando (CPD) and R Silva (SPND)*

**Experiment 2: Use of lithium chloride as a non-radio active tracer in studies on water absorption of RDS-affected coconut palms (BE and MSG, 2000)**

The experiment was conducted with the objective of testing the presence of any blockages in the xylem vessels that would affect water transport from roots to canopy, using Lithium as a tracer. Two healthy roots of three RDS-affected palms at BE and MSG were fed with 100 ml of 1% LiCl solution. Four days after treatment, the Li content in leaves, nuts (husk) and roots was determined.

The study revealed that the RD-affected palms had lower amounts of Li in leaves, husks and nut water and higher amounts of Li in roots compared to healthy palms. It seems that there are some obstructions for the transport of Li, and by inference, water from roots to the canopy and consequently, an accumulation of Li in roots of affected palms (Figs. 1 and 2). The study is in progress.

*C S Ranasinghe, W S Madurapperuma, R D N Premasiri, L R S Silva and M C Pieris (Aquinas College)*

**Experiment 3: Transmission Electron Microscopy (TEM) studies on the tissues of Rapid Decline-affected coconut palms (2000)**

With the objective of studying the possible presence of any cellular abnormalities or phytoplasma in the tissues of RDS-affected palms, young and mature leaves, mid ribs (ekel) and root samples of affected palms were collected, immediately fixed in a solution of 4% formaldehyde / 2.5 % glutaraldehyde in 0.1 M phosphate buffer, sliced up into individual pieces of 1mm<sup>2</sup> and sent to University of Sussex, UK for TEM studies.

**Experiment 4: Studies on soil physical properties of RDS-affected palm sites (MSG, 2000)**

Following an observation made during field visits of a possible involvement of soil compaction, data were gathered using a soil penetrometer. The soil compaction was found to be in the range of 350-400 N / m<sup>2</sup>. The site is supposed to have patches of clay soils and the higher compaction can be attributed to the above occurrence. It was also observed that during the wet season of the year affected palms produced a lower number of new roots compared to healthy palms. The survival of roots during dry periods was made possible by applying river sand to the manure circle. The study is in progress.

*D Giritharan (SPND), D M D I Wijebandara (SPND) and D P Panditharatne (SPND)*

**Experiment 5: Germination of nuts from RDS-affected palms (2000)**

The experiment was conducted at the Bandirippuwa Research Nursery commencing from November 2000 with the objective of comparing the germination of nuts obtained from healthy and RDS-affected palms from MSG.

*S A C N Perera (GPBD)*

**Survey on occurrence and distribution:**

The distribution of affected palms is mapped through observations at six monthly intervals to determine the pattern of spread at MSG and BE of the Coconut Research Institute.

*C S Ranasinghe (PPD), R Wijesekara (CPD), R D N Premasiri (PPD), S P Manoj (CPD) and  
C Hapuarachchi (CPD)*

**REPORT OF THE EXTENSION SERVICES DIVISION**  
**Head - P A H Nimal Appuhamy, M Sc.**

**1. GENERAL**

The Division implemented various programmes to transfer new technologies to coconut growers and extension personnel. A significant increase in the number of coconut growers who received various services under these programmes was observed.

In the "whole farm development" approach implemented through the Persuasive Extension Programme, 94 coconut growers received service during the year. Some estate companies and coconut estates of the National Livestock Development Board also participated in this programme.

The One Day Training Programme series conducted for imparting knowledge and skills to coconut growers and those who work in coconut estates, has shown a significant improvement. The total participation for the full series has shown an increase of 27% over the previous year.

**2. OTHER ACTIVITIES**

Mr I M S K Idirisinghe, Extension Officer was awarded the MSc in Agricultural Economics by the Post Graduate Institute of Agriculture Sri Lanka in November 1998.

Mr J K J P Jayawardena who served the Institute as a Graduate Trainee was appointed as an Assistant Extension Officer with effect from 01 June, 2000.

Mr A M A P G Gunawardena, Extension Officer attended a one-year part-time Tamil training programme conducted by SLIDA.

Mr I M S K Idirisinghe, Extension Officer participated in a nine day workshop and two subsequent training programmes in Agricultural Database Management and Establishment of Agricultural Information Systems in the Province, organized by the North Western Provincial Ministry of Agriculture on 19-21 July and 2-4, 16-18 August respectively.

**3. PERSUASIVE EXTENSION PROGRAMME (PEP)**

The Persuasive Extension Programme conducted to promote whole farm development among medium and large-scale coconut growers is considered to be popular. Some private estate companies and coconut estates managed by the National Livestock Development Board too received services under PEP. During the year under review, 96 estate development plans were prepared covering a total extent of 5796 acres. The implementation of estate development activities was also monitored and it was found that nearly 60% growers implemented the proposed development activities.

## 4. TRAINING PROGRAMMES

### 4.1 One Day Training Programme

The one-day training programme series conducted by the Institute has become very popular among coconut growers. During the year seven one-day programmes were conducted from April to November. The total number of participants for these seven programmes was 1006, which is 27% higher than in the previous year. Private sector and government institutions also participated in these programmes. These programmes covered different technical aspects of cultivation and estate management.

Details of the programmes are given in the following table.

Programme No	Date	Venue	Subject Area	No of Participants
01	April	Bandirippuwa Estate	Replanting of coconut	185
02	May	Ratmalagara Estate	Soil and Moisture conservation.	152
03	July	Bandirippuwa Estate	Fertilizer Application	145
04	August	Walpita Estate	Intercropping under coconut	149
05	September	Ratmalagara Estate	Pests and diseases of coconut	139
06	November	Ramalagara Estate	Rehabilitation of low yielding coconut estates	123
07	November	Bandirippuwa Estate	Estate and labour management	117

A certificate was issued to all trainees who attended the full series of training.

### 4.2 Managers Training Programme

A study conducted by the Institute has revealed that one of the major reasons for poor level of productivity of coconut estates that belong to absentee landlords was the absence of technically knowledgeable persons to manage the estate.

In order to train educated youth to manage coconut estates, CRI has made necessary arrangements to conduct an intensive practical training. Hostel and other infrastructure facilities have been developed with the financial assistance from the CESS. The training is scheduled to commence early next year.

### 4.3 Other Training Programmes

- 4.3.1 A four day training programme was conducted for 28 officials from the Second Perennial Crop Development Project from 17 to 20 January.
- 4.3.2 A professional training course organized by the National Institute of Plantation Management was conducted at CRI from 23 to 28 May.

- 4.3.3 A one month residential training was conducted for 18 newly recruited Plantation Monitoring Officers, at the request of the Ministry of Plantation Industries from 01 to 30 June.

## **5. SEMINARS, FIELD DAYS AND WORKSHOPS**

### **5.1 Seminars**

- 5.1.1 With the objective of providing an opportunity to the CRI research and non-research staff to familiarize themselves with the on-going research and development activities, a seminar was held at the CRI Auditorium on 23 February 2001.
- 5.1.2 In order to educate coconut growers in the Puttalam area on the present situation of *Aceria Mite* infestation and on fertilizer usage, a one day seminar was held at the Puttalam Town Hall on 22 April.
- 5.1.3 A Research Extension Dialogue between the research staff of CRI and the extension staff of CCB in Kegalle and Matale areas was held at the Regional Office, Kegalle on 29 April. A one day familiarization course was conducted for 20 prison officers who were responsible in agricultural programmes in prisons located in different parts of the island.
- 5.1.4 To promote coconut cultivation in Mahaweli irrigated areas, a seminar was conducted for Mahaweli Project Officers at Polonnaruwa at the request of the Mahaweli Development Authority on 07 and 08 August.

### **5.1 Field Days**

- 5.2.1 A field day was conducted at Ratmalagara Estate for coconut growers to promote soil moisture conservation, irrigation and animal husbandry under coconut, on Saturday, 11 March. Ninety members of the Coconut Growers Association participated.
- 5.2.2 A field day was conducted for Coconut Development Officers and Regional Managers of CCB on the identification and control of *Aceria Mite* on 25 March 2000 at Chilaw. One thousand colour posters, 1500 copies of leaflets and nine sets of enlarged colour photographs were supplied to CCB to be used in their extension activities.

## **6. PARTICIPATORY RESEARCH AND STUDIES**

- 6.1 On guidance provided by Head, Extension Services Division, Mr. W D S Dayawansa, Coconut Development Officer, Beruwala, conducted a study on the present constraints and potential in the toddy tapping industry in the Beruwala area. This study was conducted in partial fulfillment of the Diploma in Plantation Management conducted by the National Institute of Plantation Management. In this study, problems of landowners, tappers, toddy contractors and distillers were assessed separately. The study revealed that low price for toddy, high taxation for coconut spirit, lack of trained tappers, and lack of support given by the

Government were the main constraints in this sector. This study also highlighted that the future of this industry is doubtful unless the Government adequately supports the above sectors.

6.2 Mr U L P Perera, Coconut Development Officer, Badalgama carried out a study under the guidance of Head, Extension Services Division. This study was on the socio-economic status of watchers in coconut estates.

6.3 To build up a comprehensive database on coconut growers, preliminary arrangements were made to collect necessary information. A questionnaire was posted to coconut growers to collect information in relation to their cultivation and socio-economic status. Nearly 250 growers responded and the database is being prepared.

6.4 Under the supervision of Head, Extension Services Division, a final year undergraduate conducted a study on Socio-economic Factors Affecting the Level of Adoption of Technology by the Coconut Growers in the Kuliypitiya Area.

## **7 EDUCATIONAL PROGRAMMES AND STUDY TOURS**

7.1 The Division conducted special educational programmes for the benefit of GCE (O/ L) and (A/L) students in order to provide necessary information for their project work. During the year, 67 such educational programmes were conducted.

7.2 During the year under review 4500 school children from 79 schools visited the Institute. Suitable programmes were arranged to improve their knowledge on coconut cultivation and to create an interest among students on scientific coconut cultivation.

## **8 ADVISORY ACTIVITIES**

The number of coconut growers and representatives of plantation companies who visit the division seeking technical advice have shown a significant increase. During the year, 126 growers visited the division.

A progressive increase was observed in number of growers who obtained advice through the telephone line dedicated for this purpose.

The number of letters received requesting technical advice has increased. During the year 130 advisory letters were sent. During the year, 1050 sets of Advisory Circulars have been issued.

## **9 PRINTING SECTION**

The printing section of the Division met the major printing requirements of the Institute. During the year, the printing section undertook 110 printing jobs including printing and binding of books, journals, leaflets, forms and posters. A special diary was designed and printed for the CRI staff.

## 10 PUBLICATIONS

During the year under review the following publications were issued.

1. COCOS journal vol. 13 (1998-1999)
2. Coco News vol. 1 No. 4 – CRI Newsletter (in Sinhala and English).
3. Booklets on Replanting of Coconut, Soil Moisture Conservation, Fertilizer use, Intercropping under Coconut, Pests and Diseases and Rehabilitation of low yielding Coconut Estates.
4. The following Advisory were also revised, printed and issued.
  1. Coconut Caterpillar (in Sinhala and English).
  2. Termite Control (in Sinhala and English).
  3. Mammalian pests (in Sinhala and English).
5. CRI Annual Report 1998.
6. Colour poster on Technical Guidelines to Enhance Shelf-life of Tender King Coconut for the export market was also issued.

## 11 EXHIBITIONS

The Division participated in the following exhibitions.

1. Science Exhibition at Maris Stella College, Negombo from 02 to 04 March.
2. Science Exhibition at Maligawatta Maha Vidyalaya, from 24 to 26 March.
3. Agriculture Exhibition at Waikkala Maha Vidyalaya from 01 to 02 May.
4. Science Exhibition at Ave Maria Convent, Negambo from 01 to 03 May.
5. Exhibition and Field Day at Ingiriya Vidyalaya, Horana.
6. One Day Exhibition on 08 August at Alawva.

## 12 AUDIO-VISUAL

The Division provided all the audiovisual materials required by Research Divisions. A fifteen minute video programme was produced covering the activities of Research Divisions with technical support from the Audio Visual Center of the Department of Agriculture, Peradeniya. A new slide programme with audio facilities was produced to be used in educational and familiarization programmes.

**REPORT OF THE LIBRARY**  
**Librarian-Mrs. P A S F Perera, B Sc, M Sc (Lib. and Inf. Sci.)**

**1. GENERAL**

The library provided a regular and satisfactory service to the Institutes' staff throughout the year. Services were further extended to outside clients on request. The library stock showed satisfactory progress during the year. The number of literature searches made by users both on the coconut and CD-ROM databases shows remarkable progress compared to previous years. A user seminar was held at the Institute with a view to making the staff aware of the resources and services available.

**2. ACQUISITIONS**

**2.1 COLLECTION OF BOOKS**

In spite of the limited funds available, the library managed to purchase 135 new books. A further 16 books were received from the ADB project. Another 25 were received from various donors on a complimentary basis. Accordingly, the total stock recorded 5582 books as at 31 December 2000.

**2.2 SERIALS**

The number of journal titles received during the year was 56. Of these 32 were received on an exchange basis while 12 were complimentary. However, the number of titles subscribed to was less by 13 titles from the previous year. Funds were committed to order these titles for year 2001 with a view to avoiding delays in the receipt of issues as experienced during the last few years. Titles subscribed to was only 12. The number of Annual Reports received was 8.

**2.3 ELECTRONIC COLLECTION**

The library continuously received updates of CROP-CD electronic databases published by the CABI on subscription. The AGRIS database of the FAO covering references to agriculture was received free of charge.

More web sites of organizations and databases relevant to agriculture were book marked to provide easy access to users.

**2.4 Special collection on coconut:**

601 references were newly added to the database of literature on coconut. Of these around 75 complete items were added to the collection. The British Library Document Delivery Service was the major foreign source for acquiring coconut literature.

**2.5 Staff publications**

A programme was launched to collect full texts of all research papers published by the staff since 1929.

## SERVICES

- 3.1.1 Literature searches: In addition to the quick reference queries made by the staff, 32 literature searches were made on the coconut database to cater to the information needs of staff and researchers, both local and foreign. Thirty five (35) CD-ROM searches was made from Council for Agricultural Research Policy (CARP) library on behalf of the CRI staff while the number of searches made on the CROP-CD procured by the library database was 21.

The membership increased by 13 users. 39 people visited the library during the year for information purposes.

### 3.2 Database development

- a. Library catalogue: 271 new entries were recorded. Input of data from the card catalogue was continued.
- b. 601 new entries were added to the coconut database. It recorded a total of 8175 entries as at 31 December 2000.
- c. Data recording in the staff publication database was completed. It included 1430 records as at 31-12-2000. A draft bibliography was printed using data covered by the database.

### 3.3 External Services

Resource sharing activities were continued satisfactorily with other AGRINET libraries throughout the year.

**SDCP Service:** Selective dissemination of contents page service was offered at a personalized level to compensate for the inadequate number of journal titles received during the year. Under this service, the library disseminated contents pages of 12 journal titles to member libraries and our users were furnished with the contents pages of 21 journal titles. The library was unable to supply contents pages of certain titles due to problems in placing orders.

**Interlibrary loan service:** This service showed more progress than the previous year. More access was provided to articles not available within the country. Under this service 118 articles were requested from AGRINET member libraries of which 96 were received. 95% of the rest (not available within AGRINET libraries) were acquired from British Library Document Supply Centre (BLDSC). The total number of articles requested from the BLDSC including literature on coconut was 51 of which 45 were received. From 81 requests for articles received from member libraries, 74 were serviced.

### 3.4 Contribution to National Bibliographies and Database

Contributions were made towards the compilation of the following integrated databases.

National Union Catalogue – SLNLDC (Sri Lanka National Library and Documentation Centre)

National Agriculture Bibliography – CARP

### 3.5 Publications

The “**Current Awareness Bulletin**” on literature on coconut were distributed among the research staff and a few selected outside libraries.

- A list of book accessions to the library during the year was distributed among the research staff
- A draft bibliography was prepared from the staff publications database
- An annotated bibliography was printed covering references to literature during the period 1993 and 1994.
- A Guide setting out the resources and services offered by the CRI library was prepared

### Meetings and Workshops

A user seminar was held on 27 September sponsored by CARP to make the staff aware of the services offered by the Agriculture Information Network and various information sources and services available within the agriculture sector. Mrs. S F Perera delivered a presentation on the resources offered by the CRI library.

Mrs. S N Gunatilaka attended the workshop on “Clerical Skills Development” held at the Institute of Government Accounts and Finance, Colombo 12 from 3-5 March, 2000.

Mrs. P D U C Dharmapala attended a one day workshop on “Desktop Publishing” on 02 June 2000.

Mr. R M Gunasekera participated at the workshop on ‘Towards on Information Society’ held at Galadari Hotel on 27 June 2000.

Mr. R M Gunasekera and Librarian Mrs. P A S F Perera attended the Sri Lanka Library Associations AGM.

Mr. R M Gunasekera and Librarian Mrs. P A S F Perera attended several AGRINET meetings.

**REPORT OF THE ESTATE MANAGEMENT DIVISION**  
**Manager (Estates) - Frank Jayasinghe, B.Sc. Agric**

**1. GENERAL**

The Division administered the following Estates and Seed Gardens

1. Bandirippuwa Estate, Lunuwila
2. Rathmalagara Estate, Panirendawa
3. Pothukulama Estate, Pallama
4. Pallama Seed Garden
5. Walpita Estate, Walpita
6. Isolated Seed Garden, Ambakelle
7. Makandura Seed Garden, Gonawila
8. Maduru Oya Seed Garden, Bogaswewa

General maintenance and profitability of these properties was satisfactory. Out of the four seed gardens seednuts were released for nurseries from Ambakelle and Maduruoya Seed Gardens. Issue of seed nuts from Makandura (MSG) was later suspended due to the Rapid Decline Syndrome. The Pallama Seed Garden (PSG) which was acquired in 1998 is still in the process of establishment.

Total yield of coconut in all eight estates was 5418716 nuts which was an increase of 13% over the previous year and 62% above the average of the past five years (table 01). This increase of yield could be mainly attributed to well distributed rainfall experienced in 1999, increased numbers of mature palms and timely adoption of improved cultural practices.

However, in the meantime there was a yield decline at Ambakelle Seed Garden by about 05% compared to the previous year. This may be due to increased immature nut fall between 4th and 5th picks caused by the dry spell that prevailed and also increasing damage by Giant Squirrels that harboured in the jungle barriers.

The total rainfall received at all the substations during the year 2000 was slightly lower than the previous year, but it was well distributed (Table 02).

Out of the total area of 839.47 ha planted 136.06 ha of palms are immature (Table 04). The eight estates have a total of 72314 bearing palms and 6978 partially bearing palms. (Table 03)

Establishment of seedlings of hand pollinated Tall and San Ramon at the Pallama Seed Garden is in progress and about 4507 seedlings have been planted so far. In addition 1250 seedlings of "Ambakelle special" were planted. A further 670 seedlings were planted as a germplasm conservation block by Genetics and Plant Breeding Division.

During the year 1,236,911 seed nuts were produced in the two Seed Gardens and "plus palm" from the other estates Pothukulama, Pallama and Rathmalagara (Table 07). Of the total seed nut production, over 95% was issued to the Coconut Cultivation Board.

Several fields at Makandura and Walpita Estates were fertilized with organic fertilizer (goat manure) supplemented with P,K and Mg. Cover crops and husk pits were established

for soil moisture conservation. The use of back-hoe machines in opening/closing of husk pits and planting holes appeared more economical than manual labour.

The use of livestock (cattle and buffaloes) to control weeds was successful and the cost of weeding was substantially reduced by grazing. The buffaloes at Bandirippuwa Estate were transported to Maduruoya Seed Garden for extending the livestock based weed control programme there. However, other means of weed control mechanical, chemical and manual were also adopted where necessary and appropriate.

The Division received 07 four wheel tractors, 03 trailers, 04 water bowsers and 02 two wheel tractors, 08 disc harrows and 05 rotary slashers during the year to maintain the requirement of estate work. A total of 10010 meters new fencing and 11780 meters of old fence repairs have been done. Roads and buildings were maintained satisfactorily.

Income from toddy tapping and livestock activities increased to generate sundry income totalling Rs. 2,035,886 mainly from sale of milk, curd, fruit, trees, vegetables and treacle (Table 08).

Coconut production of the six estates was disposed of through the auction conducted by the Coconut Development Authority (CDA) mainly as husked nuts. The buyers rejections were converted into copra and tenders called from registered buyers (Table 06).

## **2. PERFORMANCE OF INDIVIDUAL UNITS**

<b>2.1 Bandirippuwa Estate</b>	<b>:</b>	<b>Lunuwila</b>
<b>Superintendent</b>	<b>:</b>	<b>Mr Shantha Hettiarachchi</b>
<b>District</b>	<b>:</b>	<b>Puttalam</b>
<b>Agro-ecological Zone</b>	<b>:</b>	<b>Wet Intermediate</b>
<b>Extent</b>	<b>:</b>	<b>148.1 ha</b>

### **Rainfall:**

For rainfall and wet days please refer table – 02. It shows a decrease of rainfall by 23% and wet days by 11% when compared with last year. However rainfall was well distributed.

### **Nut Yield:**

Nut yield increased by 36% over last year (Table 1).

### **Planting:**

653 coconut seedlings were planted in field No. 03.

### **Fencing:**

1201 meters of new boundary fencing was completed.

## **Livestock:**

Herd strength by the end of this year was as follows.

Stud bull	-	01
Milking cows	-	13
Heifers	-	43
Calves	-	<u>50</u>
		<u>107</u>

## **Milk production and sale:**

Total milk production litres = 15818.45 Lit

Total Income from milk Rs. = 136933.45

## **Other production activities:**

About 134 coconut palms were used for toddy tapping and sweet toddy production. We received Rs.666320.00 as total sundry income by selling fruits, vegetables, treacle etc. (Table 08.)

## **Cost of production & nut sale Average**

COP was Rs. 4089 and NSA Rs. 4784.00 per 1000 nuts (Table 06).

## **2.2 Rathmalagara Estate, Panirendawa**

**Superintendent** : Mr A.N. Ekneligoda  
**District** : Puttalam

**Agro-climatic Zone** : Intermediate Dry Zone

### **Rainfall:**

For rainfall and wet days please refer table 02. It shows decrease of rainfall by 16% and wet days by 23% when compared with last Year. However, rainfall was well distributed.

### **Nut yield:**

Nut yield showed a 25% increase over last year.

### **Field Operations:**

### **Replanting:**

400 coconut seedlings of Ambakelle special were planted in Field No. 06.

**Fencing:**

786 meters of new fencing were completed using bent-type concrete posts along the southern boundaries.

**Building construction and Electricity supply**

A new, toilet for the office was constructed and electricity was supplied to 03 watchers quarters.

<b>Livestock:</b>	Cart bull	-	01
	Cows	-	18
	Calves	-	06
	Heifers	-	26
			<u>51</u>
			==

**Sundry Income:**

Income received from sale of vegetables, milk and other products was Rs. 79303.12 cts (Table 08).

**Cost of production and nut sale Average** – COP was Rs. 4177.00 and NSA, Rs. 5679.00 (Table 06).

**2.3 Pothukulama Estate, Pallama**

**Superintendent** : Mr G.B.A.Wijesekera  
**District** : Puttalam  
**Agro ecological Zone:** Semi dry Intermediate zone

**Rainfall:**

For rainfall and wet days please refer table 02. Rainfall decreased by 6% and wet days by 21% respectively over last year. Rainfall was poorly distributed.

**Nut yield:**

For total nut yield please refer table 01. There was no marked increase over last year.

**Field operations:****Pest control:**

Red weevil infestation was observed and controlled effectively by installing Pheromone traps and trunk injection with monocrotophos.

## Livestock:

The herd strength by the end of the year was as follows.

Cows (milking)	-	05
Calves	-	05
Heifers	-	14
Stud bull	-	05
Buffaloes	-	02
Goats (male)	-	11
Goats (Female)	-	<u>55</u>
		<u>97</u>

## Sundry income:

Income received from food production, milk, sale and of animals etc was Rs. 40645.25 (table 08).

## Cost of production and nut sale Average:

COP was Rs. 2302.00 and NSA Rs. 5800.00 per 1000 nuts (table 06).

## 2.4 Pallama Seed Garden

**Superintendent** - **Mr W.S.M.A. Fernando**  
**District** - **Kurunegala**  
**Agro ecological Zone-** **Dry Intermediate zone**  
**Rainfall:**

For rain fall and wet days please refer table 02. It shows a decrease of rainfall by 13% and wet days by 12% respectively, when compare with last year. Rainfall was well distributed.

## Nut yield:

Nut yield increased by 8% over last year (Table 1).

## Replanting:

1143 Seedlings of San Ramon and Tall x Tall were planted in the Seed garden area. Another 660 seedlings were planted for germplasm conservation by Genetics and Plant Breeding Division. 1211 Ambakelle seedlings were planted by the Estate.

## Irrigation:

During the rain-free period, all seedlings were irrigated once a week, by water bowsers. Two tube wells were constructed and construction of two agro wells was commenced.

**Pest control:**

A severe out break of black beetle was observed and was controlled by installing Pheromone traps and by implementing a thorough estate sanitation programme.

**Fencing:**

2870 meters of new fencing was completed along the perimeter of the estate.

**Roads:**

About 4.0 k/meters of Roads were renovated by spreading gravel.

**Buildings:**

02 new toilets were constructed for the proposed labour Rest Room.

**Machinery:**

Following new farm machinery and equipments were received.

- |                            |                                     |
|----------------------------|-------------------------------------|
| 1. Four Wheel Tractor - 04 | 3. Four Wheel Tractor Trailers - 01 |
| 2. Two wheel Tractor - 01  | 4. Disc Harrows - 02                |

**Sundry Income:**

Rs. 359282.00 was received as sundry income by selling mature coconut palms, forest trees etc.

**Cost of production and nut sale Average :**

Cost was Rs. 4681.00 and NSA, Rs. 4382.00 per 1000 nuts.

**2.5 Walpita Estate, Walpita**

<b>Officer-in-charge</b>	<b>:</b>	<b>Mr W.A. Harold Upali</b>
<b>District</b>	<b>:</b>	<b>Gampaha</b>
<b>Agro-climatic Zone</b>	<b>:</b>	<b>Intermediate Wet Zone</b>

**Rainfall:**

Rainfall decreased by 20% and wet days by 22% over last year (Table 2).

**Nut yield:**

For total nut yield please see table 01. It shows a 33% increase over last year.

### **Machinery and Field Equipments:**

Following items of equipment were received.

1. Two Wheel tractor            01
2. Two Wheel Trailer            01
3. Rotary Slasher                01

### **Sundry Income:**

Rs. 248271.00 was received as sundry income by sale of pepper, cinnamon, coffee, cocoa, pineapple and vegetables (Table 08).

### **Cost of Production and Nut sale Average:**

The COP was Rs. 3650.00 and NSA, Rs. 4548.00 for 1000 nuts (Table 06).

## **2.6 Isolated Seed Garden, Ambakelle**

**Superintendent        :        Mr V.M.B.A. Weragoda**  
**District                 :        Puttalam**  
**Agro-climatic Zone    :        Dry Intermediate**

### **Rainfall:**

For Rainfall and wet days please refer table 02. Rainfall decreased by 08% and wet days by 18%. When compared with last year rainfall was poorly distributed.

### **Nut Yield:**

Nut yield decreased by 5 % when compared with last year (Table 1).

### **Disposal of crops:**

About 75% of the crop was supplied as seed nuts to Coconut Cultivation Board and a part was sold to Dunagaha Co-operative Society and balance cured into copra (Table 07).

### **Field Operations:**

#### **Fences:**

1172 meters of new fencing was completed along the Southern boundary.

#### **Building Construction:**

A new pump house was constructed in field No. 8.

### **Machinery and Equipment:**

The following items were received.

1. Water Bowsers	01
2. Rotary Slashers	01
3. Disc Harrows	02

### **Livestock:**

The buffalo Herd is as follows.

	<u>Female</u>	<u>Male</u>
Cows	06	-
Buffaloes calves	04	04
Heifers	07	-
Stud bull(buffaloes)	-	01
Cart bull	-	02
	<u>17</u>	<u>07</u>

### **Sundry Income:**

Rs.360,261.50 was received as sundry income by sales of curd, cover crop seeds, animal and by lease of cashew trees.

### **Cost of production & Nut sale Average:**

The COP was Rs. 3317.00 and NSA Rs. 6698.00 per 1000 nuts.

### **2.7 Makandura Seed Garden, Gonawila**

**Superintendent** : **Mr I.A. Nimal Hemasiri**  
**District** : **Kurunegala**  
**Agro-climatic Zone** : **Wet Intermediate**

### **Rainfall:**

For rainfall and wet days please see table 02 Rainfall decreased by 19% and wet days by 26% respectively when compared to last year. However rainfall was well distributed.

### **Nut yield:**

Nut yield shows a 42% increase when compared to last year.

## **Livestock -**

Size of the herd was as follows.

Cows	07	Buffaloes (Female)	13
Calves	13	Buffaloes (Male)	07
Stud	01	Stud	01

## **Food production programme:**

Rs. 348,008.00 was received as sundry income by sale of curd, milk, banana etc.

## **Cost of production and Nut sale Average:**

COP was Rs. 2640.00 and NSA, Rs. 5250.00 per 1000 nuts.

## **2.8 Maduruoya Seed Garden, Bogaswewa.**

**Superntendant : Mr.W.M.U.Ratnayake**  
**District : Polonnaruwa**  
**Agro climatic Zone : Dry Zone**

## **Rainfall**

For rainfall and wet days please refer table 02. Rainfall decreased by 8% and wet days by 9% respectively when compared with last year.

## **Yield :**

Nut yield increased by 41% when compared to last year.

## **New Planting programme**

400 coconut seedlings of Ambakelle Special were planted by clearing the jungle in field no. 01.

## **Fencing:**

482 meters of new fencing was completed.

## **Crop disposal:**

About 70% of the nuts were supplied as seed nuts to Coconut Cultivation Board. Rejected nuts were sold to out side buyers for conversion table 07.

## **Construction works:**

New irrigation canals (380 Meters) were constructed with 03 drop structures from the high elevation from the main canals.

### **Machinery and Equipment:**

The following farm machinery and equipment were obtained.

1.	4 W Tractor	-	01
11.	4 W Tractor trailers	-	01
111.	2 W Tractor and trailer-		01
iv.	Disc Harrows	-	01
v.	Rotary Slasher	-	01

### **Sundry Income:**

Rs. 33795.00 was received as sundry income by sale of forest trees and vegetables (table 08).

### **Cost of Production and Nut sale Average**

COP was Rs. 6810.00 and NSA, Rs. 8335.00 per 1000 nuts (table 06).

### **Routine practices on Estates:**

#### **1. Weed Control:**

Weed control was done satisfactorily on all estates by following manual, chemical, and mechanical methods and by grazing.

#### **11. Fertilizer Application:**

Fertilizer application was done according to DFR recommendations during the yala season. Due to shortage of funds, the Maha season fertilizer application was suspended.

#### **111. Moisture Conservation:**

Moisture conservation was carried out in a satisfactory manner in all Estates by establishing Husk pits, cover crops and mulching the palms with husks, coconut fronds and trash.

#### **IV Picking:**

Picking was done by manual pickers in all Estates on a bimonthly basis except at Walpita Estate.

**Table 1: Total nut production from 1996-2000 and percentage increase in 2000 production over 1999**

Estate	1996	1997	1998	1999	2000	Percentage increase
Bandirippuwa	538095	475658	479820	556185	758487	36.37%
Ratmalagara	432287	402626	445928	526947	656968	25.05%
Ambakelle	1092604	980544	1213893	1473458	1395555	-(05.21)%
Pothukulama	707669	506555	680984	816737	834061	02.12%
Makandura Seed Garden	333241	389484	356399	451152	644016	42.74%
Maduruoya Seed Garden	138529	149803	158994	210234	297328	41.43%
Garden	130155	150872	128118	142546	188958	32.55%
Walpita	--	--	441376	592661	640343	08.04%
Pallama Seed Garden						
<b>Total</b>	<b>3372580</b>	<b>3 055542</b>	<b>3 905602</b>	<b>4 769920</b>	<b>5 418716</b>	<b>13.60 %</b>

**Table 2: Rainfall in (mm) and No. of wet days**

Month	Bandirippuwa		Ratmalagara		Pothukulama		Walpita	
	1999	2000	1999	2000	1999	2000	1999	2000
January	49.4 (07)	220.6 (10)	79.1 (02)	89.9(13)	-32.8(04)	73.3(04)	79.9(05)	247.6(09)
February	113.8 (08)	127.2 (10)	42.9 (07)	231.5(10)	117.0(08)	43.4(04)	138.6(04)	238.3(12)
March	20.6 (02)	164.2 (07)	3.1 (02)	111.6(08)	---	194.3(06)	14.7(01)	104.2(-6)
April	363.6 (13)	181.5 (10)	185.9 (15)	243.1(09)	130.9(07)	164.9(05)	360.4(15)	145.0(08)
May	305.5 (20)	175.0 (11)	291.7 (21)	157.5(09)	248.8(10)	20.3(01)	524.3(21)	206.9(09)
June	92.1 (09)	126.7 (11)	83.8 (14)	108.2(07)	34.2(02)	65.4(02)	126.3(11)	130.0(07)
July	90.2 (09)	20.7 (02)	47.1 (07)	10.3(12)	20.0(01)	--	101.3(11)	52.6(01)
August	50.3 (10)	180.6 (11)	18.4 (14)	177.3(09)	8.8(01)	188.8(07)	104.9(06)	332.0(14)
September	90.3 (09)	207.6 (17)	99.8 (10)	157.1(13)	80.2(03)	147.0(03)	127.2(06)	447.6(12)
October	747.2 (26)	107.2 (09)	769.2 (23)	107.7(07)	442.8(16)	163.5(05)	823.8(26)	141.2(13)
November	261.7 (14)	76.6 (14)	367.8 (16)	120.0(11)	173.5(10)	51.8(06)	433.2(18)	163.5(06)
December	30.3 (6)	103.7 (07)	56.9 (06)	185.7(09)	70.7(03)	160.8(08)	36.4(05)	87.2(03)
<b>Total</b>	<b>2214.5(135)</b>	<b>1686.6 (119)</b>	<b>2045.7(140)</b>	<b>1699.7(107)</b>	<b>1359.7(65)</b>	<b>1273.5(51)</b>	<b>2871.9(129)</b>	<b>2296.1(100)</b>

**Table 2: Continued.**

Month	Ambakelle		Maduruoya Seed Garden		Makandura Seed Garden		Pallama Seed Garden	
	1999	2000	1999	2000	1999	2000	1999	2000
January	35.0(09)	102.5(10)	391.8(15)	205.3(18)	41.6(06)	205.6(09)	32.8(04)	73.4(04)
February	196.4(08)	79.5(08)	234.4(12)	235.3(13)	160.5(06)	165.9(10)	117.0(08)	43.4(04)
March	--	183.6(08)	0.5(01)	36.7(05)	14.0(03)	116.1(05)	----	109.4(06)
April	131.0(12)	255.8(07)	19.1(06)	34.1(03)	287.0(13)	199.1(08)	130.9(07)	154.9(06)
May	205.4(17)	164.6(02)	--	19.6(05)	484.4(19)	181(04)	248.8(10)	78.0(01)
June	32.9(07)	72.7(02)	13.8(03)	22.1(02)	134.8(11)	104.4(07)	34.2(02)	77.2(04)
July	22.1(04)	1.4(01)	--	27.9(02)	87.0(10)	25.2(01)	20.0(01)	-----
August	18.5(05)	157.6(08)	31.5(01)	79.7(07)	64.5(08)	309.7(14)	08.8(01)	198.0(07)
September	129.3(06)	164.8(09)	128.3(10)	57.6(07)	60.1(06)	349.3(09)	80.2(03)	145.5(06)
October	540.2(19)	64.9(07)	300.4(15)	24.0(05)	644.0(21)	186.6(11)	442.8(16)	93.0(05)
November	251.7(14)	65.8(16)	294.7(18)	506.5(19)	366.0(14)	76.2(07)	173.5(10)	61.0(09)
December	74.4(03)	185.2(08)	247.6(18)	257.6(19)	214.7(03)	88.4(03)	70.7(03)	143.0(05)
	<b>1636.9(104)</b>	<b>1498.9(104)</b>	<b>1662.10(98)</b>	<b>1506.4(106)</b>	<b>2477.4(120)</b>	<b>2003.2(87)</b>	<b>1359.7(65)</b>	<b>1176.8(57)</b>

**Table 3:** *Coconut extent and census of palms*

Estate	Bandiripuwa	Ratmalagara	Ambakelle	M oya S.G	Poththukulama	Walpita	Makandura	Pallama	Total
Extent (ha)	(123.94)306.15	(98.38)243.0	(1380)329.38	165.97	(73.25)180.95	3830	133.43	547	1944
No.of bearing palms	8203	11001	16392	4782	10561	1968	6272	13135	72314
No.of partial bearing palms Upto 10 years	298	1667	1919	2402	246	17	321	108	6978
No.of yong palms 2 years upto bearing	1072	1078	2459	1649	455	51	96	125	6985
No. of seedlings upto 2 years	690	28	15	196	143	-	-	5617	6689
No.of weak dud palms	2912	282	156	283	257	135	1435	403	5863
No.of vacancies	895	943	5131	3112	1923	395	2126	4980	19495
Total nos.of planting Points	14060	14999	26072	12424	13585	2566	10250	24368	118324

**Table 4:** *General performance of the estates and seed garden*

Particulars (Ha)	Bandiripuwa	Ratmalagara	Poththukulama	Walpita	ISG	Makandura	M Oya SG	Pallma	Total
Mature	2112.9	63.9	56.11	15.5	109.8	52.6	30	162.68	603.51
Immature	10.9	34.42	17.12	-	23.5	1.0	39	10.12	136.06
Total(Coconut extent ha)	233.8	98.34	7323	15.5	133.3	53.6	69	172.80	839.47
Nursery	1.61	-	-	-	1.00	-	-	-	2.61
Other crops	-	1.00	6.05	-	-	1.0	01	-	9.05
Jungle	-	3.24	-	-	309.8	-	11.0	29.54	353.58
Vacant Land	-	5.88	-	0.5	7.1	-	02	-	15.48
Reservor	3	-	-	-	3.00	2.4	-	-	5.7
Roads and Buildings	22.25	2.02	2.50	1.8	3.00	1.2	02	14.16	-
Total	147.71	115.48	8178	17.8	457.2	58.2	0.5	2165.5	-

**Table 5:** *Crop data (nuts) 2000*

	Bandirippuwa	Ratmalagara	Poththukulama	Walpita	ISG	Makandura	M Oya S.G	Pallama	Total
Pick 1	101233	64233	164624	19930	233974	48236	30464	104464	767425
Pick 2	149205	93120	146710	33936	180751	62231	33525	87296	786774
Pick 3	157714	120969	157109	43198	287995	147378	53018	114610	1081991
Pick 4	157336	159571	136759	38905	244127	175620	63017	104515	1079850
Pick 5	100048	100074	116335	29080	205947	119107	58994	122449	852034
Pick 5	92839	120301	112524	23901	243761	93344	58155	107009	851834
Total 2000	758487	658268	834061	188950	1396555	645916	297328	640543	5419908
1999	556185	526947	816737	142146	1473458	451152	210234	591961	
Av(96-2000)	561635	480362	689201	154781	1244805	435237	190998	-	
Nut/palm 2000	93	60	79	96	85	103	63	49	75
Nut/palm 1999	68	62	81	71	92	73	44	66	74
Yield/ha 2000	6719	6658	11389	15055	12719	11961	4438	2894	
Yield/ha 1999	4922	5360	11343	11324	13417	8354	3130	2678	

**Table 6:** *Crop disposal, COP and NSA - 2000*

	Bandirippuwa	Ratmalagara	Poththukulama	Walpita	ISG	Makandura	M Oya S.G	Pallama S.G	Total
Sold	438016	448431	628295	157243	203546	203546	578957	7513	461 325
Coconut Copra	136261	29826	13485	1498	116830	116830	34784	27644	41 208
Research	7233	2243	7661	1642	16430	16430	120	-	-
Seednuts	-	26900	19340	-	982824	-	199000	8700	8 700
Staff Issue	57758	8120	3022	1434	9362	9362	5764	2718	5 867
Rejections	29852	23147	49531	3623	7345	7345	10294	4834	19 727
Awaiting Disp	87787	120301	112300					53119	
Others	1580	-	447		4103			2500	
BCC, DC	-	-	-						
Total	758487	658968	834081	165440	1396555	637919	637919	297328	536 827
COP	4089	4177	2301	3650	331659	2440	6810	4481	
N S A	4784	5679	5800	4548	669847	5250	8334	4382	

**Table 7:** *Seednut production in two seed gardens*

Seed Garden	1999	2000	Increase/decrease (%)
ISG, Ambakelle	1032875	972824	(-5.80)%
MOSG, Bogaswewa	153930	199000	29.27%
Others (plus palm)	58667	65087	11.00%
<b>Total</b>	<b>1244472</b>	<b>1236911</b>	<b>(-0.60%)</b>

**Table 8:** *Sundry income*

Estate	Income (Rs)
Bandirippuwa Estate (Treacle, milk, food crops etc.)	666 320.00
ISG, Ambakelle	260 261.50
Poththukulama	40 645.25
Ratmalagara	79 303.12
Makandura	348 008.00
Maduruoya	33 795.50
Walpita	248 271.61
Pallama S.G	359 282.00
<b>Total</b>	<b>2035 886.90</b>

## REPORT OF THE ADMINISTRATION DIVISION

**Deputy Director (Adm & Fin) – W. M. D. J. Fernando (SLAS) ( Until 31.05.00)**

**Deputy Director (Adm & Fin) – E. P. Gunapala A.P.F.A. (From 06.07.00)**

**B. COM (SP), Diploma in Accountancy**

### 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 Coconut Research Institute at the end of December 2000 is given in Table I.

**TABLE 1.** *Staff position as at 31.12.00*

Grade	Upgraded	Sp Cl	Cl I	Cl II	Cl III	Cl IV	Total
Executive	01	-	09	13	24	16	63
Technical	-	33	11	21	-	-	65
Inter mediates	-	05	01	02	-	-	08
Clerical & Allied	-	23	05	11	-	-	39
Operative	-	19	08	23	-	-	50
Driver	-	18	03	12	-	-	33
Minor	-	45	13	37	-	-	95
Watcher	14	-	-	-	-	-	14
Grand Total	15	143	50	119	24	16	367

### 3. WELFARE

Welfare facilities extended towards the employees of the Board were continued. Financial assistance extended to the employees is given below.

#### 3.1 Financial Aid

**Provident fund loans:** The loans granted from the provident fund to 51 employees amounted to Rs. 9,334,500

**Distress Loans:** Distress loans paid to 63 employees amounted to Rs. 4,340,258

**Transport Loans:** Transport loans paid to 14 employees loans amounted to Rs. 685,000

**Education Loans:** Pre-education loans amounting to Rs. 10,000 were granted to 1 employee.

**Medical Aid:** A Sum of Rs. 3,031,992 was reimbursed by the Medical Aid Scheme to its members during the year 2000 and an amount of Rs. 350,152 was debited to member's savings accounts. A lecture, by Mr. Daya RohanaAthukorala, Senior Lecturer in

Education at the Colombo University, was sponsored by the Medical Scheme. A Dental Clinic was also conducted in 2000.

### **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 center, the Death Donation Society and the Seva Vanitha unit during the year 2000.

## STAFF MATTERS

### 1. APPOINTMENTS

Twenty one appointments were made during the year 2000 and details are given in Table 1.

**Table 1.** *Appointments made during the year 2000*

Name	Designation	Division	Date
Mr. N.A.K.de Silva	Research officer	Agronomy	10.01.00
Mr. D.W. Nevil	Vehicle Attendant	Establishment	10.01.00
Mr. W.M.U. Ratnayake	Estate Superintendent	Estate Management	10.01.00
Mrs. Anoma de Alwis	Chief Accountant	Accountant	01.02.00
Mr. W.M. Ranjith Sisira	Lab & Field Attendant	Engineering	01.02.00
Mr. K.K. Anura Mendis	Lab & Field Attendant	Biometry	01.02.00
Mr. P.K. Chandana Sampath	Office Attendant	Accounts	01.02.00
Mr. G.D. Asitha Milroy	Office Attendant	Coconut Processing Research	01.02.00
Mr. R.P.S.L. Abeyrathne	Office Attendant	Library	01.02.00
Mr. W.A. Sepala Jayathilake	Office Attendant	Establishment	01.02.00
Mr. J.M.P.K. Jayasekara	Forman (Buildings)	Engineering	15.03.00
Mr. J.K.J.P. Jayawardana	Assistant Extension Officer	Extension Services	16.05.00
Mrs. P.I.P. Perera	Research Officer	Tissue Culture	16.05.00
Mrs. M.A.D.W.S. Madurapperuma	Research Officer	Plant Physiology	16.05.00
Miss. J.M.M.A. Jayasundara	Research Officer	Coconut Processing Research	16.05.00
Mr. W. Ratsiri	Forman (Motor Mechanic)	Engineering	25.06.00
Mr. R.P. Sugath Rohana	Driver	Establishment	15.08.00
Miss. U.G.M.B.K. Tennakoon	Research Officer	Soils & Plant Nutrition	04.12.00
Mr. A.J. Wijeratna	Research Officer	Plant Physiology	11.12.00
Miss. H.D.D.Bandupriya	Research Officer	Tissue Culture	18.12.00

**Table 2.** *Appointments to new posts*

Name	Former Designation	New Designation	Division	Date
Mr. E.P.Gunapala	Internal Auditor	Deputy Director (Adm and Fin)	Establishment	06.07.00

### 2. RESIGNATIONS, RETIREMENTS, VACATION OF POSTS AND DEATHS

The details are given below in Table 3.

**Table 3. Resignation, Retirements, Vacation of Posts and Deaths**

Name	Designation	Division	Date
<b>Resignation</b>			
Mr. E.W.E.G. Gunasinghe	Lab & field Assistant	Estate Management	01.05.2000
Miss. N.P.S. de Silva	Technical Assistant	Coconut Processing Research	02.05.2000
Miss. J.A.S.N. Jayasinghe	Technical Assistant	Coconut Processing Research	02.05.2000
Mrs. R. Wimalasekara	Research Officer	Plant Physiology	19.05.2000
Mr. W.M.D.J. Fernando	Deputy Director (Adm & Fin)	Establishment	31.05.2000
Mrs. M.C.P. Rodrigo	Research Officer	Coconut Processing Research	31.05.2000
<b>Retirements</b>			
Mr. B.C.E. Perera	Lab & Field Assistant	Soils and Plant Nutrition	08.08.2000
Mr. M.J.David	Supervisor	Estate Management	18.10.2000
<b>Vacation of Post</b>			
Mr. J.M.I.Diupathi	Technical Assistant	Agronomy	13.03.2000
Miss. M.A.Lokuge	Research Officer	Tissue culture	11.08.2000
Dr. L.P.Vidana Arachchi	Senior Research Officer	Soils Plant Nutrition	25.09.2000
<b>Deaths</b>			
Mr. E.C.Fernandopulle	Officer attendant	Accounts	06.01.2000

### 3. PROMOTIONS

#### 3.1

The details of promotions in Executive Grades made during the year 2000 are shown in Table 4.

**Table 3. Promotions in Executive grades during the year 2000****Table 4. Executive Grade – class 111 to 11**

Name	Designation	Division	Date
Dr. A.A.F.L.K. Perera	Senior, Geneticist & Plant Breeder	Genetics and Plant Breeding	02.02.2000
Mr. N.P.A.D. Nainanayake	Senior, Plant Physiologist	Plant Physiology	01.04.2000
Mr. I.R. Wickramananda	Senior, Entomologist	Crop Protection	08.08.2000

#### 3.2 PROMOTIONS IN NON-EXECUTIVE GRADES

Following internal Promotions in Non-Executive Grades were implemented during the year 2000 as shown in Table 5. The effective date of these Promotions was 01.01.2000

**Table 5. Promotions in Non-Executive Grades during the year 2000**

Name	Designation	Division
<b>CLASS 1 TO SPECIAL CLASS</b>		
<b>Technical Grade</b>		
Mr. E. Sunil Santha	Technical Officer	Tissue Culture
Mr. L.R.S.Silva	Technical Officer	Plant Physiology
<b>Intermediate Grade</b>		
Mr. W.F.T. Fernando	Senior, Supplies Assistant	Establishment
<b>Clerical &amp; Allied Grade</b>		
Mr. M.C.H.N.Fernando	Senior, Shroff	Accounts
<b>Operative Grade</b>		
Mr. M.P.W.Fernando	Senior Supervisor	Estate Management
<b>Drivers Grade</b>		
Mr B. Darmasiri	Senior Driver	Establishment
<b>Minor Grade</b>		
Mr. A.M. L. Rupasinghe	Senior, Office Attendant	Establishment
Mr. T.M Rodrigo	Senior, Pollination Labourer	Estate Management
Mr. D.M.Ratnayake	Senior, Pollination Labourer	Estate Management
Mr. S.H.A.M. Ruparatne	Senior Pollination Labourer	Estate Management
<b>CLASS II TO CLASS I</b>		
<b>Technical Grade</b>		
Mr. E.M.A. Thilakarathna Banda	Technical officer	Soils & Plant Nutrition
Mrs.C.P.A. Kurudukubura	Technical officer	Soils & Plant Nutrition
Mrs. M.A wasanthimala	Technical officer	Soils & Plant Nutrition
Mr. R.D Sumanasiri	Book keeper	Accounts
<b>Intermediate Grade</b>		
Mrs. H.M Anoma Herath	Stenographer (English)	Soils & Plant Nutrition
<b>Operative Grade</b>		
Mr. A.G.B. Silva	Supervisor	Estate Management
<b>Driver Grade</b>		
Mr. J Amarasinghe	Driver	Establishment
<b>Minor Grade</b>		
Mr. K.M.D.Perera	Electrical Helper	Engineering

#### 4. TRANSFERS

Mrs. C. Munasinghe, Clerk/Typist from Account unit to Estate Management on 01 January.

Mr. M.A.D.M.F. Appuhamy, Clerk/Typist from Engineering unit to Establishment on 01 January.

Mr. D.L.G. Neththasinghe, field officer from Isolated Seed Gardens to Pallama Seed Garden on 01 January.

Mr. Piyal Ranjith, Supervisor from Pallama Seed Garden to Isolated Seed Garden on 01 January.

Mr. Y.H Wimalasena, Electrician from Isolated seed Garden to Engineering on 3 January.

Mrs. Nalani Ayagama, Clerk/Typist from Estate Management to Engineering unit on 3 January.

Mr. M.A.M. Perera, Clerk/Typist from Establishment to Engineering unit on 3 January.

Mr. Somasiri Madurawala from Engineering to Accounts unit on 3 January.

Mr. A.A.A. Appuhamy, Watcher from Pallama Seed Garden to Poththukulama Research Station on 3 January.

Mr. W.S. Fernando, Watcher from Poththukulama Research Station to Pallama Seed Garden on 3 January.

Mr. Upali Attanayake, audit Clerk from Internal Audit Unit to Estate Management on 04 January.

Mr. H.M.J.E. Appuhamy, Clerk from Bandirippuwa Estate to Estate Management on 11 January.

Mr. H.M. Podiratne Clerk/Typist from Pallama Seed Garden to Isolated Seed Garden on 21 January.

Mr. D.M.Thilakaratne, Watcher from Bandirippuwa Estate to Ratmalagara Estate on 01 February.

Mr. F.H.A.J.R.Silva, Lab and Field assistant from Biometry to Soils & Plant Nutrition on 2 May.

Mr. H.B.Perera, Lab and Field Assistant from Biometry to Soils and Plant Nutrition on 02 May.

Mr. Premus Fernando, Lab and field Assistant from Biometry to Agronomy on 2 May.

Mr. K.S.A.J.Fernando, Lab and field Assistant from Biometry to Soils and Plant Nutrition on 2 May.

Mr. E.M.A. Thilakarathne Banda, Technical officer from Soils and Plant Nutrition to Maduru Oya Seed Garden on 01 July.

Mr. I.M.Thilakarathne, Lab and Field Assistant from Agronomy to Engineering on 10 July.

Mrs. M.A.D.W. Madurapperuma, Research officer from soils and Plant Nutrition to Plant Physiology on 01 September.

Mr. M.Victor, Lab and Field Attendant from Genetics and Plant Breeding to Makandura Seed Garden on 25 September.

Mr. W.Sirisena, lab and Field Attendant from Makandura Seed Garden to Bandirippuwa Estate on 01 November.

Mr. Sirinimal Alahakoon, Supervisor from Pallama Seed Garden to Bandirippuwa Estate on 01 November.

Mr. A.M.Nimal Kularatne, Watcher from Isolated Seed Garden to Pothukulama Research Station on 21 November.

## 5. OVERSEAS STUDY LEAVE

**Table 6.** *Full pay leave in overseas*

Name	Designation	Period	Purpose	Institute
Mr. J.M.M.N.Marikkar	Research Officer	15.01.00 14.01.03	Postgraduate Training Leading to Ph.D	University Putra Malaysia
Mr. N.P.A.D. Nainanayake	Senior Research Officer	20.10.00 19.10.03	Postgraduate Training Program Leading to Ph.D	University of Essex U.K.

## 6. SABBATICAL LEAVE

**Table 7.**

Name	Designation	Country	Period
Dr. Mrs. W.M.U Fernando	Head/ G.P.B	Canada	01.09.00 31.08.01

## 7. TRANSPORT UNIT

The administration of drivers and maintenance of the following fleet of vehicles were done by the Transport Unit during the year 2000.

Buses	-	04
Lorries	-	02
Vans	-	10
Cars	-	02
Elf	-	01
Cabs	-	13
Jeeps	-	08
Three wheelers	-	01
Motor bicycles	-	44

## **8. FINANCE UNIT**

The budget expenses during the year were 136 Million made up of Rs. 107 Million as recurrent and Rs. 29 Million as capital expenditure. The total revenue (excluding transport) for the year was Rs. 30 Million. The Government Grant was Rs. 91.5 Million. Balance sheet and income and expenditure accounts for the year ended 31 Decembr 2000 were given in table 8 and 9 respectively.

## **9. ENGINEERING UNIT**

The Engineering Unit carried out maintenance work of buildings, electricity, Vehicles, and machinery. For the year 2000 the Engineering Unit attended to the following construction and rehabilitation work.

Construction of 02 No 5 Agro wells at Pallama Seed Garden.

Repairs of Superintendent's bungalow at Pallama Seed Garden.

Construction of a Manure Stores at Isolated Seed Garden.

Completion of work at Circuit Bungalow at Isolated Seed Garden.

Repairing Toddy Tapping Center for Farm Managers Training in 50 Acre Block .

Repairing of roof of Fertilizer Store at Walpita Estate

Modernization of Board Room and Director's office.

Renovation to BE/GR/01 Quarters at Bandirippuwa Estate.

Renovation to BE/GR/111/46 Quarters at Bandirippuwa Estate.

Renovation to BE/GR/111/33 Quarters at Bandirippuwa Estate.

Renovation to BE/GR/1/15 Quarters at Bandirippuwa Estate.

Construction of Tractor garage at Bandirippuwa Estate.

**Table 8: Balance Sheet as at 31 December 2000**

	Cost/Valuation Rs.	Accumulated Depreciation Rs.	W.D. Valuation 31.12.2000 Rs.	Valuation 31.12.1999 Rs.
<b>Fixed Assets</b>	204,098,267.47	67,545,268.00	136,552,999.47	123,482,462.10
Current Assets				
Stocks	10,344,709.33			11,966,676.97
Debtors Less Provision	3,802,575.26			3,999,199.17
Purchase Advances	2,138,094.55			3,995,360.70
Loan and Advances to Employees	16,031,284.22			16,720,777.79
Deposits Receivable	134,400.00			134,400.00
Savings Deposits	491,950.58			453,832.64
Pre Payments	1,449,329.78			730,783.26
I A E A Project	5,513.29			5,513.29
Internal Cash Transfers and in Transfers	2,340,313.10			340,313.10
Cash and Banks Balances	15,723,610.53			26,949,458.12
		52,461,780.64		65,296,315.04
<b>LESS-CURRENT LIABILITIES &amp; PROVISIONS</b>				
Sundry Creditors	320,868.59			294,489.29
Accrued Expenses	4,476,665.74			4,559,813.13
Expense Creditors	1,916,320.64			4,096,958.93
Aid from CESS Fund	4,078,447.82			323,855.51
Deposits Payable	507,297.05			660,483.39
On Going Projects	3,205,145.63			19,299,508.33
		14,504,745.47		29,235,108.58
<b>WORKING CAPITAL</b>			37,957,035.17	36,061,206.46
			<b>174,510,034.64</b>	<b>159,543,668.56</b>
<b>FINANCE BY CAPITAL</b>				
<b>AUTHORISED CAPITAL</b>			18,000,000.00	18,000,000.00
Surplus of Grant After Recurrent Expenditure			198,645,016.87	176,558,499.50
Foreign Aid			634,078.78	634,078.78
Local Aid			4,819,171.82	4,819,171.82
<b>RESERVES</b>				
Revenue Reserve		(39,818,794.55)		10,221,031.72
Capital		10,230,561.72		(32,689,113.26)
			(29,588,232.83)	(22,468,081.54)
			<b>174,510,034.64</b>	<b>159,543,668.56</b>

**Table 9:** *Income and Expenditure Account for the Year Ended 31 December 2000*

Prog.	Name of Account	Total Expe. Rs.	Total Inc. Rs.	Net Rs.	Surplus/Deficit 31.12.1999 Rs
01	Administration Unit	67,926,920.87	1,823,302.19	(66,103,618.68)	62,966,352.02
02	Tissue Culture Division	495,590.80	-	(495,590.80)	925,412.90
03	Genetics and Plant Breeding Division	1,101,356.16	48,135.00	(1,053,221.16)	1,243,405.22
04	Soils and Plant Nutrition Division	1,898,800.37	180,100.00	(1,718,700.37)	2,349,890.00
05	Agronomy Division	2,513,802.54	741,488.56	(1,772,313.98)	1,871,802.28
06	Crop Protection Division	932,215.65	179,765.50	(752,450.15)	921,305.15
07	Biometry Division	499,297.26	-	(499,297.26)	693,342.04
08	Plant Physiology Division	744,414.93	-	(744,414.93)	1,638,721.51
09	Coconut Processing Research Division	452,389.22	-	(452,389.22)	531,979.65
10	Extension Services Division	632,920.92	35,733.00	(597,187.92)	881,267.60
11	Library Services Division	2,014,246.60	137,643.75	(1,876,602.85)	1,850,389.91
12	Estate Management Division	117,327.89	-	(117,327.89)	66,169.95
13	Working Account Estates	27,497,620.61	29,991,431.23	2,493,810.62	(16,290,028.88)
<b>Total/Net surplus</b>		<b>106,826,903.82</b>	<b>33,137,599.23</b>	<b>(73,689,304.59)</b>	<b>59,650,009.35</b>

## 10. Local Training

Mrs. C Hapuarachchi, Technical Officer continued a four year Graduateship course in Chemistry at the Institute of Chemistry.

Mr. Frank Jayasinghe, Manager (Estates) attended a seminar on Basic Labour Law at the Institute of Government Accounts and Finance on 06.01.2000.

Mrs. H.M.A. Herath, Stenographer (English) followed a training course on "Windows Based Application Packages" from 16 to 23 January at the Institute of Government Accounts and Finance.

Mr. B.M.D. Bandara, Chief Clerk followed a training course on "English at work" held at Sri Lanka Institute of Development Administration from 17 January to 21 August.

Mrs. M.P. Premaratne, Stenographer (English) followed the certificate course on Windows Based Application Packages from 19 to 23 January at the Institute of Government Accounts and Finance.

Mr. E.P. Gunapala, Internal Auditor followed the certificate course on Windows Based Application Packages from 19 to 23 January at the Institute of Government Accounts and Finance.

Mr. R.D. Sumanasire, Book Keeper followed a three and half months Course in Computerized Accountancy (CCA) from 22 January at the Association of Accounting Technicians of Sri Lanka.

Mr. S.S. Rajapaksa, Technical Assistant followed a three months computer training Program for Office Staff from 29 February at IDM computer Studies (Pvt.) Ltd., Negombo.

Mr. U.W.B.A. Weragoda, superintendent Isolated Seed Garden, Mr. G.B.A. Wijesekara, superintendent, Poththukulama Research Station, and Mr. W.A.H. Upali, Supervisor, Walpita Estate commenced a 2 year course in National Diploma in Plantation Management form 2 March at National Institute of Plantation Management.

Dr. L.C.P. Fernando attended a 3 day (17 to 19 March) seminar on "Conferencing, Public Speaking and Presentation Skills" at Institute of Government Accounts and Finance, Colombo.

Mr. D.P. Panditharatne, Technical Officer attended a training workshop on " Microprocesser-Based Equipment" from 3 March to 1 April at the Atomic Energy Authority.

Mrs. P.C.A. Fernando, Mrs. W.S.R.Fernando Mrs. U.I.Abeysinghe Mrs. N.R. Ayagama, Mr. Luxman Fernando, Mrs. Nelum Gunathilake, Mrs. M.G. Karunawathi, Mr. A.A.D.N. Athauda, Clerk Typists followed a training on Clerical Skills Development from 3 to 5 March at the Institute of Government Accounts and Finance.

Mr. W.M.D.J. Fernando, Deputy Director (A and F), Mr. E.P. Gunapala Internal Auditor followed a training course on Problem Solving and Decision making (5 days) from 6 to 11 March at Sri Lanka Institute of Development Administration.

Dr. (Mrs) W.M.U. Fernando, Head Genetics and Plant Breeding Division, Dr. (Mrs.) L.K. Weerakoon, Head Tissue Culture Division, Dr. H.A.J. Gunathilaka, Head Agronomy Division followed a course on Advanced Writing in English for Government and Business from 20 to 22 March held in Sri Lanka Institute of Development Administration.

Dr. (Mrs) C. Jayasekara, Acting Director, Dr. (Mrs.) L.C.P. Fernando, Head Crop Protection Division, Mr. P.A.H.N. Appuhamy, Head, Extension Services Division followed a training course on Conferencing, Public Speaking and Presentation Skills from 17 to 19 March at the Institute of Government Accounts and Finance

Mrs. K.A.P. Chandani, Clerk/Typist followed a Diploma Course on "Page Making and Desktop Publishing" (6 months) from March at TEC Sri Lanka.

Mrs. A. de Alwis, Chief Accountant, Miss. H.D. Mangalika, Administrative Assistant followed a seminar on Leave, Holidays Over Time and recoveries from Salaries from 23 March at Institute of Personnel Management Sri Lanka (Inc.)

Mrs. K.P.S.Jayathilake, Clerk/Typist, Mrs. A de Soyza Senior Clerk/Typist followed a Certificate Course on "Windows Based Application Packages" from 29 March to 3 April at Institute of Government Accounts and Finance.

Mr. B.M.D. Bandara, Chief Clerk followed a training course on Office Supervision from 27 to 31 March at State Services Training Institute.

Dr. N.A. Tennakoon, Senior Research Officer, Dr. K.B. Dasanayake Senior research Officer, Dr.(Miss) C.S. Ranasinghe, Senior Research Officer attended a Workshop on "Excellence in Written Communication and Report Writing Skills" from 21 and 22 March at the Institute of Government and Finance.

Mrs. A. de Alwis, Chief Accountant, attended a three months Advanced Certificate Course on Corporate Business Finance from 27 March at Postgraduate Institute of Management.

Dr. (Mrs.) C. Jayasekara, Acting Director, Dr. H.A.J. Gunathilake, Head Agronomy Division, Dr. L.L.W. Somasiri, Head Soils and Plant Nutrition Division attended a seminar on "Leadership Excellence and Personality Development" on 1 and 2 April at Institute of Government Accounts and Finance.

Mr. Frank Jayasinghe, Manager (Estates) followed a Certificate course on "Windows Based Application Packages" from 5 to 9 April at Institute of Government Accounts and Finance.

Dr. H.A.J. Gunathilake, Head, Agronomy Division, Mr. A.L.D.K. Amarasinghe, Works Superintendent, Mr. P.A.H.N.Appuhamy, Head Extension Services Division, Mrs. W.N.I.S. C. Fernando, Senior Research Officer attended a seminar on Time Management on 8 April at Institute of Government Accounts and Finance.

Ms. P.H.A.P. Siriwardena underwent a practical training on Nematology for 4 days (24-27 April), 5 days (29 May – 02 June) and four weeks (26 June – 21 July) at HORDI, Gannoruwa, SRI, Udawalawe and TRI, Talawakelle respectively.

Mr. E.S. Santha, Technical Officer, Mr. K.P.I.E. Ambagala, Technical Assistant attended a short term course on Hydroponics from 2 to 5 May at the In service Training Institute, Department of Agriculture, Bandarawela .

Mrs. P.D.U.C. Dharmapala, Library Assistant attended a workshop on "Desktop Publishing Using Advanced Microsoft Words" from June 3 at Sri Lanka Library Association.

Mr. A.I.F. Fernando, Acting Administrative Assistant attended a Vehicle Knowledge and Maintenance Program on 7 and 8 June at Training and Technical Development Lanka Tractors Ltd.

Mr. N.M.R. Sarathchandra, Book Keeper attended a training on " Public Enterprises Management Fundamentals" on 10 and 11 June at Institute of Government Accounts and Finance.

Mrs. A.P. Illangakoon, Library Assistant, Mrs. S.N. Gunathilake, Clerk/Typist attended the Internet Workshop on 12 June at Sri Lanka Library Association.

Mr. R.M. Gunasekara, Assistant Librarian attended a conference on "Experience and Challenges" on 26 and 27 June at Training and Technical Development Lanka Tractors Ltd.

Mr. S.M. Sirisoma, Book Keeper attended a Seminar on Accounting Fundamentals on 17th and 18 June at Institute of Government Accounts and Finance.

Mrs. W.S.R. Fernando, Clerk/Typist, Mr. S.A.D. Richard, Accounts Clerk, Mr. D.M. Jayawardana, Clerk/Typist, Mr. H. Wijewardena, Clerk/Typist, Mr. H.M. Podiratne, Clerk/Typist attended a training for Public Sector Clerical Officers on 23 and 24 June at Institute of Government Account and Finance.

Mr. M.C.H.N. Fernando, Shroff, Mr. W.P.C. Fernando, Accounts Clerk attended a Shroff/Cashiers Training Program on 24 and 25 June at Institute of Government Accounts and Finance

Dr. (Mrs.) C. Jayasekara, Acting Director, Dr. (Mrs) L.C.P. Fernando, Head, Crop Protection division, Mr. P.A.H.N. Appuhamy, Head Extension Service Division attended a Seminar on Public speaking and Presentation Techniques on 3 and 7 July at Sri Lanka Institute of Development Administration.

Dr. H.A.J. Gunathilake, Head, Agronomy Division attended a Residential Workshop on Cinnamon on 9 July at Spices and Allied Products Procedure and Traders Association.

Ms. N. S. Aratchige participated in a two day (20 – 21 July) workshop on "Research Methods (Pure and Applied)" at National library and documentation Centre, Colombo.

Mrs. C. Yalegama, Research Officer, Mrs. N.S. Aratchige, Research Officer, Mr. D. Giritharan, Research Officer, Mrs. D.M.D.I. Wijebandara, Research Officer, Mr. N.A.K.de Silva, Research Officer, Mr. S. Senaratne, Research Officer attended a workshop on Research Methods (Pure and Applied Sciences) on 20 and 21 August at National Library and Documentation Center.

Mr. E P Gunapala, Internal Auditor attended a Seminar on "How to deal with Trade Unions and Striek Situations" on 22 August at Institute of Personnel Management Sri Lanka (INC)

Mr. R D N Premasiri, Technical Officer, Mr. K P I E Ambagala, Technical Assistant., Mr. S D J N Subasinghe, Technical Officer, Mr. L M S R Jayathilake, Technical Officer, Mr. G K Ekanayake, Technical Assistant, Mrs. P S A de Seram, Technical Officer attended a Training in Methods in Plant Eco-physiology from 4 to 6 August at University of Peradeniya.

Mr. L M S R Jayatillake Technical Officer and Mr. G K Ekanayake Technical Assistant attended the Training Programme on "Methods in Plant Eco-Physiology" from 4-6 September, 2000 at the Postgraduate Institute of Science, University of Peradeniya.

Mrs. W J M D M A Fernando, Typist (English) followed a Certificate Course in " Windows Based Application Packages" from 6 to 10 September at Institute of Government Accounts and Finance.

Mr. W A C Fernando, Book Keeper, W Ranjan Fernando, Clerk/Typist attended a Training for Accounts Assistants on 13 and 14 September at Institute of Government Accounts and Finance.

Mrs. D M D I Wijebandara, Research Officer attended a National Workshop on Scientific Writing from 15 to 17 September at University of Peradeniya.

Dr. M T N Fernando, Senior Research Officer attended 12 Intensive Training Workshop on "Environmental Impact Assessment" from 27 to 30 September at the Central Environmental Authority.

Dr L.C.P. Fernando, Ms. N. S. Aratchige, Mr. R. Wijesekara and Mr. I.R. Wickramananda attended a seminar titled "User Seminar" held at Coconut Research Institute on 27 September organized by Council for Agricultural Research Policy of Sri Lanka

Dr. (Miss) C.S. Ranasinghe, Head Plant Physiology Division, Miss. J.M.M.A. Jayasundara, Research Officer attended a Seminar on "Packaging in the New Millennium for Food Industry" on 28 September at Institute of Chemistry.

Mrs. P.A.S.F. Perera, Librarian, Mrs. C. Dharmapala, Library Assistant attended a workshop on "Win-Isis Version 1:31 (1998)" on 20 and 21 October at National Science Foundation Sri Lanka.

Mr. R.D. Sumanasiri, Book Keeper attended a seminar on "Revision of Tax" on 4 November at Association of Accounting Technician of Sri Lanka.

Dr. (Mrs.) L.C.P. Fernando, Head Crop Protection Division, Dr.(Mrs.) L.K. Weerakoon, Head Tissue Culture Division attended a workshop on Intellectual Property Rights (IPR) on 22 November at National Science Foundation.

Dr L.C.P. Fernando attended a workshop on "Intellectual Property Rights" held at Kandy on 22 November organized by National Science Foundation of Sri Lanka.

Mr. K.P.A. Pathirana, Technical Assistant attended a National Training Course on Radiation Safety from 11 to 15 December at Atomic Energy Authority.

## **11. OVERSEAS VISITS**

Mr. R. Marasinghe, Mr. L.R.S. Silva, Mrs. K.C.P. Perera, Mrs. S.D.H. Bandara, Technical Officers from Agronomy, Plant Physiology, and Soils and Plant Nutrition Divisions respectively participated in familiarization visit to Central Plantation Crops Research Institute in India from 27 May to 9 June.

Dr. A A F L Perera, Senior Research Officer, Genetics and Plant Breeding Division attended an International Conference in Malaysia on "Science and Technology for Managing Plant Genetic Diversity in the 21 Century" from 11 to 18 June.

Dr. U P de S Waidyanatha, Chairman, Coconut Research Board attended the Coconut Genetic Resources Network (COGENT) Steering Committee meeting held in Philippines from 10 to 15 July.

Dr. (Mrs) W M U Fernando, Head Genetic and Plant Breeding Division attended IFAD/ADB Funded projects annual progress review meeting of the COGENT in Philippines from 10 to 15 July.

Dr. U P de S Waidyanatha, Chairman, CRB attended the International Coconut Conference held in India from 15 to 28 July.

Dr. (Mrs) C Jayasekara, Acting Director, participated at the XXXVII APCC sessions in Fiji from 14 to 17 November.

Dr. (Miss) C S Ranasinghe, Head, Plant Physiology Division Dr. M T N Fernando, Senior Research Officer, Dr. (Mrs.) L C P Fernando, Head, Crop Protection Division, Mr. I R Wickramananda, Research Officer presented papers at the International Conference on Plantation Crops PLACROSYM-XIV held in India from 11 to 16 December.

Dr. L.C.P. Fernando and Mr I.R. Wickramananda participated the XIV conference on Plantation Crops held at Hotel Green Park, Hyderabad, India from 12 – 15 December 2000.

## 12. OVERSEAS TRAINING

Dr. L.L.W. Somasiri, Head Soils and Plant Nutrition Division attended IFDCTNAV International Training Programme on "Computers simulation for Crop Growth and Resource Management" in India from 21 February to 03 March.

Mrs. N.S. Aratchige, Research Officers followed a Training on rearing of predators of Coconut Mite in Benin from 23 March to 29 May.

Dr. N.A. Tennakoon, Senior Research Officer attended a short Term Training in "Symbiotic Micro Organisms in Tropical Agriculture and Forestry" in Japan from 28 August to 16 December.

Dr. (Mrs.) L.K. Weerakoon, Head, Tissue Culture Division attended the Regional Training course on *in vitro* Conservation and Cryopreservation of Plant Genetic Resources" held in India from 10 to 26 October.

Mr. E.S. Santha, Technical Officer attended a Short Term Training in HPLC and Spectrophotometric Techniques in China from 20 October to 19 December.

Dr. H.A.J. Gunathilake, Head, Agronomy Division followed a Oil Palm Plantation Management Course in Malaysia from 22 October to 05 November.

Mr. N.P.A.D. Nainanayake, Plant Physiologist commenced his Postgraduate studies leading to Ph.D. in the University of Essex, U K from 20 October 2000 to 19 October 2003.

Mr. J.M.M.N. Marikkar, Research Officer Commenced his postgraduate studies leading to Ph.D in the University Putra, Malaysia with the assistance of Asian Development Bank funded Science and Technology Personnel Development Project from 15 January 2000 to 14 January 2003.

## STAFF PUBLICATIONS AND COMMUNICATIONS

### AT SCIENTIFIC MEETINGS

#### THESES

**Mr N P A D Nainanayake** - Effect of soil type, soil compaction and water stress on establishment of coconut (*Cocos nucifera* L.) seedlings. M Phil thesis, University of Peradeniya, Sri Lanka.

#### JOURNALS, PRESENTATIONS AT SEMINARS/WORKSHOPS AND SCIENTIFIC SESSIONS

**Dassanayake K B, Samarajeewa A D and Abeysoma H A** (2000). Effects of Planting Material and Pruning Regime on Biomass Productivity of *Gliricidia sepium* under Coconut in the Low Country Intermediate Zone of Sri Lanka. Paper presented at the 14<sup>th</sup> National Multi Purpose Tree Species Workshop on "Green Manuring and Fodder Tree Species for Crop-Livestock Productivity Improvement" held on 18 December 2000 at the In Service Training Institute, Peradeniya. National Network on MPTS, University of Peradeniya, Peradeniya.

**Dasanayake P N, Everard J M D T, Karunanayake E H and Nandadasa H G** (2000). Genetic relatedness of coconut germplasm in Sri Lanka as revealed by Random Amplified Polymorphic DNA (RAPD). Proceedings of the Sri Lanka Association for the Advancement of Science 56: (148).

**Everard J M D T, Perera S A C N** (2000). Conservation of Coconut Genetics Resources in Sri Lanka. Proceedings of the sixth Annual Forestry and Environment Symposium of the University of Sri Jayawardenepura, Sri Lanka. 29-30 December. Kandy, Sri Lanka (43).

**Everard JMDT, Fernando WMU, Perera L, Bandaranayake CK, Perera SACN** (2000) "Genetic resources of coconut and their conservation and utilization" *Proceedings of the National Workshop on Plant Genetic Resources*, PGRC, Peradeniya, Sri Lanka, 8-16 November

**Fernando L C P** (2000). Experience on Role of Pheromones in Pest Management in Palms. Presented at the XIV Conference on Plantation Crops held at , Hyderabad, India, from 12 - 15 December 2000.

**Fernando, L C P., Wickramananda. I R. and Aratchige. N S.** (2000) Status of Coconut Mite *Aceria guerreronis* in Sri Lanka Presented at the International Workshop on Coconut Mite *Aceria guerreronis* held in Coconut Research Institute from 6-8 January 2000.

**Fernando M T N, Daw M E and Edwards I E** (2000). Adoption of Coconut-based Intercropping Systems in Sri Lanka: The fallacy of conventional wisdom on economic profitability. *CORD, XIV (2), 1-36 p.*

- Fernando M T N, Dassanayake K B and Joseph P G (2000).** Economic Feasibility of Growing *Gliricidia* under Coconuts as an Energy Source for Dendro-thermal Power Plants: An ex-ante appraisal. Paper presented at the Sixth Annual Symposium of Forestry and Environmental Science, 29 - 30 December 2000, Kandy.
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